PHYSICS IN CANADA
LA PHYSIQUE AU CANADA

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June 5-8 juin
UBC, Vancouver, BC

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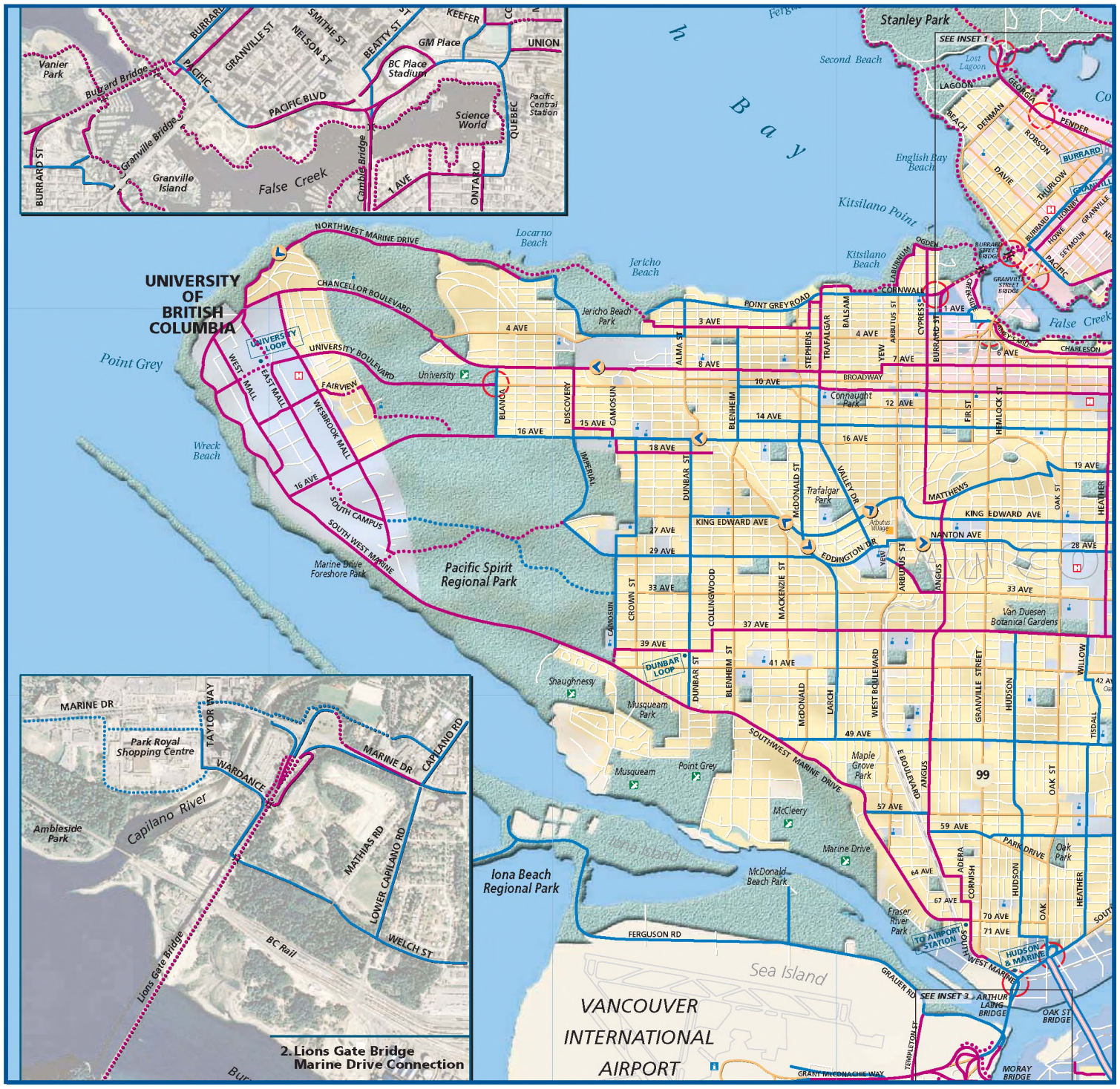
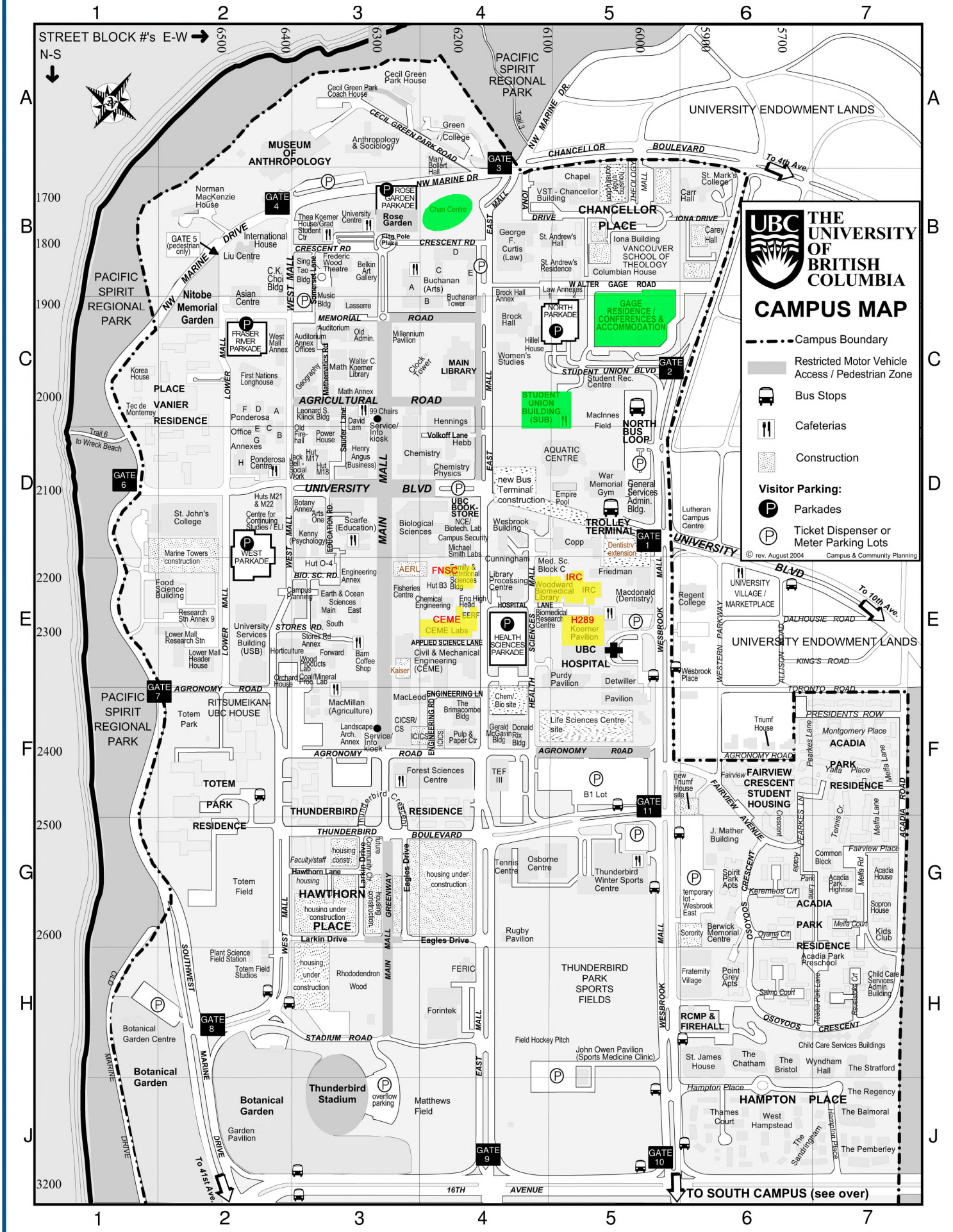


Getting to UBC from the airport by car:

1. Follow the signs at airport that say “Vancouver” to the Arthur Laing Bridge
2. Ont he Arthur Laing Bridge, follow signs for “City Centre via Granville St”
3. Once you enter Granville St., stay on your left side. At the second set of lights after accessing Granville St., turn left onto 70th Avenue (there is a left turn lane)
4. 70th Avenue becomes Marine Drive S.W. Marine Drive goes around the perimeter of the UBC campus. (You will pass through a vast green area, the Pacific Spirit National Park. Do not be concernes; you are not lost.)
5. Continue along Marine Drive until you reach Gate 4 (opposite the Museum of Anthropology). Turn right onto West Mall.
6. Continue until you reach a four-way stop at Memorial Drive and turn right. The Fraser Parkade is on your left-hand side.

Se rendre à UBC à partir de l’aéroport en voiture:

1. Suivre les panneaux à l'aéroport qui indiquent "Vancouver" jusqu’au pont Arthur Laing
2. Sur le pont de Arthur Laing, suivre les panneaux "City Centre via Granville St."
3. Une fois sur Granville St., tenir la gauche. Au deuxième feu de circulation après Granville St., tourner à gauche sur 70th Avenue (il y a une voie pour tourner à gauche)
4. 70th Avenue devient Marine Drive S.W. Marine Drive fait le tour du campus de UBC. (Vous traverserez une vaste étendue verte, le Pacific Spirit Regional Park. Ne vous inquiétez pas, vous n’êtes pas perdu.)
5. Continuer sur Marine Drive jusqu’à la porte 4 (Gate 4) (vis-à-vis le musée de l'anthropologie – Museum of Anthropology). Tourner à droite sur West Mall.
6. Continuer jusqu’à l’arrêt quatre sens à Memorial Drive, puis tourner à droite. Le stationnement Fraser Parkade est à votre gauche.

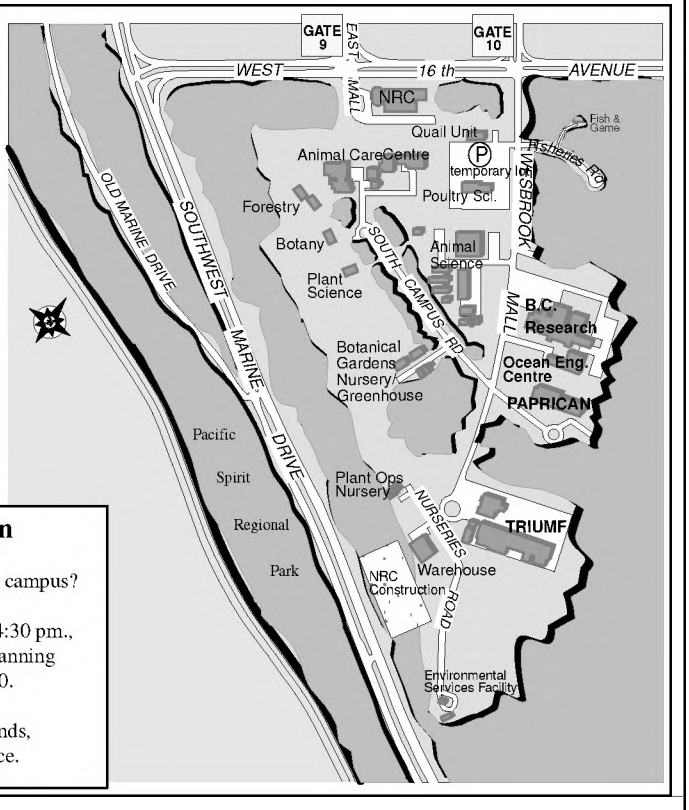

THE UNIVERSITY OF BRITISH COLUMBIA
CAMPUS MAP
Campus Boundary
Restricted Motor Vehicle Access / Pedestrian Zone
Bus Stops
Cafeteria
Construction
Visitor Parking:
Parkades
Ticket Dispenser or Meter Parking Lots
© rev. August 2004 Campus & Community Planning
STREET BLOCK #'s E-W
N-S
PACIFIC SPIRIT REGIONAL PARK
UNIVERSITY ENDOWMENT LANDS
MUSEUM OF ANTHROPOLOGY
Cecil Green Park House
Green College
Anthropology & Sociology
CECIL GREEN PARK ROAD
NW MARINE DR
CHANCELLOR BOULEVARD
To 4th Ave.
GATE 3
GATE 4
GATE 5 (pedestrian only)
ROSE GARDEN PARKADE
Rose Garden
Chan Centre
Norman MacKenzie House
International House
Liu Centre
C.K. Choi Bldg
Asian Centre
Nitobe Memorial Garden
Thea Koerner House/Grad Student Ctr
University Centre
Frederic Wood Theatre
Belkin Art Gallery
Music Bldg
Lasserre
Buchanan (Arts)
Buchanan Tower
CRESCENT RD
MEMORIAL ROAD
WEST MALL
EAST MALL
Somerset Lane
Flag Pole Plaza
CHANCELLOR PLACE
VST - Chancellor Building
Chapel
St. Mark's College
Carr Hall
Carey Hall
IONA DRIVE
George F. Curtis (Law)
St. Andrew's Hall
St. Andrew's Residence
Iona Building
VANCOUVER SCHOOL OF THEOLOGY
Columbian House
Brock Hall Annex
Law Annexes 1 & 2
Brock Hall
NORTH PARKADE
Hillel House
Women's Studies
WALTER GAGE ROAD
GAGE RESIDENCE / CONFERENCES & ACCOMMODATION
STUDENT UNION BLVD
Student Rec. Centre
GATE 2
STUDENT UNION BUILDING (SUB)
MacInnes Field
NORTH BUS LOOP
AQUATIC CENTRE
War Memorial Gym
General Services Admin. Bldg.
Lutheran Campus Centre
TROLLEY TERMINAL
GATE 1
UNIVERSITY BLVD
To 10th Ave.
UNIVERSITY VILLAGE / MARKETPLACE
Regent College
Macdonald (Dentistry)
Dentistry extension
Friedman
Copp
Empire Pool
new Bus Terminal construction
Wesbrook Building
Cunningham
Library Processing Centre
Med. Sc. Block C
Woodward Biomedical Library
IRC
Biomedical Research Centre
HOSPITAL LANE
HEALTH SCIENCES PARKADE
H289 Koerner Pavilion
UBC HOSPITAL
Purdy Pavilion
Detwiller Pavilion
Wesbrook Place
DALHOUSIE ROAD
KING'S ROAD
TORONTO ROAD
WESBROOK MALL
WESTERN PARKWAY
ALLISON ROAD
Life Sciences Centre site
Chem./Bio site
Gerald McGavin Bldg
Donald Rix Bldg
Pulp & Paper Ctr
ENGINEERING LN
ENGINEERING RD
CICSR/CS
ICICS
Civil & Mechanical Engineering (CEME)
APPLIED SCIENCE LANE
CEME
CEME Labs
AERL
FNSC
Family & Nutritional Sciences Bldg
Hut B3
Chemical Engineering
Eng. High Bay
EERF
Fisheries Centre
Earth & Ocean Sciences Main
Earth & Ocean Sciences East
Campus Planning
BIO. SC. RD.
Engineering Annex
Hut O-4
Biological Sciences
Scarfe (Education)
EDUCATION RD.
Arts One
Botany Annex
Kenny Psychology
Huts M21 & M22
Centre for Continuing Studies / ELI
WEST PARKADE
St. John's College
Marine Towers construction
Food Science Building
Research Stn Annex 9
Lower Mall Research Stn
Lower Mall Header House
University Services Building (USB)
STORES RD.
Stores Rd Annex
Horticulture
Forward
Barn Coffee Shop
Wood Products Lab
Coal/Mineral Proc. Lab
Orchard House
Kaiser
AGRONOMY ROAD
RITSUMEIKAN-UBC HOUSE
MacMillan (Agriculture)
Landscape Arch. Annex
Service/Info kiosk
MacLeod
The Brimacombe Bldg
Forest Sciences Centre
TEF III
B1 Lot
GATE 11
new Triumf House site
FAIRVIEW CRESCENT STUDENT HOUSING
FAIRVIEW AVENUE
PEARKES LN
Pearkes Lane
Tennis Cr.
Crescent
J. Mather Building
Tennis Centre
Osborne Centre
Thunderbird Winter Sports Centre
temporary lot - Wesbrook East
Spirit Park Apts
Acadia Park Highrise
Acadia House
Common Block
Fairview Place
Montgomery Place
ACADIA PARK RESIDENCE
Yalta Place
Melfa Lane
Melfa Rd
Melfa Court
Keremeos Crt
Oyama Crt
Salmo Court
Acadia Park Preschool
Child Care Services/ Admin. Building
Kids Club
Sopron House
Sorority
Berwick Memorial Centre
Fraternity Village
Point Grey Apts
Acadia Park Lane
Redwood Crt
Child Care Services Buildings
THUNDERBIRD PARK SPORTS FIELDS
Rugby Pavilion
Field Hockey Pitch
John Owen Pavilion (Sports Medicine Clinic)
RCMP & FIREHALL
OSOYOOS CRESCENT
St. James House
The Chatham
The Bristol
Wyndham Hall
The Stratford
The Regency
The Balmoral
The Pemberley
HAMPTON PLACE
Hampton Place
Thames Court
West Hampstead
The Sandringham
TOTEM PARK RESIDENCE
THUNDERBIRD RESIDENCE
THUNDERBIRD BOULEVARD
Thunderbird Crescent
HAWTHORN PLACE
Hawthorn Lane
Larkin Drive
Eagles Drive
GREENWAY
housing under construction
housing constr.
Faculty/staff housing
Community Ctr
Totem Field
Plant Science Field Station
Totem Field Studios
Rhododendron Wood
FERIC
Forintek
Botanical Garden Centre
Botanical Garden
Garden Pavilion
Thunderbird Stadium
overflow parking
Matthews Field
STADIUM ROAD
16TH AVENUE
To 41st Ave.
SOUTHWEST MARINE DRIVE
GATE 6
GATE 7
GATE 8
GATE 9
GATE 10
TO SOUTH CAMPUS (see over)

Map Directory

Site or Building Name & Address	Grid
Acadia/Fairview Common Block, 2707 Tennis Cres	G7
Acadia House, 2700-2720 Acadia Rd	G7
Acadia Park Residence	F/H-6/7
Acadia Park Highrise, 2725 Melfa Rd	G7
Acadia Park Preschool, 2750 Acadia Park Lane	H7
Animal Care Centre, 6199 S. Campus Rd	South Campus
Animal Science S. Campus Bldgs, 3473 Wesbrook Mall	South Campus
Anthropology & Sociology Bldg, 6303 NW Marine Dr	A3
Aquatic Centre, 6121 University Blvd	D5
Arts One Bldg, 6358 University Blvd	D3
Asian Centre, 1871 West Mall	B2
Auditorium, 6344 Memorial Rd	C3
Auditorium Annex Offices, 1924 West Mall	C3
Barn Coffee Shop, 2323 Main Mall	E3
B.C. Research Inc., 3650 Wesbrook Mall	South Campus
Belkin (Morris & Helen) Art Gallery, 1825 Main Mall	B3
Berwick Memorial Centre, 2765 Osoyoos Cres	G6
Biological Sciences Bldg [Science Faculty office], 6270 University Blvd	D3
Biomedical Research Ctr, 2222 Health Sciences Mall	E4
Biotechnology Laboratory, 2125 East Mall	D4
Bollert (Mary) Hall, 6253 NW Marine Dr	A4
Bookstore, 6200 University Blvd	D4
Botanical Garden Centre/Gatehouse, 6804 SW Marine Dr	H1
Botanical Garden Pavilion (enter at Gatehouse, 6804 SW Marine Dr)	J2
Botan. Gard. Greenhses/ Workshops, 6088 S. Campus Rd	South Campus
Botany Annex, 6386 University Blvd	D3
Botany Greenhouses & Trailer, 6182 S. Campus Rd	South Campus
Brimacombe Building, 2355 East Mall	F4
Brock Hall and Brock Hall Annex, 1874 East Mall	C4
Buchanan Building (Blocks A, B, C, D, & E) [Arts], 1866 Main Mall	B3/4
Buchanan Tower, 1873 East Mall	C4
C.K. Choi Building for the Institute of Asian Research, 1855 West Mall	B2
Campus & Community Planning, 2210 West Mall	E3
Campus Security, 2133 East Mall	D4
Carey Hall, 5920 Iona Dr	B6
Carr Hall [Continuing Studies], 5997 Iona Dr	B6
Cecil Green Park Coach House, 6323 Cecil Green Park Rd	A3
Cecil Green Park House, 6251 Cecil Green Park Rd	A3
CEME — *see Civil & Mechanical Engineering Building*	
Centre for Continuing Studies [English Language Inst], 2121 West Mall	D2
Centre for Integrated Computer Systems Research/Computer Science (CICSR/CS), 2366 Main Mall (*see also* ICICS)	F3
Centre for Rsrch in Women's Studies & Gender Relations, 1896 E. Mall	C4
Chan Centre for the Performing Arts, 6265 Crescent Rd	B4
Chancellor Place	B5
Chemical Engineering Building, 2216 Main Mall	E4
Chemistry Building, 2036 Main Mall	D3
Chemistry Physics Building, 6221 University Blvd	D4
Child Care Services Admin. Bldg, 2881 Acadia Rd	H7
Child Care Services Bldgs, 5580-5690 Osoyoos Cresc	H7
CICSR/CS — *see Ctr for Integrated Computer Systems Research*	
Civil & Mechanical Engineering Bldg (CEME) [Faculty of Applied Sc.], 6250 Applied Science Lane	E4
Civil & Mechanical Eng. Labs, 2246 Main Mall	E4
Coal & Mineral Processing Lab, 2332 West Mall	E3
Copp (D.H.) Building, 2146 Health Sciences Mall	D5
Cunningham (George) Building [Pharmaceutical Sc.], 2146 East Mall	E4
Curtis (George F.) Building [Law], 1822 East Mall	B4
David Lam Learning Centre, 6326 Agricultural Rd	C3
David Lam Management Research Ctr, 2033 Main Mall	C3
Donald Rix Building, 2389 Health Sciences Mall	F4
Earth & Ocean Sciences (EOS) - East, 2219 Main Mall	E3
Earth & Ocean Sciences (EOS) - Main and South, 6339 Stores Rd	E3
Earthquake Engineering Research Facility (EERF), 2235 East Mall	E4
Engineering Annex, 6298 Biological Sciences Rd	E3
Engineering High Head Room Lab, 2225 East Mall	E4
Environmental Services Facility, 6025 Nurseries Rd	South Campus
Faculty of Law Annexes 1 and 2, 6050 and 6020 Walter Gage Rd	B4/5
Fairview Crescent Student Housing, 2600-2804 Fairview Cres	F6
Family & Nutritional Sciences Bldg, School of, 2205 East Mall	E4
FERIC (Forest Eng. Res. Institute), 2601 East Mall	H4
Fire Department, 2992 Wesbrook Mall	H6
First Nations Longhouse, 1985 West Mall	C2
Fish & Game Branch Workshops, 5773 Fisheries Rd	South Campus
Fisheries Centre - Hut B-8, 2204 Main Mall	E3
Flag Pole Plaza (Main Mall & Crescent Rd)	B3
Food Science Building, 6640 NW Marine Dr	E2
Forest Sciences Centre [Faculty of Forestry], 2424 Main Mall	F4
Forest Sciences Greenhouse, 6186 S. Campus Rd	South Campus
Forestry Field House, 6186 S. Campus Rd	South Campus
Forintek Western Research Facility, 2665 East Mall	H4
Forward (Frank) Building, 6350 Stores Rd	E3
Frederic Wood Theatre, 6354 Crescent Rd	B3
Friedman Bldg, 2177 Wesbrook Mall	E5
Gage Residence, 5959 Student Union Blvd	C5
General Services Administration Bldg (GSAB), 2075 Wesbrook Mall	D5
Geography Building, 1984 West Mall	C3
Gerald McGavin Building, 2386 East Mall	F4
Graduate Student Centre (Thea Koerner House), 6371 Crescent Rd	B3
Green College, 6201 Cecil Green Park Rd	A4
Hampton Place	H/J-6/7
Hawthorn Place	G/H3
Hebb Building, 2045 East Mall	D4
Hennings Building, 6224 Agricultural Rd	C4
Henry Angus Building [Sauder School of Business], 2053 Main Mall	D3
Hillel House, 6145 Student Union Blvd	C4
Horticulture Building/Greenhouse, 6394 Stores Rd	E2/3
Hospital, UBC, 2211 Wesbrook Mall	E5
Hut B-3 - Fisheries Ctr, 6248 Biological Sciences Rd	E4
Hut M-17, 6373 University Blvd	D3
Hut M-18, 6361 University Blvd	D3
Hut M-21 & Hut M-22, 2109 West Mall	D2
Hut O-4, 6365 Biological Sciences Rd	E3
ICICS (Institute for Computing, Information & Cognitive Systems - formerly CICSR), 2366 Main Mall	F4
Instructional Resource Centre (IRC), 2194 Health Sciences Mall	E5
International House, 1783 West Mall	B2
Jack Bell Building for the School of Social Work, 2080 West Mall	D3
John Owen Pavilion & Allan McGavin Sports Medicine Centre, 3055 Wesbrook Mall	H5
Kenny (Douglas T) Building, 2136 West Mall	D3
Kids Club, 2855 Acadia Rd	G7
Klinck (Leonard S.) Bldg, 6356 Agricultural Rd	C3
Koerner (Walter C.) Library, 1958 Main Mall	C3
Korea House (in Place Vanier), 1935 Lower Mall	C1
Landscape Architecture Annex, 2371 Main Mall	D4
Lasserre (Frederic) Building, 6333 Memorial Rd	C3
Leon and Thea Koerner University Centre, 6331 Crescent Rd	B3
Library Processing Centre, 2206 East Mall	E4
Lower Mall Header House, 2269 Lower Mall	E2
Lower Mall Research Station, 2259 Lower Mall	E2
Liu Centre for the Study of Global Issues, 6476 NW Marine Dr	B2
Macdonald (J.B.) Building [Dentistry], 2199 Wesbrook Mall	E5
MacLeod Building, 2356 Main Mall	F3
MacMillan (H.R.) Bldg [Agricultural Science], 2357 Main Mall	F3
Main Library, 1956 Main Mall	C4
Mathematics Annex, 1986 Mathematics Rd	C3
Mathematics Building, 1984 Mathematics Rd	C3
Mather (James) Building, 5804 Fairview Ave	G6
Medical Sciences Block C, 2176 Health Sc. Mall	E4
Michael Smith Laboratories, 2185 East Mall	D4
Museum of Anthropology, 6393 NW Marine Dr	A2/3
Music Building, 6361 Memorial Rd	B/C3
Networks of Ctrs of Excellence (NCE), 2125 East Mall	D4
99 Chairs/Trek Express, 2015 Main Mall	C3
Nitobe Memorial Garden, 1903 West Mall	B/C2
Norman MacKenzie House, 6565 NW Marine Dr	B2
NRC Institute for Machinery Research, 3250 East Mall	South Campus
Ocean Engineering Centre, 3760 Wesbrook Mall	South Campus
Old Administration Building, 6328 Memorial Rd	C3
Old Firehall, 2038 West Mall	D3
Orchard House (formerly Header House), 2336 West Mall	E2
Osborne (Robert F.) Centre/Gym, 6108 Thunderbird Blvd	G4
PAPRICAN Building, 3800 Wesbrook Mall	South Campus
Place Vanier Residence, 1935 Lower Mall	C/D2
Plant Ops Nursery/Greenhouses, 6116/6136 Nurseries Rd	South Campus
Plant Science Field Building, 6182 S. Campus Rd	South Campus
Plant Science Field Station & Garage, 2613 West Mall	H2
Point Grey Apartments, 2875 Osoyoos Cresc	H6
Police (RCMP) & Fire Department, 2990/2992 Wesbrook Mall	H6
Ponderosa Centre, 2071 West Mall	D2
Ponderosa Office Annexes: A, B, & C, 2011-2029 West Mall	C/D2
Ponderosa Office Annexes: D to H, 2008-2074 Lower Mall	C/D2
Power House, 2040 West Mall	D3
Pulp and Paper Centre, 2385 East Mall	F4
Research Station Annex 9, 2249 Lower Mall	E2
Ritsumeikan-UBC House, 6460 Agronomy Rd	F2
Rodney Graham Millennium Pavilion	C3
Rose Garden	B3
Rugby Pavilion, 2584 East Mall	G4
Scarfe (Neville) Building [Education], 2125 Main Mall	D3
Sing Tao Building, 6388 Crescent Rd	B3
Sopron House, 2730 Acadia Rd	G7
South Campus Warehouse, 6116 Nurseries Rd	South Campus
Spirit Park Apartments, 2705-2725 Osoyoos Cresc	G8
St. Andrew's Hall/Residence, 6040 Iona Dr	B5
St. John's College, 2111 Lower Mall	D2
St. Mark's College, 5935 Iona Dr	B6
Stores Road Annex, 6368 Stores Rd	E3
Student Recreation Ctr, 6000 Student Union Blvd	C5
Student Union Bldg (SUB), 6138 Student Union Blvd	C4
Tec de Monterrey (in Place Vanier), 1935 Lower Mall	C1
Technology Enterprise Facility III, 6190 Agronomy Rd	F4
Thea Koerner House [Graduate Studies], 6371 Crescent Rd	B3
Thunderbird Residence, 6335 Thunderbird Cresc	F3/4
Thunderbird Stadium, 6288 Stadium Rd	J3
Thunderbird Winter Sports Ctr, 6066 Thunderbird Blvd	G5
Totem Field Studios, 2613 West Mall	H2
Totem Park Residence, 2525 West Mall	F/G2
TRIUMF, 4004 Wesbrook Mall	South Campus
Triumf House, 5745 Agronomy Rd	F6
UBC Hospital, 2211 Wesbrook Mall	E5
UBC Tennis Centre, 6160 Thunderbird Blvd	G4
University Centre, 6331 Crescent Rd	B3
University Services Building (USB), 2329 West Mall	E2
Vancouver School of Theology, 6000 Iona Drive	B5
Walter H. Gage Residence, 5959 Student Union Blvd	C5
War Memorial Gymnasium, 6081 University Blvd	D5
Wesbrook Bldg, 6174 University Blvd	D4
Wesbrook Place, 2250 Wesbrook Mall	E6
West Mall Annex, 1933 West Mall	C2
Wood Products Laboratory, 2324 West Mall	E3
Woodward Biomedical Library, 2198 Health Sciences Mall	E4/5

SOUTH CAMPUS MAP

Campus & Community Planning
www.planning.ubc.ca



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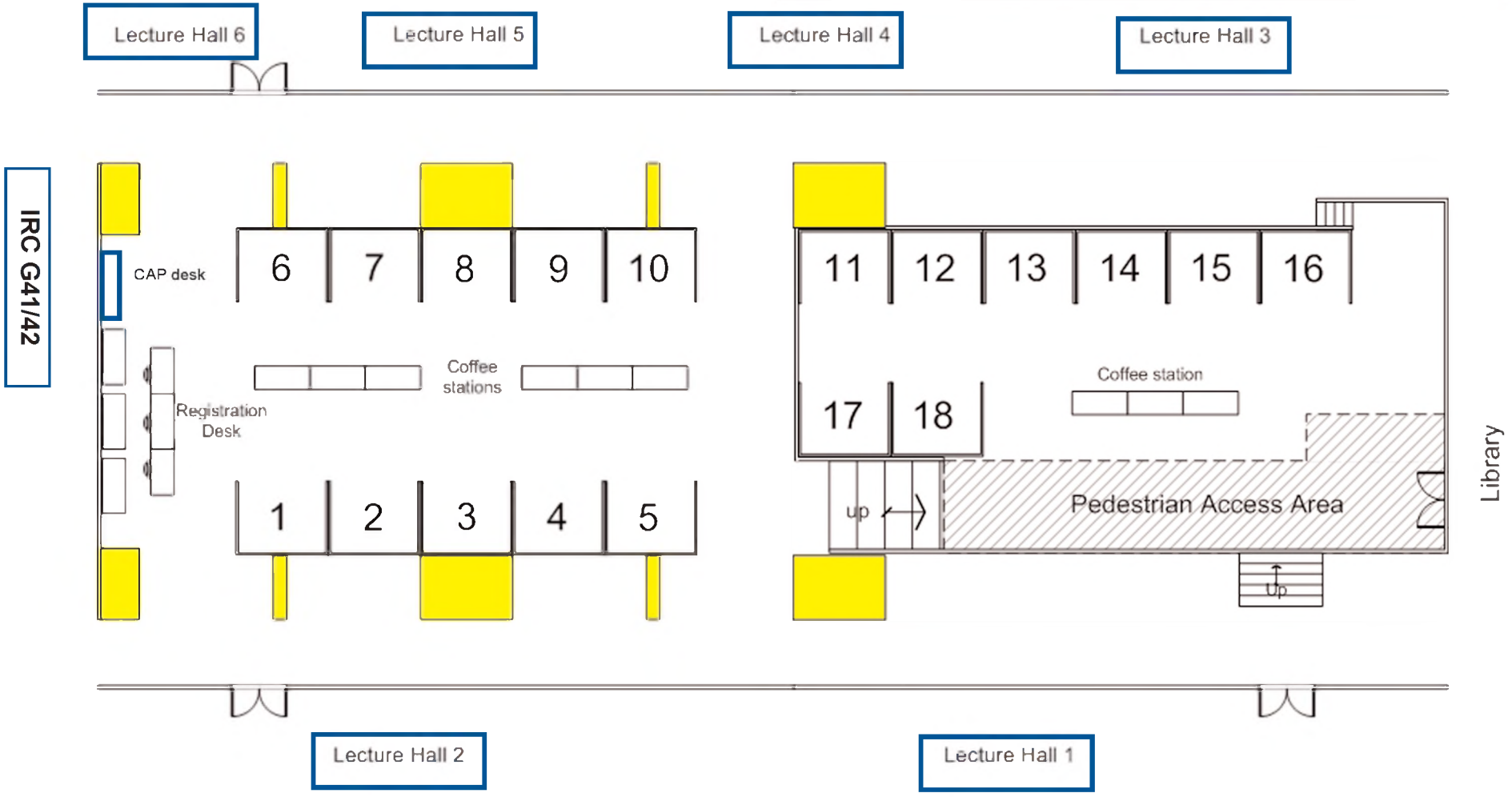

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TABLE OF CONTENTS / TABLE DES MATIÈRES

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2005 CAP CONGRESS
CONGRÈS DE L'ACP 2005

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A colorful view of space and time in Gastown (Vancouver), by Anna Gelbart (TRIUMF).

Une description artistique de l'Espace-Temps vu de Gastown (Vancouver), par Anna Gelbart (TRIUMF).

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-- EDITORIAL / ÉDITORIAL --
PHYSICS, SCIENCE AND THE CHANGING UNIVERSITY
PHYSIQUE, SCIENCE ET L'UNIVERSITÉ EN MUTATION

Before the Industrial Revolution, science was considered an integral cultural part of a gentleman's education. Even 18th century Newtonian science was seen as having little contact with the real world. Thus when the Industrial Revolution began, the universities initially were left out of the new technological expansion. The Lunar society of Birmingham of course promoted science as a respectable leisure-time activity for gentlemen; there were many public science lectures for interested laymen; and some of the academies formed in support of the sciences gave public science courses. But the universities did not share this enthusiasm; they neither taught higher-level science nor made any original contributions to scientific thought. As late as 1852 the Regius Professor of Medicine at Oxford reported that he had discontinued his lectures because there were only four students; and the Professor of Chemistry at Cambridge reported that:

> ...There is no residence, museum, library, collection, or apparatus attached to the Professorship...and there are no funds for this purpose. There are no opportunities afforded to students for instruction in the actual manipulation of instruments...Hitherto the study of Chemistry has not only been neglected but discouraged in the University, as diverting the attention of pupils from what have been considered their proper academical studies. [1]

Only gradually did the Industrial Revolution break into the universities. It happened first in France, where in 1794 the *Ecole Polytechnique* was set up. Since, however, Britain did not see eye-to-eye with either the French Revolution or Napoleon, the new scientific spirit did not cross directly into England. Rather, it first detoured through Germany, where the appropriate climate existed in the little independent duchies. There the objective and critical approach to all knowledge developed, not only in the sciences but also in the humanities. The ideal put before the students was no longer liberal humanism, but rather a fanaticism toward advancing knowledge. It was this German model which penetrated into Great Britain.

The resultant rearrangement of scholarship and education in 1868 led to the establishment of the Clarendon Laboratory at Oxford and the Cavendish Laboratory at Cambridge; practical physics became a subject recognized for a degree, and new universities were opened. Knowledge became an open-ended system with constant new additions; dissent became more recognized and accepted; the academic world became more democratized. The research model took a deep hold.

So, what have we now? in 2005?

The situation is much more complex than ever before. In Britain for example, it appears that now far from expanding their offerings in science, almost a third of physics departments are facing closure because of student shortage and financial cuts. Already 18 physics departments have closed since 1997, and 28 chemistry departments in the past nine years. The number of students taking A-level courses in secondary school has fallen from 45,000 to 31,000 in the last decade, and there are now only 3,000 undergraduates studying the subject. In contrast, 15,000 are studying psychology and, in addition, media studies, journalism and publicity pursuits have overtaken the

pure sciences. All this is occurring at a time when the study of both physical and biological systems at the molecular level or below, is where the interest is, and the future to be found for those excited enough to head for the frontiers!

Of course, the problem with modern physics and science in general has been that in order to see smaller and smaller objects with higher and higher resolution, larger and larger microscopes have had to be invented. As the cost of such devices has burgeoned in recent decades, the possibility of the construction of further more sophisticated instruments has become unlikely and the attempt to reach certain new goals abandoned. One university, or indeed one country, can no longer do the job.

We have therefore come a long way from the days of string and ceiling wax to the present era of superstrings and super ceiling wax. The financial cost of scientific endeavour has never been as high as it is today. However, despite the limiting smallness of quantal systems and the extravagance of instruments required to probe such things, there still exists a continuum of important and affordable pioneering work to be carried out in areas from soft physics to new materials, nanotubes, and molecular biology. There are still more problems in the sea of science than solutions that have ever come out of it. In addition, many fundamental physical phenomena still require a detailed explanation and understanding. Trained scientists with skills in particular disciplines are still essential to the advancement of knowledge and (through application and innovation) the economic health of the country whether in the United Kingdom or Canada. The disappearance of science courses is extremely alarming from this perspective. Is the situation in Canada similar to that in the UK?

At this point, while it is not usually advisable to answer a question with a question, I will attempt to answer the Canadian question in just that way. In early March, the chairman of the Institute of Physics in Ireland asked me a question as to whether there was a good news story available in relation to increased enrolment of students studying physics in Canada. The President of the Institute of Physics in the United Kingdom had apparently mentioned some apocryphal information to that effect. My questioner added that his one Canadian contact thus far, living as he did in Vancouver, British Columbia, was as yet blissfully unaware of any burgeoning of the number of undergraduate physicists in Canada. However I, as Editor of *Physics in Canada*, and known to welcome the odd challenge from time to time, immediately began to glean as many facts as possible from colleagues across Canada. So, with considerable assistance from Mark Whitmore, Dean of Science at the University of Manitoba, and incidentally a physicist, I have been able to acquire various interesting, topical and perhaps surprising answers to the question.

The results of my enquiry are not of overwhelming statistical significance, and as the comments received are more local than universal, it is probably best to give only those replies that are up-to-date, institutional, and contain some rationale for the facts presented. So, let me start with a comment from the Dean of Science at Athabasca University, the new academic institution in Alberta. He stated that

> "...it is possible that reference is made to my recent article about distance education physics which told how we have been able to dramatically increase the number of distance education physics students. I had a lot of trouble trying to find comparable numbers for other institutions to put into my article, so do not know what the real trends are in campus-based institutions. I am quite confident, however, that they are not looking at order of magnitude increases as has been the case for us." [2]

Clearly there is something here that is both relevant and worth following up.

A second and interesting comment comes from McMaster University in Hamilton. The Dean of Science here writes that:

> "My suspicion is that some of us at McMaster are responsible! About a year ago we had a visit by an Irish Dean and he was interested in the creation of our new Origins Institute (http://origins.mcmaster.ca/) which (as its name suggests) is more-or-less about the origins of everything (space and time, structure in the universe, matter and the elements, life, species and biodiversity, humanity). This is mostly driven by a group of astrophysicists (Ralph Pudritz, in particular, who headed the panel that developed the Long-Term Plan for Canadian astronomy on behalf of NRC, NSERC, and CASCA) who are keen on themes such as astrobiology (for which we will host a major international workshop during May 24 - June 10, 2005). I mention all this because Ralph and company have also fashioned an undergraduate program which looks something like a glorified minor. They have hopes of building up enrolments in related programs (physics, astrophysics, etc.) but it's too early to tell.

Otherwise, enrolments in physics remain modest, although the department makes great efforts to recruit students, especially women. By the way, we probably have a greater percentage than elsewhere of women faculty in our Physics & Astronomy department – 4 of 21.5 in tenure-stream, and of these two are Canada Research Chairs (one Tier I, one Tier II)."

Perhaps indeed this is what raised the original issue, and McMaster has some responsibility, but it appears that there is much more to the story. The University of Alberta has come up with fairly dramatic figures which relate to their local, rather than the national situation. Their numbers for physics enrolment have increased steadily over the past five years, and are shown in Table 1. The Dean of Science in Alberta indicates that this increased enrolment is found in all science depart-

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ments except Computer Science; and indicates pretty strong and steady growth. This increase found in Alberta is repeated and amplified by a report from the University of Toronto, our largest university, where physics enrolment stands at around 350 for 2003/4, the latest year for which full data are available; a figure which includes 2nd to 4th year students. Here anecdotal evidence is that enrolment growth is being driven by increased interest in biophysics and nanoscience at this time.

The University of Prince Edward Island has also experienced increased enrolment, in its Majors Program, which is attributed to the recent introduction of a Co-op program in physics. Even with that, they caution that they do not expect to do more than double their recent number of graduates per year to 10 or 12 in total. Overall, however, they find that first year service teaching in physics has increased to an extraordinary degree, because of new requirements from other science disciplines.

The University of Guelph is also benefitting from change, as the impact of SNO [the Sudbury Neutrino Observatory] is increasingly being felt, and the success of the Perimeter Institute of Physics at Waterloo recognised by potential theorists.

The University of Sherbrooke in Quebec is not quite as positive in relation to enrolment, but even they note that their previous downward trend at first-year level has been halted, without any real indication of significant increase in either Major students or graduates with degrees in physics. They feel that the original story and the question may be based on wishful optimism, but have not been aware of contemporary comparative information from other colleges and universities. Nonetheless, most reporting institutions quote varying degrees of increased enrolment, much of which may be attributable to a greater participation and enthusiasm from women in science.

So, in summary, and on the basis of the instant survey reported here, no university Department of Physics has so far reported a *decline* in the enrolment of students in physics. But of those advising of an increase in numbers, some of this growth is substantial and may even suggest a trend. They also indicate to some extent that the changing face of physics and science in general, is beginning to attract a new and perhaps different student population than previously. Now that much of the current interest in physics, chemistry and biology is at the atomic and molecular level, with manipulation of individual atoms becoming commonplace, there may be a commonality of interest that is beginning to transcend disciplinary boundaries, but at a quite fundamental level. We will have to wait and see.

Jasper McKee, P.Phys.
Editor, *Physics in Canada*

[1] E. Ashby, *Technology and the Academics*, London: Macmillan and Co., 1958, page 10.
[2] M. Connors, "A Decade of Success in Physics Distance Education at Athabasca University", *Physics in Canada,* **60** (2004), 49-54.

PHYSIQUE, SCIENCE ET L'UNIVERSITÉ EN MUTATION

Avant la Révolution industrielle, la science était considérée comme une partie culturelle intégrale de l'éducation d'un gentleman. Même la science newtonienne du 18e siècle était vue comme ayant peu de rapport avec la vie courante. Ainsi, au début de la Révolution industrielle, les universités ne participaient pas à la nouvelle expansion technologique. La Lunar Society of Birmingham faisait la promotion de la science en tant qu'activité de loisir convenable destinée aux gentlemen; elle organisait de nombreuses conférences scientifiques auxquelles assistaient des néophytes, et certaines des académies constituées pour promouvoir la science dispensaient des cours de science publics. Mais les universités ne partageaient pas cet enthousiasme; elles ne dispensaient pas de cours de science de haut niveau et ne contribuaient pas à la pensée scientifique. Même en 1852, le professeur titulaire de la chaire royale de médecine d'Oxford indiquait qu'il avait interrompu ses conférences parce que quatre étudiants seulement y assistaient; par ailleurs, à Cambridge, le professeur de chimie disait :

> … Il n'y a aucune résidence, bibliothèque, collection ni aucun musée ou appareil associé au professorat .. et aucun fonds n'est prévu à cette fin. Les étudiants n'ont jamais l'occasion d'étudier en manipulant de vrais instruments … Jusqu'à présent, l'étude de la chimie n'a pas seulement été négligée, mais elle a été découragée à l'université du fait que l'attention des élèves a été détournée de ce qui était considéré comme leurs propres études scolaires. [1]

Ce n'est que graduellement que la Révolution industrielle est entrée dans les universités. Ce fut d'abord en France où, en 1794, l'*École polytechnique* a été crée. Cependant, comme la Grande-Bretagne était opposée à la Révolution française et à Napoléon, la nouvelle pensée scientifique n'y a pas été acceptée immédiatement. Elle a d'abord fait un détour par l'Allemagne où un climat approprié régnait dans les petits duchés indépendants.

L'approche objective et critique vis-à-vis tout le savoir s'y développait, non seulement dans les sciences, mais aussi dans les humanités. L'idéal présenté aux étudiants n'était plus l'humanisme libéral, mais plutôt un certain fanatisme en matière de faire avancer les connaissances. C'est ce modèle allemand qui a pénétré en Grande-Bretagne.

En 1868, le réaménagement résultant de la recherche et des études mena à l'établissement du Clarendon Laboratory à Oxford et du Cavendish Laboratory à Cambridge. La physique pratique devint un sujet accepté pour le diplôme, et de nouvelles universités se sont établies. La connaissance devint un système ouvert avec des additions nouvelles constantes; la dissidence fut reconnue et acceptée et le monde de l'enseignement se démocratisa. Le modèle de recherche a eu une grande influence.

Qu'en est-il en 2005?

La situation est beaucoup plus complexe qu'elle ne l'a jamais été. En Grande-Bretagne, par exemple, il apparaît aujourd'hui qu'au lieu d'augmenter leur offre en science, presque le tiers des départements de physique font face à des fermetures en raison du manque d'étudiants et de coupures budgétaires. Déjà 18 départements de physique ont été fermés depuis 1997 et 28 départements de chimie l'ont été dans les neuf dernières années. Le nombre d'étudiants inscrits à des cours au niveau A du secondaire est passé de 45 000 à 31 000 dans les derniers dix ans, et il n'y a aujourd'hui que 3 000 étudiants de premier cycle dans cette matière. Par contraste, il y a 15 000 étudiants en psychologie, et de surcroît l'étude des médias, le journalisme et la recherche publicitaire ont surclassé les sciences pures. Tout cela se produit à un moment où l'étude des systèmes physiques et biologiques à l'échelle moléculaire ou à une échelle plus petite est le centre d'intérêt et représente l'avenir pour ceux à l'écoute des développements en science!

Bien sûr, la physique moderne et les sciences en générale doivent inventer des microscopes de plus en plus puissants pour voir des objets de plus en plus petits avec une résolution toujours plus élevée. Comme dans les dernières décennies les coûts de ces dispositifs ont explosé, la possibilité de fabriquer des instruments toujours plus complexes est devenue improbable et les tentatives d'atteindre certains nouveaux objectifs ont été abandonnées. Une université, ou même un seul pays, ne peut plus répondre au besoin.

Nous avons donc parcouru un long chemin du bout de ficelle à l'ère actuelle des cordes cosmiques! Le coût financier de l'activité scientifique n'a jamais été aussi élevé que de nos jours. Cependant, malgré la petitesse restreignante des systèmes quantiques et les coûts extravagants des instruments permettant d'explorer de telles choses, un travail de pionnier important et abordable se poursuit toujours dans les domaines allant de la physique molle aux nouveaux matériaux, aux nanotubes et à la biologie moléculaire. Il y a toujours plus de problèmes dans le domaine scientifique que de solutions qui y répondent. De plus, de nombreux phénomènes physiques fondamentaux exigent une explication et une compréhension détaillées. Des scientifiques chevronnés ayant des compétences dans des disciplines particulières sont toujours nécessaires pour l'avancement des connaissances et la santé économique du pays (grâce aux applications et aux innovations), que ce soit au Royaume-Uni ou au Canada. La disparition de cours de science est extrêmement alarmant dans cette perspective. La situation est-elle semblable au Canada qu'en Grande Bretagne?

Bien qu'il ne soit pas habituel de répondre à une question par une autre question, je vais essayer de répondre à la question canadienne de cette façon. Au début du mois de mars, le président de l'Institut de physique d'Irlande m'a demandé directement s'il y avait des nouvelles positives à rapporter concernant l'augmentation du nombre d'étudiants inscrits en physique au Canada. Le président du Institute of Physics du Royaume-Uni avait apparemment mentionné certaines informations apocryphes à cet effet. Mon interrogateur ajoutait que son contact canadien, qui vivait alors à Vancouver, Colombie-Britannique, ignorait tout de l'explosion du nombre d'étudiants de premier cycle en physique au Canada. Cependant, en tant qu'éditeur de *La physique au Canada*, et reconnu pour m'attaquer de temps en temps à des défis singuliers, j'ai immédiatement commencé à glaner autant de faits que possible auprès de collègues canadiens. Ainsi, grâce à l'aide inestimable de Mark Whitmore, doyen de la faculté des sciences à l'Université du Manitoba, et physicien, j'ai été en mesure de recueillir diverses réponses intéressantes, parfois surprenantes, à cette question.

Les résultats de mon enquête n'ont pas de signification statistique irrésistible et, comme les remarques reçues sont plus locales qu'universelles, il est sans doute préférable de ne fournir que ces réponses qui sont à jour, concernent les institutions et comportent certaines explications des faits présentés. Commençons avec une remarque du doyen de la faculté des sciences de l'Université Athabasca, la nouvelle institution universitaire de l'Alberta. Celui- dit :

> « … il est possible qu'il soit fait référence à mon récent article sur le télé-enseignement de la physique qui remarquait que nous avons été en mesure d'augmenter de façon importante le nombre d'étudiants en physique grâce au télé-enseignement. J'ai eu beaucoup de difficultés à trouver des chiffres correspondants pour d'autres institutions de sorte que je ne connais pas la tendance réelle sur les campus universitaires. Cependant, j'ai la conviction qu'ils ne s'attendent pas à une augmentation d'un ordre de grandeur telle que nous avons remarquée dans notre cas. »[2]

Évidemment il y a là quelque chose de pertinent et qui vaut la peine d'être suivi.

Une deuxième remarque intéressante provient de l'Université McMaster à Hamilton. Le doyen de la faculté des sciences a écrit :

« Je soupçonne que certains de nous à MacMaster soient responsables! Il y a un an environ, nous avons eu la visite d'un doyen irlandais qui s'intéressait à la création de notre nouvel Institut Origins (http://origins.mcmaster.ca/) qui, comme son nom l'indique, traite plus ou moins de l'origine des choses (espace et temps, structure de l'univers, la matière et les éléments, la vie, les espèces et la biodiversité, l'humanité). Il a principalement à sa tête un groupe d'astrophysiciens (Ralph Pudriz, en particulier, qui a dirigé le groupe qui a développé le plan à long terme de l'astronomie canadienne pour le compte du CNRC, CRSNG et de la Société canadienne d'astronomie) qui s'intéresse vivement aux domaines comme l'astrobiologie (pour lequel nous serons l'hôte d'un atelier international du 24 mai au 10 juin 2005). Je mentionne tout cela parce que Ralph et ses collègues ont aussi conçu un programme de premier cycle qui ressemble à quelque chose comme une mineure en plus grande. Ils espèrent augmenter les inscriptions dans des programmes connexes (physique, astrophysique, etc.), mais il est trop tôt pour prédire.

Par ailleurs, les inscriptions en physique demeurent modestes, bien que le département fasse de grands efforts pour recruter des étudiants, particulièrement des femmes. Au passage, nous avons probablement un plus grand pourcentage de femmes qu'ailleurs dans notre département de physique et d'astronomie: 4 des 21,5 professeurs réguliers, dont deux sont des chaires de recherche du Canada (l'un au niveau I et l'autre au niveau II). »

Finalement, c'est peut-être ce qui a soulevé la question initiale, et MacMaster a certaines responsabilités, mais il semble qu'il y a beaucoup plus à dire. L'université de l'Alberta nous a communiqué des chiffres intéressants qui reflètent leur situation locale plutôt que la situation nationale. Leur nombre d'inscriptions en physique a augmenté régulièrement pendant les cinq dernières années (voir tableau 1). Le doyen de la faculté des sciences de l'Alberta indique que cette augmentation des inscriptions se voit dans tous les départements de sciences, à l'exception du département d'informatique, et correspond à une croissance assez forte et soutenue. Cette augmentation se produit aussi mais avec plus d'intensité à l'Université de Toronto, notre plus grande université, où les inscriptions en physique tournent autour de 350 pour l'année 2003/2004, dernière année pour laquelle des données complètes sont disponibles. Ce nombre inclut les étudiants de 2^{e} à la 4^{e} année. L'évidence anecdotique ici indique que cette augmentation des inscriptions tient à l'intérêt grandissant pour la biophysique et la nanoscience en ce moment.

TABLEAU 1

1999	137
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2004	234

L'Université de l'Île du Prince-Édouard a aussi remarqué une augmentation des inscriptions dans son programme de majeurs, qu'ils attribuent à la récente introduction du programme coopératif de physique. Ils notent cependent qu'ils ne prévoient pas faire mieux que doubler le nombre annuel de diplômés qui devrait atteindre 10 à 12 au total. Cependant, ils ont observé que les inscriptions dans les cours de service de physique ont énormément augmenté en raison des exigences en physique des autres disciplines scientifiques de première année.

L'Université de Guelph a aussi connu un changement dans ses inscriptions bénéficient de l'impact du SNO (Sudbury Neutrino Observatory) qui se fait sentir de plus en plus, et du succès du Perimeter Institute of Physics de Waterloo, reconnu pour ses théoriciens prometteurs.

Au Québec, l'Université de Sherbrooke n'a pas obtenu le même succès quant aux inscriptions, bien qu'ils ont remarqué que la baisse des inscriptions en première année se soit arrêtée; sans aucune indication d'une augmentation importante du nombre d'étudiants en physique inscrits à une concentration ou au deuxième cycle. Ils pensent que cette histoire et la question peuvent être basées sur un optimisme qui prend un désir pour la réalité, mais ils ne connaissent pas les données comparatives actuelles provenant d'autres collèges et universités. Quoi qu'il en soit, la plupart des institutions qui ont répondu ont remarqué une certaine augmentation des inscriptions dont la plus grande partie peut être attribuable à une plus grande participation et à un plus grand enthousiasme des femmes pour la science.

En résumé, et sur la base de l'analyse instantanée mentionnée ici, aucun département universitaire de physique n'a signalé de *décroissance* des inscriptions d'étudiants en physique. Mais, parmi les augmentations du nombre d'inscriptions, certaines sont importantes et peuvent même suggérer une tendance. Cela indique aussi dans une certaine mesure que les changements qui touchent la physique et la science en général commencent à attirer de nouveaux étudiants, et peut-être des étudiants différents des étudiants précédents. Maintenant que beaucoup de l'intérêt actuel en physique, chimie et biologie se porte au niveau atomique et moléculaire, que la manipulation de chacun des atomes est devenue chose commune, un intérêt à un niveau assez fondamental, qui commence à transcender les disciplines, peut être identifié. Attendons et nous verrons.

Jasper McKee, phys.
Rédacteur, *La Physique au Canada*

[1] E. Ashby, *Technology and the Academics*, London : Macmillan and Co., 1958, page 10.
[2] M. Connors, "A Decade of Success in Physics Distance Education at Athabasca University", *La physique au Canada,* **60** (2004), 49-54.

Les commentaires de nos lecteurs au sujet de cet éditorial sont bienvenus.

NOTE: Le genre masculin n'a été utilisé que pour alléger le texte.

CAP 60TH ANNIVERSARY / *60IÈME ANNIVERSAIRE DE L'ACP*

A HISTORY OF THE CAP

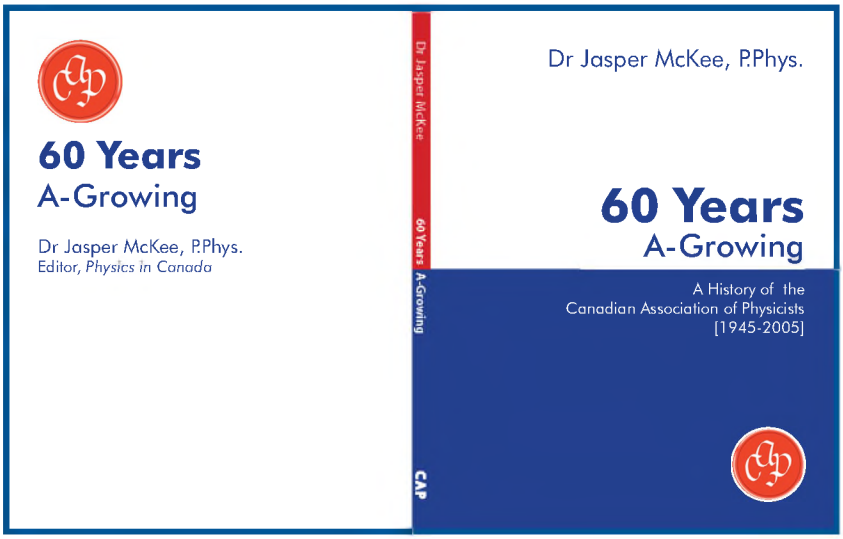
The Executive and Council of the CAP are pleased to announce that "60 Years A-Growing: A History of the Canadian Association of Physicists"by Jasper McKee, P.Phys., will be available in the Fall of 2005. This book provides readers with a brief history of the CAP, based on a combination of historical records and personal recollections submitted to the author.

Pre-order your copy now to ensure availability and avoid disappointment. Order forms are available in the Congress delegates bag or by going to www.cap.ca.

UN HISTOIRE DE L'ACP

L'Exécutif et le Conseil de l'ACP ont le plaisir d'annoncer le lancement de : << 60 ans de progrès : Une histoire de l'Association canadienne des physiciens et physiciennes >>, par Jasper McKee, phys. et disponible à l'automne 2005. Le livre présente au lecteur une courte histoire de l'ACP, basée sur les documents historiques et sur des souvenirs personnels communiqués à l'auteur.

Reservez votre copie dès maintenant pour ne pas être déçus. Les formulaires sont distribués dans le matériel fournis à chaque congressiste et à l'adresse http://www.cap.ca.



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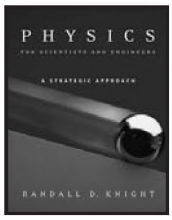
Moving Physics Education Research From The *"Laboratory"* To The Classroom



The Canadian Association of Physicists and Pearson Education Canada are pleased to have Randall Knight at the upcoming June Congress.

Sunday, June 5th 2:15 pm
RANDALL D. KNIGHT,
California Polytechnic State University

Twenty-five years of physics education research have produced truly remarkable insights not only as to how students learn physics but also about the very nature of the learning process. But this new knowledge must be transformed into new teaching methods and new curricular materials if it is to have widespread and lasting benefit. This talk will provide a *"from-the-trenches"* view of both the challenges and the opportunities for moving physics education research from the *"laboratory"* to the classroom.

CAP Congress
UBC/TRIUMF Vancouver

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L'information relative au processus de certification, ainsi que les formulaires requis, sont disponibles sous la rubrique "Certification professionnelle" du site Internet de l'ACP qui se lit ainsi : http://www.cap.ca.

Canadian Assocation of Physicists
Association canadienne des physiciens et physiciennes

MEDALLISTS 2005 LAURÉATS

CAP Medal for Achievement in Physics
Médaille de l'ACP pour contributions exceptionnelles en physique

Derek York
University of Toronto

CAP-DCMMP Brockhouse Medal
Médaille Brockhouse de l'ACP-DPMCM

David Lockwood
National Research Council

Herzberg Medal
Médaille Herzberg

Eric Poisson
University of Guelph

CAP Medal for Outstanding Achievement in Industrial and Applied Physics / *Médaille de l'ACP pour des réalisations exceptionnelles en physique industrielle et appliquée*

Anthony SpringThorpe
National Research Council

CAP Medal for Excellence in Teaching Undergraduate Physics
Médaille de l'ACP pour l'excellence en enseignement de la physique au premier cycle

André Marziali
University of British Columbia

CAP/CRM Prize in Theoretical and Mathematical Physics
Prix ACP-CRM en physique théorique et mathématique

Robert Myers
Perimeter Institute for Theoretical Physics

Come and visit the Art of Physics exhibition on display at the 2005 Congress. Entry forms for the 2005 competition will be available at the CAP Information Desk (deadine Dec. 31/05). Winning entries will be added to the travelling exhibition.

Venez visiter l'exposition l'<<Art de la Physique>> tenue lors du Congrès 2005. Les formulaires d'inscription pour le concours 2005 seront disponibles au bureau d'information (la date limite est le 31 décembre 2005). Les gagnants verront leurs œuvres ajoutées à l'exposition itinérante.

Canadian Assocation of Physicists
Association canadienne des physiciens et physiciennes

PRIZE WINNERS

University Prize Exam Results 2005 Résultats de l'examen du prix universitaire

142 students from 24 post-secondary institutions competed this year. The exam was administered by a consortium of members from the Physics Departments of the University of Prince Edward Island, Acadia University, Université de Moncton, and Mount Allison University. The names of the first, second and third prize winners are shown, followed by the fourth to tenth ranking marks.

Garry Goldstein	**First Prize / Premier Prix**	Univ. of Toronto / Univ. de Toronto
Roger Mong	**Second Prize / Deuxième Prix**	Univ. of Toronto / Univ. de Toronto
Robert Barrington Leigh	**Third Prize / Troisième Prix**	Univ. of Toronto / Univ. de Toronto

4.	David Shirokoff	U.Toronto	8.	Jonathan Braden	U.Alberta
5.	Andrew Cressman	U.Waterloo	8.	Tudor Costin	UBC
6.	Aviv Keshet	UBC	10.	Adam deGraaf	U.Manitoba
7.	Charles Huang	UBC	10.	Ali Feizmohammadi	U.Toronto

TOP STUDENT IN EACH UNIVERSITY - 2005

Acadia University	Aaryn Tonita	University of Manitoba	Adam de Graff
Bishop's University	Edward Wilson-Ewing	Université de Moncton	did not participate
Carleton University	Ahmed Ismail	Université de Montreal	Johnathan Laflame-Janssen
Concordia University	did not participate	University of New Brunswick	Mike Gill (3-way tie)
Dalhousie University	Daniel Fong		Andrew King (3-way tie)
Ecole Polytechnique	did not participate		Duncan MacLean (3-way tie)
Lakehead University	did not participate	University of Northern B.C.	did not participate
Laurentian University	did not participate	University of Ottawa	Leslie Anne Rogers
McGill University	Ivan Savov	University of Prince Edward Island	Morgan Hennessey
McMaster University	Christian Veenstra	Université de Québec à Chicoutimi	did not participate
Memorial University of NFLD	did not participate	Université de Québec à Montréal	did not participate
Mount Allison University	Kyle Hill	Université de Québec à Rimouski	did not participate
Queen's University	Martin Koslowsky	Univ. de Québec à Trois-Rivières	did not participate
Royal Military College of Cda	did not participate	University of Regina	did not participate
Saint Francis Xavier University	did not participate	University of Saskatchewan	Michael Barnett
Saint Mary's University	did not participate	Université de Sherbrooke	did not participate
Simon Fraser University	Ling Bin (Mark) Xu	University of Toronto	Garry Goldstein
Trent University	Tam Nhan	University of Victoria	Mathew Stevenson
University of Alberta	Jonathan Braden	University of Waterloo	Andrew Cressman
University of British Columbia	Aviv Keshet	University of Western Ontario	did not participate
University of Calgary	Ian Alexander Nygren	University of Windsor	did not participate
University of Guelph	Adam Pound	University of Winnipeg	did not participate
Université Laval	Nicolas Ayotte	Wilfrid Laurier University	did not participate
University of Lethbridge	did not participate	York University	did not participate

CANADIAN ASSOCIATION OF PHYSICISTS
ASSOCIATION CANADIENNE DES PHYSICIENS ET PHYSICIENNES

ANNUAL GENERAL MEETING
ASSEMBLÉE GÉNÉRALE ANNUELLE

DATE: Tuesday, June 7, 2005
Mardi, le 7 juin, 2005

TIME/HEURE: 17h00

PLACE: Room/Salle IRC-2, UBC, Vancouver, BC

DRAFT AGENDA / ORDRE DU JOUR PROVISOIRE

1. Call to Order and Approval of the Agenda

2. Approval of the Minutes of the June 17, 2004 Annual General Meeting
   - .1 Matters arising from the Minutes

3. Annual Report
   - .1 Audited Financial Statements to December 31, 2004
   - .2 Membership Report

4. Appointment of Auditors

5. Report on the Activities of the Association
   - .1 Update on Engineering Acts
   - .2 Update on Professional Certification / Trademark
   - .3 Science Policy / Lobbying / National Facilities Paper
   - .4 Preliminary Results from CAP Membership Survey
   - .5 Meetings with the APS
   - .6 2005 Year of Physics
   - .7 Other Matters

6. Report by the Chair of the 2005 Local Organizing Committee

7. Host Universities - Future Congresses

8. New Business
   - .1 2006 Membership Fees (R. Hodgson)
   - .2 Report of the Canadian National IUPAP Liaison Committee (G. Drake)
   - .3 Report by the Editor of Physics in Canada (J.S.C. McKee)
   - .4 Report by the Editor of the Canadian Journal of Physics (G.W.F. Drake)
   - .5 CUPC 2005 at UWO (A. Townshend)

9. Report of the Nominating Committee

10. Votes of Thanks and Change of the Chair

11. Date and Place of Next Meeting

12. Adjournment

THE 60th CAP ANNUAL CONGRESS
LE 60e CONGRÈS ANNUEL DE L'ACP

INFORMATION / PROGRAMME

(See page 20 for the Session Codes / Voir page 20 pour les indicatifs des sessions)

2005 CAP CONGRESS / CONGRÈS DE L'ACP 2005

TECHNICAL PROGRAM COMMITTEE / COMITÉ DU PROGRAMME TECHNIQUE

Chair / Président	W. Davidson	walter.davidson@nrc.ca
Atmospheric & Space Physics / physique atmosphérique et de l'espace	M. Connors	martinc@athabascau.ca
Atomic & Molecular Physics / physique atomique et moléculaire	W-K. Liu	wkliu@uwaterloo.ca
Condensed Matter and Materials Physics / physique de la matière condensée et des matériaux	M. Gallagher	mark.gallagher@lakeheadu.ca
Industrial and Applied Physics / physique industrielle et appliquée	R. Roy	roy@phy.ulaval.ca
Instrumentation and Measurement Physics physique des instruments et mesures	A. Mandelis	mandelis@mie.utoronto.ca
Medical and Biological Physics / physique médicale et biologique	A. Rutenberg	andrew.rutenberg@dal.ca
Nuclear Physics / physique nucléaire	M. Hasinoff	hasinoff@physics.ubc.ca
Optics and Photonics / physique optique et photonique	M. Campbell	mcampbel@quark.uwaterloo.ca
Particle Physics / physique des particules	C. Virtue	cjv@snolab.ca
Physics Education / enseignement de la physique	J. O'Meara	jomeara@physics.uoguelph.ca
Plasma Physics / physique des plasmas	C. Boucher	boucher@inrs-emt.quebec.ca
Surface Science / science des surfaces	G. Lopinski	gregory.lopinski@nrc.ca
Theoretical Physics / physique théorique	M. Paranjape M. Shegelski	paranj@lps.umontreal.ca mras@unbc.ca

LOCAL ORGANIZING COMMITTEE / COMITÉ ORGANISATEUR LOCAL

co-Chairs / co-présidents	J.-M. Poutissou / B.G. Turrell
Head, UBC Physics and Astronomy -Fundraising / Chef, physique et astronomie (UCB) -Commanditaires	J. Young
Director, TRIUMF / Directeur, TRIUMF	A. Shotter
Registration-Other Accommodations-Social / Inscription-Autres hébergements-Évenements sociaux	E. Driessen
UBC Accommodation / Hébergement UCB	R. Tate
Webmaster / Site web	M. Berciu
Poster Session / Session d'affiches	F. Zhou
Audio-visual / Audio-visuel	A. Damascelli
Congress poster / Affiche du Congrès	A. Gelbart
High School activities / Activités des écoles secondaires	M. Pavan
Exhibits / Exposants	H.Davies, G.Sheffer, and C.Winter
Publicity and Welcoming Chan Event Coordinator / Exposé et coordinatrice de la soirée au Centre Chan	M. Mossman
Graduate Students and Computing Services / Étudiants gradués et services informatiques	J. McKenna
World Year of Physics / Année mondiale de la physique	T. Tiedje

CAP OFFICE STAFF / PERSONNEL DE L'ACP

Executive Director / Directrice exécutive	F.M. Ford	CAP@physics.uottawa.ca
Administrative Assistant / Adjointe administrative	C. Harvey	carmen@physics.uottawa.ca

GENERAL INFORMATION / RENSEIGNEMENTS GÉNÉRAUX

2005 CAP Congress / Congrès de l'ACP 2005
Canadian Association of Physicists / Association canadienne des physiciens et physiciennes
Suite/Bur. 112, Imm. McDonald Bldg. , Univ. of/d'Ottawa
150, avenue Louis Pasteur Avenue OTTAWA, ON K1N 6N5
Tel/tél.: (613) 562-5614; Fax/téléc.: (613) 562-5615; e-mail: cap@physics.uottawa.ca
web: http://www.cap.ca

REGISTRATION

The registration desk for the Congress will be located in the foyer of the IRC building and will be staffed according to the following schedule:

Sunday June 5th	08h00 - 18h00 (IRC Foyer)
Sunday, June 5th	18h00 - 19h00 (Chan Centre)
Monday June 6th	07h30 - 17h00 (IRC Foyer)
Tuesday June 7th	07h30 - 17h00 (IRC Foyer)
Wednesday June 8th	07h30 - 12h00 (IRC Foyer)

PARKING

Use of cars on the UBC campus is discouraged so parking is relatively expensive. Delegates staying at the Gage residences can purchase parking privileges in the Gage residential complex for $5/day. Delegates commuting to UBC by car will have the following options:

- Health Sciences parkade: very central to the Congress location at $12/day or $3.50 after 17h00pm and on week ends. No in/out privileges.
- B1 surface lot: 7 min walk from IRC at $4/ day until 02h00.
- B4 surface lot : 10 min walk from IRC at $4/day until 02h00.
- Wesbrook roadways from Thunderbird arena to 16th Ave: 15min walk to IRC at $4 /day.

For more detailed information consult the following UBC web pages: http://www.parking.ubc.ca/visitor_rates.html

E-MAIL ACCESS

Delegates will be able to connect to internet wireless campus wide for the duration of the meeting. Account and password will be given at the registration desk. Public terminals are available at several locations on Campus. The most convenient locations for the delegates are the Student Union Building main floor and Hennings Physics building room 205

EXHIBITORS (in alphabetical order)

BOC Edwards
Canberra Co.
Delta Photonics
Gamble Technologies Ltd.
Intlvac
John Wiley and Sons Canada Ltd.
Johnsen Ultravac
Newport Canada
OCI Vacuum Engineering
Oxford Instruments
Pearson Education Canada
Plasmionique Inc.
Praxair
Quantum Technology Corp.
Systems for Research
Thompson Nielsen
Varian Inc.

SPONSORS

The Congress organizers thank each of the sponsors for their generous contributions.

Gamble Technologies
MDS Nordion (Vancouver)
TRIUMF
University of British Columbia
Varian Inc.

INSCRIPTION

Le bureau d'inscription au Congrès sera situé dans le foyer du bâtiment IRC où ont lieu la plupart des sessions et sera ouvert aux heures suivantes :

Dimanche 5 juin	08h00 - 18h00 (Foyer, bâtiment IRC)
Dimanche 5 juin	18h00 - 19h00 (Centre Chan)
Lundi 6 juin	07h30 - 17h00 (Foyer, bâtiment IRC)
Mardi 7 juin	07h30 - 17h00 (Foyer, bâtiment IRC)
Mercredi 8 juin	07h30 - 12h00 (Foyer, bâtiment IRC)

STATIONNEMENT

Le parking sur le campus est très limité et assez dispendieux. Les délégués qui demeureront au centre de conférence et aux résidences Gage pourront se procurer un permis de stationnement à Gage au coût de $5 par jour. Les délégués qui viendront en voiture auront les choix suivants :

- Garage couvert Health Sciences - très près du centre du Congrès - au coût de $12 par jour pour chaque entrée entre 07h00 et 17h00 , $3.50 après 17h00 et durant les fins de semaine.
- Stationnement extérieur public Lot B1 et B4 (7 et 10 min du centre IRC respectivement) au coût de $4/par jour jusqu'à 02h00.
- Stationnement le long du Wesbrook Mall (entre la patinoire Thunderbird et la 16ième avenue) 15 min du centre IRC à pied et $4/par jour.

Pour plus d'information et pour voir les cartes du campus, veuillez consulter les pages web suivantes : http://www.parking.ubc.ca/visitor_rates.html

ACCÈS AU COURRIER ÉLECTRONIQUE

Les délégués pourront se connecter au reseau Internet grâce au service sans fil du campus et ce pour la durée du Congrès. Le nom du compte et le mot de passe seront donnés au bureau d'inscription. Des terminaux d'ordinateurs publics sont aussi disponibles sur le campus plus spécifiquement au bâtiment des étudiants (SUB rez de chaussée) et au département de physique (salle Hennings 205)

EXPOSANTS (par ordre alphabétique)

BOC Edwards
Canberra Co.
Delta Photonics
Gamble Technologies Ltd.
Intlvac
John Wiley and Sons Canada Ltd.
Johnsen Ultravac
Newport Canada
OCI Vacuum Engineering
Oxford Instruments
Pearson Education Canada
Plasmionique Inc.
Praxair
Quantum Technology Corp.
Systems for Research
Thompson Nielsen
Varian Inc.

COMMANDITAIRES

Les organisateurs du Congrès remercient chacun des commanditaires pour leur généreuse contribution.

Gamble Technologies
MDS Nordion (Vancouver)
TRIUMF
l'Université de la Colombie-Britannique
Varian Inc.

2005 CAP CONGRESS

Welcome to the 60th Annual Congress of the Canadian Association of Physicists hosted jointly by the Department of Physics and Astronomy of the University of British Columbia and TRIUMF, at the University of British Columbia.

CONGRESS 2005 IN BRIEF

Sunday June 5th

- **1st Annual CAP Congress Student Reception**

16h30 -18h30 Students (graduate and undergraduate) are cordially invited to a reception at Thea's Lounge in the UBC Graduate Student Center. There will be a catered buffet with a cash bar. Come meet and network with other students. RSVP'ing to CAP.Grad.Rep@gmail.com will help organizers get an approximate guest count.

- **Public lecture:**

A public plenary session will take place on Sunday evening in the outstanding Chan Centre concert hall. This event is part of the World Year of Physics celebrations and will feature Professor Clifford.Will who will give the Herzberg Memorial lecture entitled "Was Einstein right". The Herzberg Lecture will be preceded by a performance by the Borealis String Quartet of a piece especially commissioned to celebrate the World Year of Physics.

A reception for registered CAP Congress delegates will follow in the Chan center foyer.

Monday June 6th

- **Committee to Encourage Women in Physics:**

In Room Hennings 200, come hear about the life of Harriet Brooks, Ernest Rutherford's first graduate student. Harriet later worked with JJ Thompson, then Marie Curie. There will be a discussion and reception after Professor Rayner-Canham's talk, followed by a showing of the PBS Documentary on Mileva Maric Einstein.

17h00-17h45	Geoff Rayner-Canham : "Harriet Brooks, An Early Canadian Nuclear Physicist"
17h45-18h45	Discussion and Reception
18h45-20h00	PBS Documentary "Einstein's Wife: The Life of Mileva Maric Einstein" followed by short discussion
20h00-20h15	CEWIP Business Meeting - Men and women interested in women in physics issues are invited to participate.

- **Beer and Poster session:**

The CAP05 beer and poster session will be held on Monday evening in the Student Union Building (SUB) Ballroom from 19h00 till 21h00. Beer and snacks will be available in the adjacent Party room for the duration of the poster session. One free beer ticket is included in the registration package.

Tuesday, June 7th

- The **CAP annual general meeting** will take place in the IRC auditorium #2 on Tuesday April 7th from 17h00 till 18h00.

- **Banquet and awards:**

The Congress banquet will take place on Tuesday June 7th in the Student Union Building ballroom from 19h30 till 21h30. A reception and cash bar will precede the banquet in the adjacent SUB "party room" from 18h30 onwards. Space limitation in the ball room will limit the number of banquet tickets to 400. The cost is $65.00 per ticket.

CONGRÉS ACP 2005

Bienvenue au 60e Congrès annuel de l'Association canadienne des physiciens et physiciennes présenté conjointement par le département de physique et d'astronomie de l'Université de la Colombie-Britannique et TRIUMF, à l'Université de la Colombie-Britannique.

LE 60IÈME CONGRÈS DE L'ACP EN BREF :

Dimanche 5 juin

- **Première réception annuelle de l'ACP pour les étudiants :**

16h30 - 18h30 Les étudiants (gradués et sous gradués) participants au congrès sont invités à une réception au centre des étudiants gradués de l'UBC, salle 'Thea'. Il y aura un buffet (gratuit) et un bar (payant).Venez rencontrer et lier connaissance avec d'autres étudiants RSVP à CAP.Grad.Rep@gmail.com pour nous aider à anticiper la participation à cet évenement.

- **Conférence public :**

Une conférence ouverte au public et aux délégués du congrès se tiendra dimanche soir le 5 juin dans la salle de concert CHAN sur le campus de l'UBC. Cet évenement qui fait partie des célébrations de l'année mondiale de la physique incluera la conférence commémorative Herzberg qui sera donnée par le professeur Clifford Will avec pour titre ≪ Einstein l'avait-il vu juste ? ≫ Cette présentation sera précédée de l'avant première d'une pièce musicale, spécialement commissionné pour célébrer l'année de la physique, et qui sera interprété par le quatuor à cordes Borealis.

Une réception s'en suivra dans le foyer du centre CHAN et à laquelle sont invités tous les délégués du Congrès.

Lundi 6 juin

- **Comité de promotion des femmes en physique - CEFEP :**

Dans la salle Hennings 200, le professeur Rayner-Canham donnera une conférence sur la vie de Harriet Brooks, qui fut la première étudiante (graduée) de E. Rutherford et qui travailla ensuite avec J.J. Thompson, puis avec Marie Curie. Une discussion, une réception, et un documentaire de PBS sur Mileva Maric Einstein s'en suivra.

17h00-17h45	Geoff Rayner-Canham : ≪ Harriet Brooks, An Early Canadian Nuclear Physicist ≫
17h45-18h45	Discussion et réception
18h45-20h00	Documentaire de PBS : ≪ Einstein's Wife: The Life of Mileva Maric Einstein ≫ suivi d'un court débat.
20h00-20h15	Réunion d'affaires CEFEP - Tout Congressiste, homme ou femme, peut participer à cet évenement.

- **Session bières et affiches :**

Une session bières et affiches aura lieu le lundi soir dans la salle de bal du centre des étudiants (SUB Ballroom) de 19h00 à 21h00. Bières et amuse-geules seront offerts durant cette session dans la salle adjacente "Party room". Un ticket valable pour une bière gratuite sera inclus dans les frais d'inscriptions au Congrès.

Mardi 7 juin

- L'**assemblée générale annuelle** de l' ACP se tiendra dans l'auditorium IRC #2 le mardi 7 avril de 17h00 à 18h00.

- **Banquet et remise des prix :**

Le banquet du Congrès aura lieu le mardi soir dans la salle de bal du Student Union Building de 19h30 à 21h30. Une réception et un bar précèderont dans la salle adjacente « party room » à partir de 18h30. L'espace disponible permet d'accomoder seulement 400 personnes pour le banquet. Les billets au coût de $65 par personne sont vendus au moment de votre inscription.

POSTER AND ORAL PRESENTATION INSTRUCTIONS:

Poster Sessions:

The poster session will take place on Monday June 6th from 19h00 to 21h00 in the Student Union Building (SUB) main ballroom. Poster boards will be available for setting up your poster by noon and each poster is given a 4 feet x 4 feet area.

Posters will have to be taken down immediately following the poster session on Monday evening.

There will be a beer and snack reception in the adjacent SUB "Party room" during the poster session.

Presentations/Audio-visual equipment:

All the conference rooms will be equipped with a standard overhead projector and an LCD data projector for computer-based presentations. Speakers who plan on using a computer-based presentation should bring their presentation on their own laptop computer, and be sure to contact the audio-visual Technical Assistant for their session before it starts. This will allow pre-connection of the laptop to the multimedia projection system and testing of the presentation. (You may also want to bring your presentation on viewgraphs as a back-up to your computer presentation.) Since all talks must keep to schedule, any time lost in setting up your computer later during the session will reduce the time available for your talk, and none of us wants that to happen!

RECREATIONAL FACILITIES:

Delegates can have access to a number of recreational facilities on Campus:

- Indoor/outdoor swimming pool near Student Union Building;
- Student Recreation Centre (gymnasium facilities);
- Hiking and jogging in Pacific Spirit Park and on local beaches;

Contact UBC conference and accommodation centre for maps and rates, and further information on UBC 's attractions:

http://www.attractions.ubc.ca/

GENERAL INFORMATION ON VANCOUVER:

Here are some useful links for information about Vancouver:

http://www.tourismvancouver.com

http://www.vancouverattractions.com/

http://www.where2eat.ca/

WEATHER:

Vancouver experiences a mild climate and one can expect temperatures in the 11 to 18 degree range for June. Average precipitation for June is 55mm with typically 10 days of rainy forecast. Although we hope that the weather will be pleasant, delegates should be prepared for some rain. The probability of 5 consecutive rain-free days in early June is 13% !!

INSTRUCTIONS POUR LES PRÉSENTATIONS ORALES OU PAR AFFICHES:

Session présentation par affiches :

La session d'affichage des présentations aura lieu le lundi 6 juin de 19h00 à 21h00 au bâtiment des étudiants (Student Union Building). Des panneaux de 4 pieds par 4 pieds seront assignés pour chaque affiche inscrite au Congrès. Elles pourront être mises en place à partir de midi le lundi.

Les affiches devront être retirées immédiatement après la session du lundi soir.

Bières et amuse-gueules seront servis durant cette session dans la salle adjacente « party room ».

Présentations et équipement audio-visuel :

Toutes les salles de la conférence seront équipées avec un retro projecteur ordinaire et un projecteur digital pour les présentation par ordinateur. Les conférenciers qui prévoient utiliser ce service par ordinateur devront utiliser leur propre ordinateur et contacter la personne responsable pour l'équipement audio-visuel de la session avant le début de la session. Chaque présentation sera alors préprogrammée afin de limiter les temps morts entre les conférenciers. Toute perte de temps due à un manque de préparation sera déduit du temps alloué à votre contribution afin de maintenir le synchronisme des sessions concurentes. Il est fortement conseillé d'apporter une copie de la présentation sur transparent ou sur une mémoire auxillaire.

ACTIVITÉS RÉCRÉATIONNELLES :

Le campus de l'UBC offre de nombreuses occasions de pratiquer du sport ou ses activités préferées

- Les délégués auront accès aux piscines intérieures et extérieures du campus situées près du SUB ainsi qu'au gymnase.
- Le Parc Pacific Spirit offre de nombreux sentiers de randonnée pour la marche ou le jogging.

Pour de plus amples informations, veuillez contacter le centre de conférence sont le site Web est :

http://www.attractions.ubc.ca/

INFORMATIONS SUR VANCOUVER :

Voici quelques liens intéressants sur Vancouver

http://www.tourismvancouver.com

http://www.vancouverattractions.com/

http://www.where2eat.ca/

LE TEMPS QU'IL FERA :

Vancouver est renommé pour son climat tempéré et vous pouvez vous attendre à avoir des températures entre 11 et 18 degrés pour la période du Congrès. Le taux moyen de précipitation en juin est de 55 mm, avec typiquement 10 jours de pluie . La probabilité d'avoir 5 jours consécutifs sans pluie est de 13% en juin. C'est pourquoi le personnel du bureau météorologique de Vancouver ne prend jamais ses vacances en juin.

Fifth Annual Physics Teacher Workshop
Saturday, June 4th, 2005
University of British Columbia, Vancouver, BC

Saturday, June 4, 2005 – **Woodward IRC #1, UBC**

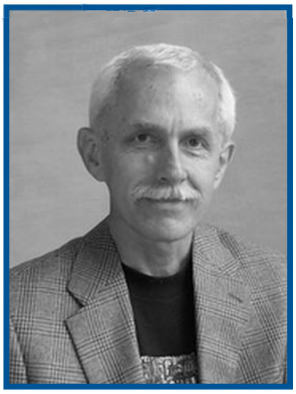
8:30 am	**Registration and Refreshment**
9:00 am	**Einstein's 1905 Paper on Relativity. Where did it come from?** by Bill Unruh, *UBC Physics*
10:00 am	**The Journal of High School Science** by Dale Stevenson, *Rick Hanson Secondary, Abbotsford, BC*
10:30 am	**Refreshment Break**
10:45 am	**Internship Programs for Physics Teachers and Students at TRIUMF** by Allan Wootton, *Caledonia Secondary School, Terrace, BC*, and Reka Moldovan, *former student, Kelowna Secondary School, Kelowna, BC.*
11:15 am	**TBA** - Randall Knight
11:45 pm	**BCAPT AGM**
12:00 pm	**LUNCH – Sponsored by Canadian Institute for Photonic Innovation / Photonics Canada**
1:00 pm	**World Year of Physics Activities in Canada** by Michael Steinitz, *St. Francis Xavier University*
1:15 pm	**Einstein and the Development of Modern Physics** by Erich Vogt, *UBC Physics & TRIUMF*
2:15 pm	**Searching for Neutrinos at the South Pole** by Eric Muhs, *Roosevelt High School, Seattle, WA*
2:45 pm	**A Special Relativity Video Illustrating Relativistic Mass** by Philip Freeman, *Richmond High School, Richmond, BC*
3:15 pm	Closing

Other Related Congress Activities

- Teachers are also invited to the public lecture "Was Einstein Right?" given by Clifford Will, *Washington University, St. Louis*, on Sunday June 5th at 7:00 pm
- The Division of Physics Education (DPE) is holding a series of sessions on the theme of "Developments in Physics Education Research" starting at 10:00 am on Sunday June 5th.
- The Division of Physics Education (DPE) is also holding a series of sessions on the theme of "Engaging Students in Classroom" starting at 2:15 pm on Sunday June 5th.

HERZBERG MEMORIAL PUBLIC LECTURE — CHAN CENTRE
CONFÉRENCE PUBLIQUE COMMÉMORATIVE HERZBERG

Sunday, June 5, 2005 — 19h00 — Dimanche, le 5 juin 2005



Clifford Will

DR. CLIFFORD WILL
WASHINGTON UNIVERSITY, ST. LOUIS

"Was Einstein Right ?"

How has the most celebrated scientific theory of the 20th century held up under the exacting scrutiny of planetary probes, radio telescopes, and atomic clocks? After 100 years, was Einstein right? In this lecture, celebrating the 100th anniversary of Einstein's "miracle year" and the World Year of Physics, we relate the story of testing relativity, from the 1919 measurements of the bending of light to the 1980s measurements of a decaying double-neutron-star system that reveal the action of gravity waves, to a 2004 space experiment to test whether spacetime "does the twist". We will show how a revolution in astronomy and technology led to a renaissance of general relativity in the 1960s, and to a systematic program to try to verify its predictions. We will also demonstrate how relativity plays an important role in daily life.

" Einstein avait-il vu juste ? "

Est-ce que la théorie la plus célèbre du 20^{ième} siècle a résisté aux vérifications les plus sévères faites par les sondes interplanétaires, les radiotélescopes et les horloges atomiques? Cent ans après, Einstein avait-il vu juste? Dans cette présentation qui célèbre le centième anniversaire de l'année miraculeuse d'Einstein et l'année mondiale de la physique, je présente l'historique des tests de la théorie de la relativité, depuis les mesures sur la courbure de la lumière en 1919 jusqu'aux mesures des années 80 sur l'évolution des systèmes binaires d'étoiles à neutrons qui mettent en évidence l'effet des ondes gravitationnelles, et en 2004 une expérience dans l'espace pour vérifier les distorsions de l'espace-temps. Je montrerai comment une révolution en astronomie et les progrès technologiques ont mené à une renaissance des recherches sur la relativité dans les années 60, et à un programme systématique de vérification de ses prédictions. Je montrerai aussi comment la relativité joue un rôle important dans notre vie de chaque jour.

BIOGRAPHY

Clifford Will is Professor of Physics, and member of the McDonnell Center for the Space Sciences at Washington University in St.Louis. Born in Hamilton, Canada in 1946, he received a B.Sc. in Applied Mathematics and Theoretical Physics from McMaster University in 1968, and a Ph.D. in Physics from the California Institute of Technology in 1971. He was an Enrico Fermi Fellow at the University of Chicago (1972-74), and an Assistant Professor of Physics at Stanford University (1974-81), From 1975 to 1979, he was an Alfred P. Sloan Foundation Fellow. In 1981 he joined Washington University as Associate Professor, in 1985 became Full Professor of Physics, and from 1991 - 2002 served as Chairman of the Department. In 1986 he was selected by the American Association of Physics Teachers to be the 46th annual Richtmyer Memorial Lecturer. He was elected a Fellow of the American Physical Society in 1989 and of the American Academy of Arts and Sciences in 2001. In recognition of his theoretical work related to the Hulse-Taylor Binary Pulsar, he was an invited guest of the Nobel Foundation at the 1993 Nobel Prize Ceremonies honoring discoverers Joseph Taylor and Russell Hulse. During 1996-97, he was both a J. William Fulbright Fellow and a Guggenheim Foundation Fellow, and in 1996, he was named Distinguished Alumnus in the Sciences by McMaster University. In 2004 he received the Fellows Award of the St. Louis Academy of Sciences, and was elected President of the International Society on General Relativity and Gravitation. He has published over 160 scientific articles or abstracts, including 13 major review articles, 23 popular or semi-popular articles, and two books: Theory and Experiment in Gravitational Physics (Cambridge University Press, 1981; 2nd Edition, 1993), and Was Einstein Right? (Basic Books, 1986; 2nd Edition, 1993). Was Einstein Right? was selected one of the 200 best books of 1986 by the New York Times Book Review, and won the 1987 American Institute of Physics Science-Writing Award in Physics and Astronomy. It has been translated into French, German, Japanese, Italian, Spanish, Portuguese, Korean, Greek, Chinese and Persian. His research interests include tests of general relativity, gravitational radiation, black holes, cosmology, and the physics of curved spacetime.

HARRIET BROOKS: EARLY CANADIAN NUCLEAR PHYSICIST

A special event organized by the Committee to Encourage Women in Physics

CAP Congress
Monday, June 6; 17h00
Hennings 200 (capacity 200)
Reception to Follow

GEOFF RAYNER-CANHAM, Sir Wilfred Grenfell College

Harriet Brook: Pioneer Canadian Woman Physicist

Ontario-born Harriet Brooks was Ernest Rutherford's first graduate student at McGill University. Among Brooks' several claims to fame was the first observation of the recoil of the radioactive atom. Brooks subsequently undertook research with J.J. Thomson and M. Curie. Her complex life reflected many of the challenges of women scientists of the time. Some of the same problems are still with us.

This talk will be followed by a reception and then a viewing, at 18h45 of the PBS documentary "Einstein's Wife". The CEWIP business meeting will be held at 20h00. All are welcome.

NEW FACULTY LUNCHEON / DÉJEUNER POUR LES NOUVEAUX PROFESSEUR(E)S

12h15, WEDNESDAY, JUNE 8, 2005 -- UNIVERSITY OF BRITISH COLUMBIA, IRC G41/42

We extend a special invitation to new Faculty members to attend the CAP Congress, to be held at the University of British Columbia in Vancouver, B.C., from the 5th to the 8th of June 2005. The CAP Congress is a unique opportunity to meet and hear colleagues from universities across Canada, and to discover a part of our country. For new Faculty members who choose to attend the Congress, we have organized a special luncheon at 12h15 on Wednesday, June 8th in IRC Room G-41/42. This luncheon will be hosted by the CAP's Director of Academic Affairs. NSERC representatives will give a short presentation followed by a question period and a round table discussion of issues of interest to new professors.

If you would like to attend, please let us know by e-mail at cap@physics.uottawa.ca. We welcome any suggestions regarding information that you would like to obtain from NSERC, or topics that you would like to hear discussed at the round table.

I hope to see you in Vancouver.

Walter Davidson, P.Phys.
Vice President of the CAP

N.B. A new professor is any regular Faculty member who started after December 31st, 2003.

Nous lançons une invitation spéciale aux nouveaux professeurs pour assister au Congrès de l'ACP à l'Université de la Colombie-Britannique, Vancouver, C.-B. du 5 au 8 juin. Le Congrès de l'ACP est une occasion unique de rencontrer et d'écouter vos collègues des autres universités canadiennes, en plus de découvrir un joli coin de notre pays. Pour les nouveaux professeurs, qui assisteront au Congrès, nous avons aussi organisé un déjeuner spécial à 12h15 le mercredi 8 juin dans la salle IRC G-41/42. Le déjeuner sera animé par le Directeur des affaires académiques de l'ACP. Des représentants du CRSNG vont faire une courte présentation sur les programmes disponibles aux professeurs de physique au Canada et resteront pour répondre à vos questions. La discussion sera suivie d'une table ronde sur les sujets d'intérêt des nouveaux professeurs.

Si vous souhaitez assister au déjeuner, veuillez nous le faire savoir en envoyant un courrier électronique à cap@physics.uottawa.ca. Toutes suggestions à propos des sujets que vous aimeriez entendre des représentants du CRSNG ou lors de la table ronde seront bienvenues.

J'espère vous voir à Vancouver.

Walter Davidson, phys.
Vice-Président de l'ACP

N.B. Un nouveau professeur est tout professeur régulier qui est entré en fonction après le 31 décembre 2003.

NSERC Workshop

Wednesday/Mercredi, June 8 juin
13h00 ; Room/salle IRC 1

Tips to Prepare Your Next Discovery Grant Application
Conseils pour l'élaboration de votre prochaine demande de subvention à la découverte

NSERC staff and Grant Selection Committee members will present an interactive overview of the peer review process, inform you of the latest changes at NSERC, give useful advice for the preparation of your next NSERC application and answer your questions on the functioning of grant selection committees. The workshop is open to all researchers. It will be particularly helpful to new faculty members and researchers likely to apply (or re-apply) in the fall.

Des employés du CRSNG et des membres des comités de sélection des subventions du CRSNG donneront une présentation en mode interactif sur le processus d'évaluation par les pairs, vous renseigneront sur les derniers changements opérés au CRSNG, vous donneront des conseils utiles pour l'élaboration de votre prochaine demande de subvention au CRSNG et répondront à vos questions sur le fonctionnement des comités de sélection des subventions. Tous les chercheurs peuvent participer à l'atelier, qui sera particulièrement utile aux professeurs et aux chercheurs récemment embauchés qui comptent soumettre une demande (ou une nouvelle demande) à l'automne.

SCIENCE POLICY SESSION DE POLITIQUE SCIENTIFIQUE
2005 JUNE 6 JUIN -- 08H15-09H45 -- ROOM-SALLE IRC2

HOW CAN CANADA'S PHYSICISTS HELP PROMOTE INVESTMENT IN SCIENCE?
Comment les physiciens au Canada peuvent-ils promouvoir l'investissement en science ?

Canada's physicists need to become more involved in science promotion and advocacy/lobbying activities. As part of its efforts to play an enhanced coordination and leadership role, the CAP has organized a special science policy plenary session for Monday morning. This session will feature three panellists: Dr. Mike Lazaridis, President, Research in Motion, Dr. Michael Lubell (Director of Public Affairs, American Physical Society and Chair of the Physics Department, City College of the City University of New York), and Dr. Julia Levy (Executive Chairman, Scientific Advisory Board, QLT Inc., Vancouver, B.C.). The session will be chaired by Dr. Eric Svensson (Chair of the CAP's Science Policy Committee). Each panellist will give a 10-12 minute opening presentation. There will then be a period of about 35 minutes for questions from the audience, followed by summary remarks/conclusions/recommended actions by each of the panellists.

The primary aims of this session are to convince Canada's physicists of the importance of advocacy to improve the funding and climate for science research and education in Canada, to encourage them to become involved, and to tell them how to be effective. In addition to direct advocacy, the overall effort must include greater science promotion and outreach. Skilful communication of science to the general public, politicians, and other decision makers will improve their perceptions of science and its importance to the well being of Canadians, and make them more favourably inclined to having governments fund it well. All of us can make important contributions to these activities. Come, ask questions, and learn how you can help to influence the political process.

Dr. Mike Lazaridis, President, Research in Motion

Mike Lazaridis is President and Co-CEO of Research In Motion (RIM), a company he founded while a student at the University of Waterloo. At RIM, he is responsible for product strategy, research and development, product development, and manufacturing. Since founding RIM he has received many patents in the field of wireless radio technology and software. His best-known product is the BlackBerry(tm), an end-to-end secure wireless platform supporting the communication and information needs of mobile professionals. Mr. Lazaridis is a member of the Natural Sciences and Engineering Research Council of Canada (NSERC), Founder and Chair of Perimeter Institute for Theoretical Physics, and principal benefactor of the Institute for Quantum Computing at the University of Waterloo. He has served as the University of Waterloo's Chancellor since May, 2003.

Dr. Michael Lubell, Director of Public Affairs, American Physical Society

Michael Lubell is Chairman of the Physics Department at the City College of the City University of New York and Director of Public Affairs of the American Physical Society. He received his B.A from Columbia University and his M.S. and Ph.D. from Yale, where he was a faculty member for ten years before assuming his position at CCNY. He has held fellowships from the U.S. National Science Foundation, the U.S. Atomic Energy Commission and the Alfred P. Sloan Foundation and visiting appointments at Brookhaven National Laboratory, the University of Texas-Austin, the University of Bielefeld and the Santa Barbara Institute of Theoretical Physics. He is a Fellow of the American Physical Society and the American Association for the Advancement of Science. Dr. Lubell's publications comprise more than 100 articles and 85 conference abstracts in scientific journals and books in the fields of high-energy physics; nuclear physics; atomic, molecular and optical physics; and science policy. He appears on radio and TV in North America, Europe and Asia and is one of the experts most frequently quoted by the U.S. media on science policy issues. He has been a newspaper columnist and presently writes a bimonthly opinion piece, "Inside the Beltway," for APS News. He has worked on many political campaigns, has held elective office and has been a policy advisor to several members of the United States Congress. He is credited as being one of the pioneers of science lobbying in Washington. His biography appears in Who's Who in America and Who's Who in the World.

Dr. Julia Levy, Executive Chairman, Scientific Advisory Board, QLT Inc.

Dr. Julia Levy has served in several key senior posts at QLT including Chief Scientific Officer and Vice President as well as President and CEO from 1995 to February 2002. Under her leadership, QLT recorded the strongest period of growth in company history and earned a reputation for achieving milestones, including FDA approval for Visudyne® therapy to treat age-related blindness in April 2000. Following her doctorate degree in immunology from the University of London, Dr. Levy was awarded an Industrial Professorship in the Department of Microbiology from the University of British Columbia and is the recipient of several honorary degrees. A fellow of the Royal Society of Canada and former President of the Canadian Federation of Biological Sciences, Dr. Levy has earned numerous awards and honors including an appointment as an Officer of the Order of Canada in 2001. The author of many published scientific articles and a sought-after speaker, Dr. Levy currently serves as a director on a number of early-stage biotechnology company boards and on the board of the Working Opportunity Fund, a British Columbia, Canada-based venture capital firm.

ABBREVIATION KEY / CODES DES ABBRÉVIATIONS

Divisions

DAMP	Division of Atomic and Molecular Physics
DPAM	Division de physique atomique et moléculaire
DASP	Division of Atmospheric and Space Physics
DPAE	Division de physique atmosphérique et de l'e-space
DCMMP	Division of Condensed Matter and Materials Physics
DPMCM	Division de physique de la matière condensée et matériaux
DMBP	Division of Medical and Biological Physics
DPMB	Division de physique médicale et biologique
DIAP	Division of Industrial and Applied Physics
DPIA	Division de physique industrielle et appliquée
DIMP	Division of Instrumentation and Measurement Physics
DPIM	Division de physique des instrumentation et mesures
DNP	Division of Nuclear Physics
DPN	Division de physique nucléaire
DOP	Division of Optics and Photonics
	Division d'optique et photonique
DPE	Division of Physics Education
DEP	Division de l'enseignement de la physique
DPP	Division of Plasma Physics
	Division de physique des plasmas
DSS	Division of Surface Sciences
	Division de la science des surfaces
DTP	Division of Theoretical Physics
DPT	Division de physique théorique
PPD	Particle Physics Division
	Division de physique des particules
CEWIP	Committee to Encourage Women in Physics
CEFEP	Comité d'encourager les femmes en physique

Sessions

SA-A#	Saturday A.M. Session / Session du samedi matin
SA-P#	Saturday P.M. Session / Session du samedi après-midi
SU-CHAIRS	Sunday Physics Department Heads/Chairs Workshop / Réunion des directeurs de départements de physique le dimanche
SU-A#	Sunday A.M. Session / Session du dimanche matin
SU-P#	Sunday P.M. Session / Session du dimanche après-midi
SU-KEY	Sunday Keynote Speaker / Session plénière publique du dimanche soir
MO-A#	Monday A.M. Session / Session du lundi matin
MO-P#	Monday P.M. Session / Session du lundi après-midi
MO-STUD	Monday Best Graduate Student Paper Competition / Compétition de la meilleure présentation étudiante, le lundi après-midi
MO-POS#	Monday evening Poster Session / Session d'affiche du lundi soir
TU-A#	Tuesday A.M. Session / Session du mardi martin
TU-P#	Tuesday P.M. Session / Session du mardi après-midi
WE-A#	Wednesday A.M. Session / Session du mercredi matin
WE-P#	Wednesday P.M. Session / Session du mercredi après-midi

INVITED SPEAKERS / CONFÉRENCIERS INVITÉS

(in alphabetical order / *selon l'ordre alphabétique*)

AWSCHALOM, David (DCMMP/*DPMCM*) [SU-A1-2]
University of California

Spintronics: Semiconductors, Molecules, and Quantum Information Processing

BALDERAS-LÓPEZ, José Abraham (DIMP/*DPIM*) [TU-A10-3]
University of Miyazaki

Thermal-Wave Photoacoustic Setup, High Precision Technique for Thermal Diffusivity Measurements: Applications to Foods

BANDRAUK, André (DAMP/*DPAM*) [TU-P4-1]
Université de Sherbrooke

Molecules in Intense Laser Fields and Electron-Nuclear Dynamics from Femto to Attosecond Time Scales

BARTH, Johannes (DCMMP/*DPMCM*) [WE-A8-1]
University of British Columbia

Supramolecular Architecture at Surfaces: Control of Matter at the Nanoscale

BEHR, J. (DAMP/*DPAM*) [TU-A5-4]
TRIUMF

Weak Interaction Symmetries with Atom Traps

BENNEWITZ, Roland (DCMMP/*DPMCM*) [WE-A8-2]
McGill University

Observing Atoms at Work

BERNATH, Peter (DASP/*DPAE*) [SU-A2-2]
University of Waterloo

Atmospheric Chemistry Experiment (ACE): First Results

BIZHEVA, K. (DMBP-DOP/*DPMB-DOP*) [MO-P6-3]
University of Waterloo

Novel Biomedical Applications of Ultrahigh Resolution Optical Coherence Tomography

BIZZOTTO, Dan (DCMMP/*DPMCM*) [MO-P5-1]
University of British Columbia

An Electrochemical and In-Situ Fluorescence Investigation of Role of Potential in Manipulating the Properties of an Adsorbed Lipid-Like Layer

BRABEC, Thomas (DAMP/*DPAM*) [TU-P4-3]
University of Ottawa

Many Body Dynamics in Strong Fields

BRASSARD, Gilles (DTP/*DPT*) [WE-A7-3]
Université de Montréal

Quantum Foundations in the Light of Quantum Information

BRINKMANN, Kai-Thomas (DNP /*DPN*) [MO-P2-5]
IKTP, TU Dresden

Search for the Pentaquark

BUCHEL, Alex (DTP/*DPT*) [TU-A6-3]
University of Western Ontario/Perimeter Institute

Transport Properties of Strongly Coupled Gauge Theory Plasma

BUTLER, Malcolm (DTP/*DPT*) [MO-P4-2]
St. Mary's University

Effective Field Theories for Nuclear Physics

CAGGIANO, Jac (DNP/DPN) [MO-A3-3]
TRIUMF

Nuclear Astrophysics at TRIUMF-ISAC

CAMPBELL, Melanie (DOP-DIAP-DMBP/*DOP-DPIA-DPMB*) [MO-A5-4]
University of Waterloo

Two-Photon Photodynamic Therapy and the Eye

CELLER, Anna (DMBP-DOP/*DPMB-DOP*) [MO-P6-2]
University of British Columbia / VGH

In Vivo Molecular Imaging - Quantitative and Dynamic SPECT Studies

CHEN, Mark (PPD) [WE-P7-5]
Queen's University

SNO+: SNO with Liquid Scintillator

CHIN, S.L. (DAMP-DOP/*DPAM-DOP*) [WE-A6-1]
Université Laval

The Physics of Femtosecond Laser Filamentation and its Potential Applications

CHOPTUIK, Matthew (DTP/*DPT*) [WE-P4-5]
University of British Columbia

Numerical Relativity in the World Year of Physics

CHUPP, Timothy (DNP/*DPN*) [WE-A4-2]
University of Michigan

Electric Dipole Moment Measurements with Radioactive Beams

COOKE, David (DCMMP/*DPMCM*) [TU-A8-1]
University of Alberta

Using Terahertz Pulses to Probe Ultrafast Carrier Dynamics in Semiconductor Nanostructures

CORKUM, Paul (DAMP/*DPAM*) [TU-A1-1]
National Research Council Canada

Attosecond Science

CORRIVEAU, François (PPD) [TU-P10-2]
IPP / McGill University

ZEUS Gets Polarized

DAMASCELLI, Andrea (DCMMP/*DPMCM*) [MO-A6-1]
University of British Columbia

Fermi Surface and Quasiparticle Excitations of Overdoped $Tl_2Ba_2CuO_{6+\delta}$

DE BRUYN, John (DCMMP/*DPMCM*) [WE-P5-1]
University of Western Ontario

Penetration of Spheres Into Loose Granular Media

DELGADILLO-HOLTFORT, Isabel (DIMP/*DPIM*) [MO-P8-5]
Ruhr-Universitaet Bochum

Nondestructive Locally Resolved Characterization of Thermophysical Properties of NiTi Shape-Memory Alloys

DIGNAM, Marc (DCMMP/*DPMCM*) [TU-A8-4]
Queen's University

High-Order Nonlinearities in the Ultrafast Optical Response of Biased Semiconductor Superlattices

DONOVAN, Eric (DASP/*DPAE*) [SU-P3-1]
University of Calgary

UV Imaging in Space, From ISIS to Ravens and Beyond

DRUMMOND, James R. (DASP/*DPAE*) [SU-A2-5]
University of Toronto

Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO)

DUNCAN, Fraser (PPD) [WE-P7-1]
Queen's University / SNOLAB

SNOLAB

DUTTA, Dipangkar (DNP/*DPN*) [WE-P2-2]
Duke University/TUNL

From Quarks to Nuclei: The Search for Signatures of QCD in Nuclei

EIGLER, Donald (DCMMP/*DPMCM*) [WE-A3-1]
IBM Almaden Research Center

Single-Atom Spin-Flip Spectroscopy

ERWIN, Steve (DCMMP/*DPMCM*) [MO-A6-3]
Naval Research Laboratory, Washington, DC

Self-Doping of Gold Chains on Silicon: A New Structural Model for Si(111)5x2-Au

EVANS, Evan (DMBP/*DPMB*) [WE-P3-3]
University of British Columbia

From Innate Immunity to Cell Death: Exploring the Energy Landscape Governing Membrane Permeation by Small Peptides with Dynamic Tension Spectroscopy

FARINE, Jacques A. (DNP/*DPN*) [MO-P2-4]
Laurentian University

Results from the Salt Phase of SNO

FORDE, Nancy (DMBP/*DPMB*) [TU-A7-1]
Simon Fraser University

Using Optical Tweezers for Single-Molecule Biophysics Studies

FOURNIER, Danièle (DIMP/*DPIM*) [MO-A8-1]
CNRS, UPR A0005 / UPMC / ESPCI

Microscale Thermal Imaging in Microelectronics : Optical Methods for 2005 .. and Beyond

FRANK, Mariana (DTP/*DPT*) [TU-A6-2]
Concordia University

Neutrino Masses and Mixings in rank-5 subgroups of E6

GARRETT, Paul (DNP/*DPN*) [TU-A4-5]
University of Guelph/TRIUMF

Gamma-Ray Spectroscopy with the 8π Array at TRIUMF-ISAC

GEGENBERG, Jack (DTP/*DPT*) [WE-P4-2]
University of New Brunswick

Quantization of Dilaton Gravity

GELBART, Dan (DIAP/*DPIA*) [MO-A11-4]
CREO

From Bad Idea to Great Company: The story of Creo

GINGRAS, Michel (DCMMP/*DPMCM*) [MO-A7-1]
University of Waterloo

Quantum Magnetism in the $LiHo_xY_{1-x}F_4$ Ising Material - Where do we Stand?

GOMIS, Jaume (DTP/*DPT*) [TU-P2-4]
Robarts Research Institute

to be announced

GRÉGOIRE, Thomas (DTP/*DPT*) [MO-P4-4]
CERN

Gravity Mediated Supersymmetry Breaking in Warped Brane Worlds

GRUNDLER, Dirk (DCMMP/*DPMCM*) [SU-A1-3]
University of Hamburg

Tailored Spin Dynamics in Nanostructured Ferromagnets

GUO, Houyang (DPP) [TU-P7-1]
University of Washington

A Unique High-Beta, Sustainable Plasma Confinement Configuration

HALL, Kimberley C. (DCMMP/*DPMCM*) [SU-P2-2]
Dalhousie University

Spin Control for Semiconductor Spintronics

HERON, Paula (DPE/*DEP*) [SU-A3-2]
University of Washington

Student Understanding of Thermal Physics: Microscopic Models and Macroscopic Processes

HIMPSEL, Franz J. (DCMMP/*DPMCM*) [MO-A6-2]
University of Wisconsin Madison

Atomic Chains: From Low- Dimensional Electrons to the Limits of Data Storage

HORNIDGE, David (DNP/*DPN*) [WE-P2-4]
Mount Allison University

The Magnetic Dipole Moment of the Δ(1232) Resonance

IKARI, Tetsuo (DIMP/*DPIM*) [WE-A9-2]
University of Miyazaki

Characterization of the Semiconductor Thin Film Quantum Structures by Using a Piezoelectric Photo-Thermal Spectroscopy (PPTS)

JAMES. H.G. (DASP/*DPAE*) [SU-A2-3]
Communications Research Centre

Radio-Science Experiments Using the RRI, GAP, and CERTO Instruments of the Enhanced Polar Outflow Probe Satellite Payload

JOHNSTON, Tudor (DPP) [TU-P7-4]
INRS-EMT

KEEN Waves: A New Nonlinear Wave Phenomenon in the Interaction of Waves With Plasmas

KALMAN, Calvin (DPE/*DEP*) [SU-A3-3]
Concordia University

Some Thoughts on Current Physics Educational Research

KATSARAS, John (DMBP/*DPMB*) [WE-P3-2]
National Research Council, Chalk River

Spontaneously Forming, Varying Polydispersity Unilamellar Lipid Vesicles

KAYSER, Boris (PPD) [WE-P1-1]
Fermi National Accelerator Laboratory, Chicago, USA

The Neutrinos: Discoveries and Open Questions

KEE, Hae-Young (DCMMP/*DPMCM*) [TU-P5-1]
University of Toronto

Anisotropic Spin Excitation in High Temperature Superconductors: Signature of Electronic Nematic Order

KENDALL, David (DASP/*DPAE*) [SU-A2-1]
Canadian Space Agency

Advancing Knowledge Through Science -- Canadian Space Agency's Role in Canada's Space Science Program

KIM, Young-June (DCMMP/*DPMCM*) [TU-A3-2]
University of Toronto

Inelastic X-Ray Scattering Study of Cuprate Superconductors

KNECHT, Neil (PPD) [MO-A9-2]
University of British Columbia

Unitarity Triangle Angles with BaBar

KNIGHT, Randall (DPE/*DEP*) [SU-P4-1]
California Polytechnic State University

Moving Physics Education Research from the "Laboratory" to the Classroom

KNUDSEN, David (DASP/*DPAE*) [SU-P3-2]
University of Calgary

Plasma Wind and Suprathermal Ion Imaging in Space: From GEODESIC to Cassiope e-POP to Swarm

KORPIUN, Peter (DIMP/*DPIM*) [TU-P9-4]
PA-Group Scheyern, Germany

Photoacoustic Detection of Sorption and Diffusion in Thin Layers of Porous Materials

KRAUSS, Carsten (PPD) [WE-P7-2]
Queen's University

Results of the Picasso Experiment and Development Towards a Large Scale SNOLAB Dark Matter Detector

KRÜCKEN, Reiner (DNP/*DPN*) [WE-A4-1]
Technical University Munich

Recent Results from REX-ISOLDE

KUBONO, Shigeru (DNP/*DPN*) [MO-A3-2]
University of Tokyo

Study of Stellar Reactions Relevant to Explosive Hydrogen Burning with Crib

KUMARAKRISHNAN, A. (DAMP/*DPAM*) [TU-A5-1]
York University

Precision Measurements using Laser Cooled Atoms

KUNZLE, Hans-Peter (DTP/*DPT*) [WE-P4-3]
University of Alberta

Spherical Symmetry of Generalized Einstein-Yang-Mills-Higgs Fields

LANGLEY, Richard B. (DASP/*DPAE*) [SU-P3-5]
University of New Brunswick

GPS Research In Space At UNB: E-POP And Beyond

LASSEN, Jens (DNP/*DPN*) [WE-A4-5]
ISAC/TRIUMF

Resonant Ionization Laser Ion Source - Application of Laser Spectroscopy in Nuclear and Particle Physics

LEBLANC, Roger M. (DIMP/*DPIM*) [TU-P8-3]
University of Miami

Spectroscopy and Imaging of Peptide-Capped Quantum Dots to Study Amyloid Aggregation

LEE, Paul (DTP/DMBP-*DPT/DPMB*) [MO-A4-1]
National Central University

Complexity, Universality, and Growth of Genomes

LESSARD, Roger (DIAP/*DPIA*) [TU-A12-2]
Université Laval

Holographic Memories

LEVICK, Andrew (DIMP/*DPIM*) [MO-P8-6]
National Physical Laboratory

Temperature Measurement of Levitated Metal Drops using the Laser Absorption Radiation Thermometry (LART)

LEVY, Julia (DOP-DIAP-DMBP/*DOP-DPIA-DPMB*) [MO-A5-1]
QLT Inc

Various Applications of Photodynamic Therapy

LEWIS, Randy (DNP/*DPN*) [WE-P2-3]
University of Regina

Recent Successes and Future Directions in Lattice QCD

LIN, Chii-Dong (DAMP/*DPAM*) [TU-P4-2]
University of Victoria

Probing Dynamics of Molecules with Few-Cycle Intense Laser Pulses

LLEWELLYN, E.J. (DASP/*DPAE*) [SU-A2-4]
University of Saskatchewan

OSIRIS on Odin: Advances Made with OSIRIS Measurements of Atmospheric Ozone

LOCKWOOD, David (CAP/DCMMP Brockhouse Medal Winner/*récipiendaire de la médaille Brockhouse ACP-DPMCM*) [SU-P1-1]
National Research Council of Canada

Bringing Silicon to Light!

LU, Qing-Bin (DOP-DIAP-DMBP/*DOP-DPIA-DPMB*) [MO-A5-2]
University of Waterloo

High Sensitivity Time-Resolved Femtosecond Laser Spectroscopic Studies of Light-Activated Drugs

LUKE, Graeme (DCMMP/*DPMCM*) [MO-A7-2]
McMaster University

Muon Spin Relaxation in Exotic Magnetic Systems

LUPIEN, Christian (DCMMP/*DPMCM*) [TU-A3-1]
Université de Sherbrooke

Probing the Hidden Order of Cuprates Superconductors with Very Low Temperature Scanning Tunneling Microscopy

LVOVSKY, Alex (DAMP/*DPAM*) [WE-P10-2]
University of Calgary

Homodyne Tomography for Quantum Information: A New Application for an Old Method

MACAULAY, Calum (DMBP-DOP/*DPMB-DOP*) [MO-P6-6]
University of British Columbia/BC Cancer Centre

Optical Techniques In Early Cancer Management

MACDONALD, Allan (DCMMP/*DPMCM*) [SU-P2-1]
Memorial University of Texas at Austin

Anomalous Transport in Metals and Semiconductors

MACKENZIE, Richard (DTP/*DPT*) [MO-P4-1]
Université de Montréal

Abelian Chern-Simons Q-Balls

MAEV, Roman (DIMP/*DPIM*) [TU-P9-5]
University of Windsor

Physics and Art: Look Inside

MAJARON, Boris (DIMP/*DPIM*) [TU-P8-2]
Jozef Stefan Institute

Toward Photothermal Imaging for Medicine

MALKIN, Shmuel (DIMP/*DPIM*) [TU-A10-4]
Weizmann Institute of Science

Photoacoustic Signals from Plant Leaves - Markers of Photosynthetic Activity

MANDELIS, Andreas (DIMP/*DPIM*) [MO-A8-4]
University of Toronto

Two-Beam Cross-Modulation Photo-Carrier Radiometry of Electronic Solids. Principles and Applications to Ion Implanted Silicon

MANN, Ian (DASP/*DPAE*) [SU-A2-6]
University of Alberta

Tackling the Van Allen Belts: The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS)

MANSANARES, Antonio (DIMP/*DPIM*) [WE-A9-3]
Physics Institute - University of Campinas - Brazil

Sensitivity Enhancement in Thermo-Reflectance Microscopy of Semiconductor Devices Using Suitable Probe Wavelengths

MARIC, Radenka (DCMMP/*DPMCM*) [MO-P5-4]
NRC Institute for Fuel Cell Innovation

Ceria Doped Materials As Electrolyte Materials For Low Temperature Solid Oxide Fuel Cells

MARZIALI, André (CAP Excellence in Teaching Medal Winner/*récipiendaire de la médaille l'ACP pour l'excellence en enseignement*)
University of British Columbia [MO-P1-1]

No, Really, I Want You To Talk In Class...

MARZLIN, Karl-Peter (DTP/*DPT*) [WE-A7-4]
University of Calgary

Applications of Electromagnetically Induced Transparency in Quantum Information

MAZNEV, A.A. (DIMP/*DPIM*) [WE-A9-4]
Philips Advanced Metrology Systems

Measuring Microelectronic Thin Films with Transient Grating Photoacoustics

MCDADE, Ian Carey (DASP/*DPAE*) [SU-P3-3]
York University

SWIFT - The Next Generation Atmospheric Wind Instrument

MCDERMOTT, Lillian (DPE/*DEP*) [SU-A3-1]
University of Washington

Physics Education Research: The Key to Student Learning

MCFARLAND, Ernie (DPE/*DEP*) [SU-P4-2]
University of Guelph

What's the Use of Demonstrations?

MCLEAN, Alastair (DCMMP/*DPMCM*) [MO-A6-4]
Queen's University at Kingston

Heteroepitaxy, Surfactants and Atomically Perfect Nanolines

MEIJER, Jan (DIMP/*DPIM*) [MO-A8-3]
Runr-Universitat Bochum

High Energy Ion Implantation and Industrial Applications

MICHAELIAN, Kirk H. (DIMP/*DPIM*) [TU-P9-3]
Natural Resources Canada

Signal Recovery in Step-Scan Photoacoustic Spectroscopy

MILLER, C.A. (DNP/*DPN*) [WE-P2-1]
TRIUMF

Studying Quark Confinement in the Nuclear Environment with Deeply Inelastic Scattering

MOFFAT, John (DTP/*DPT*) [WE-P4-1]
University of Waterloo/Perimeter Institute for Theoretical Physics

Gravitational Theory, Galaxy Rotation Curves and Cosmology Without Non-Baryonic Dark Matter

MOMOSE, Takamosa (DAMP/*DPAM*) [WE-P10-3]
University of British Columbia

Relaxation Dynamics of Molecules in Quantum Crystals

MOSCA, Michele (DTP/*DPT*) [WE-A7-5]
Waterloo/St. Jerome/Perimeter Institute

Quantum Phase Estimation

MOSTAGHIMI, Javad (DIMP/*DPIM*) [MO-P8-3]
University of Toronto

Surface Tension Measurement of High Temperature Liquids

MOUSSEAU, Normand (DTP-DMBP/*DPT-DPMB*) [MO-A4-2]
Université de Montréal

Wriggling and Hopping - A Study of Protein Dynamics

MYERS, Robert (CAP/CRM Medal Winner/*récipiendaire de la médaille ACP-CRM*) [WE-A1-1]
Perimeter Institute

Cosmic Superstrings

MYERS, Robert (DTP/*DPT*) [TU-P2-1]
Perimeter Institute

Warped Superstring Cosmology

NAYAK, Ashwin (DTP/*DPT*) [WE-A7-1]
Waterloo/Perimeter Institute

Near Optimal Quantum Test of Group Commutativity

NICOLAIDES, Lena (DIMP/*DPIM*) [MO-A8-5]
Therma Wave Inc

Advanced Non-Destructive Photo-Thermal Methods for Characterization of Ultra-Shallow Junctions

NITTA, Junsaku (DCMMP/*DPMCM*) [SU-A1-1]
NTT Basic Research Laboratories, CREST-JST

Spin-controlled Transportand Devices in Semiconductor Hetrostructures

NOERTERSHAEUSER, Wilfried (DNP/*DPN*) [TU-A4-2]
GSI

Electronic Eavesdropping on Nuclei: Determination of the ^{11}Li Charge Radius

O'NEIL, Dugan (PPD) [TU-P10-1]
Simon Fraser University

Latest Results from the D0 Experiment

PAGE, John (DCMMP/*DPMCM*) [WE-P5-4]
University of Manitoba

The Squishy Physics of Dough and Bread

PARANJAPE, Manu (DTP/*DPT*)
Université de Montréal [MO-P4-5}

The Josephson Effect and Pseudo-Goldstone Bosons

PARKER, Peter (DNP/*DPN*) [MO-A3-1]
Yale University

^{26}gAl+p, ^{26}mAl+p, and ^{25}Al+p Resonances

PATEL, Chandra (DIMP/*DPIM*) [TU-A10-1]
UCLA and Pranalytica, Inc

Optical Techniques for High Sensitivity, High Selectivity Detection of Chemical Warfare Agents

PEARSON, Chris (DNP/*DPN*) [WE-A4-6]
TRIUMF

Gamma Ray Tracking in Segmented Germanium Detectors

PLOTKIN, Steve (DTP-DMBP/*DPT-DPMB*) [MO-A4-3]
University of British Columbia

Many Body Forces and Topology in Protein Folding

POISSON, Eric (CAP Herzberg Medal winner /récipiendaire de la médaille ACP Herzberg) [TU-A2-1]
University of Guelph

Tidal Heating of Black Holes

POSPELOV, Maxim (DNP/*DPN*) [MO-P2-1]
University of Guelph/Perimeter Institute/University of Victoria

Precision Tests of the Standard Model at Low Energies

POWER, J.F. (DIMP/*DPIM*) [WE-P9-1]
McGill University

Raman Effect Light Profile Microscopy

QURAAN, Maher (PPD) [MO-A9-1]
University of Alberta / TRIUMF

First Results on Muon Decay from TWIST

RAGAN, Kenneth J. (PPD) [WE-P7-6]
IPP / McGill University

On to VERITAS

RANGAN, Chitra (DAMP/*DPAM*) [WE-P10-1]
University of Windsor

Coherent Control and Quantum Information Processing in Rydberg Atoms

RANKIN, Robert (DASP/*DPAE*) [SU-P3-4]
University of Alberta

A Grid-based Portal for e-POP/CASSIOPE Data Dissemination

RATSCH, Christian (DSS) [MO-P9-4]
University of California Los Angeles

A Level-Set Method For Epitaxial Growth And Self-Organization Of Quantum Dots

RAYNER-CANHAM, Geoff (CEWIP/*CEFEP*) [MO-P12-1]
Sir Wilfred Grenfell College

Harriet Brooks: Pioneer Canadian Woman Physicist

RODRIGUEZ, M. (DIMP/*DPIM*) [MO-A8-2]
UNAM Mexico

Photothermal and Optical Characterization of Intrinsic and Te-doped GaSb Wafers

ROMANOV, Dmitry V. (DPP) [TU-A9-1]
University of Alberta

Plasma Physics of Photoionized Gases by Short X-Ray Pulses

ROY, Pierre-Nicholas (DAMP/*DPAM*) [MO-A10-1]
University of Waterloo

Structure and Dynamics of Weakly-Bound Clusters

ROZALI, Moshe (DTP/*DPT*) [TU-P2-3]
University of British Columbia

Helicity Amplitudes in Supersymmetric gauge Theories

RYAN, Dominic (DCMMPP/*DPMCM*) [MO-P5-3]
McGill University

Proximity-Induced Magnetisation of Palladium in Pd-Fe Multilayers

SANDERSON, Joseph (DAMP-DOP/*DPAM-DOP*) [WE-A6-4]
University of Waterloo

Controlling and Imaging Molecules with Ultrashort Laser Pulses

SARAZIN, Fred (DNP/*DPN*) [TU-A4-1]
Colorado School of Mines

Halo Neutrons and the Beta-Decay of ^{11}Li

SARTY, Adam (DPE/*DEP*) [SU-P4-3]
St. Mary's University

Wireless Responders in First-Year Physics Lectures: Attempting to Assess Effectiveness

SCHLEICH, Kristin (DTP/*DPT*) [WE-P4-4]
University of British Columbia

Topological Censorship and Beyond: Black Holes and Singularities in Dimension Greater Than 4

SCHMID, Andreas K. (DSS) [MO-P9-1]
Lawrence Berkeley National Laboratory

Exploring Magnetic Nanostructures By Spin Polarized Low Energy Electron Microscopy

SCHUESSLER, Hans A. (DIMP/*DPIM*) [TU-P9-2]
Texas A&M University

Linear and Nonlinear Laser Opto-Acoustic Measurements in Solids From the Macro- to the Nano-Scale

SHAPIRO, Moshe (DTP/*DPT*) [WE-A7-2]
University of British Columbia

Principle of Coherent Control and the Detection and Automatic Repair of Mutations by Coherent Light

SHEN, Jun (DIMP/*DPIM*) [WE-P9-2]
National Research Council Canada

Methanol Concentration Sensors for Direct Methanol Fuel Cell Systems: A Review

SHEN, Jun (DIMP/*DPIM*) [MO-P8-1]
National Research Council Canada

An Overview of Thermal-Wave Resonant Cavity Technique

SHER, Aleksey (PPD) [MO-P11-1]
TRIUMF

KOPIO: Study of the CP-Violating Decay $K_L^0 \rightarrow \pi^0 \nu \bar{\nu}$

SHIELL, Ralph (DAMP/*DPAM*) [MO-P3-4]
Trent University

Coherent Spectroscopy: Population Trapping and Stark Wave Packets

SIGRIST, Markus W. (DIMP/*DPIM*) [TU-A10-2]
Swiss Federal Institute of Technology (ETH)

Laser Spectroscopy in Trace Gas Analysis

SMIRNOVA, Olga (DAMP-DOP/*DPAM-DOP*) [WE-A6-3]
National Research Council / Vienna University of Technology

Attosecond Measurements Without Attosecond Pulses: Using Particle Correlation

SONIER, Jeff (DCMMP/*DPMCM*) [TU-P5-5]
Simon Fraser University

Hole-Doping Dependence of the Effective Magnetic Penetration Depth and Vortex Core Size in $Y_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$

SOSSI, Vesna (DMBP-DOP/*DPMB-DOP*) [MO-P6-1]
University of British Columbia/TRIUMF

In-Vivo Detection of Early Compensatory Changes in Parkinson's Disease Using Positron Emission Tomography: A Physicist Perspective

SPANNER, Michael (DAMP/*DPAM*) [MO-P3-1]
University of Toronto

Field-Free Alignment and Strong Field Control of Molecular Rotors

SPRINGTHORPE, Anthony (CAP/DIAP Medal Winner/récipiendaire de la médaille ACP-DPIA)
National Research Council of Canada [WE-A2-1]

III-V Compound Semiconductor Epitaxy:- Then and Now

STOTZ, James (DCMMP/*DPMCM*) [SU-P2-3]
Paul-Drude-Institut fur Festkorperelektronik, Germany

Coherent Spin Transport Via Dynamic Quantum Dots

TERAZIMA, Masahide (DIMP/*DPIM*) [TU-P9-1]
Kyoto University

Time-Resolved Study of Refractive Index Change After Irradiation of Ultra-Short Laser Pulse Inside Glasses

TIEDJE, T. (DCMMP/*DPMCM*) [TU-P6-3]
University British Columbia

Surface Dynamics During MBE Growth of GaAs on Patterned Substrates

TUSZYNSKI, Jack (DTP-DMBP/*DPT-DPMB*) [MO-A4-4]
University of Alberta

New Nano-Scale Oncotherapy Approaches Inspired by Computational Biophysics

UNSWORTH, Larry (DCMMP/*DPMCM*) [MO-P5-2]
McMaster University

End-Thiolated Monomethoxy PEO Molecular Architecture Evolution And Its Effect On Protein Adsorption: Investigated Using Neutron Reflectometry

VAN RAAMSDONK, Mark (DTP/*DPT*) [TU-P2-2]
University of British Columbia

An Analytic Study of Confinement/Deconfinement in Four Dimensional Gauge Theory

VINCETT, Paul (DIAP/*DPIA*) [MO-A11-1]
School of Business & Economics/Wilfried Laurier University

Economic Impacts of Academic Research: Canadian Physics Shows a Profit!

VINCTER, Manuella Greta (PPD) [TU-A11-1]
Carleton University

Into the Unknown: TeV Physics with the ATLAS Detector

WARBURTON, Andreas (PPD) [TU-A11-2]
IPP / McGill University

Recent Results from the Collider Detector at Fermilab

WHELAN, William M. (DIMP/*DPIM*) [TU-P8-1]
Ryerson University

Interstitial Optical Radiance Measurements: A New Approach to Guiding Laser Thermal Therapies

WHITEHEAD, Lorne (DIAP/*DPIA*) [MO-A11-2]
University of British Columbia

High Dynamic Range Displays - a Multi-Disciplinary Challenge

WIEBE, Christopher (DCMMP/*DPMCM*) [TU-A3-3]
Brock University

Quantum Phase Transitions as Routes to Strange Materials

WILL, Clifford M. (CAP / *ACP*) [SU-KEY]
Washington University, St. Louis

Was Einstein Right?

WISE, Mark (DTP/*DPT*) [TU-A6-1]
Caltech

Naturalness and the Values of Cosmological Parameters

WOLOSHYN, Richard (DTP/*DPT*) [TU-A6-4]
TRIUMF

Acting Chiral: Light Quarks in Lattice QCD

WOODS, Michael (DNP/*DPN*) [MO-P2-2]
Stanford Linear Accelerator Center (SLAC)

Results from SLAC E-158: A Study of Parity Violation in Moller Scattering

WORTIS, Michael (DMBP/*DPMB*) [WE-P3-1]
Simon Fraser University

Biomechanics of Human Red-Cell Shapes: The Stomatocyte-Discocyte-Echinocyte Sequence

XU, Li-Hong (DAMP/*DPAM*) [MO-A10-4]
University of New Brunswick, St. John)

Torsion-Mediated Intramolecular Vibrational Energy Redistribution in Methyl-Top Molecules: High Resolution Findings and Ab Initio Assisted Dynamics

XU, Yunjie (DAMP/*DPAM*) [MO-A10-2]
University of Alberta

Infrared Laser Spectroscopy and ab initio Investigations of Chiral Recognitions

YE, Jun (DAMP-DOP/*DPAM-DOP*) [WE-A6-2]
JILA, University of Colorado

Ultrafast-Based Precision Measurements and Control in Ultracold World

YETHIRAJ, Anand (DCMMP/*DPMCM*) [TU-A3-4]
Memorial University of Newfoundland

Self-Assembly in Soft Matter: Structure and Kinetics in Colloids and in Surfactant Mesophases, and the Creation of Photonic Crystals

YORK, Derek (CAP Medal of Achievement winner /récipiendaire de la médaille de l'ACP pour contributions exceptionnelles à la physique) [TU-P1-1]
University of Toronto

In Search of Lost Time

ZEIDLER, Dirk (DAMP/*DPAM*) [MO-P3-2]
National Research Council Canada

Controlling Double Ionization Dynamics via Molecular Alignment

ZENG, Haishan (DOP-DIAP-DMBP/*DOP-DPIA-DPMB*) [MO-A5-3]
BC Cancer Research Centre

Dosimetry for Photodynamic Therapy

ZHANG, Shu-Yi (DIMP/*DPIM*) [MO-P8-4]
Institute of Acoustics, Nanjing University

Characterization of Thermal Parameters of Materials by Scanning Thermal Wave Microscopies

ZHITNITSKY, Ariel (DTP/*DPT*) [MO-P4-3]
University of British Columbia

Topological Phenomena in QCD at Large Baryon Density

ZMESKAL, Johann (DIAP/*DPIA*) [MO-A11-3]
Stephan Meyer Institute, Vienna

Cutting Edge Physics in the European Union - an Outlook and Review

LEGEND/*LÉGENDE*
SUB = Student Union Building
IRC = Woodward
CEME = Civil & Mechanical Eng.
FNSC = Family & Nutritional Sciences
G279-hos = University Hospital
HENN = Hennings Physics Building

CAP CONGRESS / CONGRÈS DE L'ACP

UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, BC

JUNE 5-8 JUIN 2005

Saturday / Samedi, June 4 juin

09h00 (all day)	**High School Teachers' Workshop**	IRC 1 (133)
09h30 - 14h00	CAP Executive Meeting / *Réunion de l'exécutif de l'ACP* (SA-A2)	SUB Council Chamber
14h00 - 18h00	CAP Council Meeting (Old and New) / *Réunion du conseil (ancien et nouveau) de l'ACP* (SA-P1)	SUB Council Chamber

Sunday / Dimanche, June 5 juin

08h00 - 18h00	**Conference Registration and Information / *Inscription au Congrès et information***	IRC Foyer
18h00 - 19h00	**Conference Registration and Information / *Inscription au Congrès et information***	Chan Centre
08h30 - 12h30	CAP - Physics Department Heads/Chairs Workshop - Wall Centre *ACP - Réunion des directeurs de départements de physique* (SU-HEADS) - Wall Centre	Univ. Centre
09h00 - 12h00	IPP Board of Trustees Meeting / *Réunion du conseil d'administration de l'IPP* (SU-IPP-AM)	TRIUMF Conf.Rm.
09h30 - 12h30	Spin Electronics - a.m. session / *Spintronique - session du matin* (SU-A1)	IRC 2 (500)
09h30 - 13h00	Canadian Space Science Satellites for the Twenty-First Century: SciSat to CASSIOPE and Beyond - A.M. Session / *Les satellites canadiens pour le 21e siècle : De SciSat à CASSIOPE et au delà - avant-midi* (SU-A2)	IRC 3 (108)
10h00 - 12h30	Developments in Physics Education Research - a.m. session / *Nouveautés en recherche sur l'enseignement des sciences* (SU-A4)	IRC 1 (133)
13h30 - 14h15	**CAP Brockhouse Medal Winner / *Récipiendaire de la médaille Brockhouse de l'ACP*** ***- DAVID LOCKWOOD, National Research Council*** (SU-P1)	IRC 2 (500)
14h15 - 16h45	Spin Electronics - p.m. session / *Spintronique - session d'après-midi* (SU-P2)	IRC 2 (500)
14h15 - 17h00	Canadian Space Science Satellites for the Twenty-First Century: SciSat to CASSIOPE and Beyond - P.M. Session / *Les satellites canadiens pour le 21e siècle : de SciSat à CASSIOPE et au delà - après-midi*..... (SU-P3)	IRC 3 (108)
14h15 - 16h15	Engaging Students in the Classroom / *Implication des étudiants dans la salle de cours* (SU-P4)	IRC 1 (133)
14h30 - 17h30	IPP General Meeting / *Assemblée générale (IPP)* (SU-IPP-PM)	IRC 4 (135)
16h30 - 18h30	Student Réception / *Réception pour les étudiants* (SU-GRAD) - Thea Koerner House, 6371 Crescent Road	Grad.Stud.Centre
19h00 - 21h00	**CAP's Herzberg Public Commemorative Memorial Lecture / *Conférence publique commémorative Herzberg de l'ACP*** **- Dr. Clifford Will, Washington University, St. Louis - (SU-KEY)**	Chan Centre
21h00 - 22h30	**Opening Réception / *Réception d'accueil***	Chan Centre

Monday / Lundi, June 6 juin

07h30 - 17h00	**Conference Registration and Information / *Inscription au Congrès et information***	IRC Foyer
07h00 - 08h15	"Friends of CAP" Breakfast / *Déjeuner des "Ami(e)s de l'ACP"* (MO-FRIENDS)	SUB Council Ch.
08h15 - 09h45	**Science Policy Session**: "How Can Canada's Physicists Help Promote Investment in Science?" (MO-A1) ***Session de Politique scientifique**: Comment les physiciens au Canada peuvent-ils promouvoir l'investissement en science?*	IRC 2 (500)
10h00 - 12h30	Polymeric and Organic Materials / *Matériaux polymères et organiques* (MO-A2)	IRC 3 (108)
10h00 - 12h30	Nuclear Astrophysics / *Astrophysique nucléaire* (MO-A3)	CEME 1204 (60)
10h00 - 12h30	Theoretical Biology / *Biologie théorique* (MO-A4)	G279-hos (140)
10h00 - 12h30	Photodynamic Therapy / *Thérapie photodynamique* (MO-A5)	IRC 6 (226)
10h00 - 12h00	Low Dimensional Systems / *Systèmes à peu de dimensions* (MO-A6)	IRC 1 (133)
10h00 - 12h15	Correlated Electrons: Magnetism / *Électrons corrélés : magnétisme* (MO-A7)	IRC 2 (500)
10h00 - 12h30	Semiconductor and Thin Film Characterization I / *Caractérisation des films minces et des semi-conducteurs I* (MO-A8)	IRC 4 (135)
10h00 - 12h30	Precision Frontier in Particle Physics I / *Les limites de la précision en physique des particules I* (MO-A9)	CEME1202 (119)
10h00 - 12h15	Atomic and Molecular Spectroscopy & Dynamics / *Spectroscopie et dynamique des atomes et molécules* (MO-A10)	IRC 5 (120)
10h15 - 12h30	Impacts of Academic Science at Home and Abroad / *Impact de la science dans les universités - au pays et à l'étranger* (MO-A11)	FNSC 60 (119)
12h30 - 13h30	DASP Business Meeting / *Réunion d'affaires DPAE* (with lunch / *avec repas*)	IRC 5 (120)
12h30 - 13h30	DCMMP Business Meeting / *Réunion d'affaires DPMCM* (with lunch / *avec repas*)	IRC 3 (108)
12h30 - 13h30	DNP Business Meeting / *Réunion d'affaires DPN* (with lunch / *avec repas*)	CEME 1204 (60)
12h30 - 13h30	DTP Business Meeting / *Réunion d'affaires DPT* (with lunch / *avec repas*)	G279-hos. (140)
12h30 - 13h30	DPP Business Meeting / *Réunion d'affaires DPP* (with lunch / *avec repas*)	IRC 1 (133)
12h30 - 14h15	CAP Past Presidents' Lunch / *Déjeuner des anciens présidents de l'ACP* (MO-Pres) - SAGE Bistro	Univ. Centre

13h30 - 14h15	**Teaching Medal winner / *récipiendaire de la médaille d'enseignement* - ANDRE MARZIALI, UBC** (MO-P1)	IRC 2 (500)
14h15 - 17h15	Tests of the Standard Model / *Tests du modèle standard* (MO-P2)	CEME 1204 (60)
14h15 - 17h00	Coherent Interaction with Atoms and Molecules / *Interactions cohérentes entre les atomes et les molécules* (MO-P3)	IRC 4 (135)
14h15 - 16h45	Field Theory / *Théorie des champs* (MO-P4)	IRC 1 (133)
14h15 - 16h45	InterfaceScience / *La science des interfaces* (MO-P5)	IRC 3 (108)
14h15 - 17h00	Biomedical Imaging / *Imagerie biomédicale* (MO-P6)	G279-hos. (140)
14h15 - 17h15	Condensed Matter Student Paper Competition / *Compétition étudiante pour le meilleur papier présenté* (MO-P7)	IRC 2 (500)
14h15 - 17h30	Thermophysics and Thermal Sensors / *Thermophysique et senseurs thermiques* (MO-P8)	IRC 6 (226)
14h15 - 16h30	Frontiers in Surface Science / frontières en physique des surfaces (MO-P9)	IRC 5 (120)
14h15 - 17h00	Atmospheric and Space Contributed / Papiers présentés en physique de l'atmosphère et de l'espace (MO-P10)	FNSC 60 (119)
14h15 - 16h45	Precision Frontier in Particle Physics II / *Les limites de la précision en physique des particules II* (MO-P11)	CEME1202 (119)
17h30 - 19h00	Harriet Brooks: Early Canadian Nuclear Physicist / *Amélioration du climat pour les femmes en physique* (MO-P12)	Hennings 200
18h30 - 19h00	CJP Editorial Board Meeting / *Réunion du Comité de rédaction de la RCP* (MO-CJP)	SUB Council Ch
19h00 - 20h30	**Poster Session, with Beer / *Session d'affiches, bière servie* (MO-POS)**	SUB Ball Room
	DASP/*DPAE* (2); DAMP/*DPAM* (17); DCMMP/*DPMCM* (40); DIAP/*DPIA* (1); DMBP/*DPMB* (7); DNP/*DPN* (1); DOP (2); PPD (3); DPE/*DEP* (4); DPP (1); DSS (3); DTP/*DPT* (13)	

Tuesday / Mardi, June 7 juin

07h30 - 17h00	**Conference Registration and Information / *Inscription au Congrès et information***	IRC Foyer
07h00 - 09h00	Meeting of the Canadian National IUPAP Liaison Committee *Réunion du comité de liaison national canadien (IUPAP)*	SUB Council Ch
08h15 - 09h00	**Plenary Session / *Session plénière* - PAUL CORKUM, NRC** (TU-A1)	IRC 2 (500)
09h00 - 09h45	**CAP Herzberg Medal winner - récipiendaire de la médaille Herzberg de l'ACP) (TU-A2)** **ERIC POISSON, U of Guelph**	IRC 2 (500)
10h00 - 12h00	DCMMP Young Investigators I / *Jeunes chercheurs en matières condensées I (TU-A3)*	IRC 3 (108)
10h00 - 12h45	Nuclear Structure / *Structure nucléaire (TU-A4)*	CEME 1204 (60)
10h00 - 12h15	Cooling and Trapping of Atoms / *Refroidissement et capture d'atomes et de molécules (TU-A5)*	IRC 4 (135)
10h00 - 12h30	Particle Theory / *Théorie des particules élémentaires (TU-A6)*	IRC 1 (133)
10h00 - 11h45	DMBP Young & New Investigators / *Jeunes et nouveaux chercheurs en physique médicale et biologique (TU-A7)*	G279 -hos. (140)
10h00 - 12h15	Semiconductors / *Semiconducteurs (TU-A8)*	IRC 2 (500)
10h00 - 12h15	Plasmionique Best Student Prize / *Prix plasmionique pour la meilleure présentation par un étudiant en plasma (TU-A9)*	FNSC 50 (45)
10h00 - 12h15	Biotechnologies and Biothermophotonic Instruments and Methods I / *Instrumentation et techniques en biotechnologie et biophotonique I (TU-A10)*	FNSC 60 (119)
10h00 - 12h30	Energy Frontier in Particle Physics I / *La limite en énergie en physique des particules I (TU-A11)*	CEME1202 (119)
11h00 - 12h00	Applications of Photonics / *Applications de la photonique (TU-A12)*	IRC 6 (226)
12h00 - 12h30	DIAP Business Meeting / *Réunion d'affaires DPIA* (with lunch / *avec repas*)	IRC 6 (226)
12h15 - 13h15	DMBP Business Meeting / *Réunion d'affaires DPMB* (with lunch / *avec repas)*	G279-hos. (140)
12h30 - 13h15	DAMP Business Meeting / *Réunion d'affaires DPAM* (with lunch / *avec repas*)	IRC 4 (135)
12h30 - 13h15	DIMP Business Meeting / *Réunion d'affaires DPIM*	IRC 6 (226)
12h30 - 13h15	PPD Business Meeting / *Réunion d'affaires PPD*	CEME1202 (119)
12h15 - 13h00	Physics in Canada Editorial Board Meeting / *Réunion du Comité de rédaction de La physique au Canada* (MO-PiC)	IRC G41/42
13h15 - 13h30	**Best student paper competitors announced / Les compétiteurs dans la compétition meilleur communication annoncés**	IRC 2 (500)
13h30 - 14h15	**CAP Medal of Achievement winner - Récipiendaire de la médaille ACP (TU-P1)** **DEREK YORK, U of Toronto**	IRC 2 (500)
14h15 - 16h45	String Theory / *Théorie des cordes (TU-P2)*	IRC 1 (133)
14h15 - 16h45	DMBP Contributed / *Papiers présentés en physique médicale et biologique (TU-P3)*	G279 -hos. (140)
14h15 - 16h45	Strong Field Physics and Spectroscopy / *Physique et spectroscopie en champ fort (TU-P4)*	IRC 6 (226)
14h15 - 16h45	Correlated Electrons: Superconductivity / *Électrons corrélés : supraconductivité (TU-P5)*	IRC 2 (500)
14h15 - 16h30	Materials: Growth and Characterization / *Matériaux : croissance et caractérisation (TU-P6)*	IRC 3 (108)
14h15 - 16h30	General Plasma Physics / *Physique générale des plasmas (TU-P7)*	IRC 4 (135)
14h15 - 16h30	Biotechnologies and Biothermophotonic Instruments and Methods II / *Instrumentation et techniques en biotechnologie et biophotonique II (TU-P8)*	FNSC 60 (119)
14h15 - 17h15	Laser Ultrasonics and Photoacoustics / *Caractérisation ultrasonique et photo-acoustique des matériaux par laser (TU-P9)*	FNSC 50 (45)
14h15 - 17h00	Energy Frontier in Particle Physics II / *La limite en énergie en physique des particules II (TU-P10)*	CEME1202 (119)
17h00 - 18h30	**CAP Annual General Meeting / *Assemblée générale de l'ACP***	IRC 2 (500)
19h00	**Banquet Réception / *Réception du banquet***	SUB Party Rm
19h30	**Banquet**	SUB Ballroom

Wednesday / Mercredi, June 8 juin

07h30 - 12h00	**Conference Registration and Information / *Inscription au Congrès et information***	IRC Foyer
07h00 - 09h00	Meeting of the CAP-NSERC Liaison Committee / *Réunion du comité de liaison ACP-CRSNG* (WE-A1)	SUB Coun.Cham
08h15 - 09h00	**CAP/CRM Medal winner - récipiendaire de la médaille ACP/CRM (WE-A1)** ROBERT MYERS, Perimeter Institute	IRC 2 (500)
08h15 - 09h00	**CAP Industrial and Applied Medal winner -récipiendaire de la médaille pour les réalisations exceptionnelles en physique industrielle et appliquée (WE-A2)** ANTHONY SPRINGTHORPE, NRC	IRC 4 (135)
09h00 - 09h45	**Plenary Session / *Session plénière* - DONALD EIGLER,** IBM Almaden Research Center (WE-A3)	IRC 2 (500)
10h00 - 12h45	Instrumentation for Nuclear Physics */ Instrumentation en physique nucléaire (WE-A4)*	CEME 1204 (60)
10h00 - 12h30	Instrumentation for Particle Physics */ Instrumentation en physique des particules (WE-A5)*	CEME1202 (119)
10h00 - 12h30	Ultrafast Science and Applications / *Science et applications des processus ultrarapides (WE-A6)*	IRC 4 (135)
10h00 - 12h30	Quantum Information Computing / *Information/ordinateur quantique (WE-A7)*	IRC 1 (133)
10h00 - 12h00	Nanoscale Physics */ Physique nanométrique (WE-A8)*	IRC 2 (500)
10h00 - 12h15	Semiconductor and Thim Film Characterization II / *Caractérisation des films minces et des semi-conducteurs II* (WE-A9)	IRC 6 (226)
10h00 - 12h30	Best Student Paper Competition */ Compétition étudiante pour le meilleur papier présenté (WE-A10)*	IRC 3 (108)
12h15 - 13h00	Young-New Faculty Luncheon with NSERC, followed by workshop / *Déjeuner-rencontres des jeunes-nouveaux professeurs avec le CRSNG, suivi d'un atelier*	IRC G41/42
13h00 - 13h30	**NSERC Workshop / *Atelier du CRSNG***	IRC 1 (133)
13h15 - 13h30	**Best student paper competition winners announced / Les résultats de la compétition meilleur communication annoncés**	IRC 2 (500)
13h30 - 14h15	**Plenary Session / *Session plénière* - BORIS KAYSER,** Fermilab, Chicago (WE-P1)	IRC 2 (500)
14h15 - 17h00	QCD in Nuclear Physics / *QCD en physique nucléaire* (WE-P2)	CEME 1204 (60)
14h15 - 15h45	Membranes and Vesicles / *Membranes et vésicules* (WE-P3)	G279 -hos. (140)
14h15 - 16h45	General Relativity and Gravitation / *Relativité générale et gravité* (WE-P4)	IRC 1 (133)
14h15 - 17h00	Soft Matter / *Matière molle* (WE-P5)	IRC 2 (500)
14h15 - 17h00	Correlated Electrons: Mostly Thin Films / *Électrons corrélés : Surtout les films minces* (WE-P6)	IRC 3
14h15 - 17h30	Non-Accelerator Particle Physics / *Physique des particules sans accélerateur* (WE-P7)	IRC 6 (226)
14h15 - 16h15	Advances in Optics and Photonics / *Progrès en optique et photonique* (WE-P8)	IRC 5 (120)
14h15 - 16h45	Analytical Techniques and Sensors / *Techniques analytiques et senseurs pour la physique et l'évaluation non-destructive* (WE-P9)	IRC 4
14h15 - 16h15	Quantum Coherence, Relaxation and Theory / *Cohérence quantique, relaxation et théorie* (WE-P10)	CEME1202 (119)
17h00 - 18h30	**Meeting of New and Old CAP Council / Réunion du nouveau et de l'ancien conseil de l'ACP**	SUB Council Chamber

DETAILED CONGRESS SUMMARY
PROGRAMME DÉTAILLÉ DU CONGRÈS

(SEE PG. 20 FOR DESCRIPTION OF CODES-ABBREVIATIONS / VOIR PG. 20 POUR UNE DESCRIPTION DES CODES-ABBRÉVIATIONS)
(ABSTRACTS START ON PAGE 50 / LES RÉSUMÉS COMMENCENT À LA PAGE 50)

Saturday, June 4, 2005 / *Samedi, le 4 juin*

09h00 (all day)	**High School Teachers' Workshop / *Atelier pour les professeurs du secondaire***	IRC 1 (cap. 133)
09h30 - 14h00	CAP Executive Meeting / *Réunion de l'exécutif de l'ACP* (SA-A2)	SUB Council Chamber
14h00 - 18h00	CAP Council Meeting (Old and New) / *Réunion du conseil (ancien et nouveau) de l'ACP* (SA-P1)	SUB Council Chamber

Sunday, June 5, 2005 / *Dimanche, le 5 juin*

TIME HEURE	IRC 2 (500)	IRC 3 (cap. 108)	Other Rooms/Autres salles
	SU-A1 (DCMMP / *DPMCM*) **SPIN ELECTRONICS - A.M. / *SPINTRONIQUE A.M.*** Chair: T. Chakroborty, U.Manitoba	**SU-A2** (DASP / *DPAE*) **CDN. SPACE SCIENCE SATELLITES FOR THE 21ST CENTURY: SCISAT TO CASSIOPE AND BEYOND - A.M. / *LES SATELLITES CANADIENS POUR LE 21E SIÈCLE : DE SCISAT À CASSIOPE ET AU DELÀ - A.M.*** Chair: M. Connors, Athabasca Univ.	**08h30-12h30** **Wall Centre, Univ. Centre** (CAP-*ACP*) Physics Department Heads/Chairs Workshop / *Réunion des directeurs de départements de physique* (SU-CHAIRS)
09h00			**09h00-12h00** **TRIUMF Conf.Room** IPP Board of Trustees Meeting *Réunion du conseil d'administration de l'IPP* (SU-IPP-AM)
09h30	**NITTA, Junsaku** CREST-JST *Spin-controlled transport and devices in semiconductor heterostructures* (SU-A1-1)	**KENDALL, David** Cdn. Space Agency *Advancing Knowledge through Science - Canadian Space Agency's Role in Canada's Space Science Program* (SU-A2-1)	**SU-A3** **IRC 1 (133)** **DEVELOPMENTS IN PHYSICS EDUCATION RESEARCH / *NOUVEAUTÉS EN RECHERCHE SUR L'ENSEIGNEMENT DES SCIENCES*** (DPE / *DEP*) Chair: R.I. Thompson, U.Calgary
10h00	**AWSCHALOM, David** U.California-S.B. *Spintronics: Semiconductors, Molecules, and Quantum Information Processing* (SU-A1-2)	**BERNATH, Peter** U.of Waterloo *Atmospheric Chemistry Experiment (ACE): First Results* (SU-A2-2)	**McDERMOTT, Lillian** U.Washington *Physics education research: The key to student learning* (SU-A3-1)
10h30	**Coffee Break / *Pause café***	**JAMES, H. George** Comm.Research Centre *Radio-science experiments using the RRI, GAP, and CERTO instruments of the enhanced Polar Outflow Probe satellite payload* (SU-A2-3)	**HERON, Paula** U.Washington *Student understanding of thermal physics: Microscopic models and macroscopic processes* (SU-A3-2)
11h00	**GRUNDLER, Dirk** Inst.für Angewandte Physik *Tailored spin dynamics in nanostructured ferromagnets* (SU-A1-3)	**Coffee Break / *Pause café***	**Coffee Break / *Pause café***
11h15	↓	↓	**KALMAN, Calvin S.** Concordia U. *Some thoughts on current physics educational research* (SU-A3-3)
11h30	Morning Session ends / *Fin de la session du matin* Lunch / déjeuner	**LLEWELLYN, E.J.** U. Saskatchewan *OSIRIS on Odin: Advances made with OSIRIS measurements of atmospheric ozone* (SU-A2-4)	↓
11h45		↓	**R. Kruhlak (c)** U. of Auckland *Online practice and assessment in first year physics* (SU-A3-4)
12h00		**DRUMMOND, James R.** U.Toronto *Measurements of Aerosol Extinction in the Stratosphere and Troposphere retrieved by Occultation (MAESTRO)* (SU-A2-5)	**D. Ahrensmeier (c)** U. Winnipeg *Teaching physics to apples and oranges* (SU-A3-5)
12h15		↓	**M. Milner-Bolotin (c)** UBC *The role and place of imagination in contemporary science education: The case study of introductory physics courses* (SU-A3-6)
12h30		**MANN, Ian** U.Alberta *Tackling the Van Allen Belts: The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS)* (SU-A2-6)	Morning Session ends / *Fin de la session du matin* Lunch / déjeuner
13h00		Morning Session ends / *Fin de la session du matin* Lunch / déjeuner	

Sunday, June 5, 2005 / *Dimanche, le 5 juin* *(cont'd / suite)*

IRC 2 (cap. 500)	IRC 3 (cap. 108)	Other Rooms / *Autres endroits*	TIME HEURE
SU-P1 Plenary Session plénière (CAP Brockhouse Medal winner / Récipiendaire de la médaille Brockhouse de l'ACP) Chair: B. Joos, U.Ottawa **DAVID LOCKWOOD** NRC *Bringing Silicon to Light!* **(SU-P1-1)**			**13h30**
SU-P2 (DCMMP / *DPMCM*) **SPIN ELECTRONICS - P.M. / SPINTRONIQUE - *APRÈS-MIDI*** Chair: T. Chakraborty, U.Manitoba	**SU-P3** (DASP / *DPAE*) **CDN. SPACE SCIENCE SATELLITES FOR THE 21ST CENTURY: SCISAT TO CASSIOPE AND BEYOND - P.M. / *LES SATELLITES CANADIENS POUR LE 21E SIÈCLE : DE SCISAT À CASSIOPE ET AU DELÀ - APRÈS-MIDI*** Chair: A. Yau, U.Calgary	**SU-P4** IRC 1 (cap. 133) (DPE / *DEP*) **ENGAGING STUDENTS IN CLASSROOMS / *IMPLICATION DES ÉTUDIANTS DANS LA SALLE DE COURS*** Chair: R.I. Thompson, U.Calgary	**14h15**
MacDONALD, Allan U.Texas at Austin *Anomalous transport in metals and semiconductors* **(SU-P2-1)**	**DONOVAN, Eric** U.Calgary *UV imaging in space: from ISIS to Ravens and beyond* **(SU-P3-1)**	**KNIGHT, Randall** Calif.Polytech.State U. *Moving physics education research from the "laboratory" to the classroom* **(SU-P4-1)**	
↓	↓	↓ **14h30-17h00 IRC 4 (cap. 135)** IPP General Meeting *Assemblée générale de l'IPP* **(SU-IPP-PM)**	**14h30**
↓	**KNUDSEN, David** U.Calgary *Plasma wind and suprathermal ion imaging in space: from GEODESIC to Cassiope e-POP to Swarm* **(SU-P3-2)**	**McFARLAND, Ernie** U.Guelph *What's the use of demonstrations?* **(SU-P4-2)**	**14h45**
HALL, Kimberley Dalhousie U. *Spin control for semiconductor spintronics* **(SU-P2-2)**	↓	↓	**15h00**
↓	**McDADE, Ian C.** York U. *SWIFT - The next-generation atmospheric wind instrument* **(SU-P3-3)**	**Coffee Break / Pause café**	**15h15**
↓	↓	**SARTY, Adam** St.Mary's U. *Wireless responders in first-year physics lectures: Attempting to assess effectiveness* **(SU-P4-3)**	**15h30**
Coffee Break / Pause café	**RANKIN, Robert** U.Alberta *A grid-based portal for e-POP/CASSIOPE data dissemination* **(SU-P3-4)**	↓	**15h45**
	↓	**P. Freeman (c)** Richmond Sec.School *Demonstrating special relativity with the TRIUMF cyclotron* **(SU-P4-4)**	**16h00**
STOTZ, James A.H. Paul Drude Institute *Coherent spin transport via dynamic quantum dots* **(SU-P2-3)**	**LANGLEY, Richard B.** U.New Brunswick *GPS Research in Space at UNB: e-POP and Beyond* **(SU-P3-5)**	**M. Connors (c)** Athabasca U. *Moving distance education physics online at Athabasca University* **(SU-P4-5)**	**16h15**
↓	↓	**M. Milner-Bolotin (c)** UBC *Bringing the excitement of science to local community: Helping children from 5 to 105 years old rediscover the wonders of physics* **(SU-P4-6)**	**16h30**
		↓ **UBC Grad. Student Centre** **16h30** **Student Reception / Réception pour les étudiants** (Greek food; cash bar / *buffet grec; bar payant*) -- sponsored by / *commandité par* UBC/TRIUMF (SU-GRAD)	
Session ends / *Fin de la session*	**J. Drummond (c)** U.Toronto *Measurements of Pollution in the Troposphere (MOPITT): 5 years of measurements* **(SU-P3-6)**	**A. Pejovic-Milic (c)** Ryerson U. *Contemporary science at Ryerson University* **(SU-P4-7)**	**16h45**
	Session ends / *Fin de la session*	**R.I. Thompson (c)** U.Calgary *The role of dirac notation in undergraduate quantum mechanics instruction: when and why do we introduce it?* **(SU-P4-8)**	**17h00**
CAP Herzberg Memorial Public Lecture / *Conférence publique commémorative Herzberg de l'ACP* **plus performance by / *spectacle par* Borealis String Quartet** [SU-KEY] **Clifford Will, University of Washington at St. Louis** Followed by the Opening Reception / suivi par la réception d'accueil UBC Chan Centre (see pg. 17 for details / voir pg. 17 pour les détails)			**19h00**

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 5 (cap. 120)
07h00	"Friends of CAP" Breakfast / *Déjeuner des 'Ami(e)s de l'ACP'* (07h00-08h10) - SUB Council Chamber (30) (MO-Friends)				
08h15		**MO-A1** Plenary Session (CAP/*ACP*) *Session plénière* **Science Policy Session / *Session de politique scientifique* :** How can Canada's physicists help promote investment in science? Chair: E. Svensson, NRC **MIKE LAZARIDIS**, RIM **MICHAEL LUBELL**, APS **JULIA LEVY**, QLT Inc. (see page 19 for more details / *voir page 19 pour les plus amples renseignements*)			
09h45		Session ends / *Fin de la session* **Coffee Break / *pause café***			
	MO-A6 (DCMMP / *DPMCM*) ***LOW DIMENSIONAL SYSTEMS / SYSTÈMES À PEU DE DIMENSIONS*** Chair: M. Gallagher, Lakehead U.	**MO-A7** (DCMMP / *DPMCM*) ***CORRELATED ELECTRONS: MAGNETISM / ÉLECTRONS CORRÉLÉS : MAGNÉTISME*** Chair: I. Affleck, UBC	**MO-A2** (DCMMP/DPMCM) **POLYMERIC AND ORGANIC MATERIALS / *MATÉRIAUX POLYMÈRES ET ORGANIQUES*** Chair: J.L. Hutter, UWO	**MO-A8** (DIMP / *DPIM*) **SEMICONDUCTOR AND THIN FILM CHARACTERIZATION I / *CARACTÉRISATION DES FILMS MINCES ET DES SEMI-CONDUCTEURS I*** Chair: A.Mandelis/D.Fournier	**MO-A10** (DAMP / *DPAM*) **ATOMIC AND MOLECULAR SPECTROSCOPY & DYNAMICS / SPECTROSCOPIE ET DYNAMIQUE DES ATOMES ET MOLÉCULES** Chair: A.A. Madej, NRC
10h00	**DAMASCELLI, Andrea** UBC *Fermi surface and quasiparticle excitations of overdoped* $T1_2Ba_2CuO_{6+\delta}$ **(MO-A6-1)**	**GINGRAS, Michel** U.Waterloo *Quantum magnetism in the* $LiHo_xY_{1-x}F_4$ *ising material: Where do we stand?* **(MO-A7-1)**	**M. Whitmore (c)** U.Manitoba *Compression of polymer end-anchored polymers* **(MO-A2-1)**	**FOURNIER, Danièle** UPMC/ESPCI *Microscale thermal imaging in microelectronics: Optical methods for 2005 and beyond* **(MO-A8-1)**	**ROY, Pierre-Nicholas** U.Waterloo *Structure and dynamics of weakly-bound clusters* **(MO-A10-1)**
10h15	↓	↓	**J. Dutcher (c)** U.Guelph *Glass transition temperature of freely-standing poly(methyl methacrylate) films* **(MO-A2-2)**	↓	↓
10h30	**HIMPSEL, Frank** U.Wisconsin, Madison *Atomic chains: from low-dimensional electrons to the limits of data storage* **(MO-A6-2)**	**LUKE, Graeme** McMaster U. *Muon spin relaxation in exotic magnetic systems* **(MO-A7-2)**	**B. Joos (c)** U.Ottawa *Shear induced overaging in a polymer glass* **(MO-A2-3)**	**RODRIGUEZ, Mario** Centre de Fisica/UNAM, Mexico *Photothermal and optical characterization of intrinsic and Te-doped GaSb wafers* **(MO-A8-2)**	**XU, Yunjie** U.Alberta *Infrared laser spectroscopy and ab initio investigations of chiral recognitions* **(MO-A10-2)**
10h45	↓	↓	**R. Wickham (c)** St.F-X *Phase behaviour of a diblock copolymer melt under cylindrical confinement* **(MO-A2-4)**	↓	↓
11h00	**ERWIN, Steven** Naval Res.Laboratory *Self-doping of gold chains on silicon: A new structural model for Si(111)5x2-Au* **(MO-A6-3)**	**G. Williams (c)** U.Manitoba *The temperature-dependent spontaneous magnetisation in single crystal* $La_{0.73}Ba_{02.7}MnO_3$*: Evidence for moment canting?* **(MO-A7-3)**	**L. Livadaru (c)** NRC *A self-consistent molecular theory of polymers and solutions* **(MO-A2-5)**	**MEIJER, Jan** Run-Universitat, Bochum *High energy ion implantation and industrial applications* **(MO-A8-3)**	**R. Lees (c)** UNB *ECTDL spectrum of N-15 ammonia in the 6350-6550* cm^{-1} *region of the N-H stretching combination band* **(MO-A10-3)**
11h15	↓	**G. Quirion (c)** MUN *The elastic properties of* $CsNiCl_3$ *revisited* **(MO-A7-4)**	**A-C. Shi (c)** McMaster U. *Self-assembly of hollow micelles from rod-coil block copolymers* **(MO-A2-6)**	↓	**Coffee break / Pause café**
11h30	**McLEAN, A.** Queen's U. *Heteroepitaxy, surfactants and atomically perfect nanolines* **(MO-A6-4)**	**S. Kamal (c)** SFU *Low frequency conductivity scaling in* $CaRuO_3$ **(MO-A7-5)**	**A. Borodich (c)** U.Manitoba *Compositional fluctuations in the diblock copolymer lamellae studied with the method of averaging the weak-segregation limit* **(MO-A2-7)**	**MANDELIS, Andreas** U.Toronto *Two-beam cross-modulation photo-carrier radiometry of electronic solids, principles and applications to ion implanted silicon* **(MO-A8-4)**	**XU, Li-Hong** UNB *Torsion-mediated intramolecular vibrational energy redistribution in methyl-top molecules: High resultion findings and ab initio assisted dynamics* **(MO-A10-4)**
11h45	↓	**D.R. Taylor (c)** Queen's U. *Crossover from random field critical susceptibility in arsenic-doped KDP* **(MO-A7-6)**	**B-Y. Ha (c)** U.Waterloo *Molecular theory of asymmetrically charged bilayers: preferred curvatures* **(MO-A2-8)**	↓	↓
12h00	Session ends / *Fin de la session*	**R. Miller (c)** U.Penn. *Novel non-equilibrium magnetism in La(1-x)Ca(x)MnO3 studied with time-resolved Kerr spectroscopy* **(MO-A7-7)**	**C. Roth (c)** SFU *Probing molecular mobility in freely-standing polystyrene films using hole growth* **(MO-A2-9)**	**NICOLAIDES, Lena** Therma Wave Inc. *Advanced non-destructive photo-thermal methods for characterization of ultra-shallow junctions* **(MO-A8-5)**	**J.R. Cooper (c)** U.Calgary *Global fit analysis including the* $\nu_9+\nu_4-\nu_4$ *hot band of* CD_3CD_3 **(MO-A10-5)**

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	Other locations autres endroits	TIME HEURE
					07h00
					08h15
					09h45
MO-A5 (DOP-DIAP-DMBP / *DOP-DPIA-DPMB*) ***PHOTODYNAMIC THERAPY / THÉRAPIE PHOTODYNAMIQUE*** Chair: M. Campbell, U.Waterloo	**MO-A9** (PPD) ***PRECISION FRONTIER IN PARTICLE PHYSICS I / LES LIMITES DE LA PRÉCISION EN PHYSIQUE DES PARTICULES I*** Chair: F. Corriveau, McGill U.	**MO-A3** (DNP / *DPN*) **NUCLEAR ASTROPHYSICS / *ASTROPHYSIQUE NUCLÉAIRE*** Chair: A.A. Chen, McMaster U.	**MO-A4** (DTP-DMBP / *DPT-DPMB*) **THEORETICAL BIOLOGY / *BIOLOGIE THÉORIQUE*** Chair: A. Linhananta, Lakehead U	**ROOM FNSC-60** (cap. 119) **MO-A11** (DIAP / *DPIA*) **IMPACTS OF ACADEMIC SCIENCE AT HOME AND ABROAD / *IMPACT DE LA SCIENCE DANS LES UNIVERSITÉS - AU PAYS ET À L'ÉTRANGER*** Chair: G. Beer, U.Vic	10h00
LEVY, Julia QLT Inc. *Various Applications of Photodynamic Therapy* **(MO-A5-1)**	**QURAAN, Maher** U.Alberta/TRIUMF *First Results on muon decay from TWIST* **(MO-A9-1)**	**PARKER, Peter** Yale U. *^{20g}Al+p, ^{26m}Al+p, and ^{25}Al+p Resonances* **(MO-A3-1)**	**LEE, Paul** Nat'l Central U. *Complexity, universality, and growth of Genomes* **(MO-A4-1)**		
↓	↓	↓	↓	**VINCETT, Paul** Wilfrid Laurier U. *Economic impacts of academic research: Canadian physics shows a profit !* **(MO-A11-1)**	10h15
↓	**KNECHT, Neil** UBC *Unitarity triangle angles with BaBar* **(MO-A9-2)**	**KUBONO, Shigeru** U.Tokyo *Study of stellar reactions relevant to explosive hydrogen burning with Crib* **(MO-A3-2)**	**MOUSSEAU, Normand** U.Montreal *Wriggling and hopping - a study of protein dynamics* **(MO-A4-2)**	↓	10h30
LU, Qing-Bin U.Waterloo *High sensitivity time-resolved femtosecond laser spectroscopic studies of light-activated drugs* **(MO-A5-2)**	↓	↓	↓	**WHITEHEAD, Lorne** UBC *High dynamic range displays - a multi-disciplinary challenge* **(MO-A11-2)**	10h45
↓	**A. Sher (c)** TRIUMF *E865 Result: An improved limit on the LFNV Decay K+ --> π+ μ+ e-* **(MO-A9-3)**	**Coffee Break / *pause café***	**Coffee Break / *pause café***	↓	11h00
Coffee Break / *pause café*	**Z. Song (c)** UBC *Monte Carlo studies for parameterization of B-mixing with inclusive dilepton events* **(MO-A9-4)**	**CAGGIANO, Jac** TRIUMF *Nuclear Astrophysics at TRIUMF-ISAC* **(MO-A3-3)**	↓	**ZMESKAL, Johann** Stephan Meyer Institute, Vienna *Cutting edge physics in the European Union - an outlook and review* **(MO-A11-3)**	11h15
ZENG, Haishan BC Cancer Agency *Dosimetry for photodynamic therapy* **(MO-A5-3)**	**D. Fortin (c)** U.Victoria *Determination of |Vub| from inclusive semileptonic B decays at BaBar* **(MO-A9-5)**	↓	**PLOTKIN, Steven** UBC *Many body forces and topology in protein folding* **(MO-A4-3)**	↓	11h30
↓	**Y. Santoso (c)** U.Guelph *Gravitino as dark matter and its implication for supersymmetry searches* **(MO-A9-6)**	**K.S. Sharma (c)** U.Manitoba *Recent results from the Canadian Penning Trap Mass Spectrometer at Argonne National Laboratory* **(MO-A3-4)**	↓	**GELBART, Dan** CREO *From bad idea to great company: The story of CREO* **(MO-A11-4)**	11h45
CAMPBELL, Melanie U.Waterloo *Two-photon photodynamic therapy and the eye* **(MO-A5-4)**	**M. Roney (c)** U.Victoria *Search for Lepton Flavour Violation at BaBar* **(MO-A9-7)**	**V.L. Ryjkov (c)** TRIUMF *TITAN Penning trap mass spectrometer: Status report* **(MO-A3-5)**	**TUSZYNSKI, Jack** U.Alberta *New nano-scale oncotherapy approaches inspired by computational biophysics* **(MO-A4-4)**	↓	12h00

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 5 (cap. 120)
12h15		Session Ends / *Fin de la session*	**J.R. deBruyn (c)** UWO *Rheology of a polymer-clay dispersion under shear* **(MO-A2-10)**	↓	Session Ends / *Fin de la session*
12h30	**DPP Business Meeting** (20 lunches provided) ***Réunion d'affaires DPP*** *(20 repas fournis)*		Session Ends / *Fin de la session* **DCMMP Business Meeting** (25 lunches provided) ***Réunion d'affaires DPMCM*** *(25 repas fournis)*	Session Ends / *Fin de la session*	**DASP Business Meeting** (15 lunches provided) ***Réunion d'affaires DPAE*** *(15 repas fournis)*
13h15		Presentation of special award to Mike Lazaridis, President, RIM / *Un présentation d'un prix spécial pour Mike Lazaridis, RIM*			
13h30		**MO-P1** Plenary Session (CAP/*ACP*) Session plénière (Teaching Medal winner - récipiendaire de la médaille d'enseignement) Chair: K. Ragan, McGill U. **ANDRÉ MARZIALI** UBC *No, really, I want you to talk in class ....* **(MO-P1-1)**			
	MO-P4 (DTP / *DPT*) ***FIELD THEORY / THÉORIE DES CHAMPS*** Chair: K. Schleich, UBC	**MO-P7** (DCMMP / *DPMCM*) ***CONDENSED MATTER STUDENT PAPER COMPETITION/ COMPÉTITION ÉTUDIANTE POUR LE MEILLEUR PAPIER PRÉSENTÉ*** Chair: C. Bennett, Acadia U.	**MO-P5** (DCMMP/DPMCM) **INTERFACESCIENCE / *LA SCIENCE DES INTERFACES*** Chair: Z.Tun, AECL	**MO-P3** (DAMP / *DPAM*) **COHERENT INTERACTION WITH ATOMS AND MOLECULES / *INTERACTIONS COHÉRENTES ENTRE LES ATOMES ET LES MOLÉCULES*** Chair: R. Lees, UNB	**MO-P9** (DSS) **FRONTIERS IN SURFACE SCIENCE / *FRONTIÈRES EN PHYSIQUE DES SURFACES*** Chair: G. Lopinski, NRC
14h15	**MacKENZIE, Richard** U. Montreal *Abelian Chern-Simons Q-balls* **(MO-P4-1)**	**Z.L. Bao (c)** SFU *Epitaxial Fe electrodeposited on GaAs(001) substrates* **(MO-P7-1)**	**BIZZOTTO, Dan** UBC *An electrochemical and in situ fluorescence investigation of role of potential in manipulating the properties of an adsorbed lipid-like layer* **(MO-P5-1)**	**SPANNER, Michael** U.Toronto *Field-free alignment and strong field control of molecular rotors* **(MO-P3-1)**	**SCHMID, Andreas** Lawrence Berkeley Nat'l Lab *Exploring magnetic nanostructures by spin polarized low energy electron microscopy* **(MO-P9-1)**
14h30	↓	**T. Pereg-Barnea (c)** UBC *Andreev bound states on the edge of a triangular lattice: pinning down the order parameter symmetry of the cobaltates* **(MO-P7-2)**	↓	↓	↓
14h45	**BUTLER, Malcolm** St.Mary's U. *Effective field theories for nuclear physics* **(MO-P4-2)**	**L. Coehring (c)** U.Toronto *Columnar jointing: a self-organizing fracture pattern* **(MO-P7-3)**	**UNSWORTH, Larry** McMaster U. *End-thiolated monomethoxy PEO molecular architecture evolution and its effect on protein adsorption: Investigated using neutron reflectometry* **(MO-P5-2)**	**ZEIDLER, Dirk** NRC *Controlling double ionization dynamics via molecular alignment* **(MO-P3-2)**	**A. Weber (c)** AMPEL/UBC *Self-assembly of N-terminated porphyrin molecules on single crystal metal surfaces* **(MO-P9-2)**
15h00	↓	**Z.S. Khan (c)** U.Toronto *Subdiffusive transport of granular mixtures in a rotating drum* **(MO-P7-4)**	↓	↓	**E.T. Jensen (c)** UNBC *Selection of Photodissociation pathway for orientationally ordered CH_3I on Cu(110)-I at 1=308nm, 248nm and 222nm* **(MO-P9-3)**
15h15	**ZHITNITSKY, Ariel** UBC *Topological phenomena in QCD at large baryon density* **(MO-P4-3)**	**W. Li (c)** SFU *Ballistic electron emission microscopy studies of Au./molecule/n-GaAs diodes* **(MO-P7-5)**	**Coffee Break / *pause café***	**Q. Hu (c)** UBC *Spectroscopy and dynamics of photoion-pair formation* **(MO-P3-3)**	**Coffee Break / *pause café***
15h30	↓	**Coffee Break / *pause café***	↓	**Coffee Break / *pause café***	**RATSCH, Christian** U.California, Los Angeles *A level-set method for epitaxial growth and self-organization of quantum dots* **(MO-P9-4)**
15h45	**GREGOIRE, Thomas** CERN *Gravity mediated supersymmetry breaking in warped brane worlds* **(MO-P4-4)**	**M. Musa (c)** UBC *Dynamics of molecular deuterium released from the dissociation of heavy water on a zirconium surface* **(MO-P7-6)**	**RYAN, Dominic** McGill U. *Proximity-induced magnetisation of palladium in Pd-Fe multilayers* **(MO-P5-3)**	↓	↓

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	Other locations autres endroits	TIME HEURE
↓	**S.R. Menary (c)** York U. *Neutrinos with FLARE* **(MO-A9-8)**	**J.P. Svenne (c)** U.Manitoba *Structure of light nuclei from a multichannel algebraic scattering theory* **(MO-A3-6)**	↓	**T. Spanos (c)** Wavefront Energy and Env. *From fundamental physical theory to applications in enhanced oil recovery and environmental remediation* **(MO-A11-5)**	12h15
Session Ends / *Fin de la session*	Session Ends / *Fin de la session*	Session Ends / *Fin de la session* **DNP Business Meeting** (15 lunches provided) ***Réunion d'affaires DPN*** *(15 repas fournis)*	Session Ends / *Fin de la session* **DTP Business Meeting** (25 lunches provided) ***Réunion d'affaires DPT*** *(25 repas fournis)*	Session Ends / *Fin de la session* (SAGE Bistro, Univ. Centre) - **Past President's Lunch** ***Déjeuner des anciens présidents***	12h30
					13h15
					13h30
				ROOM FNSC-60 (cap. 119)	
MO-P8 (DIMP / *DPIM*) ***THERMOPHYSICS AND THERMAL SENSORS / THERMOPHYSIQUE ET SENSEURS THERMIQUES*** Chair: L. Nicolaides, ThermaWave	**MO-P11** (PPD) ***PRECISION FRONTIER IN PARTICLE PHYSICS II / LES LIMITES DE LA PRÉCISION EN PHYSIQUE DES PARTICULES II*** Chair: M. Roney, U.Victoria	**MO-P2** (DNP / *DPN*) **TESTS OF THE STANDARD MODEL / *TESTS DU MODÈLE STANDARD*** Chair: W. van Oers, U.Manitoba	**MO-P6** (DMBP-DOP / *DPMB-DOP*) **BIOMEDICAL IMAGING / *IMAGERIE BIOMÉDICALE*** Chair: B. Whelan, Ryerson U.	**MO-P10** (DASP / *DPAE*) **ATMOSPHERIC AND SPACE CONTRIBUTED / *PAPIERS PRÉSENTÉS EN PHYSIQUE DE L'ATMOSPHÈRE ET DE L'ESPACE*** Chair: J-M. Noel, RMC	
SHEN, Jun NRC *An overview of thermal-wave resonant cavity technique* **(MO-P8-1)**	**SHER, Aleksey** TRIUMF *KOPIO: Study of the CP-violating decay* $K_L^0 \to \pi^0 \nu \bar{\nu}$ **(MO-P11-1)**	**POSPELOV, Maxim** U.Guelph / PI / U.Victoria *Precision tests of the standard model at low energies* **(MO-P2-1)**	**SOSSI, Vesna** UBC *In-vivo detection of early regulatory changes in Parkinson's disease using positron emission tomography: a physicist's perspective* **(MO-P6-1)**	**A.W. Yau (c)** U.Calgary *The CASSIOPE enhanced polar outflow probe (e-POP) small satellite mission* **(MO-P10-1)**	14h15
↓	↓	↓	↓	**M. Connors (c)** Athabasca U. *Joint interpretation of satellite and ground-based data for understanding auroral physics* **(MO-P10-2)**	14h30
A. Mandelis (c) U.Toronto *High-precision and high-resolution measurements of thermal diffusivity and infrared emissivity of water-methanol mixtures using a pyroelectric thermal wave resonator cavity* **(MO-P8-2)**	**I. Kato (c)** TRIUMF *The latest results of the K2K experiment* **(MO-P11-2)**	**WOODS, Mike** SLAC *Results from SLAC E-158: A study of parity violation in moller scattering* **(MO-P2-2)**	**CELLER, Anna** UBC/VGH *In vivo molecular imaging - Quantitative and dynamic SPECT studies* **(MO-P6-2)**	**G. James (c)** CRC *Old and new experiments on transionospheric HF propagation* **(MO-P10-3)**	14h45
MOSTAGHIMI, Javad U.Toronto *Surface tension measurement of high temperature liquids* **(MO-P8-3)**	**B. Jamieson (c)** UBC *Status of the TWIST measurement of the muon decay asymmetry* **(MO-P11-3)**	↓	↓	**R. Gillies (c)** U.Sask. *Transionospheric HF propagation modelling to the ISIS II and e-POP satellites* **(MO-P10-4)**	15h00
↓	**D. Asgeirsson (c)** UBC *Track impact parameter resolution of the BaBar Detector* **(MO-P11-4)**	**S. Page (c)** U.Manitoba *The* Q_{Weak} *experiment at Jefferson Laboratory* **(MO-P2-3)**	**Coffee Break / *pause café***	**L. Kagan (c)** UWO *New discoveries with artificial auroras* **(MO-P10-5)**	15h15
Coffee Break / *pause café*	**Coffee Break / *pause café***	**Coffee Break / *pause café***	**BIZHEVA, Kostadinka** U.Waterloo *Novel biomedical applications of Ultrahigh resolution optical coherence tomography* **(MO-P6-3)**	**Coffee Break / *pause café***	15h30
↓	↓	**FARINE, Jacques** Laurentian U. *Results from the Salt Phase of SNO* **(MO-P2-4)**	↓	**J. Laframboise (c)** York U. *Do ponderomotive double layers exist?* **(MO-P10-6)**	15h45

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 5 (cap. 120)
16h00	↓	**J.A. Quilliam (c)** U.Waterloo *Specific heat and AC susceptibility of $LiHo_xY_{1-x}F_4$* **(MO-P7-7)**	↓	**SHIELL, Ralph** Trent U. *Coherent spectroscopy: population trapping and stark wave packets* **(MO-P3-4)**	**K. Mitchell (c)** UBC *Pattern formation in eroded surfaces* **(MO-P9-5)**
16h15	**PARANJAPE, Manu** U.Montreal *The Josephson effect and pseudo-Goldstone bosons* **(MO-P4-5)**	**M.C. Rogers (c)** U.Toronto *Chemical Smoke Rings* **(MO-P7-8)**	**MARIC, Radenka** NRC *Ceria doped materials as electrolyte materials for low temperature solid oxide fuel cells* **(MO-P5-4)**	↓	**P. Budnik (c)** SFU *Structural characterization of the magnetic trilayer system Fe/Pd/Fe grown epitaxially on GaAs(001)-4 x 6 using XAFS* **(MO-P9-6)**
16h30	↓	**R. Sanderson (c)** Dalhousie U. *Crystallization of $Bi_2Sr_2Ca_{1-x}Y_xCu_2O_y$ ($0 \le x \le 0.5$) thin films prepared by a spatial composition spread approach* **(MO-P7-9)**	↓	**Z. Abusara (c)** U.Calgary *Hot band spectroscopy of CCO in the C-O stretching region* **(MO-P3-5)**	Session Ends / *Fin de la session*
16h45	Session Ends / *Fin de la session*	**P. Tsai (c)** U.Toronto *Current-voltage scaling in turbulent electroconvection* **(MO-P7-10)**	Session Ends / *Fin de la session*	**T. Cocolios (c)** McGill U. *Collinear laser spectroscopy at ISAC-TRIUMF* **(MO-P3-6)**	**Hennings 200** (cap. 200) **MO-P12** (CEWIP/CEFEP) HARRIET BROOKS: EARLY CANADIAN NUCLEAR PHYSICIST / *AMÉLIORATION DU CLIMAT POUR LES FEMMES EN PHYSIQUE* Chair: B. Frisken, SFU
17h00		**H. Zhang (c)** SFU *Reconstructing DNA replication kinetics from small DNA fragments* **(MO-P7-11)**		Session Ends / *Fin de la session*	**RAYNER-CANHAM, Geoff** Sir Wilfred Grenfell College *Harriet Brooks: Pioneer Canadian woman physicist* **(MO-P12-1)**
17h15		Session Ends / *Fin de la session*			↓
17h30					↓
17h45					**Discussion followed by reception / Discussion suivie par une réception**
18h30					↓
18h45					**Viewing of PBS documentary "Einstein's Wife"**
19h45					**Discussion after film / Discussion après le film**
20h00					**CEWIP Business meeting / Réunion d'affaires de la CEFEP**

19h00 — Poster Session, with Beer — SUB Ballroom, Reception in SUB Party Room

Atmospheric and Space Physics / *Physique atmosphérique et de l'espace (2)*	Atomic and Molecular Physics / *Physique atomique et moléculaire (17)*	Condensed Matter and Materials Physics / *Physique de la matière condensée et matériaux (40)*	Industrial and Applied Physics / *Physique industrielle et appliquée (1)*	Medical and Biological Physics / *Physique médicale et biologique (7)*	Nuclear Physics / *Physique nucléaire (1)*
MO-POS-1-2	MO-POS-3-19	MO-POS-20-59	MO-POS-60	MO-POS-61-67	MO-POS-68

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	Other locations autres endroits	TIME HEURE
ZHANG, Shu-yi Nanjing U. *Characterization of thermal parameters of materials by scanning thermal wave microscopies* **(MO-P8-4)**	**R.J. Slobodrian (c)** U.Laval *High energy gravitons* **(MO-P11-5)**	↓	**M. Campbell (c)** U,.Waterloo *Mueller matrix polarimetry and biomedical imaging* **(MO-P6-4)**	**J. McMahon (c)** York U. *Interaction between a finite cylinder and a drifting collisionless plasma* **(MO-P10-7)**	16h00
↓	**T. Cuhadar-Donszelmann (c)** UBC *Search for the* $B \to K \nu \bar{\nu}$ *rare decays* **(MO-P11-6)**	**BRINKMANN, Kai-Thomas** IKTP, TU Dresden *Search for the Pentaquark* **(MO-P2-5)**	**D.M. Thiessen (c)** BC Cancer Agency *Constructing a new spectrometer for measuring the excitation-emission matirix of skin autofluorescence* **(MO-P6-5)**	**F. Nichitiu (c)** U.Toronto *MOPITT acceleration sensor as a Piezoelectric particle detector* **(MO-P10-8)**	16h15
DELGADILLO-HOLTFORT, I. Ruhr-Universitaet Bochum *Nondestructive locally resolved characterization of thermophysical properties of NiTi shape-memory alloys* **(MO-P8-5)**	**R. Dick (c)** U.Sask. *Models for the origin of ultra-high energy cosmic rays* **(MO-P11-7)**	↓	**MacAULAY, Calum** UBC/BC Cancer Centre *Optical techniques in early cancer management* **(MO-P6-6)**	**P. Rahnama (c)** York U. *Preliminary assessment of the SWIFT instrument performance* **(MO-P10-9)**	16h30
↓	Session Ends / *Fin de la session*	**M.C. Fujiwara (c)** TRIUMF *Confronting CPT with cold antihydrogen* **(MO-P2-6)**	↓	**A-L. Norman (c)** U.Calgary *Tropospheric Be-7 concentrations in southern Alberta* **(MO-P10-10)**	16h45
LEVICK, Andrew National Physical Laboratory *Temperature measurement of levitated metal drops using the laser absorption radiation thermometry (LART)* **(MO-P8-6)**		**C. Gillis (c)** U.Manitoba *The NPD Gamma experiment: A measurement of parity violation in radiative neutron-proton capture* **(MO-P2-7)**	Session Ends / *Fin de la session*	**W. Ward (c)** UNB *The Waves Michelson Interferometer (WaMI) and an Atmospheric Dynamics Mission* **(MO-P10-11)**	17h00
↓		Session Ends / *Fin de la session*		Session Ends / *Fin de la session*	17h15
Session Ends / *Fin de la session*					17h30
					17h45
				SUB Council Chamber **CJP Editorial Board Meeting / *Réunion du Comité de rédaction de la RCP***	18h30
					18h45
					19h45
					20h00

SUB Ballroom
Réception au SUB Party Room

Session d'affiches, bière servie

19h00

Optics and Photonics / *Optique et photonique* (2)	Particle Physics / *Physique des particules* (3)	Physics Education / *L'enseignement de la physique* (4)	Plasma Physics / *Physique des plasmas* (1)	Surface science / *Sciences des surfaces* (3)	Theoretical Physics / *Physique théorique* (12)
MO-POS-69-70	MO-POS-71-73	MO-POS-74-77	MO-POS-78	MO-POS-79-81	MO-POS-82-93

Tuesday, June 7

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 6 (cap. 226)
07h00	Meeting of the Canadian National IUPAP Liaison Committee (07h00-09h00) - SUB Council Chamber (TU-CNILC)				
08h15		**TU-A1** Plenary Session plénière Chair: W.K. Liu, U.Waterloo **CORKUM, Paul** NRC *Attosecond Science* (TU-A1-1)			
09h00		**TU-A2** Plenary Session plénière (CAP Herzberg Medal winner - récipiendaire de la médaille Herzberg de l'ACP) Chair: M. Morrow, MUN **POISSON, Eric** U.Guelph *Tidal Heating of Black Holes* (TU-A2-1)			
09h45		**Coffee Break / *pause café***			
10h00	**TU-A6** (DTP / *DPT*) ***PARTICLE THEORY / THÉORIE DES PARTICULES ÉLÉMENTAIRES*** Chair: P. Lee, National Central U. **WISE, Mark** Caltech *Naturalness and the values of cosmological parameters* **(TU-A6-1)**	**TU-A8** (DCMMP / *DPMCM*) ***SEMICONDUCTORS / SEMICONDUCTEURS*** Chair: S. Patitsas, U.Lethbridge **COOKE, David** U.Alberta *Using terahertz pulses to probe ultrafast carrier dynamics in semiconductor nanostructures* **(TU-A8-1)**	**TU-A3** (DCMMP/DPMCM) ***YOUNG INVESTIGATORS I / JEUNES CHERCHEURS I*** Chair: J.E. Sonier, SFU **LUPIEN, Christian** U.Sherbrooke *Probing the hidden order of cuprates superconductors with very low temperature scanning tunneling microscopy* **(TU-A3-1)**	**TU-A5** (DAMP / *DPAM*) ***COOLING AND TRAPPING OF ATOMS / REFROIDISSEMENT ET CAPTURE D'ATOMES ET DE MOLÉCULES*** Chair: R.I. Thompson, U.Calgary **KUMARAKRISHNAN, A.** York U. *Precision measurements using laser cooled atoms* **(TU-A5-1)**	
10h30	↓	**D. Morris (c)** U.Sherbrooke *Generation and characterization of intense and ultrashort terahertz pulses from ion-implanted photoconductive materials* **(TU-A8-2)**	**KIM, Young-June** U.Toronto *Inelastic X-ray scattering study of cuprate superconductors* **(TU-A3-2)**	**E.J. Prime (c)** TRIUMF/UBC *Development of a circularly polarized dipole force trap for radioactive isotopes* **(TU-A5-2)**	
10h45	↓	**Y.G. Gurevich (c)** CINVESTAV *Electron and phonon thermal pulse propagation in semiconductors* **(TU-A8-3)**	↓	**S. Aubin (c)** U.Toronto *Towards an ultra-cold Bose-Fermi mixture in a micro-magnetic trap* **(TU-A5-3)**	**TU-A12** (DIAP-DOP / *DPIA-DOP*) ***APPLICATIONS OF PHOTONICS / APPLICATIONS DE LA PHOTONIQUE*** Chair: R. Roy, U.Laval
11h00	**FRANK, Mariana** Concordia U. *Neutrino masses and mixings in rank-5 subgroups of E_6* **(TU-A6-2)**	**DIGNAM, Marc** Queen's U. *High-order nonlinearities in the ultrafast optical response of biased semiconductor superlattices* **(TU-A8-4)**	**WIEBE, Christopher** Brock U. *Quantum phase transitions as routes to strange materials* **(TU-A3-3)**	**Coffee Break / *pause café***	**S. Chandani (c)** UBC *All fiber-based electric field sensors for the power utility industry* **(TU-A12-1)**
11h15	↓	↓	↓	**BEHR, J.** TRIUMF *Weak Interaction Symmetries with Atom Traps* **(TU-A5-4)**	**LESSARD, Roger** U.Laval *Holographic Memories* **(TU-A12-2)**
11h30	**BUCHEL, Alex** UWO/Perimeter Institute *Transport properties of strongly coupled gauge theory plasma* **(TU-A6-3)**	**W. Sheng (c)** NRC *Electronic and optical properties of InAs/InP self-assembled quantum dots on patterned substrates* **(TU-A8-5)**	**YETHIRAJ, Anand** MUN *Self-assembly in soft matter: structure and kinetics in colloids and in surfactant mesophases, and the creation of photonic crystals* **(TU-A3-4)**	↓	↓
11h45	↓	**A. Yang (c)** SFU *Determination of the isotopic mass dependence of the lattice parameter in silicon using high resolution photoluminescence spectroscopy* **(TU-A8-6)**	↓	**N. Blinov (c)** U.Alberta *Quantum solvation, rotational dynamics and superfluid response of doped helium clusters* **(TU-A5-5)**	**M. Banaee (c)** UBC *Multiple soliton formation in short lengths of photonic crystal optical fibre* **(TU-A12-3)**

Mardi, le 7 juin

CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	FNSC 50 (cap. 45)	Other locations autres endroits	TIME HEURE
(TU-CNILC) Réunion du comité de liaison national Canadien (IUPAP) (07h00-09h00) - SUB Council Chamber					07h00
					08h15
					09h00
				ROOM FNSC-60 (cap. 119)	09h45
TU-A11 (PPD) ***ENERGY FRONTIER IN PARTICLE PHYSICS I / LA LIMITE EN ÉNERGIE EN PHYSIQUE DES PARTICULES I*** Chair: D. O'Neil, SFU	**TU-A4** (DNP / *DPN*) **NUCLEAR STRUCTURE / *STRUCTURE NUCLÉAIRE*** Chair: G.C. Ball, TRIUMF	**TU-A7** (DMBP / *DPMB*) **DMBP YOUNG & NEW INVESTIGATORS / *JEUNES ET NOUVEAUX CHERCHEURS EN PHYSIQUE MÉDICALE ET BIOLOGIQUE*** Chair: A. Pejovic-Milic, Ryerson U	**TU-A9** (DPP) **PLASMIONIQUE BEST STUDENT PRIZE / *PRIX PLASMIONIQUE POUR LA MEILLEURE PRÉSENTATION PAR UN ÉTUDIANT EN PLASMA*** Chair: A.Sarkissian, Plasmionique	**TU-A10** (DIMP / *DPIM*) **BIOTECHNOLOGIES AND BIOTHERMOPHOTONIC INSTRUMENTS AND METHODS I / *INSTRUMENTATION ET TECHNIQUES EN BIOTECHNOLOGIE ET BIOPHOTONIQUE I*** Chair: B. Whelan, Ryerson U.	
VINCTER, Manuella Carleton U. *Into the unknown: TeV physics with the ATLAS detector* **(TU-A11-1)**	**SARAZIN, Fred** Colorado School of Mines *Halo neutrons and the beta-decay of ^{11}Li* **(TU-A4-1)**	**FORDE, Nancy** SFU *Using optical tweezers for single-molecule biophysics studies* **(TU-A7-1)**	**ROMANOV, Dmitry** U.Alberta *Plasma physics of photoionized gases by short x-ray pulses* **(TU-A9-1)**	**PATEL, Chandra** UCLA/Pranalytica Inc. *Optical techniques for high sensitivity, high selectivity detection of chemical warfare agents* **(TU-A10-1)**	10h00
WARBURTON, Andreas McGill U. *Recent results from the collider detector at Fermilab* **(TU-A11-2)**	**NOERTERSHAEUSER, Wilfried** GSI *Electronic eavesdropping on nuclei: Determination of the ^{11}Li charge radius* **(TU-A4-2)**	↓	**D. Liu (c)** U.Sask. *Study of compact torus assisted breakdown in the STOR-M Tokamak* **(TU-A9-2)**	**SIGRIST, Markus** Swiss Federal Inst. of Tech. *Laser spectroscopy in trace gas analysis* **(TU-A10-2)**	10h30
	↓	**Coffee Break / *pause café***	**D. Li (c)** U.Alberta *Modeling solar wind plasma transport into the inner magnetosphere* **(TU-A9-3)**	↓	10h45
C. Cojocaru (c) Carleton U. *ATLAS 2002 test beam energy reconstruction* **(TU-A11-3)**	**J.J. Ressler (c)** SFU *Search for isomers in the neutron-rich Cu and Zn isotopes* **(TU-A4-3)**	**J. Liu (c)** Lakehead U. *In silico mutations and molecular dynamic studies on the Trp-cage folding* **(TU-A7-2)**	**Coffee Break / *pause café***	**Coffee Break / *pause café***	11h00
I. Yavin (c) Harvard U. *The littlest Higgs in anti-de sitter space* **(TU-A11-4)**	**N. Hoq (c)** SFU *Beta decay of neutron-rich Ga-80* **(TU-A4-4)**	**P. Cheung (c)** McGill U. *Quantum dots as voltage sensitive probes in neurophysiology* **(TU-A7-3)**	↓	↓	11h15
T. Spreitzer (c) U.Toronto *Measurement of the top anti-top production cross section in the dilepton channel using lepton+isolated track* **(TU-A11-5)**	**GARRETT, Paul** U.Guelph/TRIUMF *Gamma-ray spectroscopy with the 8π Array at TRIUMF-ISAC* **(TU-A4-5)**	**G. Cranmer-Sargison (c)** U.Victoria *Equivalent stochastic dose (ESD): Quantifying the impact of dose uncertainties on radiotherapy treatment plans* **(TU-A7-4)**	**C. Serbanescu (c)** U.Alberta *Hot electrons and keV x-rays from femtosecond laser produced micro plasmas* **(TU-A9-4)**	**BALDERAS-LÓPEZ, José** UPIBI-IPN *Thermal-wave photoacoustic setup, high precision technique for thermal diffusivity measurements: applications to foods* **(TU-A10-3)**	11h30
V.W. Elias (c) UWO *Experimental signatures of radiatively broken electroweak symmetry* **(TU-A11-6)**	↓	Session Ends / *Fin de la session*	**S. Livingstone (c)** U.Sask. *In search of high frequency fluctuations through microwave scattering in the STOR-M Tokamak* **(TU-A9-5)**	↓	11h45

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 6 (cap. 226)
12h00	**WOLOSHYN, R.M.** TRIUMF *Acting chiral: light quarks in lattice QCD* **(TU-A6-4)**	**M.I. Berciu (c)** UBC *Magnetic susceptibility of diluted magnetic semiconductors at low carrier densities* **(TU-A8-7)**	Session Ends / *Fin de la session*	**J.J. Choquette (c)** U.Calgary *Q-scan mass spectrometry and the time evolution of mixed ion species* **(TU-A5-6)**	Session Ends / *Fin de la session* **DIAP Business Meeting** ***Réunion d'affaires DPIA***
12h15	↓	Session Ends / *Fin de la session*		Session Ends / *Fin de la session*	↓
12h30	Session Ends / *Fin de la session*			**DAMP Business Meeting** (20 lunches provided) ***Réunion d'affaires DPAM*** *(20 repas fournis)*	**DIMP Business Meeting** ***Réunion d'affaires DPIM***
12h45					
13h30		**TU-P1** Plenary Session plénière (CAP Medal of Achievement winner - Récipiendaire de la médaille ACP) Chair: M. Morrow, MUN **DEREK YORK** U.Toronto *In search of lost time* (TU-P1-1)			
	TU-P2 (DTP / *DPT*) ***STRING THEORY / THÉORIE DES CORDES*** Chair: M. Wise, Caltech	**TU-P5** (DCMMP / *DPMCM*) ***CORRELATED ELECTRONS: SUPERCONDUCTIVITY / ÉLECTRONS CORRÉLÉS : SUPRACONDUCTIVITÉ*** Chair: A. Damascelli, UBC	**TU-P6** (DCMMP/DPMCM) **MATERIALS: GROWTH AND CHARACTERIZATION / *MATÉRIAUX : CROISSANCE ET CARACTÉRISATION*** Chair: K. Robbie, Queen's U.	**TU-P7** (DPP) **GENERAL PLASMA PHYSICS / *PHYSIQUE GÉNÉRALE DES PLASMAS*** Chair: Y.Y. Tsui, U.Alberta	**TU-P4** (DAMP / *DPAM*) **STRONG FIELD PHYSICS AND SPECTROSCOPY / *PHYSIQUE ET SPECTROSCOPIE EN CHAMP FORT*** Chair: J. Sanderson, U.Waterloo
14h15	**MYERS, Robert** Perimeter Inst. *Warped superstring cosmology* **(TU-P2-1)**	**KEE, Hae-Young** U.Toronto *Anisotropic spin excitation in high temperature superconductors : Signature of electronic nematic order* **(TU-P5-1)**	**B. Heinrich (c)** SFU *Two magnon scattering on self-assembled network of misfit dislocations* **(TU-P6-1)**	**GUO, Houyang** U.Washington *A unique high-beta, sustainable plasma confinement configuration* **(TU-P7-1)**	**BANDRAUK, André** U.Sherbrooke *Molecules in intense laser fields and electron-nuclear dynamics from femto to attosecond time scales* **(TU-P4-1)**
14h30	↓	↓	**B. Terreault (c)** INRS-EMT *Giant isotope effects in H- and D-ion implanted semiconductors* **(TU-P6-2)**	↓	↓
14h45	**VAN RAAMSDONK, Mark** UBC *An analytical study of confinement/deconfinement in four dimensional gauge theory* **(TU-P2-2)**	**R. Wortis (c)** Trent U. *Vortex vibrations and NMR T_2 relaxation in YBCO* **(TU-P5-2)**	**TIEDJE, Tom** UBC *Surface dynamics during MBE growth of GaAs on patterned substrates* **(TU-P6-3)**	**M.P. Bradley (c)** U.Sask. *Plasma ion implantation of silicon for electroluminescent device applications* **(TU-P7-2)**	**LIN, C.D.** Kansas State U. *Probing dynamics of molecules with few-cycle intense laser pulses* **(TU-P4-2)**
15h00	↓	**R. Miller (c)** TRIUMF *Coexistence of magnetism and superconductivity in ultraclean underdoped $YBa_2Cu_3O_{6.37}$* **(TU-P5-3)**	↓	**R. Marchand (c)** U.Alberta *3D modelling of shear-compressional waves in Earth magnetosphere* **(TU-P7-3)**	↓
15h15	**Coffee Break / *pause café***	**W. Stephan (c)** Bishop's U. *Magnon dispersion of the half-filled Hubbard model: a comparison with neutron scattering on La_2CuO_4* **(TU-P5-4)**	**O.F. Adurodija (c)** Mount Allison U. *Crystallization and electro-optical properties of In_2O_3 and ITO thin films* **(TU-P6-4)**	**Coffee Break / *pause café***	**Coffee Break / *pause café***
15h30	↓	**Coffee Break / *pause café***	**Coffee Break / *pause café***	↓	↓
15h45	**ROZALI, Moshe** UBC *Helicity amplitudes in supersymmetric gauge theories* **(TU-P2-3)**	**SONIER, Jeff** SFU *Hole-doping dependence of the effective magnetic penetration depth and vortex core size in $Y_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$* **(TU-P5-5)**	**Y. Zhang (c)** SFU *The characterization of temporary extrusion failures in accelerated electromigration tests of Cu metallization* **(TU-P6-5)**	**JOHNSTON, Tudor** INRS-EMT *KEEN Waves: A new nonlinear wave phenomenon in the interaction of waves with plasmas* **(TU-P7-4)**	**BRABEC, Thomas** U.Ottawa *Many-body dynamics in strong fields* **(TU-P4-3)**

CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 119)	FNSC 50 (cap. 45)	Other locations autres endroits	TIME HEURE
B. Stelzer (c) U.Toronto *Search for electroweak single top quark production with CDFII* **(TU-A11-7)**	**L. Blomeley (c)** McGill U. *Commissioning of TITAN's gas filled RFQ ion beam buncher and cooler* **(TU-A4-6)**	Session Ends / *Fin de la session*	**M. Varner (c)** U.Calgary *Molybdenum isotope abundance variations in selected iron meteorites* **(TU-A9-6)**	**MALKIN, Shmuel** Weizmann Inst. of Science *Photoacoustic signals from plant leaves - markers of photosynthetic activity* **(TU-A10-4)**	12h00
S. Lai (c) U.Toronto *Search for ttH production at CDF* **(TU-A11-8)**	**F. Gagnon-Moisan (c)** U.Laval *Modifications on the HERA-CLES array for the energies at ISAC-II, TRIUMF* **(TU-A4-7)**	**DMBP Business Meeting** (10 lunches provided) ***Réunion d'affaires DPAM*** *(10 repas fournis)*	**IRC G41/42** **Physics in Canada Editorial Board Meeting / *Réunion du Comité de rédaction de La Physique au Canada*** (Ends at 13h00 / Se termine à 13h00)	↓	12h15
Session Ends / *Fin de la session* **PPD Business Meeting** ***Réunion d'affaires PPD***	**W.R. Falk (c)** U.Manitoba The $^{13}C(p,\pi^-)^{14}O$ Reaction in a $pn \rightarrow pp\pi^-$ Model **(TU-A4-8)** **Session ends at 12h45 / *Fin de la session à 12h45***			Session Ends / *Fin de la session*	12h30
	Session Ends / *Fin de la session*				12h45
					13h30
				ROOM FNSC-60 (cap. 119)	
TU-P10 (PPD) ***ENERGY FRONTIER IN PARTICLE PHYSICS II / LA LIMITE EN ÉNERGIE EN PHYSIQUE DES PARTICULES II*** Chair: M. Vincter, Carleton U.		**TU-P3 (DMBP / *DPMB*)** **DMBP CONTRIBUTED / *PAPIERS PRÉSENTÉS EN PHYSIQUE MÉDICALE ET BIOLOGIQUE*** Chair: A. Linhananta, Lakehead U	**TU-P9 (DIMP / *DPIM*)** **LASER ULTRASONICS AND PHOTOACOUSTICS / *CARACTÉRISATION ULTRASONIQUE ET PHOTO-ACOUSTIQUE DES MATÉRIAUX PAR LASER*** Chair: M. Sigrist, Swiss Fed.Inst.	**TU-P8 (DIMP / *DPIM*)** **BIOTECHNOLOGIES AND BIOTHERMOPHOTONIC INSTRUMENTS AND METHODS II / *INSTRUMENTATION ET TECHNIQUES EN BIOTECHNOLOGIE ET BIOPHOTONIQUE II*** Chair: A. Mandelis, U.Toronto	
O'NEIL, Dugan SFU *Latest results from the D0 experiment* **(TU-P10-1)**		**C. Roth (c)** SFU *AFM imaging of three-way DNA junctions* **(TU-P3-1)**	**TERAZIMA, Masahide** Kyoto U. *Time-resolved study of refractive index change after irradiation of ultra-short laser pulse inside glasses* **(TU-P9-1)**	**WHELAN, William** Ryerson U. *Interstitial optical radiance measurements: a new approach to guiding laser thermal therapies* **(TU-P8-1)**	14h15
↓		**A. Linhananta (c)** Lakehead U. *The equilibrium properties and folding kinetics of an all-atom Go model of the Trp-Cage* **(TU-P3-2)**	↓	↓	14h30
CORRIVEAU, Francois IPP/McGill U. *ZEUS gets polarized* **(TU-P10-2)**		**Z. Zhou (c)** Tamkang U. *Elasticity and stability of an elastic helical rod* **(TU-P3-3)**	**SCHUESSLER, Hans A.** Texas A&M U. *Linear and nonlinear laser opto-acoustic measurements in solids from the macro- to the nano-scale* **(TU-P9-2)**	**MAJARON, Boris** Jozef Stefan Institute *Toward photothermal imaging for medicine* **(TU-P8-2)**	14h45
↓		**M. Wiggin (c)** UBC *Characterization of a nanosensor for trans-membrane identification of single nucleic acid molecules* **(TU-P3-4)**	↓	↓	15h00
Y. Coadou (c) SFU *Search for single top quark production at D_0 in Run II* **(TU-P10-3)**		**A. Marziali (c)** UBC *Selective pre-concentration of nucleic acids by synchronous 2-D non-linear electrophoresis* **(TU-P3-5)**	**Coffee Break / *pause café***	**Coffee Break / *pause café***	15h15
Coffee Break / *pause café*		**J.L. Hobson (c)** SFU *Influence of frequency noise on the analysis of NMR free induction decays* **(TU-P3-6)**	↓	↓	15h30
J. Standage (c) York U. *Measurements of α_s at the HERA accelerator* **(TU-P10-4)**		**E. Chapple (c)** SFU *Power absorption by a spherical phantom in the context of low-field MRI* **(TU-P3-7)**	**MICHAELIAN, Kirk H.** Natural Resources Canada *Signal recovery in step-scan photoacoustic spectroscopy* **(TU-P9-3)**	**LEBLANC, Roger M.** U.Miami *Spectroscopy and imaging of peptide-capped quantum dots to study amyloid aggregation* **(TU-P8-3)**	15h45

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 6 (cap. 226)
16h00	↓	↓	**A. Ballestad (c)** UBC *Modeling the surface shape evolution of flat and patterned GaAs (001) substrates during epitaxial growth* **(TU-P6-6)**	↓	↓
16h15	**GOMIS, JUAME** Robarts Research Inst. *to be announced* **(TU-P2-4)**	**F. Callaghan (c)** SFU *Muon spin rotation measurements of the vortex core size in single-gap and multi-gap type-II superconductors* **(TU-P5-6)**	**S.E. Webster (c)** UBC *The bandgaps of the quaternary dilute nitride alloys $GaN_xSas_{1-x-y}Bi_y$ and $Ga_{1-y}In_yN_xAs_{1-x}$* **(TU-P6-7)**	**A. Hirose (c)** U.Sask. *On q dependence of thermal diffusivities in tokamaks* **(TU-P7-5)**	**J.H. Brewer (c)** TRIUMF *Relativistic shifts of g_μ in muonic atoms* **(TU-P4-4)**
16h30	↓	**A. Iyengar (c)** UBC *Exact summation of vertex corrections to the penetration depth in d-wave superconductors* **(TU-P5-7)**	Session Ends / *Fin de la session*	Session Ends / *Fin de la session*	**A. Predoi-Cross (c)** U.Lethbridge *High temperature near-infrared emission measurements of $HC^{15}N$* **(TU-P4-5)**
16h45	Session Ends / *Fin de la session*	Session Ends / *Fin de la session*			Session Ends / *Fin de la session*
17h00		**CAP Annual General Meeting / *Assemblée générale de l'ACP***			

19h00	**Banquet Reception**	SUB Party Room and Ballroom
19h30	**Banquet**	

Wednesday, June 8

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)
07h00	(WE-A1) - Meeting of the CAP-NSERC Liaison Committee (07h00-09h00) - SUB Council Chamber			
08h15		**WE-A1** Plenary Session plénière (CAP/CRM Medal winner - récipiendaire de la médaille ACP/CRM) Chair: B. Joos, U. Ottawa **ROBERT MYERS** Perimeter Institute *Cosmic superstrings* (WE-A1-1)		**WE-A2** Plenary Session plénière (CAP Industrial and Applied Medal winner -récipiendaire de la médaille pour les réalisations exceptionnelles en physique industrielle et appliquée) Chair: D. Lockwood, NRC **ANTHONY SPRINGTHORPE** NRC *III-V compound semiconductor epitaxy - Then and now* (WE-A2-1)
09h00		**WE-A3** Plenary Session plénière Chair: J. Barth, UBC **DONALD EIGLER** IBM Almaden Research Center *Single-atom spin-flip spectroscopy* (WE-A3-1)		
09h45		**Coffee Break / *pause café***		
	WE-A7 (DTP / *DPT*) ***QUANTUM INFORMATION COMPUTING / INFORMATION/ORDINATEUR QUANTIQUE*** Chair: R. MacKenzie, U.Montreal	**WE-A8** (DCMMP / *DPMCM*) ***NANOSCALE PHYSICS / PHYSIQUE NANOMÉTRIQUE*** Chair: M. Dignam, Queen's U.	**WE-A10** (DCMMP/DPMCM) **BEST STUDENT PAPER COMPETITION / *COMPÉTITION ÉTUDIANTE POUR LE MEILLEUR PAPIER PRÉSENTÉ*** Chair: M. Campbell, U.Waterloo	**WE-A6** (DAMP-DOP / *DPAM-DOP*) **ULTRAFAST SCIENCE AND APPLICATIONS / *SCIENCE ET APPLICATIONS DES PROCESSUS ULTRARAPIDES*** Chair: R. Shiell, Trent U.
10h00	**NAYAK, Ashwin** U.Waterloo/PI *Near optimal quantum test of group commutativity* **(WE-A7-1)**	**BARTH, J.** UBC *Supramolecular architecture at surfaces: control of matter at the nanoscale* **(WE-A8-1)**	Competitor #1	**CHIN, See L.** U.Laval *The physics of femtosecond laser filamentation and its potential applications* **(WE-A6-1)**

CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	FNSC 50 (cap. 45)	Other locations autres endroits	TIME HEURE
J-F. Arguin (c) U.Toronto *Measurement of the top quark mass with simultaneous determinationof the jet energy scale using in situ $W \to q\ \bar{q}$ decays at CDF* **(TU-P10-5)**		**A.Y.C. Fung (c)** Nebraska Medical Centre *Daily ultrasound guided IMRT of prostate cancer* **(TU-P3-8)**	↓	↓	16h00
S. Pashapour (c) U.Toronto *An investigation of top quark pair production mechanisms* **(TU-P10-6)**		**E. Galiano (c)** Laurentian U. *A statistical analysis of the initial biodistribution of ^{153}Sm-EDTMP in a canine* **(TU-P3-9)**	**KORPIUN, Peter** PA-Group Scheyern, Germany *Photoacoustic detection of sorption and diffusion in thin layers of porous materials* **(TU-P9-4)**	**C.H. Winter** Quantum Technology Corp. *Proposal for a Canadian National High Magnetic Field Laboratory* **(TU-P8-4)**	16h15
P. Savard (c) U.Toronto/TRIUMF *Search for large extra dimensions with the CDFII detector* **(TU-P10-7)**		**J.C. Kumaradas (c)** Ryerson U. *Modeling nano-particle rotation in magnetocarcinotherapy* **(TU-P3-10)**	↓	Session Ends / *Fin de la session*	16h30
Session Ends / *Fin de la session*		Session Ends / *Fin de la session*	**MAEV, Roman** U.Windsor *Physics and Art: Look Inside* **(TU-P9-5)**		16h45
			Session Ends at 17h15 / *Fin de la session à 17h15*		17h00

19h00 — **Réception du banquet** — SUB Party Room and Ballroom

19h30 — **Banquet**

Mercredi, le 8 juin

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	Other locations autres endroits	TIME HEURE
	(WE-A1) - Réunion du comité de liaison ACP-CRSNG (07h00-09h00) - SUB Council Chamber			07h00
				08h15
				09h00
				09h45
WE-A9 (DIMP / *DPIM*) **SEMICONDUCTOR AND THIM FILM CHARACTERIZATION II / *CARACTÉRISATION DES FILMS MINCES ET DES SEMI-CONDUCTEURS II*** Chair: M. Terazima, Kyoto U.	**WE-A5** (PPD) **INSTRUMENTATION FOR PARTICLE PHYSICS / *INSTRUMENTATION EN PHYSIQUE DES PARTICULES*** Chair: K. Ragan, McGill U.	**WE-A4** (DNP / *DPN*) **INSTRUMENTATION FOR NUCLEAR PHYSICS / *INSTRUMENTATION EN PHYSIQUE NUCLÉAIRE*** Chair: J. Dilling, TRIUMF		
A. Mandelis (c) U.Toronto *Contactless characterization of photocarrier recombination processes in Si using rate-window photo-carrier radiometry* **(WE-A9-1)**	**P.D. Jackson (c)** Ohio State U. *Radiation-hard ASIC's for optical data transmission in the ATLAS pixel detector* **(WE-A4-2)**	**KRÜCKEN, Reiner** Tech. Univ. Munich *Recent results from REX-ISOLDE* **(WE-A4-1)**		10h00

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)
10h15	↓	↓	Competitor #2	↓
10h30	**SHAPIRO, Moshe** UBC *Principle of coherent control and the detection and automatic repair of mutations by coherent light* **(WE-A7-2)**	**BENNEWITZ, Roland** McGill U. *Observing Atoms at Work* **(WE-A8-2)**	Competitor #3	**YE, Jun** JILA,MIST,U.Colorado *Ultrafast-based precision measurements and control in ultracold world* **(WE-A6-2)**
10h45	↓	↓	Competitor #4	↓
11h00	**BRASSARD, Gilles** U.Montreal *Quantum foundations in the light of quantum information* **(WE-A7-3)**	**J.L. Hutter (c)** UWO *Mechanical properties of multiwalled carbon nanotubes* **(WE-A8-3)**	Competitor #5	**SMIRNOVA, Olga** NRC/Vienna U. of Technology *Attosecond measurements without attosecond pulses: using particle correlation* **(WE-A6-3)**
11h15	↓	**B.C. Choi (c)** U.Victoria *Magnetization dynamics depending on As-patterned magnetic states in submicron elements* **(WE-A8-4)**	Competitor #6	↓
11h30	**MARZLIN, Karl-Peter** U.Calgary *Applications of electromagnetically induced transparency in quantum information* **(WE-A7-4)**	**H. Dalgleish (c)** SFU *Molecular spintronics: Theory of spin-dependent electron transport between iron nano-contacts bridged by organic molecules and Fe atomic chains* **(WE-A8-5)**	Competitor #7	**SANDERSON, Joseph** U.Waterloo *Controlling and imaging molecules with ultrashort laser pulses* **(WE-A6-4)**
11h45	↓	**J.W. Buker (c)** SFU *Two-probe theory of scanning tunneling microscopy of single molecules* **(WE-A8-6)**	Competitor #8	↓
12h00	**MOSCA, Michele** U.Waterloo/St.Jerome/PI *Quantum phase estimation* **(WE-A7-5)**	Session Ends / *Fin de la session*	Session Ends / *Fin de la session*	**A.A. Madej (c)** NRC *Precision optical frequency measurements using a 1.5μm infrared frequency comb* **(WE-A6-5)**
12h15	↓			**A. Czajkowski (c)** U.Ottawa *Applications of a 1.5 micron frequency standard for precision measurements* **(WE-A6-6)**
12h30	Session Ends / *Fin de la session*			Session Ends / *Fin de la session*
12h45				
13h00				
13h15		**Best Student paper competition winners announced / *Les résultats de la compétition meilleur communication annoncés***		
13h30		**WE-P1** Plenary Session plénière Chair: C. Virtue, Laurentian U. **BORIS KAYSER** Fermilab, Chicago *The neutrinos: Discoveries and open questions* (WE-P1-1)		

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	Other locations autres endroits	TIME HEURE
IKARI, Tetsuo U.Miyazaki *Characterization of the semiconductor thin film quantum structures by using a Piezoelectric photo-thermal spectroscopy (PPTS)* **(WE-A9-2)**	**G. Rosenbaum (c)** U.Victoria *Resolution studies of a GEM - TPC in a high magnetic field* **(WE-A5-2)**	↓		10h15
↓	**S. Yen (c)** TRIUMF *Development of water-bearing scintillating liquid and gel detectors for the T2K neutrino oscillation experiment* **(WE-A5-3)**	**CHUPP, Tim** U.Michigan *Electric dipole moment measurements with radioactive beams* **(WE-A4-2)**		10h30
Coffee Break / *pause café*	**J. Wendland (c)** UBC *A time projection chamber for the near detector of the T2K experiment* **(WE-A5-4)**	↓		10h45
↓	**R. Helmer (c)** TRIUMF *The K2K calibration source manipulator* **(WE-A5-5)**	**M. Smith (c)** UBC/TRIUMF *A digital RFQ for TITAN* **(WE-A4-3)**		11h00
MANSANARES, Antonio U.Campinas, Brazil *Sensitivity enhancement in thermo-reflectance microscopy of semiconductor devices using suitable probe wavelengths* **(WE-A9-3)**	**B. Fulsom (c)** UBC *LSTs to the rescue: saving BaBar's beleaguered muon detection system* **(WE-A5-6)**	**J. Birchall (c)** U.Manitoba *Control of systematic errors in the Q_{weak} experiment at Jefferson Lab.* **(WE-A4-4)**		11h15
↓	**A. Bellerive (c)** Carleton U. *Spatial resolution of a micromegas readout TPC using the charge dispersion signal* **(WE-A5-7)**	**LASSEN, Jens** ISAC/TRIUMF *Resonant ionization laser ion source - application of laser spectroscopy in nuclear and particle physics* **(WE-A4-5)**		11h30
MAZNEV, A.A. Philips Advanced Metrology Systems *Measuring microelectronic thin films with transient grating photoacoustics* **(WE-A9-4)**	**O. Simard (c)** Carleton U. *Improvements to the optical calibration methods for the final phase of the Sudbury Neutrino Observatory experiment* **(WE-A5-8)**	↓		11h45
↓	**R. MacDonald (c)** U.Alberta *Evaluation and simulation of the response function in the TWIST experiment* **(WE-A5-9)**	**PEARSON, Chris** TRIUMF *Gamma ray tracking in segmented germanium detectors* **(WE-A4-6)**		12h00
Session Ends / *Fin de la session*	**D. Gillberg (c)** SFU *Jet response in the D0 calorimeters* **(WE-A5-10)**	↓	**IRC G41/42** **Young-New Faculty Luncheon with NSERC, followed by workshop / Déjeuner-rencontres des jeunes-nouveaux professeurs avec le CRSNG, suivi d'un atelier**	12h15
	Session Ends / *Fin de la session*	**M.A. Schumaker (c)** U.Guelph *Investigation of optimal compton suppression schemes for TIGRESS* **(WE-A4-7)**	↓	12h30
		Session Ends / *Fin de la session*	↓	12h45
			IRC 1 (cap.133) **NSERC Workshop / Atelier du CRSNG**	13h00
				13h15
				13h30

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 5 (cap. 120)
	WE-P4 (DTP / *DPT*) ***GENERAL RELATIVITY AND GRAVITATION / RELATIVITÉ GÉNÉRALE ET GRAVITÉ*** Chair: M. Paranjape, U.Montreal	**WE-P5** (DCMMP / *DPMCM*) ***SOFT MATTER / MATIÈRE MOLLE*** Chair: J. Bechhoefer, SFU	**WE-P6** (DCMMP/DPMCM) **CORRELATED ELECTRONS: MOSTLY THIN FILMS / *ÉLECTRONS CORRÉLÉS : SURTOUT LES FILMS MINCES*** Chair: G. Williams, U.Manitoba	**WE-P9** (DIMP / *DPIM*) **ANALYTICAL TECHNIQUES AND SENSORS / *TECHNIQUES ANALYTIQUES ET SENSEURS POUR LA PHYSIQUE ET L'ÉVALUATION NON-DESTRUCTIVE*** Chair: M. Rodriguez/S-Y.Zhang	**WE-P8** (DOP) **ADVANCES IN OPTICS AND PHOTONICS / *PROGRÈS EN OPTIQUE ET PHOTONIQUE*** Chair: M. Campbell, U.Waterloo
14h15	**MOFFAT, John W.** PI/Waterloo U. *Gravitational theory, galaxy rotation curves and cosmology without non-baryonic dark matter* **(WE-P4-1)**	**DE BRUYN, John** UWO *Penetration of spheres into loose granular media* **(WE-P5-1)**	**A. Morello (c)** UBC *Nuclear spins as local probes for the quantum dynamics of single-molecule magnets* **(WE-P6-1)**	**POWER, J.F.** McGill U. *Raman effect light profile microscopy* **(WE-P9-1)**	**R. Hodgson (c)** U.Ottawa *Optimization of depth-graded multilayer reflectors for EUV and X-ray optics* **(WE-P8-1)**
14h30	↓	↓	**J. van Lierop (c)** U.Manitoba *Local ordering effects in exchange-coupled thin-films* **(WE-P6-2)**	↓	**E. Ouellet-Bélanger (c)** Laval U. *Analysis of thickness modification of polymers layers under light illumination* **(WE-P8-2)**
14h45	**GEGENBERG, Jack** UNB *Quantization of dilaton gravity* **(WE-P4-2)**	**I. L'Heureux (c)** U.Ottawa *Effects of quenched porosity fluctuations in nonlinear reaction-diffusion porous systems* **(WE-P5-2)**	**C. Buzea (c)** Queen's U. *Magneti c properties of nanozigzag cobalt films fabricated by glancing angle deposition* **(WE-P6-3)**	**SHEN, Jun** NRC *Methanol concentration sensors for direct methanol fuel cell systems: A review* **(WE-P9-2)**	**P. Rochon (c)** RMC *The use of relief gratings to control and observe surface plasmon propagation* **(WE-P8-3)**
15h00	↓	**S. Allen (c)** U.Guelph *Conformational changes of adsorbed proteins* **(WE-P5-3)**	**E.D. Crozier (c)** SFU *Investigating in-plane anisotropy of ultrathin Fe films on GaAs(001)-4x6* **(WE-P6-4)**	↓	**Coffee Break / Pause café**
15h15	**KUNZLE, Hans-Peter** U.Alberta *Spherical symmetry of generalized Einstein-Yang-Mills-Higgs fields* **(WE-P4-3)**	**Coffee Break / Pause café**	**B.C. Choi (c)** U.Victoria *Dynamic magnetic domain configurations assisted by thermally excited spin fluctuations* **(WE-P6-5)**	**P. Eles (c)** UBC *Two-photon excitation in nuclear magnetic resonance* **(WE-P9-3)**	↓
15h30	↓	↓	**Coffee Break / Pause café**	**J.L. Bechhoefer** SFU *Feedforward control of scanning stages* **(WE-P9-4)**	**M. Dignam (c)** Queen's U. *Quantum path interference in spontaneous emission in dielectric microstructures* **(WE-P8-4)**
15h45	**SCHLEICH, Kristin** UBC *Topological censorship and beyond: Black holes and singularities in dimension greater than 4* **(WE-P4-4)**	**PAGE, John** U.Manitoba *The squishy physics of dough and bread* **(WE-P5-4)**	↓	**E. Galiano (c)** Laurentian U. *Determination of the activity concentration of a Pu-238 solution by the defined solid angle method utilizing a novel dual diaphragm-detector assembly* **(WE-P9-5)**	**A. Pattantyus-Abraham (c)** UBC *Colloidal nanocrystalline PbSe coupled to Si-based photonic crystal microcavities* **(WE-P8-5)**
16h00	↓	↓	**K. Edmonds (c)** UBC *Spontaneous magnetisation in quantum dots* **(WE-P6-6)**	**J. Gauthier (c)** U.Laval *HERACLES detectors array adaptation for low energies experiments* **(WE-P9-6)**	**H. van Driel (c)** U.Toronto *Ultrafast optical tuning of photonic crystals* **(WE-P8-6)**
16h15	**CHOPTUIK, Matthew** UBC *Numerical relativity in the World Year of Physics* **(WE-P4-5)**	**A. Sukhovich (c)** U.Manitoba *Negative refraction of acoustic waves in a 2D phononic crystal* **(WE-P5-5)**	**C. Mugford (c)** U.Waterloo *Measurements of the 1/f noise in Josephson Junctions for potential use as qubits* **(WE-P6-7)**	**W.D. Ramsay (c)** U.Manitoba *Current mode electronics for the Qweak experiment* **(WE-P9-7)**	Session Ends / *Fin de la session*
16h30	↓	**C.A. Murray (c)** U.Guelph *Swelling and surface modification of ultrathin chitosan films* **(WE-P5-6)**	**L. Covaci (c)** U.Alberta *Generalized proximity effect* **(WE-P6-8)**	Session Ends / *Fin de la session*	
16h45	Session Ends / *Fin de la session*	**A. Plyukhim (c)** U.Sask. *Effects of thermal fluctuations on transport in quasi-1D systems* **(WE-P5-7)**	**M. Berciu (c)** UBC *Manipulation of nanoscale spin and charge textures in diluted magnetic semiconductors using superconducting vortices* **(WE-P6-9)**		
17h00		Session Ends / *Fin de la session*	Session Ends / *Fin de la session*		

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	Other locations autres endroits	TIME HEURE
WE-P7 (PPD) ***NON-ACCELERATOR PARTICLE PHYSICS / PHYSIQUE DES PARTICULES SANS ACCÉLERATEUR*** Chair: D. Sinclair, Carleton U.	**WE-P10** (DAMP / *DPAM*) **QUANTUM COHERENCE, RELAXATION AND THEORY / *COHÉRENCE QUANTIQUE, RELAXATION ET THÉORIE*** Chair: W-K. Liu, U.Waterloo	**WE-P2** (DNP / *DPN*) **QCD IN NUCLEAR PHYSICS / *QCD EN PHYSIQUE NUCLÉAIRE*** Chair: G. Huber, U.Regina	**WE-P3** (DMBP / *DPMB*) **MEMBRANES AND VESICLES / *MEMBRANES ET VÉSICULES*** Chair: A. Rutenberg, Dalhousie U		
DUNCAN, Fraser Queen's U./SNOLAB *SNOLAB* **(WE-P7-1)**	**RANGAN, Chitra** U.Windsor *Coherent control and quantum information processing in Rydberg atoms* **(WE-P10-1)**	**MILLER, C.A.** TRIUMF *Studying quark confinement in the nuclear environment with Deeply Inelastic Scattering* **(WE-P2-1)**	**WORTIS, Michael** SFU *Biomechanics of human red-cell shapes: The stomatocyte-discocyte-echinocyte sequence* **(WE-P3-1)**		14h15
↓	↓	↓	↓		14h30
KRAUSS, Carsten Queen's U. *Results of the Picasso experiment and development towards a large scale SNOLAB dark matter detector* **(WE-P7-2)**	**LVOVSKY, Alexander** U.Calgary *Homodyne tomography for quantum information: A new application for an old method* **(WE-P10-2)**	**DUTTA, Dipangkar** Duke U./TUNL *From quarks to nuclei: The search for signatures of QCD in nuclei* **(WE-P2-2)**	**KATSARAS, John** NRC *Spontaneously forming, varying polydispersity unilamellar lipid vesicles* **(WE-P3-2)**		14h45
↓	↓	↓	↓		15h00
M. Hasinoff (c) UBC *Latest results from the CERN Axion Solar Telescope (CAST)* **(WE-P7-3)**	**MOMOSE, Takamosa** UBC *Relaxation dynamics of molecules in quantum crystals* **(WE-P10-3)**	**Coffee break / *Pause café***	**EVANS, Evan** UBC *From innate immunity to cell death: Exploring the energy landscape governing membrane permeation by small peptides with dynamic tension spectroscopy* **(WE-P3-3)**		15h15
L. Heelan (c) Carleton U. *The search for a periodic solar neutrino rate at the Sudbury Neutrino Observatory* **(WE-P7-4)**	↓	**LEWIS, Randy** U.Regina *Recent successes and future directions in lattice QCD* **(WE-P2-3)**	↓		15h30
Coffee break / *Pause café*	**S. Bandyopadhyay (c)** U.Calgary *When is teleportation 'quantum'?* **WE-P10-4)**	↓	Session Ends / *Fin de la session* **Coffee break / *Pause café***		15h45
CHEN, Mark Queen's U. *SNO+: SNO with liquid scintillator* **(WE-P7-5)**	**J.L. Herman (c)** SFU *A simple phenomenological model for metastability exchange optical pumping of helium* **(WE-P10-5)**	**HORNIDGE, David** Mount Allison U. *The magnetic dipole moment of the Δ(1232) resonance* **(WE-P2-4)**			16h00
↓	Session Ends / *Fin de la session*	↓			16h15
RAGAN, Ken McGill U. *On to VERITAS* **(WE-P7-6)**		**J.W. Martin (c)** U.Winnipeg *The strange form-factors of the proton and the G0 Experiment* **(WE-P2-5)**			16h30
↓		**A. Olin (c)** TRIUMF/U.Victoria *Search for K^{-pp} nuclei with FINUDA* **(WE-P2-6)**			16h45
U. Wichoski (c) U.Montreal *Improved spin dependent limits from the PICASSO dark matter search experiment* **(WE-P7-7)**		Session Ends / *Fin de la session*		**SUB Council Chamber (30)** (CAP/ACP) **New and Old Council Meeting / Réunion du Conseil (nouveau et ancien)**	17h00

TIME HEURE	IRC 1 (cap. 133)	IRC 2 (cap. 500)	IRC 3 (cap. 108)	IRC 4 (cap. 135)	IRC 5 (cap. 120)
17h15					
17h30					

Thursday, June 9

Meeting of the CAP/NSERC Liaison Committee (09h00 - 12h00) - location to be announced

Next CAP Annual Congress
2006 June 11-14
at Brock University, St. Catharine's, ON

Prochain Congrès annuel de l'ACP
11-14 juin 2006
à l'Université Brock, St. Catharine's, ON

IRC 6 (cap. 226)	CEME 1202 (cap. 119)	CEME 1204 (cap. 60)	G279 (hos) (cap. 140)	Other locations autres endroits	TIME HEURE
M. Bergevin (c) U.Guelph *Multiple ring fitter for the Sudbury Neutrino Observatory* **(WE-P7-8)**					17h15
Session Ends / *Fin de la session*					17h30

Jeudi, le 9 juin

Réunion de la Comité de liaison de l'ACP-CRSNG (09h00 - 12h00) - endroit à venir

Come and visit the Art of Physics exhibition on display at the 2005 Congress. Entry forms for the 2005 competition will be available at the CAP Information Desk (deadine Dec. 31/05). Winning entries will be added to the travelling exhibition.

Venez visiter l'exposition l'<<Art de la Physique>> tenue lors du Congrès 2005. Les formulaires d'inscription pour le concours 2005 seront disponibles au bureau d'information (la date limite est le 31 décembre 2005). Les gagnants verront leurs œuvres ajoutées à l'exposition itinérante.

2005 CONGRESS ORAL SESSION ABSTRACTS
RÉSUMÉS DES SESSIONS ORALES - CONGRÈS 2005

The oral session abstracts presented here are organized by session codes (SU-A1 to WE-P10). Each presentation is cross-referenced in the Author Index (pg. 113). *Les résumés des sessions orales ci-après sont par code (SU-A1 à WE-P10). L'index des auteurs (pg. 113) établit des renvois à cette liste de présentations.*

Please see the Congress Program Summary for details on the times and locations of each of the sessions as well as all other (non-session) meetings organized in conjunction with the 2005 Congress. *Veuillez vous référer au résumé du programme du Congrès pour les heures et endroits de chaque session ainsi que pour toutes les autres rencontres organisées en conjonction avec le Congrès 2005.*

[SU-A1] Spin Electronics - A.M.
(DCMMP/*DPMCM*) ***Spintronique - A.M.***

SUNDAY, JUNE 5
DIMANCHE, 5 JUIN
09h30 - 11h30

ROOM / SALLE IRC 2 (cap. 500) ***Chair: T. Chakraborty, U. Manitoba***

SU-A1-1 **09h30**

JUNSAKU NITTA, NTT Basic Research Laboratories, CREST-JST

Spin-Controlled Transport and Devices in Semiconductor Heterostructures

The manipulation of spins in semiconductor materials is a currently attractive research area for the future spintronic devices. Different approaches have been applied to accomplish it. Main advantages of using semiconductor materials are the possibilities to control the spin states by an external gate voltage. We have found that the spin-orbit interaction parameters in InGaAs/InAlAs heterostructures can be controlled by the heterostructure interface and the gate voltage. This results shows that the Rashba spin-orbit interaction plays an important role in the above heterostructures. We will discuss the possibility of gate controlled spin precession and the spin interference device.

SU-A1-2 **10h00**

DAVID AWSCHALOM, University of California - Santa Barbara

Spintronics: Semiconductors, Molecules, and Quantum Information Processing *

There is a growing interest in exploiting electronic and nuclear spins in semiconductor nanostructures for the manipulation and storage of information in emergent technologies based upon spintronics and quantum logic. Such schemes offer qualitatively new scientific and technological opportunities by combining elements of standard electronics with spin-dependent interactions between electrons, nuclei, electric and magnetic fields. Here we provide an overview of recent developments in the field through a discussion of temporally- and spatially-resolved magneto-optical measurements. We demonstrate new electrical schemes for the local generation and manipulation of spins in conventional semiconductor heterostructures, thereby providing a compelling proof-of-concept that quantum spin information can be controlled within high-speed electrical circuits. Furthermore, we discuss a different experimental approach that enables the molecular wiring and assembly of colloidal semiconductor nanostructures to engineer hybrid systems for room temperature coherent spin transport. These experiments explore electronic, photonic, and magnetic control of spin in a variety of nanostructures, and show significant steps towards spin-based quantum information processing in the solid state.

* This work is being supported by DARPA, NSF, ONR

10h30 **Coffee Break / Pause café**

SU-A1-3 **11h00**

DIRK GRUNDLER, Institut fuer Angewandte Physik

Tailored Spin Dynamics in Nanostructured Ferromagnets *

Dynamic properties of ferromagnetic nanostructures on the sub-ns time scale have become increasingly important due to the increased data transfer rates in existing magneto-electronic devices. Recently intriguing novel phenomena like DC current induced ferromagnetic resonance (FMR) [1] or spin pumping in magnetic multilayers [2] have been discovered. Based on FMR a spin battery for semiconductors has also been proposed [3]. Spin dynamics in nanomagnets is a topic of great current interest in spintronics. Using a broadband microwave spectrometer (45 MHz - 20 GHz) we have studied the FMR of periodic arrays of nanostructured $Ni_{80}Fe_{20}$ rings. The 20 nm thick devices were fabricated by means of electron beam lithography and lift-off processing on coplanar wave guides exhibiting a high bandwidth. For all rings we observe a series of FMR modes which shift characteristically as a function of width and external magnetic field H. In particular, modes are hysteretic and show irreversible switching. We attribute them to intrinsically localized spin waves. Very intriguingly the dynamic response can be controlled via the quasistatic spin configuration of the rings, i.e., via the vortex and the onion states [4]. We thank D. Heitmann and T. Korn. Financial support by the BMBF via 13N8283 and by the DFG is gratefully acknowledged.

1. S.I. Kiselev *et al.*, *Nature* **425**, 380 (2003).
2. R. Urban *et al.*, *Phys. Rev. Lett.* **87**, 217204 (2001).
3. A. Brataas *et al.*, *Phys. Rev. B* **66**, 060404 (2002).
4. F. Giesen *et al.*, *Appl. Phys. Lett.*, (March 2005).

* In collaboration with F. Giesen, J. Podbielski, Universität Hamburg

11h30 **Session Ends / *Fin de la session***

[SU-A2] (DASP/*DPAE*) Canadian Space Science Satellites for the Twenty-First Century: SciSat to CASSIOPE and Beyond - A.M. / *Les satellites canadiennes pour le 21e siècle: de SciSat à CASSIOPE et au délà - A.M.*

SUNDAY, JUNE 5 / DIMANCHE, 5 JUIN

09h30 - 13h00

ROOM / SALLE IRC 3 (cap. 108) ***Chair: M. Connors, Athabasca U.***

SU-A2-1 **09h30**

DAVID KENDALL, Canadian Space Agency

Advancing Knowledge Through Science - Canadian Space Agency's Role in Canada's Space Science Program

The Canadian space science community is arguably the best in the world in terms of reputation and scientific results per capita or per dollar spent. In this colloquium celebrating Canada's small scientific satellite program, we find many recent examples of outstanding Canadian successes in space. Because of the lack of a national space science institute, which is present in almost all other major space-faring nations, the Canadian Space Agency has taken a more active and direct role than a typical funding agency to help the Canadian space science community succeed internationally. In this talk, I present a retrospective of the CSA Space Science Program and the role it has played in fulfilling one of the Agency's primary mandates - Advancing knowledge through science. I will outline the mandate and modus operandi of the 'New CSA Space Science'. I will close with some thoughts on the future of Canada's space-borne scientific experiments, including those using the Canadian small- or microsatellite bus as the carrier.

SU-A2-2 **10h00**

PETER BERNATH, University of Waterloo

Atmospheric Chemistry Experiment (ACE): First Results *

The ACE mission goals are: (1) to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere, particularly in the Arctic; (2) to explore the relationship between atmospheric chemistry and climate change; (3) to study the effects of biomass burning in the free troposphere; (4) to measure aerosol number density, size distribution and composition. ACE is making a comprehensive set of simultaneous measurements of trace gases, thin clouds, aerosols, and temperature by solar occultation from a satellite in low earth orbit. A high inclination (74 degrees) low earth orbit (650 km) gives ACE near-global coverage. A high-resolution (0.02 cm^{-1}) infrared Fourier Transform Spectrometer (FTS) operating from 750-4400 cm^{-1} is the primary instrument. Aerosols and clouds are monitored using the extinction of solar radiation at 0.525 and 1.02 microns as measured by two filtered imagers as well as by their infrared spectra. A spectrophotometer called MAESTRO was added to the mission to extend the wavelength coverage to the 280-1000 nm spectral region. The principal investigator for MAESTRO is T. McElroy of the Meteorological Service of Canada. The FTS and imagers have been built by ABB-Bomem in Quebec City, while the satellite bus has been made by Bristol Aerospace in Winnipeg. ACE was selected in the Canadian Space Agency's SCISAT program, and was successfully launched by NASA on August 12, 2003 for a 2 year mission. First results for ACE will be presented.

* In collaboration with C. Boone, K. Walker, S. McLeod, R. Nassar and R. Skelton, University of Waterloo

SU-A2-3 **10h30**

H.G. JAMES, Communications Research Centre

Radio-Science Experiments Using the RRI, GAP, and CERTO Instruments of the Enhanced Polar Outflow Probe Satellite Payload *

The enhanced Polar Outflow Probe (e-POP) is a scientific payload to be launched in late 2007 on the Canadian CASSIOPE small satellite into a low-altitude, elliptical polar orbit with 80 inclination, 325 km perigee, and 1500 km apogee. The scientific objectives of e-POP are described by Yau *et al*. elsewhere at this meeting. The e-POP science payload is a suite of 8 scientific instruments, of which three are radio instruments: the Radio Receiver Instrument (RRI), the dual-frequency GPS receiver system for Attitude, position and Profiling (GAP), and the beacon transmitter for Coherent Electromagnetic Radiation Tomography (CERTO). The RRI is a four-channel digital ULF-HF receiver fed by four 3-m monopoles. The receiver will measure waves created by collaborating ground transmitters and spontaneous emissions of auroral processes. GAP has five GPS receivers outputting the position, velocity and attitude of the spacecraft and Universal Time. Scientifically, GAP also will be used for radio occultation, in which the refraction and resulting relative phase delay of signals in both the L1 and L2 bands from a GPS satellite occulted by the limb ionosphere will provide large-scale (thousands of kilometers) electron-density information. CERTO emits CW simultaneously at 150, 400 and 1067 MHz. The radiation will be received by coherent ground arrays of dedicated receivers, located at various places around the world. Analyses of the resulting RRI, GAP and CERTO data will permit reconstruction of the ionospheric density distribution and hence be bases for studies of ionospheric dynamics.

* In collaboration with P.A. Bernhardt [1], R.B. Langley [2], C.L. Siefring [1], A.W. Yau [3], [1] Naval Research Laboratory, [2] University of New Brunswick, [3] University of Calgary

11h00 **Coffee Break / *Pause café***

SU-A2-4 **11h30**

E.J. LLEWELLYN, University of Saskatchewan

OSIRIS on Odin: Advances Made with OSIRIS Measurements of Atmospheric Ozone *

The OSIRIS instrument onboard the Odin satellite, that was launched on February 20, 2001, from Svobodny in Russia, is a combined optical spectrograph and infrared imager that obtains atmospheric images when Odin observes the terrestrial limb. These limb observations, of both scattered sunlight and the airglow, have been used to provide new information on atmospheric ozone over the entire globe. The ability to determine the ozone profile from 12-40 km, with a 1 km vertical resolution, was demonstrated very early in the mission. The detection and mapping of polar stratospheric clouds was demonstrated in the first winter of operations and the extreme vertical gradient in the ozone profile at the edge of the polar vortex was observed. In 2002 the splitting of the Antarctic Ozone Hole was followed in detail. The structure in the ozone profile, up to 90 km, is easily detected by OSIRIS and the dynamic nature of the profile well recorded. The atmospheric ozone reduction caused by the massive solar proton event of October 2004 was followed with a time resolution that exceeds current modeling capability. In 2005 OSIRIS has been put into an observing mode that will allow for the detection of an Arctic Ozone Hole. This paper will describe these OSIRIS findings and discuss our hopes for the future with the OSIRIS technology.

* In collaboration with the OSIRIS Team

SU-A2-5 **12h00**

JAMES R. DRUMMOND, University of Toronto

Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO) *

Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO) was launched on August 12, 2003 aboard the Canadian Space Agency's SCISAT 1 along with a Fourier Transform Spectrometer (ACE-FTS). MAESTRO is a dual diode array spectrophotometer and measures the atmospheric extinction In the

occultation mode In the wavelength range 270-1040 nm. The spectrometers are designed to be able to measure solar radiation with a very large dynamic range in order to be able to determine the concentration of atmospheric constituents in the atmosphere. The vertical resolution of the instrument is quite small, enabling high resolution profiles to be obtained. With nearly two years of data, a comprehensive picture of the atmosphere is being established. Vertical profiles of NO2 and ozone are currently being retrieved from these measurements. In particular we shall focus on the validation of the data In the high latitudes, which are sampled extensively by both the Instruments thus providing a large number of coincident measurements. We shall also present comparisons with ACE-FTS as well as ground based measurements at EUREKA. Some salient results from these MAESTRO retrievals will be presented. The MAESTRO instrument was constructed by EMS Technologies. Funding was provided by the Canadian Space Agency, the Natural Sciences and Engineering Research Council and the Canadian Foundation for Climate and Atmospheric Science.

* In collaboration with C.T. McElroy [1], J. Kar [2], C. Nowlan [2], D. Dufour [2], J. Zou [2], F. Nichitiu [2], T. Kerzenmacher [2], D.I. Wardle [1], P. Bernath [3], K. Walker [3], C. Midwinter [2], [1] Meteorological Service of Canada, [2] University of Toronto, [3] University of Waterloo

SU-A2-6 **12h30**

IAN R. MANN, University of Alberta [1]

Tackling the Van Allen Belts: The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS) *

The Outer Radiation Belt Injection, Transport, Acceleration, and Loss Satellite (ORBITALS) is a small satellite mission undergoing CSA Concept Study as a Canadian contribution to the satellite infrastructure for the International Living With a Star (ILWS) program. The ORBITALS will target the long-standing question of why the Earth's magnetosphere, which can be considered to be rather quiescent in astrophysical terms, is such an efficient accelerator of particles to MeV energies in the Van Allen belts. The ORBITALS mission goal is to "determine the dominant processes leading to the acceleration, global distribution, and variability of energetic electrons and ions in the inner magnetosphere". The ORBITALS will monitor the energetic electron and ion populations in the inner magnetosphere across a wide range of energies (keV to tens of MeV) as well as the dynamic electric and magnetic fields, waves, and cold plasma environment which govern the injection, transport, acceleration and loss of these energetic and space weather critical particle populations. The ORBITALS will be launched into a low-inclination GTO-like orbit with long-lasting apogee conjunctions with the ground-based instruments of the Canadian Geospace Monitoring (CGSM) array, with GOES East and West, and with geosynchronous communications satellites in the North American sector. ORBITALS measurements at MEO altitudes will also provide essential input into the development of the next-generation of radiation belt specification models. Experiments will also monitor the dose, single event upset, and deep-dielectric charging responses of electronic components on-orbit. ORBITALS data will also provide significant benefits for anomaly resolution for commercial GEO satellites.

1. On behalf of the ORBITALS Science Team

* This work is being supported by Canadian Space Agency

13h00 **Session Ends / *Fin de la session***

[SU-A3] Developments in Physics Education Research / *Nouveautés en recherche sur l'enseignement des science*

(DPE/*DEP*)

SUNDAY, JUNE 5
DIMANCHE, 5 JUIN
10h00 - 12h30

Room / *Salle* IRC 1 (cap. 133) ***Chair: R.I. Thompson, U. Calgary***

SU-A3-1 **10h00**

LILLIAN MCDERMOTT, University of Washington

Physics Education Research: The Key to Student Learning *

Research on the learning and teaching of physics is an efficient means for achieving cumulative improvement in physics instruction. Treating teaching as a science as well as an art increases the likelihood that innovations will be effective beyond a particular instructor or institutional setting. Results from systematic studies indicate that students at different educational levels often have similar conceptual and reasoning difficulties. These findings have been used to design instruction that has proved effective for undergraduate education, for the preparation of graduate teaching assistants and for the professional development of K-12 teachers. Examples will be presented that illustrate how this approach has provided a useful guide for setting higher (yet realistic) standards, for helping students meet the increased expectations, and for assessing the extent to which meaningful learning has occurred.

* This work is being supported by National Science Foundation

SU-A3-2 **10h30**

PAULA HERON, University of Washington

Student Understanding of Thermal Physics: Microscopic Models and Macroscopic Processes *

The Physics Education Group at the University of Washington has been conducting research on student understanding of the first and second laws of thermodynamics. Results indicate that many students emerge from university-level courses with an incomplete or incorrect understanding of fundamental concepts that are necessary for applying these laws (e.g., work, heat transfer, temperature, and thermal equilibrium). Moreover, many students use incorrect microscopic models to support predictions about macroscopic processes. Findings will be illustrated with results from individual student interviews, and from quizzes and exam questions administered at the University of Washington and elsewhere.

* This work is being supported by National Science Foundation

11h00 **Coffee Break / Pause café**

SU-A3-3 **11h15**

CALVIN S. KALMAN, Concordia University

Some Thoughts on Current Physics Educational Research

We need to adopt a mix of approaches and be prepared that some of them will not work for some students, (Paraphrase of "Joe" Redish in his book Teaching Physics). I present case studies of how students differ in their responses to the same activities during a semester course. These studies are based on pre/post test data and interviews taken at the beginning, middle and end of a course. Some video taped segments from these interviews will be viewed. I especially focus on how students are alike and different and the nature of changes which occur in their perceptions of activities across the course.

SU-A3-4 **11h45**

Online Practice and Assessment in First Year Physics*. **Robert Kruhlak**, T.G.G. Mullins, C. Coghill, H.K. Ng, *University of Auckland* - We report on the use of Online ASsessment and Integrated Study (OASIS) software in first year physics courses at the University of Auckland. OASIS allows us to conduct flexible online practices and assessments in our large first year physics courses. Online practice questions are released to students one week before an online assessment allowing the students sufficient time to master new concepts through practice. The assessment is conducted online with similar questions to those in the practice. Some advantages of OASIS assignments over traditional assignments, namely instant feedback, multiple opportunities for students to practice key concepts, automatic marking of assessments, and detailed statistics about student outcomes and usage, will be presented. In addition, we will discuss student participation rates, feedback and outcomes for both advancing physics and life sciences students. Overall positive student feedback and a noticeable improvement in student problem solving skills in the first full year of OASIS assignments are very encouraging.

* This work is being supported by Teaching Improvement Grant

SU-A3-5 **12h00**

Teaching Physics to Apples and Oranges. **Daria Ahrensmeier**, *University of Winnipeg* - For three years, I taught physics to undergraduate engineering students in all-female, all-male and mixed groups, many of which consisted of students from a wide variety of ethnic/cultural backgrounds. Based on this experience, I will introduce several models describing how people from different backgrounds (gender, culture, age etc.) learn concepts of physics, mathematical techniques, or even conduct experiments. This leads to the conclusion that as teachers we need to be more flexible in how we communicate physics to different students and in our expectations of their response, e.g. regarding time scales, wording of solutions etc., unless we are willing to lose a considerable number of them just because of subtle differences in communication. I will discuss how far this flexibility can be extended without lowering the academic standards. I will also compare these results to some common misconceptions in the literature.

SU-A3-6 **12h15**

The Role and Place of Imagination in Contemporary Science Education: The Case Study of Introductory Physics Course*. **Marina Milner-Bolotin**, *University of British Columbia* - What should be the goals of contemporary science education and what is the role of imagination in achieving them? Should the development of scientific imagination be one of the core educational targets on its own right or the means for achieving better conceptual understanding and improved problem solving? The paper discusses a case study of an innovative inquiry-based approach to college level introductory physics teaching (N = 180 students) at a large public university and the role and place of imagination in student exploration of physics concepts. In the proposed physics teaching model, physics is taught in a way, which reflects the process of the original scientific discovery: exploration of the new phenomena via careful observations, creating testable models to describe these phenomena and designing and performing experiments to test the proposed models. At every stage of this process (during the lectures, labs, problem solving sessions, laboratory practicals and exams), the students are actively engaged in the process of scientific discovery rather than being exposed to the final results. Based on the results of the case study, this philosophical rather than factual approach to physics teaching makes a significant difference not only in students' and instructor's (!) problem solving abilities, but also in their interest and motivation. The challenges of designing large-scale inquiry-based introductory physics courses and appropriate assessment tools for evaluating student learning will be also discussed.

* This work is being supported by Department of Physics and Astronomy, University of British Columbia

12h30 **Session Ends / *Fin de la session***

[SU-P1] Brockhouse Medal Winner / *Récipiendaire de la médaille Brockhouse*

(CAP-/ACP)

SUNDAY, JUNE 5 / DIMANCHE, 5 JUIN

13h30 - 14h15

SALLE / ROOM IRC 2 (cap. 500) ***Chair: B. Joos, University of Ottawa***

SU-P1-1 **13h30**

DAVID J. LOCKWOOD, National Research Council of Canada

Bringing Silicon To Light!

The rapidly developing field of semiconductor photonics is driving new technology. In the information technology field, a silicon-based platform would be ideal [1], but the main difficulty in producing such a platform is the lack of a suitable silicon light source. In this talk our use of the quantum confinement approach at NRC to producing light emission in silicon will be reviewed. Nanostructured systems to be covered include porous silicon, disordered and crystalline silicon quantum wells, and arrays of silicon quantum dots and bricks.

1. L. Pavesi and D.J. Lockwood, *Silicon Photonics* (Springer, Berlin, 2004).

14h15 **Session Ends / *Fin de la session***

[SU-P2] Spin Electronics - P.M. / *Spintronique - P.M.*

(DCMMP/*DPMCM*)

SUNDAY, JUNE 5 / DIMANCHE, 5 JUIN

14h15 - 16h45

SALLE / ROOM IRC 2 (cap. 500) ***Chair: T. Chakraborty, U.Manitoba***

SU-P2-1 **14h15**

ALLAN MACDONALD, University of Texas at Austin

Anomalous Transport in Metals and Semiconductors

In metals with broken translational symmetry, the Hall effect has a contribution due to coherence between Bloch bands induced by an external electric field. A similar transverse current of spins occurs even in paramagnetic metals and contributes to the spin Hall effect. We refer to these transport effects as anomalous transport. When disorder is neglected, the anomalous Hall transport of a ferromagnet is dependent only on the Berry phases associated with the variation of Bloch states with wavevector in momentum space. I will discuss the physics which determines the size of the Berry phase Hall conductivity in various ferromagnetic systems, including transition metal ferromagnets and diluted magnetic semiconductor ferromagnets. I will also discuss attempts to combine analytic and numerical approaches in order to achieve a general understanding of the dependence of anomalous transport on disorder scattering between Bloch states.

SU-P2-2 **15h00**

KIMBERLEY HALL, Dalhousie University

Spin Control for Semiconductor Spintronics

The prospect of novel semiconductor device technologies that exploit the spin property of the electron has lead to a considerable research effort into the spin-related properties of semiconductor materials. Possible application areas include low-power logic, nonvolatile memory, and optoelectronic devices, such as integrated optical isolators and photonic switching technologies. Innovation in these areas necessitates the development of methods for manipulating electron spin in semiconductor materials. Spin manipulation schemes that do not require an external magnetic field are especially attractive for integration into existing technologies because they eliminate the need to control stray magnetic fields or to manage the complex materials issues associated with the incorporation of magnetic contacts. Several approaches to electrical control of spin transport and relaxation in nonmagnetic semiconductor nanostructures will be highlighted. Methods for engineering the spin relaxation time for target spintronic device applications will be described. Device configurations exploiting these spin control methods will be presented, including a spin field effect transistor (spin FET), spin resonant tunnel diode (spin RTD), and a spin photonic switch. Our recent demonstration of electrical control of spin dynamics in InAs using all-optical pump probe techniques on gated nanostructures will also be described.

15h45 **Coffee Break / Pause café**

SU-P2-3 **16h15**

JAMES A.H. STOTZ, Paul Drude Institute

Coherent Spin Transport Via Dynamic Quantum Dots *

Quantum information processing using electron spins in semiconductor structures requires the coherent transport and manipulation of spin polarized carriers. Previous studies have typically focussed on either the transport of spins with little control of their microscopic movement or the use of quantum dots to manipulate spins locally without microscopic transport. I will present an alternative approach using the unique system of dynamic quantum dots (DQDs), which allows the transport and manipulation of electron spins while retaining their microscopic confinement. The DQDs are produced by the superposition of the piezoelectric fields from two surface acoustic wave (SAW) beams propagating along orthogonal directions on a GaAs/(Al,Ga)As quantum well sample. Within the DQD array, spin polarized carriers are excited by circularly polarized laser light and captured by the DQDs, and the carriers are then transported at a well-defined velocity determined by the SAWs. During transport, the photogenerated electrons and holes are spatially separated by the piezoelectric potential of the DQDs resulting in a dramatic increase of the electron-spin lifetime. We demonstrate that the electron spins can be transported over distances exceeding 70 µm, which is attributed to the reduction of the D'yakonov-Perel' spin scattering mechanism within the confinement potential of the DQDs. Furthermore, the spins precess during transport because they are sensitive to the effective magnetic field of the GaAs crystal resulting from the Dresselhaus spin-orbit term. Spin precession during transport can be further controlled by the application of an external magnetic field.

* In collaboration with R. Hey, P.V. Santos, K.H. Ploog, Paul Drude Institute

16h45 **Session Ends / *Fin de la session***

[SU-P3] (DASP/*DPAE*) Canadian Space Science Satellites for the Twenty-First Century: SciSat to CASSIOPE and Beyond - P.M. / *Les satellites canadiennes pour le 21e siècle: de SciSat à CASSIOPE et au délà - P.M.*

SUNDAY, JUNE 5 / DIMANCHE, 5 JUIN

14h15 - 17h00

SALLE / ROOM IRC 3 (cap. 108) ***Chair: A. Yau, U.Calgary***

SU-P3-1 **14h15**

ERIC DONOVAN, University of Calgary

UV Imaging in Space, From ISIS to Ravens and Beyond

The scientific focus of the International Living With a Star (ILWS) program is on advancements in our understanding of the Sun-Earth connection. A key objective is to develop physics-based understanding of geospace as a complex-coupled system. In this approach, the Sun can be thought of as a source that provides energy to various sinks, including the ring current, radiation belts, ionosphere, thermosphere, and large-scale magnetospheric convection. Physical processes mitigate how energy makes its way from this source to these sinks. In order to understand these processes, and to assess their relative and absolute importance, it is essential to have targetted *in situ* observations, ongoing observations of the Sun and solar wind to track input from the source and the various sinks, where the energy ultimately ends up. Within this context, global auroral imaging is an essential tool for quantifying energy input into the ionosphere and thermosphere, and for observing the time evolving global magnetosphere, at least in terms of its projection along magnetic field lines into the ionosphere. In designing a new imaging mission, it is interesting to consider past Canadian and international projects, their accomplishments, and what technical challenges they have encountered. Doing so reveals that there are a number of "zeroth order" types of observations that have either not been done or that could be done better with current and upcoming technologies. These include long-duration 24X7 global imaging and simultaneous imaging across all relevant scales from global to tens of meters. The planned Canadian Ravens satellite mission would accomplish both of these, and more.

SU-P3-2 **14h45**

DAVID KNUDSEN, University of Calgary

Plasma Wind and Suprathermal Ion Imaging in Space: From GEODESIC to Cassiope e-POP to Swarm

Low-energy plasmas having temperatures of order 1 eV or less are found commonly in the ionospheres of the Earth and other planets. Measuring their density, temperature, drift velocities, phase-space anisotropies and other properties is challenging, due for example to wakes, spacecraft charging, and highly structured and turbulent plasmas. The Suprathermal Ion Imager (SII) was developed to address these problems. It combines a novel electrostatic grid system with a 3000-pixel, CCD-based imaging system in order to produce high-resolution, 2-D images of ion velocity distributions. The SII can measure ion drift with resolutions of better than 10 m/s, and ion temperature with resolutions of order 50 K. Following successful test flights on the GEODESIC, Cusp, and JOULE sounding rockets, the SII is currently undergoing further development for flight on the Canadian-led Cassiope/e-POP (Polar Outflow Probe) satellite, and on the European Space Agency's Swarm, a precision geomagnetic field mapping mission. This talk overviews the past performance and new applications of the SII instrument.

SU-P3-3 **15h15**

IAN CAREY MCDADE, York University

SWIFT - The Next Generation Atmospheric Wind Instrument *

SWIFT, the Stratospheric Wind Interferometer For Transport studies, is a Canadian satellite instrument designed to measure wind profiles between 20 km and 45 km in the stratosphere with an accuracy of about 5 ms^{-1}. It simultaneously provides co-located ozone density profiles. SWIFT is a follow on to the highly successful WINDII instrument (WIND Imaging Interferometer) on the UARS satellite. WINDII measured winds in the upper mesosphere and lower thermosphere using Doppler shifts in visible airglow features. SWIFT will measure winds in the stratosphere using Doppler shifts of an ozone thermal emission line in the mid-IR region near 9 m. SWIFT is currently under Canadian Space Agency Phase B study for potential flight on a Canadian small satellite to be launched in late 2009.

* This work is being supported by CSA, NSERC, ESA

SU-P3-4 **15h45**

ROBERT RANKIN, University of Alberta

A Grid-based Portal for e-POP/CASSIOPE Data Dissemination *

In order to meet scientific and operational objectives of large coordinated space science missions, it is desirable to have a functional workspace that allows scientists to collaborate across common science goals. This type of environment is facilitated by the development of grid-based data portals, which integrate remote computer systems and data into a browser-based user interface. This talk will describe the development of one such data portal that is intended to support archival, retrieval and dissemination of space science data collected by the Canadian Geospace Monitoring Program (CGSM) and the Canadian Space Agency microsatellite e-POP/CASSIOPE. The basic hardware and software elements will be described, along with supporting Grid-ware applications that are needed.

* In collaboration with M. Jankowska and C. Liu, University of Alberta

SU-P3-5 **16h15**

RICHARD B. LANGLEY, University of New Brunswick

GPS Research In Space At UNB: E-POP And Beyond

CASSIOPE, the CAScade Demonstrator Smallsat and Ionospheric Polar Explorer, is a Canadian satellite scheduled for launch in late 2007. It is a hybrid mission designed for a wide range of tasks including space-based communication, high capacity information delivery, and observations of the Earth's atmospheric environment. The atmospheric mission, termed the Enhanced Polar Outflow Probe (e-POP), is a satellite mission to investigate atmospheric and plasma flow processes in the polar ionosphere. Its primary science objective is to study the detailed quantitative relationship between the solar electromagnetic (EUV) energy input, the photo-ionization of the polar region of the atmosphere, and the acceleration and outflow of the polar wind plasma and accompanying neutrals to the magnetosphere. The e-POP platform includes a suite of eight scientific instruments including plasma imagers, radio wave receivers, magnetometers, and cameras. Among these instruments is the GPS Attitude and Positioning Experiment (GAP). A total of five GPS receivers on the satellite will be used for high precision navigation, attitude determination, and radio occultation measurements. The design and operation of GAP will be described in this paper along with a review of complementary ground-based observations of GPS ionospheric signals and the use of GPS on other spacecraft.

SU-P3-6 **16h45**

Measurements of Pollution in the Troposphere (MOPITT): 5 Years of Measurements*, **James Drummond** [1], J.C. Gille [2], D. Edwards [2], J. Kar [1], J. Liu [1], F. Nichitiu [1], J. Zou [1], [1] *University of Toronto*, [2] National Center for Atmospheric Research -- The Measurements of Pollution In the Troposphere (MOPITT) was launched on the Terra spacecraft on 18th December 1999 and has been retrieving vertical profiles of carbon monoxide (CO) - a major pollutant - globally since March 2000. The retrievals have been validated extensively by comparison with in-situ aircraft measurements through a regular program as well through special field campaigns. This dataset, which is still being expanded, represents the most comprehensive measurement set on any constituent of the troposphere, apart from water vapour. It is now being used effectively to study the role of CO in tropospheric chemistry, its role as a tracer of transport processes and in inverse models to better constrain the emissions. The retrievals have been shown to have sufficient vertical information to distinguish the upper troposphere from the middle troposphere. This is being exploited to study the upper tropospheric phenomena. We shall present some of the most fascinating results from the analysis of five years of MOPITT data. These include: The first observational confirmation of the Asian summer monsoon plume of CO that is created by deep convective uplifting of boundary layer pollution during the south Asian monsoon. Evidence of "fronts" in MOPITT CO data when CO concentrations vary by 50-100% within a horizontal distance of 100 kms across a very sharp boundary. From a study of large forest fires in Northwest United States in 2000, it was found that the spatial CO plumes match remarkably well with the location and density of fires and wind direction, and the spatial and temporal variation of CO emission can be captured by MOPITT in 3-day composites. Globally, we found that for a year with normal fire activities, the CO annual cycle is closely influenced by biomass burning in South America, Africa, and Australia, while in other regions, it is more controlled by other CO source/sink terms. However, the normal cycle in different regions can be disturbed by anomalously strong fire activities in those regions in other years. The MOPITT instrument was constructed by COMDEV of Cambridge, Ontario and the project was financed by the Canadian Space Agency and the Natural Sciences and Engineering Research Council.

* This work is being supported by CSA, NSERC

17h00 **Session Ends / *Fin de la session***

[SU-P4] (DPE/*DEP*) Engaging students in classrooms / *Implication des étudiants dans la salle de cours*

SUNDAY, JUNE 5
DIMANCHE, 5 JUIN
14h15 - 17h15

SALLE / ROOM IRC 1 (cap. 133) ***Chair: R.I. Thompson, U.Calgary***

SU-P4-1 **14h15**

RANDALL D. KNIGHT, California Polytechnic State University

Moving Physics Education Research from the "Laboratory" to the Classroom

Twenty-five years of physics education research have produced truly remarkable insights not only as to how students learn physics but also about the very nature of the learning process. But this new knowledge must be transformed into new teaching methods and new curricular materials if it is to have widespread and lasting benefit. This talk will provide a "from-the-trenches" view of both the challenges and the opportunities for moving physics education research from the "laboratory" to the classroom.

SU-P4-2 **14h45**

ERNIE MCFARLAND, University of Guelph

What's the Use of Demonstrations?

A good physics lecture demonstration requires work to design it, set it up, and think about the best way to use it, so why bother? There are several reasons, the most important of which is that demonstrations can be very helpful in promoting student learning. The many positive aspects of using demonstrations will be discussed in this presentation, and a list of good sources of demonstrations will be provided.

15h15 **Coffee Break / Pause café**

SU-P4-3 **15h30**

ADAM J. SARTY, Saint Mary's University

Wireless Responders in First-Year Physics Lectures: Attempting to Assess Effectiveness *

In a large first-year physics courses, students have very limited opportunity to directly answer questions posed by the instructor. This lack of opportunity might also reduce the likelihood of students processing the information of the lecture. To address this, several methodologies have been developed over the past decade or so to enhance the interactive engagement of students in such larger courses – of particular interest for this talk is the use of "wireless responders" that allow students to anonymously answer multiple-choice questions asked by the instructor (with the resulting class answers histogrammed immediately following). While it seems intuitive that such responders should enhance the opportunities for students to respond, and thus be required to process the information being discussed in class, evaluating the success of the tool/methodology in terms of improved retention of material/concepts is challenging. During the spring of 2004, a pilot study was performed in an attempt to shed some light on this issue of "effectiveness" by following standard psychological testing protocols. The study used a base lecture on the topic of special relativity, and incorporated two kinds of Control Groups and one Experimental Group (that used the wireless responders). The design and the implementation of the pilot study will be outlined, and a discussion of "lessons learned" will be provided. In the "where do we go from here" conclusion of the presentation, plans for the next follow-up study will be outlined.

* In collaboration with R.J. Konopasky, Saint Mary's University

SU-P4-4 **16h00**

Demonstrating Special Relativity with the TRIUMF Cyclotron. **Philip Freeman** [1], B. Chan [2], M. Hapke [3], P. Jones [3], S. Lapi [3], M. Pavan [3], J. Wong [4], S. Yen [3], [1] *Richmond Secondary School*, [2] TRIUMF/UBC, [3] TRIUMF, [4] TRIUMF/U of Waterloo — Although it is part of the curriculum in many high school and first year university physics programmes, special relativity is often difficult to teach and even more difficult to convince students of. It therefore remains an exciting, but vague and abstract, topic to many students. In celebration of the International Year of Physics, TRIUMF with the assistance of Richmond Secondary School has produced an educational video in which students are introduced to and guided through an experiment showing the experimental confirmation of the relativistic momentum formula. The experiment uses relativistic particles produced by the TRIUMF cyclotron. The video and accompanying materials are intended to be used with a high school class to give students a sense for relativity in action and to bring home the reality of relativistic effects. This presentation will outline the design of the video and materials; discuss experience using it in the classroom; and show how it may be used in teaching students about the nature of Special Relativity.

SU-P4-5 **16h15**

Moving Distance Education Physics Online at Athabasca University*. **Martin Connors**, F. Al-Shamali, *Athabasca University* — Distance Education Physics has made rapid strides in recent years at Athabasca University. The traditional "correspondence course" approach has always been supplemented at Athabasca University by tutor support, providing one-on-one contact that is very valuable in helping students over conceptual difficulties. Traditionally this has been by telephone, but now email plays a much larger role. In addition, recurrent problem areas can be dealt with by setting up web pages to directly tackle those identified by the students. One of our courses now exists in a CD-ROM form with useful simulations, and our latest revision of this course has its materials online for easy and quick access by the students. What is perhaps most innovative, however, is our approach to labs, traditionally a problem area in distance education. In addition to continuing with great success to loan out home laboratory kits through the library, we are exploring methods of putting introductory labs onto the internet. In this approach, a real experiment occurs, remotely controlled by the student. Real errors arise, and the best approach to using the equipment to obtain enough data is determined by the student. In addition to a large degree of control over the experiment, the student has a feeling of presence due to being able to observe the experiment in progress using a webcam. We will discuss the technology that makes this type of remote experimentation possible.

* This work is being supported by Office of Learning Technology

SU-P4-6 **16h30**

Bringing the Excitement of Science to Local Community: Helping Children from 5 to 105 years old to Rediscover the Wonders of Physics*. **Marina Milner-Bolotin**, Andrzej Kotlicki, Janis McKenna, Valery Milner, Peter Newbury, Kristine Schleich, Chris Waltham, Don Witt, *University of British Columbia* — When is the right time to expose children or adults to the wonders of science? At the Department of Physics and Astronomy at UBC we believe that everybody deserves such and opportunity and the earlier the children are exposed to science, the better it is. Our department participates and initiates multiple outreach opportunities such as Physics Summer Camps, Faraday Physics Lectures, Physics Olympics, Science Fair, various physics shows at local elementary and secondary schools, science teacher training workshops and many others. The feedback from local community indicates that these activities not only inspire young people and their families to become more interested and involved in science, but also leads students to consider science as a possible future career. In this talk we will discuss these outreach activities, as well as propose some new ideas for reaching local community outside the university walls.

* This work is being supported by the Department of Physics & Astronomy, University of British Columbia.

SU-P4-7 **16h45**

Contemporary Science at Ryerson University*. **Ana Pejovic-Milic,** *Ryerson University* — In 1948 Ryerson Institute of Technology was officially opened, while in 1993 Ryerson University was granted a fully funded research role and the power to develop graduate programs. In the 2005/2006 school year, for the first time in its 57 years long history, Ryerson offers a Bachelor of Science degrees. It is designed as the convergence of knowledge, methods and skills emanating from the basic sciences in a cultural context applied to innovation, new technology, health, economic growth and a sustainable environment. In science today the knowledge, methods, and skills of formerly discrete disciplines are converging. Advances in such areas as new technology, health care, and environmental sustainability have all arisen from the multidisciplinary application of science. Our science education, furthermore, offers a range of liberal studies courses to broaden awareness of the world, and of the social and cultural context in which innovation and technology emerge. Students may also earn an optional designation in Management Science that will prepare them for a career in applied science management or for graduate studies in management related to their area of interest. Point of entry is the Contemporary Science program, through which all new science students at Ryerson complete a common first year. This will allow exploring various science-based routes to degree completion before they commit to any program, such as the Contemporary Sciences (with physics stream), Biology (with biophysics specialization), Chemistry (with applied physics specialization) and Medical Physics. Our new Bachelor of Science in Biology has been designed to meet student demand for greater diversity and flexibility in curriculum with an emphasis in biochemistry, microbiology and biophysics. The field of chemistry is diversifying in many exciting ways, from the development of new materials and advances in analytical chemistry to the growth of entire new opportunities in biological chemistry arising from developments in applied physics, computational chemistry, proteomics, biochemistry, and molecular biology. As a discipline, Medical Physics is physics applied to the diagnosis and treatment of disorders and diseases. Our new Bachelor of Science program in Medical Physics, planned for launch in 2006, promotes interactions across a variety of disciplines including physics, computer science, mathematics and biology. The flexibility built into our curricula will enable students to chart their own academic path to the career opportunities or research fields.

* This work is being supported by Ryerson University

SU-P4-8 **17h00**

The Role of Dirac Notation in Undergraduate Quantum Mechanics Instruction: When and Why Do We Introduce It?. **Robert I. Thompson**, *University of Calgary* — Teaching quantum mechanics to third and fourth year students is a fascinating and enjoyable challenge for an instructor. The combination of conceptual novelty and mathematical complexity makes designing a course structure and communicating this topic a very thought provoking process. One of the fundamental decisions related to the structure of undergraduate quantum mechanics courses is the question of Dirac Notation. Specifically, at what point in the course should Dirac Notation be introduced to the students? Although a general, fundamental, and remarkably powerful tool of quantum mechanics, Dirac Notation can also be conceptually challenging to a student, especially when they are already trying to adapt themselves to the at times counter-intuitive thought processes associated with quantum mechanics. This presentation will discuss two broad approaches to the instruction of senior undergraduate quantum mechanics courses: 1. introducing quantum mechanics through wave mechanics with an eventual generalization to Dirac Notation or 2. introducing quantum mechanics through Dirac Notation with an eventually specialization to include wave mechanics. It will examine some relative merits and drawbacks of the approaches, providing some statistical data breaking down student exam performance on specific topics, as well as some more general thoughts on this topic based on student feedback, with an overall goal of eliciting some feedback and discussion on the challenges and rewards of effectively teaching quantum mechanics. Finally, I will include a brief comment regarding the challenge of analysing the effectiveness of teaching strategies with the data available from the small numbers of students in senior physics courses.

17h15 **Session Ends / *Fin de la session***

[SU-KEY] Herzberg Memorial Public Lecture / *Conférence publique commemmorative Herzberg*

(CAP-PI/*ACP-PI*)

SUNDAY, JUNE 5 / DIMANCHE, 5 JUIN

19h00

UBC Chan Centre ***Chair: M. Steinitz, St. F-X Univ.***

SU-KEY **19h00**

CLIFFORD WILL, University of Washington, St. Louis

Was Einstein Right?

How has the most celebrated scientific theory of the 20th century held up under the exacting scrutiny of planetary probes, radio telescopes, and atomic clocks? After 100 years, was Einstein right? In this lecture, celebrating the 100th anniversary of Einstein's miracle year and the World Year of Physics, we relate the story of testing relativity, from the 1919 measurements of the bending of light to the 1980s measurements of a decaying double-neutron-star system that reveal the action of gravity waves, to a 2004 space experiment to test whether spacetime does the twist. We will show how a revolution in astronomy and technology led to a renaissance of general relativity in the 1960s, and to a systematic program to try to verify its predictions. We will also demonstrate how relativity plays an important role in daily life.

20h30 **Session Ends / *Fin de la session***

[MO-A1] Science Policy Session - Room IRC 2 (cap.500) / *Session politique scientifique*

(CAP/*ACP*)

(see page 19 for details / voir page 19 pour détails)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

08h15 - 09h45

[MO-A2] Polymeric and Organic Materials / *Matériaux polymères et organiques*

(DCMMP/*DPMCM*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

ROOM / SALLE IRC 3 (cap. 108) ***Chair: J. Hutter, UWO***

MO-A2-1 **10h00**

Compression of Polymer End-Anchored Polymers*. **Mark Whitmore** [1], R. Baranowski [2], [1] *University of Manitoba*, [2] University of British Columbia — End-tethered polymers have been the subject of much experimental and theoretical study. Early theories are applicable to a particular high-density limit known as the "brush limit", and many experiments have been interpreted under the assumption that real systems fall in this limit. However, systematic experiments have subsequently shown that this is not the case, and both the interpretation of the experiments and our understanding of these systems have been compromised. This paper presents a detailed study of these layers and their behaviour in an important class of experiments, *i.e.* their compression by various mechanisms. We treat layers in both good and Theta solvents, and in the range of polymer densities that is normally encountered in experiments. Our primary technique is numerical self-consistent field (NSCF) theory. We compare the NSCF results for the different mechanisms with each other, and with those of the analytic SCF (brush) theory. For each mechanism, we calculate the density profiles, layer thicknesses and free energies, all as functions of the degree of polymerization and density. The free energy and the deformation of each layer depend on the compression mechanism, and they can be very different from the ASCF theory. The overall physical picture simplifies if the free energy is expressed in terms of the layer deformation, rather than the reduced surface separation used in brush theories. We also examine the interpenetration of layers, and the difficulties in extracting quantitative information from surface-forces experiments.

* This work is being supported by NSERC

MO-A2-2 **10h15**

Glass Transition Temperature of Freely-Standing Poly(methyl methacrylate) Films*. **John Robert Dutcher**, A. Pound, C.B. Roth, S.W. Kamp, C.A. Murray, *University of Guelph* — We have used transmission ellipsometry to measure the glass transition temperature Tg of freely-standing poly (methyl methacrylate) (PMMA) films as a function of film thickness h for different tacticities and molecular weights (159k < Mw < 1310k). For all Mw values, we observe Tg reductions at small values of h, which is qualitatively similar to previous results obtained for freely-standing polystyrene (PS) films [1]. However, the magnitude of the Tg reductions is much less for freely-standing PMMA films than for freely-standing PS films with comparable Mw and h values.

1. K. Dalnoki-Veress *et al.*, *Phys. Rev.* **E 63**, 031801 (2001).

* This work is being supported by NSERC, PREA

MO-A2-3 **10h30**

Shear Induced Overaging in a Polymer Glass*, **Bela Joos**, Matthew L. Wallace, *University of Ottawa* — A polymer glass subjected to instantaneous shear deformations is shown by molecular dynamics simulation to exhibit a phenomenon called "overaging", in which the collective (slow) relaxation modes exhibit an increase in decay time $t_{1/2}$. Two distinct regimes are observed, primarily based on how the system evolves after a waiting time t_w following one deformation. In the low-shear regime, both the energy of the inherent

structure of the system and the relaxation time $t_{1/2}$ change very little with t_w , and there are no apparent structural changes in the system. In the high-shear regime, we see an initial combination of rejuvenation and overaging in the system and $t_{1/2}$ has a well-defined logarithmic dependence on t_w . We shed light on the origins and characteristics of overaging, finding increases in pressure, orientational order and in the energy of the inherent structure (e_{IS}) of the system, which also depend on the type of deformation. These results are compared with "tapping" experiments on granular matter to provide some insight into the process known as jamming.

* This work is being supported by NSERC

MO-A2-4 10h45

Phase Behaviour of a Diblock Copolymer Melt Under Cylindrical Confinement*. **Robert Wickham**, W. Li, *St. Francis Xavier University* — The phase behaviour of a diblock copolymer melt confined inside an infinitely-long cylindrical pore of radius R is investigated using real-space self-consistent mean-field theory. A short-range, preferential interaction between the walls of the pore and one of the copolymer blocks is assumed. Confinement leads to a rich phase diagram, which is explored in detail for fixed R=8.5 Rg, as a function of χ N and f. Disordered, lamellar and cylindrical morphologies are obtained, but with arrangements and symmetries not seen in the bulk, for example: onion-like lamellar layering, arrays of cylinders symmetric under 3-, 4- and 5-fold rotations, and structures intermediate between cylinders and lamellae. Near the pore walls the structural rearrangement is severe, leading to the presence of defects in the cylindrical order. Phase transitions as the pore radius varies have also been observed.

* This work is being supported by NSERC

MO-A2-5 11h00

A Self-Consistent Molecular Theory of Polymers in Melts and Solutions*. **Lucian Livadaru**, A. Kovalenko, *NRC - National Institute for Nanotechnology* — We propose a self-consistent molecular theory of conformational properties of flexible polymers in melts and solutions. The method employs the Polymer Reference Interaction Site Model for the intermolecular correlations and the Green's functions technique for the intramolecular correlations. We demonstrate this method on n-alkane molecules in different environments: water, hexane, and in melt, corresponding to poor, good, and theta-condition, respectively. The numerical results on the intramolecular correlation function, radius of gyration, and characteristic ratio of a polymer chain clearly show the conformational changes from one environment to another, and are found to be in good agreement with other findings in literature. Scaling laws for the chain size with respect to the number of monomers are discussed. We show results for the intra- and inter-molecular correlation functions, and the medium induced potential. We analyze the effect of various closure approximations on the chain's properties. We also extract the Kuhn length and the characteristic ratio for the infinite chain limit for melts. The latter is compared with experimental results and computer simulation. The intramolecular conformational free energy and the free energy of solvation are calculated for each solvent case. Our treatment can be readily generalized to other polymer-solvent systems, e.g. containing branched copolymers and polar solvents.

* This work is being supported by NRC- NINT

MO-A2-6 11h15

Self-Assembly of Hollow Micelles from Rod-Coil Block Copolymers. **An-Chang Shi**, L. Zhang, *McMaster University* - The formation of hollow spherical micelles from rod-coil block copolymers has been well established experimentally. In this work a simple mechanism for the self-assembly of hollow cylindrical and spherical micelles from rod-coil diblock copolymers is proposed. In a coil-selective solvent, the diblock copolymers self-assemble into a layered structure. We assume that the rigid rods form an elastic shell whose properties are dictated by a bending energy. For a hollow micelle, the coils outside the micelle form a brush, while the coils inside the micelle can be in two different states, a brush or an adsorption layer, corresponding to symmetric or asymmetric configurations, respectively. The total energy density of a hollow micelle is calculated by combining the interfacial energy, elastic bending energy and the stretching energy of the brushes. For the asymmetric configuration with a polymer brush on one side, the competition between the elastic bending energy and the brush stretching energy leads to a finite spontaneous curvature, stabilizing hollow cylindrical and/or spherical micelles. Comparison of the free energy density for different geometries demonstrates that transitions from lamellar to cylindrical to spherical micelles are controlled by the degree of polymerization of the coils and the length of the rods. These results will be compared with relevant experiments and previous theoretical treatments.

* This work is being supported by NSERC, SHARCNET

MO-A2-7 11h30

Compositional Fluctuations in the Diblock Copolymer Lamellae Studied with the Method of Averaging in the Weak-Segregation Limit. **Andrei Borodich**, M.D. Whitmore, *University of Manitoba* - We consider the lamellar phase of the diblock copolymer system following an analogy between a flexible polymer chain in a periodic structure and an electron in crystalline solid. We solve the eigenproblem for the chain Hamiltonian using the Bogolyubov method of averaging, which implies a perturbation approach with some small parameter and works well in the weak-segregation limit. The calculated eigenfunctions are the approximate analytical solutions of the Mathieu equation. We discuss the regions of stability and instability of these solutions in the parametric space. The calculated eigenvalues form the energy bands. We analyze the spectrum of eigenvalues and band gaps at the zone boundaries. The eigenfunctions and eigenvalues are used for expansion of the fluctuating fields around the known mean-field solution of the lamellar structure and calculation of the density correlation function in the random phase approximation. Then we examine the stability of the lamellar phase and the effects of the leading fluctuating mode in two ways. The scattering function close to the spinodal line is compared with that calculated in the reciprocal space theory of anisotropic fluctuations, and the number and positions of the secondary peaks due to fluctuations are discussed. Density contour plots at various amplitudes of the least stable mode are presented for the system parameters close to the spinodal line and compared with those obtained by A.-C. Shi and coworkers.

MO-A2-8 11h45

Molecular Theory of Asymmetrically Charged Bilayers: Preferred Curvatures*. **Bae-Yeun Ha**, Y. Li, *University of Waterloo* - In this talk, I will discuss the preferred curvature of asymmetrically-charged lipid bilayers, in which the inner layer is negatively charged while the outer one is neutral. In particular, I will present a molecular theory for the computation of the relaxed-area difference A0 and the spontaneous curvature C0 of the bilayer. Our theory shows how packing properties of lipids and counterion (e.g., Ca^{2+}) valences are intertwined. Interestingly, Ca^{2+} has a dramatic effect on A0 and C0: For wide parameter ranges, the presence of 0.1mM of Ca^{2+} ensures positive A0 and C0 that are nominally negative.

* This work is being supported by NSERC

MO-A2-9 12h00

Probing Molecular Mobility in Freely-Standing Polystyrene Films Using Hole Growth*. **Connie Roth** [1], John R. Dutcher [2], [1] *Simon Fraser University*, [2] University of Guelph - Hole growth provides an elegant technique for measuring the viscoelastic response of a thin film of material to the constant stress applied at the edge of the growing hole due to surface tension. The time-dependent deformation of the material has been studied in detail for thin freely-standing polystyrene (PS) films using both optical microscopy and a unique differential pressure experiment (DPE). We present shear strain rate dependent viscosity results that span reductions in viscosity by 8 orders of magnitude, and we discuss our findings in the context of the large glass transition temperature reductions observed for very thin freely-standing PS films.

* This work is being supported by NSERC, PREA

MO-A2-10 12h15

Rheology of a Polymer-Clay Dispersion Under Shear*. **John R. de Bruyn** [1], F. Pignon [2], J.-M. Piau [2], A. Magnin [2], [1] University of Western Ontario, [2] Laboratoire de Rhéologie, France - Polymer-colloid composites can display spectacular rheological behavior under shear. We examine the influence of shear flow on the bulk properties and micron-scale structure of a Laponite clay-polyethylene oxide dispersion. We performed bulk rheometric measurements and static light scattering from the dispersions under shear. From rheometric measurements we obtain information about the time scales that characterize the material's response to step changes in shear rate. These time scales are interpreted in terms of a competition between aggregation and bond formation mechanisms between the clay particles and polymer chains. A critical shear rate separates two regions with

different rheological behaviors. A qualitative change in the anisotropy of the dispersion under shear, studied by static light scattering, is observed at the same critical shear rate. Above this shear rate, shear enhances the interactions between clay particles and polymer chains, leading to the formation of an enhanced polymer-clay network and a change in the structure of the material.

* This work is being supported by NSERC, CNRS

12h30 Session Ends / *Fin de la session*

[MO-A3] Nuclear Astrophysics / *Astrophysique nucléaire*

(DNP/DPN)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

SALLE / ROOM CEME 1204 (cap. 60) ***Chair: A. Chen, McMaster University***

MO-A3-1 10h00

PETER PARKER, Yale University

^{26g}Al+p, ^{26m}Al+p, and ^{25}Al+p Resonances *

We have utilized stable-beam spectroscopy measurements of ^{26g}Al+p, ^{26m}Al+p, and ^{25}Al+p resonances to study the production and destruction of ^{26g}Al in our galaxy.

* This work is being supported by USDOE

MO-A3-2 10h30

SHIGERU KUBONO, University of Tokyo

Study of Stellar Reactions Relevant to Explosive Hydrogen Burning with Crib

Proton-rich unstable nuclei play a crucial role in explosive hydrogen burning. Although experimental efforts are definitely needed, only a few reactions have been studied directly with RI beams so far. We have constructed an extensive, low-energy RI beam separator, called CRIB, for this purpose, and we are conducting nuclear astrophysics experiments using low-energy RI beams. We present briefly a new development with CRIB that has a Wien filter and a windowless gas target in addition to the magnetic double-achromatic system. The Wien filter is successfully operating to separate better RI beams of interest with higher purity and with smaller beam emittance. A series of resonant scattering experiments have been made with the RI beams from CRIB, which include ^{21}Na+p, ^{22}Mg+p, ^{23}Mg+p, ^{25}Al+p and ^{26}Si+p, in addition to earlier studies of ^{11}C+p and ^{12}N+p. We have seen new states in most cases. The critical stellar reaction ^{14}O(α,p)^{17}F for the breakout to the rp-process was also investigated by the thick target method using an intense ^{14}O beam and a cooled He gas target. The proton spectrum confirms the predicted major resonant contributions. It is, however, found that the (α,p) transition to the first excited state in ^{17}F has a cross section roughly a half of that to the ground state, which enhances the reaction rate significantly. We will touch on the AVF Upgrade Project that optimizes the accelerator facility for intense RI beams of about 10^8 pps with CRIB, and also on plans to study the r-process at RIKEN's RIBF project.

11h00 Coffee Break / Pause café

MO-A3-3 11h15

JAC CAGGIANO, TRIUMF

Nuclear Astrophysics at TRIUMF-ISAC

In recent years, understanding explosive cosmic events has received much attention, largely due to three major occurrences: faster computers enable more detailed and accurate models, new gamma-ray observatories have been launched and are collecting exciting new data, and radioactive beam facilities have been built which are finally capable of reaching many of the reactions that occur in the explosions. One such facility is the TRIUMF-ISAC facility in Vancouver BC. A review of past measurements and operating experience at TRIUMF will be presented, followed by current quests and future experimental plans, particularly as they pertain to the abundance of the cosmic gamma ray emitters ^{26}Al and ^{22}Na.

MO-A3-4 11h45

Recent Results from the Canadian Penning Trap Mass Spectrometer at the Argonne National Laboratory. **Kumar Satish Sharma** [1], R.C. Barber [1], F. Buchinger [2], J.A. Clark [1], J.E. Crawford [2], J. Fallis [1], S. Gulick [2], J.K.P. Lee [2], A.F. Levand [3], G. Savard [3], N.D. Scielzo [3], H.P. Sharma [1], Y. Wang [1], [1] *University of Manitoba*, [2] McGill University, [3] Argonne National Laboratory — The Canadian Penning Trap (CPT) mass spectrometer, online to the ATLAS facility at ANL is used to obtain the masses of unstable nuclides. To date, the masses of more than 60 radioactive nuclides have been measured with half-lives as short as one second and with a precision ($\delta M/M$) approaching 10^{-8}. Our measurements so far have concentrated on nuclides of importance to astrophysics and tests of fundamental symmetries in nuclear and particle physics. The ongoing additions and improvements to the spectrometer will be described and a summary of our recent results presented.

MO-A3-5 12h00

TITAN Penning Trap Mass Spectrometer: Status Report*. **Vladimir L. Ryjkov** [1], M. Brodeur [2], Z. Ke [3], G. Gwinner [3], J. Dilling [1], [1] *TRIUMF*, [2] University of British Columbia, [3] University of Manitoba — The TITAN (Triumf's Ion Trap for Atomic and Nuclear science) facility for precision mass measurements of the short-lived isotopes is currently being constructed at the TRIUMF national laboratory in Vancouver, Canada. First on-line mass measurements are planned for 2006. TITAN consists of a gas-filled RFQ cooler and buncher, a charge-breeding EBIT, and an m/q selecting Wien-filter to deliver highly charged ions to the Penning trap for the determination of the mass via the cyclotron frequency. The advantage of using the highly charged ions lies in the much higher cyclotron frequency than the corresponding singly charged ions, which will allow to achieve the precision of $\delta m/m \sim 10^{-8}$ for the short-lived isotopes ($t_{1/2} \sim 100$ ms), and improve precision of the isotopes with even shorter half-lives ($t_{1/2} \sim 10$ ms). Such improvements in precision are important for the test of the Standard Model, and nuclear astrophysics. Necessary conditions for operating the Penning trap mass spectrometer with highly charged ions will be discussed, and the developed and proposed solutions will be presented. Current status and developments in the project will be reported.

* This work is being supported by NSERC

MO-A3-6 12h15

Structure of Light Nuclei from a Multichannel Algebraic Scattering Theory*. **Juris P. Svenne** [1], G. Pisent [2], L. Canton [3], K. Amos [4], S. Karataglidis [4], D. van der Knijff [5], [1] *University of Manitoba*, [2] Dipartimento di Fisica dell'Universita di Padova, [3] INFN, Padova, Italy, [4] School of Physics, University of Melbourne, Australia, [5] Advanced Research Computing, University of Melbourne, Australia — A multichannel algebraic scattering (MCAS) theory, developed by the authors, has been demonstrated to have good predictive power for both nucleon-nucleus scattering and the bound states of the corresponding compound systems. In the context of a rotational model for the target nucleus, the Pauli

principle has been taken into account by the use of orthogonalizing pseudo-potentials. Results are presented for the well-studied scattering of neutrons and protons from ^{12}C. For energies up to ~10 MeV in the compound nucleus, all compound and quasi-compound resonances observed in total cross-section data are well reproduced, and the sub-threshold states in ^{13}C and ^{13}N are predicted with correct spin-parities, and at reasonable energies. The results of calculations, in the limit of the deformation of the target tending to zero, give precise information on the structure of both the bound states and the compound and quasi-compound resonances in scattering. In the nucleon-^{12}C system, the assumed structure of a nucleon interacting with ^{12}C in its three lowest-energy sates yields satisfactory interpretations for all bound states and resonances in nucleon-nucleus scattering, over the selected energy range, consistent with results of an earlier study by Pisent and Svenne done in a schematic model. These results give us confidence to proceed to calculations of less well-studied systems. Preliminary results have been obtained for proton scattering on ^{6}He.

12h30 Session Ends / *Fin de la session*

[MO-A4] Theoretical Biology / *Biologique théorique*

(DTP-DMBP/ *DPT-DPMB*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

SALLE / ROOM G279 -hos. (cap. 140) ***Chair: A. Linhananta, Lakehead University***

MO-A4-1 10h00

PAUL H.C. LEE, National Central University

Complexity, Universality, and Growth of Genomes *

Our recent textual analysis of complete genomes reveals clear evidence that segmental duplication is likely the most important mechanism that has driven the large-scale growth and evolution of genomes. The study covers all complete prokaryotic and eukaryotic genomes or chromosomes available in the GenBank; about 280 sequences ranging in length from 0.3 to 230 million bases. Our study shows that (i) a suitably defined Shannon information (SI) of the genome has a (broadly defined) universal value independent of sequence length, as opposed to the SI of random sequences that is inversely proportional to sequence length; (ii) the genomes are maximally self-similar and, (iii) short of being a random sequence, segment-wise genomes are close to being maximally random. The nontriviality of the universality (in SI) of genomes coupled with their randomness imposes strict constraints on mechanisms for genome growth. We show that a simple, three-parameter, growth model based on maximally stochastic segmental duplication generates sequences that possess the many complex properties of genomes reported here: universality, self-similarity, diversity, and randomness. We discuss biological implications of our result.

* In collaboration with L.S. Hsieh [1], T.Y. Chen [2], C.H. Chang [3], H.D. Chen [3], L.F. Luo [4], [1] University of Chicago, [2] Ho-Hsin Cancer Center Hospital, [3] National Central University and [4] University of Inner Mongolia

MO-A4-2 10h30

NORMAND MOUSSEAU, Université de Montréal

Wriggling and Hopping - A Study of Protein Dynamics *

Understanding and predicting the structure of the native state of proteins remains one of the major challenges in science. Native states are not frozen, however, and should be considered as representative of an ensemble that gives proteins their function. Protein-protein and protein-ligand interactions, for example, require a significant change in molecular conformations. Recent experiments have also shown that out-of-equilibrium structures, such as protein oligomers, could be responsible with the death of cells in Alzheimer's and other amyloid diseases. Using the activation-relaxation technique, we have identified a number of mechanisms that could be play an important role in protein folding and aggregation. I'll discuss those in light of recent results we have obtained on the aggregation of fragments of the β-amyloid protein as well as model peptides.

* This work is a joint research effort with Philippe Derreumaux [1,2] and was done in collaboration with Geneviève Boucher [3], Adrien Melquiond [1,2] and Guanghong Wei [4], [1] IBPC, [2] Université Paris VII, [3] Université de Montréal and [4] UCSB. It was supported in part by NSERC, FQRNT and the Canada Research Chair program.

11h00 Coffee Break / Pause café

MO-A4-3 11h30

STEVEN PLOTKIN, University of British Columbia

Many Body Forces and Topology in Protein Folding

A theory for how a protein folds up to a biologically functional structure has occupied researchers for the last few decades. The difficulties stem from an incomplete knowledge of an accurate Hamiltonian, as well as non-trivial aspects of polymer physics that complicate the kinetics of folding. Here I will describe some recent results showing that relaxation rates increase significantly as the folding mechanism becomes increasingly heterogeneous, as governed by native interactions and topology. I will go on to discuss the role of many-body interactions in the Hamiltonian, and show how accounting for them is essential for predicting folding rates and mechanisms.

MO-A4-4 12h00

JACK A. TUSZYNSKI, *University of Alberta*

New Nano-Scale Oncotherapy Approaches Inspired by Computational Biophysics *

My group has been involved in computational cell biophysics research over the past decade or so. In this talk I'll give an overview of our quantitative understanding of the key cellular protein, tubulin, and its cylindrical polymers called microtubules. Since 1998 when the Berkeley group of Ken Downing was able to crystallize tubulin, our focus shifted to the application of molecular and Brownian dynamics of tubulin in the quest to understand the relationship between atomic resolution structure and biological function. We have now concentrated our efforts entirely on one key issue, i.e. a rational drug design targeting tubulin with molecules that would interfere with the formation of mitotic spindles during cell division. In collaboration with biochemists and oncologists from the University of Texas our group is using computational methods applied to rational drug design of anti-mitotic compounds with specific preferences for tubulin isotypes. I'll describe our results in the early stages of this exciting research project. New promising compounds will be presented that represent a class of taxane derivatives with better targeting and binding properties. In addition, our better understanding of mechanical properties of microtubules has led to the design of new treatment modalities based on the use of ultrasound, laser action and magnetic fields.

* This research has been supported by grants from NSERC, MITACS, PIMS, US Department of Defense and Technology Innovations LLC.

12h30 Session Ends / *Fin de la session*

[MO-A5] Photodynamic Therapy / *Thérapie photodynamique*

(DOP-DIAP-DMBP / *DOP-DPIA-DPMB*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

SALLE / ROOM IRC 6 (cap. 226)

Chair: M. Campbell, University of Waterloo

MO-A5-1 **10h00**

JULIA LEVY, QLT Inc

Various Applications of Photodynamic Therapy.

Photodynamic therapy or PDT is now a widely used technology, with applications in ophthalmology, urology, oncology and other areas of medicine. PDT involves the use of photosensitive chemicals that accumulate selectively in certain targeted tissues in the body. Activation of the chemicals with the appropriate wavelength and intensity of light when they are located in cells, creates a fluorescent signal as well as a high energy state that results in the formation of singlet oxygen or, in some circumstances, other reactive oxygen intermediates (ROI). These ROI create an apoptotic signal in cells thus activated with the subsequent elimination of the targeted cells or tissues. This principle has been exploited in developing PDT treatments for the ablation of solid tumors, faulty blood vessels, and hyperplastic tissues. QLT is a biotechnology company located in Vancouver, that is the world leader in the commercialization of PDT, having taken two photosensitizers through clinical development for both cancer and age related macular degeneration, the commonest form of blindness in people over the age of 50. The presentation will cover some of the high lights of the twenty-five year history of the company.

MO-A5-2 **10h45**

QING-BIN LU, University of Waterloo

High Sensitivity Time-Resolved Femtosecond Laser Spectroscopic Studies of Light-Activated Drugs *

Time-resolved femtosecond laser spectroscopy has been a tremendously powerful technique for direct real-time observation of structural and reaction dynamics in molecular systems. Recently, this technique has been used to investigate the structural and reaction dynamics of biological systems such as DNA/RNA and proteins. In this talk, I will present and discuss some recent applications of this technique to study reaction dynamics of light-activated anticancer drugs. Then, our new observation of the light-activated reactions of radio-(photo-) sensitizers in water will also be presented and discussed.

* This work is being supported by CIHR, CFI, OIT

11h15 **Coffee Break / Pause café**

MO-A5-3 **11h30**

HAISHAN ZENG, Cancer Imaging Dept., BC Cancer Agency†

Dosimetry for Photodynamic Therapy *

Photodynamic therapy (PDT) is a novel therapeutic modality involving sequential administration of photosensitizer drug and light. Dosimetry for PDT is challenge because the treatment efficacy not only depends on drug and light doses, but also on drug pharmacokinetics, drug and light distribution within tissue and local oxygen supply. This presentation will start with reviewing various efforts on quantifying light and drug distribution within tissue and experiments on measuring singlet oxygen. Then will be introduced our own work on monitoring photoproduct formation and photobleaching for improving PDT dosimetry. Our experiments were carried out on normal mouse skin using QLT0074 photosensitizer at fixed dose (0.3 mg/kg). PDT treatments with 686-nm laser light irradiation and fluorescence spectroscopy measurements with 437-nm light excitation before and after PDT were performed on 60 mice divided into 6 groups. Each group received a different light dose ranging from 5 to 50 J/cm^2. Skin responses were measured using severity of necrosis/ulceration, scored from 0 to 4. The photoproduct formed during PDT has a distinct fluorescence peak at 650-nm and therefore was quantified from the measured fluorescence spectra. The photosensitizer itself has a fluorescence peak at 695-nm; the decrease of this peak during PDT is termed photobleaching and was also quantified. The correlation between skin responses and photoproduct score, photobleaching score, and light dose were analyzed with an ordinal logistic regression model. The result suggests that photoproduct score or photobleaching score alone or the combination of them with light dose can better predict PDT outcome than light dose alone.

* This work is being supported by CDF & Biomax Technologies Inc.

† In collaboration with M. Korbelik [1], D.I. McLean [2], C. MacAulay [1], H. Lui [2], [1] Cancer Imaging Dept., BC Cancer Agency, [2] Div. of Dermatology, Univ. of British Columbia

MO-A5-4 **12h00**

MELANIE C.W. CAMPBELL, University of Waterloo

Two-Photon Photodynamic Therapy and the Eye *

Two-photon photodynamic therapy has many advantages for treatment of diseases affecting the eye. Age related macular degeneration (AMD) and diabetic retinopathy, two of the three leading causes of blindness, both affect structures at the rear of the eye, visible in wavelengths used for exciting PDT drugs. Deeper, choroidal structures affected by AMD are potentially more accessible to wavelengths used in two-photon therapies. Two-photon therapy can be better spatially localized than one photon treatments. However, this requires the delivery of high intensities into a small focal volume, without damage to other, more anterior structures. We are investigating the ideal beam profiles and delivery via a scanning laser ophthalmoscope with adaptive optics correction in an eye with an f number as good as possible.

* This work is being supported by CIPI

12h30 **Session Ends / *Fin de la session***

[MO-A6] Low Dimensional Systems / *Systèmes à peu de dimensions*

(DCMMP/*DPMCM*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h00

SALLE / ROOM IRC 1 (cap. 133)

Chair: M. Gallagher, Lakehead University

MO-A6-1 **10h00**

ANDREA DAMASCELLI, University of British Columbia

Fermi Surface and Quasiparticle Excitations of Overdoped $Tl_2Ba_2CuO_{6+\delta}$ *

Angle-resolved photoemission spectroscopy (ARPES) on the high-T_c copper oxides superconductors (such as $La_{2-x}Sr_xCuO_4$ and the Bi-cuprates) did provide us with crucial insights into the complex electronic structure of these materials. On the other hand, despite the intense effort, no conclusive agreement was reached yet on some of the most fun-

damental issues. In this context, important breakthroughs could come from the study by ARPES of $Tl_2Ba_2CuO_{6+\delta}$ (Tl2201): this system is characterized by a well ordered crystal structure, with very flat CuO_2 planes far apart from each other, and a very high $T_{c,max}$=93K; in addition, it would also offer an alternative approach to superconductivity, *i.e.* from the very overdoped side of the phase diagram. Unfortunately, until now ARPES studies of Tl2201 were prevented by the lack of high-quality single crystals due to the difficulties of the growth process. Very recently, however, these difficulties were successfully dealt with and single crystals of unprecedented quality were produced at UBC, which gave us the opportunity of obtaining an extensive set of ARPES data from Tl2201 for two different doping levels. This study provided us with detailed information on normal state Fermi surface, quasiparticle dispersion, and symmetry of the superconducting gap, as well as preliminary insights on the effects of charge inhomogeneity, many-body, and quantum-critical phenomena in overdoped cuprates. These findings will be discussed in relation to what is observed on the under and optimally doped side of the cuprate phase diagram.

* This work is being supported by NSERC

MO-A6-2 **10h30**

FRANZ J. HIMPSEL, University of Wisconsin Madison

Atomic Chains: From Low-Dimensional Electrons to the Limits of Data Storage

One-dimensional physics is particularly elegant because of its mathematical transparency. However, it is not easy to realize a one-dimensional system experimentally. Recently, it has become possible to produce chains of atoms on top of silicon surfaces by self-assembly. Angle-resolved photoemission reveals exotic band structures and Fermi surfaces, including a fractional electron count of 8/3 that is explained by a low-dimensional version of the doping in HiTc superconductors [1]. These structures can be used as atomically-precise tracks for a memory where a bit is stored by the presence or absence of a single silicon atom. This toy memory is used to test the fundamental limits of data storage and to see how well storage in silicon compares to storage by DNA [2].

1. Crain *et al.*, *Phys Rev. Lett.* **90**, 176805 (2003) and *Phys. Rev. B* **69**, 125409 (2004).
2. Bennewitz *et al*, *Nanotechnology* **13**, 499 (2002).

MO-A6-3 **11h00**

STEVEN ERWIN, Naval Research Laboratory

Self-Doping of Gold Chains on Silicon: A New Structural Model for Si(111)5x2-Au

Gold forms linear chain-like reconstructions on several vicinal surfaces of silicon, as well as on the parent (111) surface. These quasi-1D nanostructures have been widely studied for their unusual electronic properties, but the lack of any accepted structural model has hampered theoretical understanding and modeling of those properties. Here, a new structural model for the Si(111)5x2-Au reconstruction is proposed and analyzed using first-principles calculations. The basic model consists of a "double honeycomb chain" decorated by Si adatoms. The 5x1 periodicity of the honeycomb chains is doubled by the presence of a half-occupied row of Si atoms that partially rebonds the chains. Additional adatoms supply electrons that dope the parent band structure and stabilize the period doubling; the optimal doping corresponds to one adatom per four 5x2 cells, in agreement with experiment. All the main features observed in scanning tunneling microscopy and photoemission are well reproduced.

MO-A6-4 **11h30**

A.B. MCLEAN, Queen's University

Heteroepitaxy, Surfactants and Atomically Perfect Nanolines *

The growth mode of one semiconductor (B) on another (A) is, ignoring strain energies, determined by the free energies of surfaces A and B and the interfacial free energy. To grow smooth, defect-free layers, surfactants can be used to change the surface free energy of A and modify the growth mode of B. On Si(001), studies of surfactant mediated epitaxial growth led to the unexpected discovery that Bi atoms can self organize into nanolines. The growth of these lines is unusual because the Si(001) surface must be heated to above the Bi desorption temperature (>500 C) to activate the formation of the lines. Once the lines have nucleated they grow perfectly straight with no kinks. They also have a very low density of vacancy defects and appear to be limited in length only by the availability of Si(001) terrace. We have measured the line width to be 1.5 nm and found that the line length can be as large as 500 nm. A detailed study of the equilibrium atomic geometry of the Bi lines using STM and ab initio calculations has been performed. We have also studied the striking bias dependence found in constant-current STM topographical images. The atomic geometry of the lines will be discussed and an explanation for the bias dependence will be presented. Moreover, it will be demonstrated that arrays of lines, with aperiodic line spacing, can be grown and used to modify the Si(001)1x2/2x1 domain ratio.

* In collaboration with J.M. MacLeod [1], A.G. Mark [1], R.H. Miwa [2], G.P. Srivastava [3], [1] Queen's University, [2] Universidade Federal de Uberlandia, [3] University of Exeter

12h00 **Session Ends / *Fin de la session***

[MO-A7] Correlated Electrons: Magnetism / *Électrons corrélés: magnétisme*

(DCMMP/*DPMCM*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

SALLE / ROOM IRC 2 (cap. 500) ***Chair: I. Affleck, University of B.C.***

MO-A7-1 **10h00**

MICHEL GINGRAS, University of Waterloo

Quantum Magnetism in the $LiHo_xY_{1-x}F_4$ Ising Material – Where do we Stand?

The Ising model of magnetism constitutes the simplest example of a system exhibiting a phase transition driven by thermal fluctuations. Similarly, the transverse field Ising model (TFIM) where Ising spins are subject to an magnetic field applied perpendicular to the direction of the magnetic moments is one of the simplest system that possess a quantum phase transition at zero temperature driven by quantum fluctuations. In this latter context, the insulating body-centered tetragonal $LiHo_xY_{1-x}F_4$ material has over the past twenty years attracted most attention from experimentalists as a physical realization of the TFIM. In $LiHo_xY_{1-x}F_4$ the Ho^{3+} are Ising moments pointing along the c-axis, Y^{3+} is non-magnetic and substitutes for Ho^{3+} without causing lattice distortions. A magnetic field perpendicular to the c-axis causes quantum tunneling between the "up" and the "down" Ising spin directions. A field larger than a few Teslas destroys the magnetic order via a quantum phase transition at zero temperature. For x>0.20, the ground state is ferromagnetic, while for 0.05<x<0.20 the ground state is a spin glass. By varying the concentration x of Ho^{3+} one can therefore study the nature of the quantum transition out of a ferromagnetic or spin glass ground state. While the quantum phase transition at x=1 is reasonably quantitatively well understood, the behavior of the system with $x \neq 1$ when subject to a transverse field is quite perplexing and not qualitatively understood. Most interesting, it appears that no static frozen order exist for x<0.05 even when no transverse field is applied, possibly suggesting a novel type of quantum disordered ground state. In this talk, I will review the experimental situation as per physics of the TFIM as offered (or rather not!) by $LiHo_xY_{1-x}F_4$. I will argue how this material is in disguise not a TFIM, but a novel realization of a cornerstone of the field of statistical mechanics of disordered materials: the random field Ising model (RFIM).

MO-A7-2 **10h30**

GRAEME M. LUKE, McMaster University

Muon Spin Relaxation in Exotic Magnetic Systems

There has been considerable effort expended over the past decade or so towards the understanding of exotic magnetic systems. This interest has been motivated by a number of phenomena including high temperature superconductivity (where magnetism is of interest both as a possible mechanism and as a byproduct of new materials synthesis) and the identification of novel ground states which can emerge when long range order is precluded. Muon spin relaxation is an exquisitely sensitive real space probe of magnetism and thus is well-suited for studying exotic magnetic states. I will describe some of our recent studies on a number of systems including high temperature superconductors and the randomly diluted $LiHo_xY_{1-x}F_4$ dipolar Ising ferromagnet. $La_{2-x}(Sr,Ba)_xCuO_4$ evolves from an antiferromagnetic insulator to a spin glass to a superconductor to a quasi-normal metal with doping. We have found that an external magnetic field can induce an inhomogeneous internal magnetic field distribution whose overall magnitude obeys a Curie-Weiss temperature dependence. In the case of $LiHo_xY_{1-x}F_4$, at low Ho concentrations (x=4.5%), we see roughly temperature-independent spin fluctuations which may be evidence for the existence of an anti-glass state.

MO-A7-3 **11h00**

The Temperature-Dependent Spontaneous Magnetisation in Single Crystal $La_{0.73}Ba_{0.27}MnO_3$: Evidence for Moment Canting?*, **Gwyn Williams** [1], T. Brown [1], W. Li [1], H. Kunkel [1], X. Zhou [1], Y. Mukovskii [2] and A. Arsenov [2], [1] *University of Manitoba* and [2] Moscow State Steel and Alloys Institute — The spontaneous magnetisation of single crystal $La_{0.73}Ba_{0.27}MnO_3$ can be fit by a standard gapped acoustic spin-wave dispersion relation: $\hbar\omega_{ac} = \Delta + Dq^2$ with Δ = 0.45(±0.02) meV and D = 65.7(±2.5) meV Å^2 between 60 and 140 K (~Tc/2). Below 50 K however, the spontaneous magnetisation decreases, and as T approaches zero can be fit by the same dispersion relation but with Δ = 2.35 meV and, more importantly, a 4% reduction in the zero-temperature spontaneous magnetisation. The latter is consistent with (amongst others) moment canting, a long predicted feature (de Gennes, Phys. Rev. 118 (1960) 141) of doped manganese perovskites.

* This work is being supported by NSERC

MO-A7-4 **11h15**

The Elastic Properties of $CsNiCl_3$ Revisited*, **Guy Quirion** [1], T. Taylor [1], M. Poirier [2], [1] *Memorial University of Newfoundland*, [2] Sherbrooke University — We present a Landau Model that accounts for the unusual elastic properties of the quasi-one-dimensional antiferromagnetic compound $CsNiCl_3$. The model's predictions are tested using published strain measurements and recent high resolution sound velocity measurements realized as a function of temperature and pressure. In particular, we derive an analytical expression which indicates how the low temperature dependence of the elastic constants is related to the critical order parameters. A close inspection of the temperature dependence of C_{33} indicates that the obtained value of the critical exponent agrees with the expected critical behavior of $CsNiCl_3$ in the absence of an external magnetic field (conventional 3D XY criticality). Moreover, using sound velocity measurements under hydrostatic pressures up to 7.0 kbar, we derive the pressure-temperature phase diagram of $CsNiCl_3$. Finally, taking advantage of the magnetoelastic coupling in the paramagnetic state, we also estimate the pressure dependence of the interchain exchange coupling along the c-axis. All these results seem to indicate that the Ising-type anisotropy and the quasi-one-dimensional character $CsNiCl_3$ are both enhanced with pressure.

* This work is being supported by NSERC and CFI

MO-A7-5 **11h30**

Low Frequency Conductivity Scaling in $CaRuO_3$, **Saeid Kamal** [1], J.S. Dodge [1], D.M. Kim [2], C.B. Eom [2], [1] *Simon Fraser University*, [2] University of Wisconsin-Madison — We report on low frequency conductivity measurements of $CaRuO_3$ thin films using time domain terahertz spectroscopy. The complex conductivity is measured in the frequency range of 200 GHz to 1.4 THz and temperature range of 10 K to 290 K. Below 50 K a Drude-like peak develops which is sufficiently narrow that it is only observable in our frequency window. We find that the frequency-dependent conductivity does not follow a Drude form as predicted by Fermi liquid theory; instead we observe a power law relationship of the form $\sigma(\omega) = A / (1 / \tau - i\omega)^{0.5}$. We also observe a scaling of conductivity in the form of $\sigma_1(\omega,T) \propto T^{1/2} g(\omega / T)$ for $1 < \hbar\omega / (K_B T) < 4$ where g is a universal function of ω/T. A similar scaling has been reported in infrared measurements of Lee *et al* (Y.S. Lee *et al. Phys Rev B* **66**, 041104 (2002)), however, our low frequency range allows us to identify deviations from such scaling for $\hbar\omega / (K_B T) < 1$. Observations of such scaling law are generally attributed to the proximity of the material to a quantum critical point. We will discuss the implications of such interpretation for the $CaRuO_3$.

MO-A7-6 **11h45**

Crossover From Pure to Random Field Critical Susceptibility in Arsenic-Doped KDP*, **Donald R. Taylor**, J.T. Love, G.J. Topping, J.G.A. Dane, *Queen's University* — Convincing observations of the crossover from pure to random field exponents due to substitutional impurities in Ising systems require accurate measurements over several decades of reduced temperature. Unfortunately the accessible critical regime is generally limited by transition rounding due to compositional inhomogeneities and by slow equilibration. Ferroelectric systems should offer strong advantages because of the precision available with dielectric susceptibility measurements, and because equilibration can be rapid if the random fields are introduced without diluting the interactions. We have found that the well known Ising ferroelectric KH_2PO_4 with arsenic/phosphorus substitutions provides an excellent realization of the random field Ising model, and have observed a clear and essentially complete crossover from pure to random field critical susceptibility. The effective susceptibility exponent varies in a non-monotonic fashion from ~1.2 at reduced temperature t=0.1 to ~1.7 for small t. The latter value is consistent with a reduction in effective dimensionality of approximately 2 due to random fields. .

* This work is being supported by NSERC

MO-A7-7 **12h00**

Novel Non-Equilibrium Magnetism in La(1-x)Ca(x)MnO3 Studied with Time-Resolved Kerr Spectroscopy, **Roger Miller**, S.A.M. McGill, O.N.T. Torrens, J.M.K. Kikkawa, A.M. Mamchik, I.W.C. Chen, *University of Pennsylvania*. — We use pump-probe optical Kerr spectroscopy to explore the magnetic response of La(1-x)Ca(x)MnO3 to optical pump pulses at 3.1 eV. Reflectivity and magnetization dynamics are compared near T_c and are found to exhibit striking differences. An anomalous signal is identified in the time-resolved Kerr response that peaks at T_c. By studying its magnetic field dependence and measuring the DC Kerr response, we infer the presence of pump-induced magnetization which has not been reported yet in these materials. Quantitative comparison of its temperature dependence with published neutron scattering data suggests that time-resolved Kerr spectroscopy may be sensitive to phase separation near the ferromagnetic transition.

12h30 **Session Ends / *Fin de la session***

[MO-A8] Semiconductor & Thin Films Characterization I / *Caractérisation des films minces et des semi-conducteurs I*

(DIMP/*DPIM*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

SALLE / ROOM IRC 4 (cap. 135) ***Chair: A. Mandelis, University of Toronto / D. Fournier, UPMC***

MO-A8-1 **10h00**

DANIÈLE FOURNIER, CNRS, UPR A0005 / UPMC / ESPCI

Microscale Thermal Imaging in Microelectronics : Optical Methods for 2005 .. and Beyond *

Modern Silicon microelectronic components are nowadays in the nanometer scale regime. The thermal transport can be modified by the close proximity of interfaces and the extremely small volume of heat dissipation. The thermal management being more and more difficult to achieve, strong efforts have been done both on theoretical and experimen-

tal points of view. In this paper we will discuss the advances in optical measurement with special emphasis to modulated thermoreflectance set-ups which enable new capabilities for nanometer and micrometer scale thermal metrology. The paper will be illustrated with examples taken in the microelectronics and material science fields.

* In collaboration with C. Filloy, S. Holé, J.P. Roger and G. Tessier

MO-A8-2 10h30

M.E. RODRÍGUEZ, Centro de Física Aplicada y Tecnología Avanzada de la UNAM, México.

Photothermal and Optical Characterization of Intrinsic and Te-doped GaSb Wafers *

Photothermal radiometry (PTR) signals obtained with a highly focused laser beam, were used to obtain PTR amplitude and phase, two-dimensional and three-dimensional thermoelectronic images of an n-type Gallium Antimony wafer (100) with a diameter of 50.8 mm doped with Tellurium (Te), with a carrier concentration of $7x10^{17}$ cm^{-3}, an EPD < $5 x10^{3}$ cm^{-2} from Atramet Inc.USA; and an undoped GaSb wafer from Firebird semiconductors Ltd., Canada. The frequency chosen to carry out the PTR images was 10 kHz, corresponding to an optimal difference between the phase and amplitude signals in the case of the doped GaSb sample. The results indicate that, for the doped sample, the concentration of Tellurium (Te) is inhomogeneous over the full wafer area because the thermoelectronic image shows a high plasma component, which is related to the carrier concentration, at the ends sides of the wafer; meaning that there is a higher Te concentration at the wafer borders. MicroRaman spectroscopy was used to monitor the presence of Te along the sample; at the center of the wafer, the μ-Raman spectra shows a decrease in the Te signal that is related with the Te concentration. Reflectance images were measured in both samples in order to make corrections in the PTR signal as result of the changes in the reflectance across the sample.

* In collaboration with R. Velazquez [1], I. Rojas [1], J. Garcia [2], J. Mendoza [3], [1] UNAM-Mexico, [2] UNAM-MExdico, [3] Cinvestav-mexico

MO-A8-3 11h00

JAN MEIJER, Runr-Universität Bochum

High Energy Ion Implantation and Industrial Applications

A 4 MV tandem accelerator at Bochum is equipped with different end stages for industrial high energy ion implantation. It allows the production of nearby all ions with a large uptime and good energy stability. This system is used for the development, prototyping as well as production of high power devices. The most common industrial applications are life-time adjustment by He- or H- implantation and unstructured doping using P or B ions. However, new types of high power devices like super junction devices require vertically structured doping. Today these structures are produced by epitactical growth combined with diffusion and/or low energy ion implantation. This method is time consuming, cost intensive and yield reducing. But a replacement of this technique by a common ion implantation using contact resists is not suitable. A thick masking material is required to stop high energetic ions in areas not to be implanted. Typical resists like polyimide cannot fulfil this requirement. Furthermore they will be destroyed at a high-energy ion impact. We suggest a 3D structured high energy ion projection process as a simple, cost effective and reliable alternative. A feasibility study has shown that this technique allows the production of three 3D implantation structures with high throughput [1]. An ion beam with a few mm diameters penetrates a stencil mask and a superconducting magnet subsequently demagnifies and projects the mask structures onto the substrate surface. An experimental setup exists with demagnification factors up to 15. Additionally, a variation of the ion energy leads to a variation of the implantation deeps and allows a controlled vertical modulation of the doping profile. The contribution will give an overview about techniques and applications of high energy implantation for the semiconductor industries and some details of new developments.

1. J. Meijer, B. Burchard, K. Ivanova, B.E. Volland, I.W. Rangelow, G. Deboy; "High energy ion projection for deep ion implantation as a low cost high throughput alternative for subsequent epitaxy processes", *J.Vac. Technol.* **22** –1 (2004) 152-157.

MO-A8-4 11h30

ANDREAS MANDELIS, University of Toronto

Two-Beam Cross-Modulation Photo-Carrier Radiometry of Electronic Solids. Principles and Applications to Ion Implanted Silicon *

A novel development in the evolution of photo-carrier radiometry (PCR) of semiconductors will be presented. The method consists of spatially overlapping frequency-modulated superband-gap and unmodulated subband-gap laser beams incident on a semiconductor sample and generating PCR signals (a form of modulated room-temperature photoluminescence in Si). The free photoexcited carrier diffusion wave generated by the superband-gap source acts like a photonic chopper on the dc subband-gap beam thus imparting a degree of cross-modulation. The resulting PCR signal is proportional to both ac and dc beam intensities. Therefore, the secondary subband-gap beam with adjustable intensity can act like an optical amplifier of the PCR signal. This amplification principle has been used to enhance sub-surface images of heavy metal contaminated Si wafers and images of proton-implanted Si. Theoretical and experimental aspects of the new technique will be presented.

* In collaboration with D. Shaughnessy and J. Tolev, University of Toronto

MO-A8-5 12h00

LENA NICOLAIDES, Therma Wave Inc.

Advanced Non-Destructive Photo-Thermal Methods for Characterization of Ultra-Shallow Junctions *

Surface modifications of semiconductor materials – ion implantation and thermal annealing – are key technological processes at the initial stages of microelectronics manufacturing. Modern semiconductor technology uses low energy ion implantation process to achieve ultra-shallow (< 500 Å) implantation depths. The process problems in forming ultra-shallow junction (USJ) layers lie in both the implant and the anneal procedures. While it is relatively easy to create a shallow layer by implantation, keeping the USJ profile abrupt and close to the surface after anneal is a big challenge. Similarly, as indicated by the ITRS roadmap, obtaining accurate information on the electrically active dopant profile for sub-30 nm structures is a key issue. Presently, however, there is no conventional, probe based (destructive) technique available satisfying the ITRS targeted depth and carrier level reproducibility and accuracy. In this work, we explore the promising capabilities of non-destructive photo-thermal techniques, based on the local (micrometer beam size) detection of variations in the reflectivity of the sample due to thermal and plasma (excess carrier) effects as can be generated by a modulated pump laser. It is shown that the method allows for a determination of the most important USJ parameters – depth and profile abruptness and peak carrier concentration. Further, by combining correlation plots representing the in-phase reflected signal versus the quadrature signal and the quadrature signal versus the junction depth, as calibrated by Secondary Ion Mass Spectrometry, it is possible to determine independently the carrier peak concentration and junction depth.

* In collaboration with A. Salnick, M. Bakshi, J. Opsal, Therma Wave Inc

12h30 Session Ends / *Fin de la session*

[MO-A9] (PPD) Precision Frontier in Particle Physics I / *Les limites de la précision en physique des particules I*

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h30

SALLE / ROOM CEME 1202 (cap. 119) ***Chair: F. Corriveau, McGill U.***

MO-A9-1 10h00

MAHER QURAAN, University of Alberta / TRIUMF

First Results on Muon Decay from TWIST *

The TRIUMF Weak Interaction Symmetry Test (TWIST) has recently completed the analyses of its first physics run. The results provide a significant improvement in precision for two of the four Michel parameters that describe the energy and angular distributions of positrons from polarized positive muon decay. These results represent a significant first

step toward the ultimate TWIST goal of testing the Standard Model in a purely leptonic decay interaction by improving upon previous determinations of three of the four Michel parameters by at least an order of magnitude. TWIST stops a highly polarized muon beam at the center of a spectrometer consisting of a low mass, high precision array of planar drift chambers in a two tesla solenoidal field. The spectrometer, its operation and the methods employed to extract the decay parameters in a reliable way will be described. Systematic uncertainties achieved and how TWIST plans to improve upon them will be outlined. Some new physics limits derived using the recent TWIST results will be discussed.

* Representing the TWIST Collaboration)

MO-A9-2 10h30

NEIL KNECHT, University of British Columbia

Unitarity Triangle Angles With BaBar

CP violation within the Standard Model of particle physics is completely described by a single parameter. This is a complex phase in the Cabibbo-Kobayashi-Maskawa (CKM) matrix that parameterizes transitions between different generations of quarks. The unitarity of the CKM matrix imposes constraints on its elements and it is illustrative to express these constraints through a Unitarity Triangle that interrelates the CKM matrix elements. CP violation is manifest in the angles which can be related to experimental decay amplitude asymmetries in certain meson systems. The system of neutral B mesons is a particularly sensitive environment with which to constrain the Unitarity Triangle. This is one of the foci of the BaBar experimental program. The ability to measure the Unitarity Triangle angles in several complementing channels tests the Standard Model picture of CP violation and provides the exciting possibility of seeing evidence for physics beyond the Standard Model. Current BaBar measurements of the Unitarity Triangle angles will be discussed.

MO-A9-3 11h00

E865 Result: An Improved Limit on the LFNV Decay $K^+ \rightarrow \pi^+ \mu^+ e^-$, **Aleksey Sher**, *TRIUMF* — We report results of a search for the lepton-family-number-violating decay $K^+ \rightarrow \pi^+ \mu^+ e^-$ with data collected by experiment E865 at the Alternating Gradient Synchrotron of Brookhaven National Laboratory.

MO-A9-4 11h15

Monte Carlo Studies for Parameterization of B-Mixing with Inclusive Dilepton Events. **Zhongzhi Song**, *University of British Columbia* — In this talk, we report on Monte Carlo (MC) studies for parameterization of probability density functions (PDFs) for B-mixing with two-lepton events. Data were generated by the EvtGen package within the BaBar framework. Following the same methods applied in real experimental data analysis, the boost approximation and the point of closest approach (POCA) were used in our MC analysis. The parameterization was obtained by fitting MC data, which were generated with different lifetimes and mixing parameters. Our results, combined with MC studies of detector resolutions, can be applied to a more precise measurement of the B-mixing parameters.

MO-A9-5 11h30

Determination of |Vub| from Inclusive Semileptonic B Decays at BaBar. **Dominique Fortin**, *University of Victoria* — A measurement of the CKM matrix element |Vub| is performed using charmless semileptonic B decays from a sample of 88 million B anti-B events recorded with the BaBar detector. Decays are primarily identified by a high momentum electron and a neutrino inferred from the missing momentum. Further selection requirements using a combination of q2 and Ee are applied to suppress the dominating charm background. Signal efficiency and background estimates derived from Monte Carlo simulations are then used to measure the B $\rightarrow$ Xu e nu branching fraction in data. Combining this measurement with the B lifetime allows for the determination of the CKM matrix element |Vub|.

MO-A9-6 11h45

Gravitino as Dark Matter and its Implication for Supersymmetry Searches. **Yudi Santoso**, *University of Guelph* — Dark matter is currently one great puzzle in astroparticle physics. Although it has been quite clear that there must be some extra source of gravity in the universe, the nature of this source is still not known. Supersymmetry provides good candidates for dark matter particle. Neutralino dark matter has been studied extensively for more than a decade. Nonetheless, there is another candidate of supersymmetric dark matter, *i.e.* gravitino. We will discuss in this talk, the feasibility of gravitino dark matter and its implication for supersymmetry and dark matter searches.

MO-A9-7 12h00

Search for Lepton Flavour Violation at BABAR*. **Michael Roney**, *University of Victoria* — A search for the non-conservation of lepton flavor number in the decay $t \rightarrow mg$ has been performed using 2.07×10^8 $e + e^- \rightarrow t + t^-$ events produced at a center-of-mass energy near 10.58 GeV with the BABAR detector at the PEP-II storage ring. We find no evidence for a signal and set an upper limit on the branching ratio of $BR(t \rightarrow mg) < 6.8 \times 10^{-8}$ at 90% confidence level.

*This work is being supported by NSERC

MO-A9-8 12h15

Neutrinos with FLARE. **Scott Robert Menary**, *York University* — Fermilab's NuMI facility started providing a ν_μ beam for the MINOS experiment in December, 2004. MINOS is located in the Soudan mine in northern Minnesota about 732 km northwest of Fermilab. The FLARE **F**ermilab **L**iquid **AR**gon **E**xperiments) collaboration proposes putting a 50 kton liquid argon TPC in northwestern Ontario about 850 km from Fermilab and 60 km east of Fort Frances. I will describe how FLARE can measure θ_{13} of the PMNS Matrix using the "off-axis" NuMI beam. This is not all one can do as the excellent energy resolution and particle identification capabilities of the FLARE detector also allows access to a wide range of physics topics including proton decay and supernova neutrinos.

12h30 Session Ends / *Fin de la session*

[MO-A10] Atomic and Molecular Spectroscopy and Dynamics / *Spectroscopie et dynamique des atomes et molécules*

(DAMP / *DPAM*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h00 - 12h15

SALLE / ROOM IRC 5 (cap. 120) ***Chair: A. Madej, NRC***

MO-A10-1 10h00

PIERRE-NICHOLAS ROY, University of Waterloo

Structure and Dynamics of Weakly-Bound Clusters *

We describe current challenges of quantum molecular dynamics and review approaches for the treatment of complex molecular systems. We focus on the case of weakly bound clusters. For smaller systems consisting of a few solvent atoms, exact calculations of spectroscopic accuracy are possible. For much larger systems, path integral Monte Carlo simulations are used, and the analysis of imaginary time correlation functions provides insight into the size evolution of experimentally observed spectral signatures. These are

then used to explore the onset of nano-scale superfluidity. Alternate techniques are presented that allow for the direct calculation of real-time correlation functions in the context of a semi-classical approximation. We finally discuss the relative merits of the described approaches.

* In collaboration with N. Blinov, B. Issack, Y. Liu, University of Alberta

MO-A10-2 10h30

YUNJIE XU, Chemistry Department, University of Alberta

Infrared Laser Spectroscopy and ab initio Investigations of Chiral Recognitions *

Chirality and chiral discrimination are essential for living systems and are of tremendous importance in life sciences. For example, the chemistry of life is built almost exclusively on L-enantiomers of amino acids and D-sugars, a pattern known as the 'homochirality of life'. Our research focuses on understanding how chiral molecules differentiate a chiral molecule from its mirror image on the molecular level. In this talk, I will discuss the current spectroscopic investigations of chiral recognitions and the new approaches we take to tackle this problem. Specifically, we have developed a mid-infrared cavity ring down spectrometer in combination with a pulsed slit molecular expansion to study the infrared signatures of chiral diastereomers. These studies are complemented with high level *ab initio* calculations to arrive at a fundamental, molecular level understanding of the fascinating phenomenon of chiral recognition.

* This work is being supported by NSERC, CFI, Alberta Ingenuity

MO-A10-3 11h00

ECTDL Spectrum of N-15 Ammonia in the 6350-6550 cm^{-1} Region of the N-H Stretching Combination Band*. **Ronald Lees**, *University of New Brunswick* — The infrared spectrum of the N-15 isotopic species of ammonia is being investigated in the 6370-6580 cm^{-1} region with an external cavity tunable diode laser spectrometer. The patterns of some of the stronger absorption lines are very similar to those known for the $n_1 + n_3$ N-H stretching combination band of normal $^{14}NH_3$, permitting immediate assignment by analogy with the known N-14 transitions. For $^{15}NH_3$, the $n_1 + n_3$ band origin is shifted downwards by 12.2 cm^{-1} relative to $^{14}NH_3$. From the preliminary spectra, the absorption intensities appear fairly comparable for both species, but more careful measurements to better define the isotopic intensity ratio are underway.

* This work is being supported by CIPI, NSERC

11h15 Coffee Break / Pause café

MO-A10-4 11h30

LI-HONG XU, University of New Brunswick

Torsion-Mediated Intramolecular Vibrational Energy Redistribution in Methyl-Top Molecules: High Resolution Findings and Ab Initio Assisted Dynamics

Intramolecular vibrational energy redistribution (IVR) is a process where energy deposited in one vibrational mode of a molecule can flow or be redistributed to other vibrational degrees of freedom. Such processes have traditionally been studied in the time domain where the molecular dynamics can be followed directly. However, high-resolution spectroscopy has been proven to be an equally powerful tool to provide complementary information on the molecular dynamics by studying the strengths of the interactions and perturbations associated with the energy redistribution channels in high resolution spectra. Methyl rotors are considered to be significant mediators in accelerating the IVR process. Thus, comprehensive understanding of the spectral behaviour of methanol (CH_3OH) and acetaldehyde (CH_3COH) is likely to be crucial to our knowledge of IVR as these prototype systems are the simplest compounds with a single methyl top and are small enough in size to permit accurate high resolution analysis which could lead to meaningful and potentially full understanding. In this talk, we will first present the observed energy maps for methanol in its vibrational fundamental region. Our industrious efforts so far have revealed complicated vibration-torsion-rotation patterns with extensive networks of interactions between nearby vibrational states both with and without the torsion. The observed energy patterns are found to deviate significantly from the existing one-dimensional Hamiltonian model, calling for an alternative approach where at a minimum the interacting vibrational states must be considered simultaneously together with the torsion and rotation. In order to assist our understanding of these interactions among different vibration-torsion-rotational states, we seek *ab initio* help. Progress to date on our exploration of the possibility of obtaining useful spectroscopic information from *ab initio* calculations will be presented. More specifically, we will report our investigation on the meaning of various off-diagonal elements occurring in a Hessian (force constant) matrix obtained by rotating the Cartesian Hessian matrix (containing second derivatives of the potential surface) to a coordinate system consisting of 3*N*-7 small-amplitude vibrations (where *N* is the number of atoms in the molecule), one large-amplitude vibration (the torsion), the three overall rotations of the molecule, and the three translations. Algebraic expression will then be supplemented by numerical results calculated using quantum chemistry methods. Finally we discuss how these results can be applied to analyses of the vibration-torsion-rotation bands of methanol.

MO-A10-5 12h00

Global Fit Analysis Including the $\nu_9+\nu_4-\nu_4$ Hot Band of CD_3CD_3*, **J.R. Cooper**, N. Moazzen-Ahmadi, *The University of Calgary* — A previous global fit frequency analysis including data from the torsional (ν_4) stack of the ground vibrational state as well as the lowest-frequency perpendicular fundamental ν_9 of CD_3CD_3 has been extended to include new data for the weaker but infrared-active $\nu_9 + \nu_4 - \nu_4$ hot band. Analysis is complicated by the small torsional splitting in both the ground-state and hot band data. The combined data set includes more than 2600 frequencies, and was fitted to within experimental accuracy using a 34-parameter model Hamiltonian. Remarkably, no resonances were observed and no new intervibrational interactions required in analyzing the hot band data; the barrier dependence of several purely-vibrational terms, however, was found to be important. This represents the first global fit analysis including a hot band for any ethane-like molecule.

* This work is being supported by NSERC, Alberta Ingenuity Fund

12h15 Session Ends / *Fin de la session*

[MO-A11] (DIAP/DPIA) Impacts of Academic Science - at home and abroad / *Impact de la science dans les universités - au pays et à l'étranger*

MONDAY, JUNE 6 / LUNDI, 6 JUIN

10h15 - 12h30

SALLE / ROOM FNSC 60 (cap. 119) ***Chair: G. Beer, University of Victoria***

MO-A11-1 10h15

P.S. VINCETT, School of Business & Economics, Wilfrid Laurier University

Economic Impacts of Academic Research: Canadian Physics Shows a Profit!

Despite the importance of international academic research ('AR') to long-term global economic growth, governments naturally seek measures of the more directly attributable benefits of their research expenditures within their own country. We are therefore quantifying various intra-country impacts of AR that (unlike many long-term benefits) can be directly, incrementally, and causally attributed to a government's outlays. Such impacts, while only a fraction of the long-term benefits, justify the investment if they significantly exceed the outlays. Remembering the often-long timeframes between research and large-scale exploitation, we study Canadian AR performed in the NSERC disciplines since the 1950s, and compare its economic impacts (allowing for the time value of money) with funding from all government sources. We know of no previous effort to quantify the impacts and costs of

such a broad, long-term effort in any country. 'Applied' disciplines are sometimes assumed to be the most 'commercializable', so we focus especially on physics, as a very 'basic' science, and compare it with the NSERC disciplines combined. Companies spun-off directly from university physics IP (mostly before the current emphasis on commercialization) are alone generating impacts conservatively more than triple the government funding; governments themselves will receive significantly more tax than they invested. Physics actually fares 25% better than all disciplines combined. Preliminarily, other spin-offs founded by former graduate students will probably add 50-100% to this impact. Licensing to existing companies appears much less important. The results suggest that calls for more 'commercialization' should not be answered by less emphasis on basic, long-term work.

MO-A11-2 **10h45**

LORNE WHITEHEAD, University of British Columbia

High Dynamic Range Displays – a Multi-Disciplinary Challenge *

Although the creation of images, both photographic and electronic, is highly advanced, the current state of the art has a fundamental inadequacy. Conventional images are incapable of displaying the range of luminance values that are present in most settings and which the human visual system is readily able to perceive simultaneously. This range is typically from about 10,000 cd/m^2, (the luminance of white snow in sunlight), down 5 orders of magnitude to about 0.1 cd/m^2. Conventional electronic image displays can only produce accurately controlled luminance values over a much smaller range (typically 200 cd/m^2 down to 1 cd/m^2). Recently, our laboratory has lead the development of a new image display method that can maintain all the usual advantages of a conventional colour active matrix LCD display while allowing the full real-world luminance range to be achieved. We achieve that dynamic range by combining two display systems – a high resolution transmissive LCD and a low resolution, monochrome display formed by an array of high brightness light emitting diodes. This presentation provides a description of this new system as well as findings from a supporting psychological study that establishes the perceptual rational for this hybrid display. One of the themes of this presentation will be the fact that this research outcome was dependent on the collaboration of researchers in quite varied fields – optical physics, electrical engineering, computer science, and vision psychology.

* In collaboration with H. Seetzen [1], G. Ward [2], W. Heidrich [3], [1] University of British Columbia, Physics and Astronomy, [2] Sunnybrook Technologies Inc., [3] University of British Columbia, Computer Science

MO-A11-3 **11h15**

JOHANN ZMESKAL, Stephan Meyer Institute, Vienna

Cutting Edge Physics in the European Union - an Outlook and Review

Recent progress in the development of cutting-edge nuclear detectors and in new European facilities for physics and medical physics research and therapy will be discussed. Particular attention will be paid to Silicon Drift Detectors as room-temperature x ray detectors and heavy ion accelerators for both fundamental research and cancer therapy. In particular, the unique financial structure and technical details for an Austrian proposal based on Darmstadt and Heidelberg machines will be presented.

MO-A11-4 **11h45**

DAN GELBART, CREO

From Bad Idea to Great Company: The story of CREO

CREO was started to develop Optical Tape Recorders (one of several bad ideas I had) but used the technology developed for this machine to revolutionize the printing industry, becoming BC's largest high tech company in the process. Today CREO employs over 4000 people and has revenues approaching a billion dollars per year. Recently CREO was sold to Kodak so this is a good time to look back and try to condense a 20 year history into 30 minutes.

MO-A11-5 **12h15**

From Fundamental Physical Theory to Applications in Enhanced Oil Recovery and Environmental Remediation*. **Tim Spanos**, *Wavefront Energy and Environment* — A heart pulses blood through arteries and veins, with the nature of the pulse very dependent on the size of the animal. For example a humming birds heart beats 60 times per second with a very tiny amplitude whereas a blue whales heart beats 3 to 5 times a minute and is about the size of a Volkswagen beetle. It is the same pressure pulsing action that has been applied to energy and environmental applications such as: 1) Improved oil recovery by increasing sweep efficiency during production; 2) Workovers to enhance production from wells; 3) Mobilizing and enhancing recovery of LNAPL's and DNAPL's; 4) Placement of chemicals such as surfactants and oxidants; 5) Introduction of bioactive agents and nutrients in a well dispersed manner; 6) Stabilization of permeability channeling or viscous fingering; 7) Increasing the basic flow rate so as to shorten any clean-up activity; 8) Enhanced placement of grout or other binding agents; 9) Unplugging, or rehabilitation of water wells through the mechanical perturbation effects of Pressure Pulse Technology; 10) Deep well disposal of liquid dominated slurries such as feel lot wastes The permeabilities that are encountered in these energy and environmental jobs range from mili-darcies to hundreds of darcies. Requiring pulsers that vary by many orders of magnitude in frequency and amplitude. An important point to be made is that pressure pulse technology (PPT) is not a stand-alone technology but rather an enabling technology. It yields improved reservoir conformance and injectivity. PPT is a patented technology which is used by Wavefront Energy and Environment for environmental and oil field applications. It is also licensed to top gun for oil field workovers in Alberta, to Haliburton for oil field applications world wide and to ERM for environmental applications world wide. These industrial applications are based on theoretical developments (*e.g.* de la Cruz *et al.* 1993, Hickey *et al.* 1995, Spanos, 2001). Later experiments on dynamic excitation of liquid flow rate in laboratory cells under constant pressure head were carried out. Low-frequency excitation applied externally (by pressure impulses or by impacting on the solid body of the cell), and increased flow rates of 40-100% were observed without alteration of the external heads or pumping (Davidson *et al.* 1999, Dusseault, 1999). Findings were applied in several heavy oil fields in east-central Alberta (Spanos *et al.* 1999, 2003, Dusseault *et al.* 1999, Dusseault *et al.* 2002) with reasonable success. This led to the building of a publicly traded company and world wide commercial applications of its patented technologies.

* This work is being supported by NSERC

12h30 **Session Ends / *Fin de la session***

[MO-P1] (CAP/ACP) CAP Teaching Medal Winner / *Médaille de l'ACP pour l'excéllence en enseignement*

MONDAY, JUNE 6 / LUNDI, 6 JUIN

13h30 - 14h15

SALLE / ROOM IRC 2 (cap. 500) ***Chair: K. Ragan, McGill U.***

MO-P1-1 **13h30**

ANDRE MARZIALI, University of British Columbia

No, Really, I Want You To Talk In Class…

During my brief teaching career so far, I've had the pleasure of being immersed in a variety of teaching environments, from large introductory physics classes to upper level biophysics and lab-based engineering classes. In my naiveté as a new professor, and haunted by the relatively recent memory of countless hours spent taking notes, I tested approaches in each of these classes that were in some cases risky, but often produced surprising dividends. I will present the sum of my experience with these classes, and, among anecdotes and videos of robots, try to distill from my attempts the essential elements that led to the students' enjoyment of the classes, and, hopefully, a lasting positive impact in their education.

14h15 **Session Ends / *Fin de la session***

[MO-P2] Tests of the Standard Model / *Tests du modèle standard*

(DNP/*DPN*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 - 17h15

SALLE / ROOM CEME 1204 (cap. 60) ***Chair: W.T.H. van Oers, University of Manitoba***

MO-P2-1 **14h15**

MAXIM POSPELOV, University of Guelph/Perimeter/University of Victoria

Precision Tests of the Standard Model at Low Energies

I review the current status of the Standard Model, arguing that it represents the low-energy limit of a more fundamental physical theory. I then concentrate on some possibilities to sensitively probe such an underlying theory, covering the probes of CP violation, flavour physics, and electroweak tests. I show that the precision probes at low and intermediate energies provide independent and complementary to colliders information about physics at ultra-short distance scales.

MO-P2-2 **14h45**

MIKE WOODS, Stanford Linear Accelerator Center (SLAC)

Results from SLAC E-158: A Study of Parity Violation in Moller Scattering *

SLAC Experiment E-158 has made the first measurement of parity violation in electron-electron (Moller) scattering. The experiment measures the right-left parity-violating cross-section asymmetry (A_{PV}) in the elastic scattering of 45 and 48 GeV longitudinally polarized electron beams with unpolarized electrons in a liquid hydrogen target. We find A_{PV} = [-128 ± 14 (stat) ± 12 (syst)] parts per billion, with a significance of 7.6σ for observing parity violation. In the context of the Standard Model, this yields a measurement of the weak mixing angle, $\sin^2(\theta_W)(Q^2 = 0.026\ GeV^2)_{MS\text{-}bar} = 0.2403 +- 0.0010$ (stat.) +- 0.0009 (syst.). This value of the weak mixing angle is 3.8% higher than what is observed at $Q^2=M_Z^2$ (from measurements of Z-pole asymmetries at LEP and SLC). This establishes running of the weak mixing angle, due to electroweak radiative corrections, with 6.5s significance. The result is consistent with Standard Model expectations and sets limits on new physics contributions at the TeV scale. We also present results for the first observation of a single-spin transverse asymmetry in Moller scattering, and results for longitudinal and transverse asymmetries in electron-proton scattering.

* This work is being supported by U.S. DOE DE-AC03-76SF00515

MO-P2-3 **15h15**

The Q_{weak} Experiment at Jefferson Laboratory*, **Shelley A. Page**, *University of Manitoba* — A major new initiative is under underway at Jefferson Laboratory to measure the proton's weak charge — a basic property, like its electric charge and mass, which determines how a proton responds to the weak interaction. The Standard Model makes a firm prediction of the proton's weak charge , $Q_{wp} = 1 - 4 \sin^2(\theta_W)$, based on the running of the weak mixing angle $\sin^2(\theta_W)$ from the Z^0 pole down to low energies, corresponding to a 10σ effect in our experiment. The Q_{weak} collaboration [1] will carry out the first precision measurement of Q_{wp} by measuring the parity violating asymmetry in elastic electron-proton scattering, which is proportional to $Q^2 * Q_{wp}$; a hadronic form factor contribution proportional to Q^4 is suppressed by carrying out the measurements at very low momentum transfer ($Q^2 = 0.03\ (GeV/c)^2$). Our ultimate goal is to determine the proton's weak charge with 4% combined statistical and systematic errors which in turn leads to a 0.3% measurement of $\sin^2(\theta_W)$. A longitudinally polarized electron beam, a liquid hydrogen target, a room temperature toroidal magnetic spectrometer, and a set of current mode detectors for the scattered electrons at forward angles are the key elements of the experimental apparatus. The experiment will benefit from technical advances in polarized source operation at JLab and from the results of weak hadronic form factor measurements that have been made in the laboratory's parity violation program and elsewhere. The Canadian institutions participating in Q_{weak} include the Universities of Manitoba, Winnipeg, Northern B.C., and TRIUMF; our hardware contribution is centered on the magnetic spectrometer coils and detector readout electronics, with funding provided by NSERC and technical assistance provided by TRIUMF. The experiment is currently under construction; installation in Hall C at Jefferson Lab followed by data taking is planned for late 2007.

* This work is being supported by NSERC, TRIUMF

1. Qweak collaboration: http:/www.ilab.org/qweak/

15h30 **Coffee Break / Pause café**

MO-P2-4 **15h45**

JACQUES A. FARINE, Laurentian University

Results from the Salt Phase of SNO

Results are reported from the complete salt phase of the Sudbury Neutrino Observatory experiment in which NaCl was dissolved in the D_2O target. The addition of salt enhanced the signal from neutron capture, as compared to the pure D_2O detector. By making a statistical separation of charged-current events from other types based on event-isotropy criteria, the effective electron recoil energy spectrum has been extracted. In units of $10^6\ cm^{-2}s^{-1}$, the total flux of active-flavor neutrinos from ^8B decay in the Sun is found to be 4.94+0.21-0.21(stat)+0.38-0.34(syst) and the integral flux of electron neutrinos for an undistorted ^8B spectrum is 1.68+0.06-0.06(stat)+0.08-0.09(syst) signal from (n_x,e) elastic scattering is equivalent to an electron-neutrino flux of 2.35+0.22-0.22 (stat)+0.15-0.15(syst). These results are consistent with those expected for neutrino oscillations with the so-called Large Mixing Angle parameters, and also with an undistorted spectrum. A search for matter-enhancement effects in the Earth through a possible day-night asymmetry in the charged-current integral rate is consistent with no asymmetry. Including results from other experiments, the best-fit values for two-neutrino mixing parameters are Dm^2 = 8.0+0.6-0.4 $10^{-5}\ eV^2$ and q = 33.9+2.4-2.2 degrees. Key aspects of the transition from the pure D_2O phase to the Salt phase of the SNO detector, and implied changes in the data analysis will be highlighted. The signal extraction and new results will be discussed. Finally, progress into the third phase, using Neutral Current Detectors, will be presented.

MO-P2-5 **16h15**

KAI-THOMAS BRINKMANN, IKTP, TU Dresden

Search for the Pentaquark

In 2003, several experiments reported evidence for a manifestly exotic baryonic state with a mass of about 1530 MeV/c^2. The experimental width of this object, which decays into final states with a kaon and a nucleon, appears to be much less than the experimental resolutions of the order of 20 MeV/c^2. The state was found to decay into K^0p and K^+n. It was populated using various probes on different targets ranging from protons to heavy nuclei such as Xe. This baryon with strangeness S=+1 was named q^+ and identified with the antidecuplet baryon predicted by Diakonov, Petrov and Polyakov [1] in 1997. Many experiments have scanned their data for the pentaquark signal with varying results. Some searches resulted in evidence for the q^+ and other states that can be constructed analogously, while others fail to produce any narrow structures in the region of interest. Further arguments on the width can be derived from analyses of kaon-nucleon scattering. While there seems to be a general agreement on the isospin of the state among experiments, other properties such as the parity of the q^+ have not yet been derived and will be needed in order to discriminate between the various theoretical approaches if the signal will be confirmed in the present round of high-statistics experiments. The experimental status and further prospects will be discussed.

1. D. Diakonov, V. Petrov and M. Polyakov, *Z. Phys. A* **359** (97) 305.

MO-P2-6 **16h45**

Confronting CPT with Cold Antihydrogen. **Makoto C. Fujiwara**, *TRIUMF* — A long-term goal of antihydrogen research is precision tests of CPT and other symmetries between matter and antimatter, via precise comparisons of their properties. Any violations of these fundamental symmetries imply new physics at a very high energy scale, e.g., the Planck scale. The ATHENA experiment, located at CERN's Antiproton Decelerator, produced the first cold antihydrogen in 2002, establishing an important milestone towards the ultimate goal. The ATHENA data taking has been completed, and we are developing a second generation experiment, ALPHA (Antihydrogen Laser Physics Apparatus) with the aim of stably trapping cold antihydrogen atoms. After briefly reviewing ATHENA's achievements, I will present an overview of the ALPHA experiment, with an emphasis on its detection system using Si vertex detector. I will also discuss the prospects of Canadian participation in this exciting new project.

MO-P2-7 **17h00**

The NPDGamma Experiment: A Measurement of Parity Violation in Radiative Neutron-Proton Capture*, **R.Chad Gillis**, S.A. Page, *University of Manitoba*, for the NPDGamma Collaboration — The NPDGamma experiment is under development at the Los Alamos Neutron Science Center. NPDGamma will measure a parity-violating gamma-ray asymmetry in a simple two-nucleon system. The motivation is to provide a cleanly interpretable and precise measurement of the pion-nucleon weak coupling constant. The pulsed neutron beam is cooled in a liquid hydrogen moderator, polarized by transmission through polarized ^{3} He, and captured in a liquid para-hydrogen target. The 2.2 MeV gamma rays from the capture reaction are detected in an array of CsI(Tl) scintillators which are read out in current mode by vacuum photodiodes. The present status of the experiment will be discussed.

* Work on NPDGamma is supported by the US DOE, NSF, TRIUMF, and NSERC Canada.

17h15 **Session Ends / *Fin de la session***

[MO-P3] Coherent Interaction with Atoms and Molecules
(DAMP/*DPAM*) ***Interactions cohérentes entre les atomes et les molécules***

MONDAY, JUNE 6
LUNDI, 6 JUIN
14h15 - 17h00

SALLE / ROOM IRC 4 (cap. 135) ***Chair: R.M. Lees, University of New Brunswick***

MO-P3-1 **14h15**

MICHAEL SPANNER, University of Toronto

Field-Free Alignment and Strong Field Control of Molecular Rotors *

Methods of controlling molecular rotations using linearly polarized femtosecond and picosecond pulses are presented. These laser pulses, typically in the infrared, are highly non-resonant with respect to the electronic degrees of freedom of the molecules and have intensities of 10^{13} to 10^{14} W/cm^2. It is shown how these laser pulses can force small linear molecules to align with the direction of the electric field vector of the laser both in the presence of the laser field as well as after the application of a short laser pulse. Recent experiments on laser-induced molecular alignment are modeled and excellent agreement between experiment and theory is found.

Applications of field-free alignment dynamics are then discussed. The first application uses the wave packets of molecular alignment to demonstrated a method of controlling wave packet revival dynamics. The control works by applying position-dependent phase shifts to the wave packet at select times called fractional revivals. At these select moments, an initially localized wave function splits into several copies of the initial state. Adding phase shifts to the copies then induces interference effects which can be used to control the subsequent evolution of the rotational wave function. The next application uses field-free aligned molecules as a non-linear medium for compression of a laser pulse to the 1 gs regime at optical wavelengths. At such durations, these laser pulses contain nearly a single oscillation of the electric field and represent the shortest laser pulses physically achievable for such frequencies.

Molecular alignment can be used to create a sort of gas phase "molecular crystal". These are moments in time when all the molecules in the laser focus are aligned in the same direction. Such an ensemble can be used to conduct experiments in the molecular frame where averaging over the usual random orientations of the molecules in space is no longer required. This ensemble forms a basis for many interesting strong field experiments on molecules, for example, laser-induced electron diffraction and imaging of the aligned molecules. Here, a first laser pulse aligns the molecules in space. A second laser pulse is then used to ionize outer-shell electrons, accelerate them in the laser field, and steer them back to collide with the parent ion creating a diffraction image with sub-femtosecond and sub-Angstrom resolution. The method of molecular imaging by laser-induced diffraction will be presented. Additional recent applications of the gas phase molecular crystal related to the angular dependence of high-harmonic generation will be briefly discussed.

* This work is being supported by NSERC

MO-P3-2 **14h45**

DIRK ZEIDLER, National Research Council of Canada

Controlling Double Ionization Dynamics via Molecular Alignment *

Femtosecond pump-probe technology is widely used in optical experiments to time-resolve and control ultrafast processes. We apply this technology to measure and control the probability and dynamics of re-collision-induced double ionization of nitrogen molecules. A pump pulse aligns the molecules, and a probe pulse ionizes them. Observing one electron and one ion in co-incidence at different pump-probe time delays determines the alignment-dependence of elastic (single ionization) and inelastic (double ionization) scattering. We find that the temporal structure of the electron wave packet formed in the continuum by tunneling does not dependent on molecular alignment, but its magnitude and spatial shape do. We also find that the two electrons involved in non-sequential double ionization usually exit the molecule in the same direction if the molecule is parallel to the laser polarization, indicating that they are ejected within a few hundred attoseconds of each other. Double ionization is less probable and takes much longer for perpendicular molecules.

* In collaboration with A. Staudte [1], A.B. Bardon [2], D.M. Villeneuve [3], R. Dörner [1], P.B. Corkum [3], [1] Inst. f. Kernphysik, University Frankfurt, Germany, [2] Mount Allison University, [3] National Research Council of Canada

MO-P3-3 **15h15**

Spectroscopy and Dynamics of Photoion-Pair Formation*, **Qichi Hu**, J. Hepburn, *University of British Columbia* — Threshold Ion-Pair Production Spectroscopy (TIPPS) is a high resolution spectroscopic technique. It involves the excitation of molecules by coherent VUV photons to highly vibrationally excited ion-pair states, which are then field dissociated into oppositely charged fragments. Since only threshold ions are monitored, this technique can measure the ion-pair dissociation energy and thus the bond dissociation energy with unprecedented accuracy (as good as 1cm^{-1}). The application of this technique in recent years to molecules HCl/DCl, HF/DF, HCN and $(HF)_2$ will be presented. From the high resolution spectra of these molecules, we can obtain the high resolution energetic and dynamic information of the ion-pair dissociation processes.

* This work is being supported by NSERC, PDF, UBC

15h30 **Coffee Break / Pause café**

MO-P3-4 **16h00**

RALPH SHIELL, Trent University

Coherent Spectroscopy: Population Trapping and Stark Wave Packets

The coherent properties of laser light enable physicists to investigate and control matter to an unprecedented degree, with applications in academic and industrial sectors. I shall describe some results from two recent experiments in which we have observed the effects of quantum coherences formed within atomic and molecular species. In one experiment, we have compared the absorption of ^{7}Li atoms in a vapour cell at the D1 and D2 transitions when illuminated by a bichromatic laser field. At Raman resonance coherent population trapping is observed which behaves differently at each transition under various incident polarizations due to the differing proximity of nearby atomic states. Transparency is observed at the D2 transition only under laser polarizations that result in open interaction contours that can couple the hyperfine ground states [1]. In the second experiment Stark wave packets of the weakly-bound ion-pair species H^{+}/F^{-} have been created by exciting HF molecules in an electric field using a 1 XUV + 1 UV excitation scheme in which a near-Fourier-transform-limited laser pulse is used for the second step. The ion-pair yield spectrum is highly resonantly enhanced and the evolution and observation of the Stark wave packets at different resonances will be presented [2]. Prospects for future work on both these systems will also be discussed.

1. F. Magnus, A.L. Boatwright, A. Flodin and R.C. Shiell, "Optical Pumping and Electromagnetically Induced Transparency in a Lithium Vapour", *J. Opt. B: Quantum Semiclass. Opt.* (in press, 2005)
2. In collaboration with W. Ubachs and E. Reinhold, Vrije Universiteit Amsterdam.

MO-P3-5 **16h30**

Hot Band Spectroscopy of CCO in the C-O Stretching Region*, **Z. Abusara**, N. Moazzen-Ahmadi, *University of Calgary* — Spectroscopic information regarding the energetics of the electronic states of CCO is essential for establishing the most likely reaction mechanisms in combustion, interstellar clouds, and photodissociation dynamics of carbon suboxide. For example, the photodissociation of C_3O_2 (with $^{1}\Sigma^{+}$ ground electronic state) is still the subject of considerable debate. The question of which electronic state, $\tilde{X}\,^{3}\Sigma^{-}$ or $\tilde{a}^{1}\Delta$ the CCO fragment will be in after the dissociation of C_3O_2 still remains unanswered. In this talk I will discuss the observation and analysis of two hot bands $(2\nu_1 + \nu_3) - \nu_3$ and $(\nu_1 + 2\nu_3) - 2\nu_3$ in the ground electronic state. The upper state of the $(\nu_1 + 2\nu_1) - 2\nu_1$ band is at approximately 6000 cm^{-1}. This is about 800 cm^{-1} higher than the (000) state of the $\tilde{a}^{1}\Delta$ state.

* This work is being supported by NSERC

MO-P3-6 **16h45**

Collinear Laser Spectroscopy at ISAC - TRIUMF, **Thomas Cocolios** [1], H. Schuessler [2], J.K. Lee [1], J.E. Crawford [1], P. Levy [3], F. Buchinger [1], H. Iimura [4], [1] *McGill University*, [2] Texas A&M University, [3] TRIUMF, [4] JAERI — Collinear fast beam laser spectroscopy is a method by which the atomic structure of an atom or ion is probed under Doppler-free conditions by superposing an accelerated particle beam with a laser beam. The atomic spectroscopy yields hyperfine structure and isotope shift. From this can be extracted nuclear shape and size. This study proves to be extremely relevant along chains of isotopes. The ISAC facility at TRIUMF provides various beams with isotopes far from stability that are of interest to physicists. Current efforts of TRIUMF concern the study of the neutron deficient La isotopes to complement previous work done on long lived La isotopes at JAERI, Japan. Collinear laser spectroscopy on the stable isotope ^{19}F has also been carried out to facilitate the production of polarised ^{20}F beam. The development of the system, its current achievements, limits and expectations for both La-II and F-I studies shall be presented.

17h00 **Session Ends / *Fin de la session***

[MO-P4] Field Theory / *Théorie des champs*

(DTP/*DPT*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 - 16h45

SALLE / ROOM IRC 1 (cap. 133) ***Chair: K. Schleich, University of B.C.***

MO-P4-1 **14h15**

RICHARD MACKENZIE, Université de Montréal

*Abelian Chern-Simons Q-Balls**

The energetics of Q-balls in an abelian gauge theory with Chern-Simons term will be studied; conditions of stability against decay into ordinary matter will be given.

* In collaboration with M. Deshaies-Jacques, Université de Montréal

MO-P4-2 **14h45**

MALCOLM BUTLER, Saint Mary's University

Effective Field Theories for Nuclear Physics

The nucleon-nucleon interaction is well-modelled, but not well understood. Further, the modeling of short-distance behaviour via meson-exchange has dynamical implications that are not well-controlled. It is worthwhile to examine other approaches to the problem. I will review some of the effective field theories that have been proposed to connect the fundamental symmetries of quantum chromodynamics (QCD) to the nuclear degrees of freedom (nucleons and pions). Specific examples will be discussed for both one and two-nucleon systems.

MO-P4-3 **15h15**

ARIEL ZHITNITSKY, University of British Columbia

Topological Phenomena in QCD at Large Baryon Density

The main leitmotiv of the present talk is analysis of different topological objects such as strings and domain walls in QCD. As it is well known, the standard model in general (and QCD in particular) does not support any kind of such objects due to some simple topological arguments. However, the situation cardinally changes when one considers QCD in the limit of large baryon density. I discuss the domain walls and global strings which occur in high density QCD. I also discuss the effects of quantum anomalies in the presence of topological objects in high-density QCD. The anomaly induced interactions lead to a number of interesting phenomena (such as the induced currents along the strings) which may have important phenomenological consequences such as neutron star kicks observable in neutron stars.

MO-P4-4 **15h45**

THOMAS GREGOIRE, CERN

Gravity Mediated Supersymmetry Breaking in Warped Brane Worlds

Despite the lack of experimental evidence for it, low energy supersymmetry remains a favored candidate for solving the gauge hierarchy problem. One of the most serious issue in this framework is the generation of soft masses that do not generate unacceptable level of flavor changing neutral current. To solve this problem it is useful to separate the

supersymmetry breaking sector from the Standard Model in an extra dimension of space. In this talk I will present the calculation of the transmission of supersymmetry breaking from one sector to the other in the case where the extra dimension is warped.

MO-P4-5 **16h15**

MANU PARANJAPE, Université de Montréal

The Josephson Effect and Pseudo-Goldstone Bosons *

We consider the Josephson effect from a field theoretic point of view and describe its relation to psuedo-Goldstone bosons. These are the putatively massless Goldstone modes that would arise from the spontaneous symmetry breaking leading to superconductivity yet obtain small masses due to explicit symmetry breaking terms. Such a formulation allows a straighforward generalisation to the nonabelian case. We consider some applications.

* In collaboration with L.-P. Guay, Université de Montréal

16h45 **Session Ends / *Fin de la session***

[MO-P5] Interface Science / *La science des interfaces*

(DCMMP/DPMCM)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 - 16h45

SALLE / ROOM IRC 3 (cap. 108) ***Chair: Z. Tun, AECL***

MO-P5-1 **14h15**

DAN BIZZOTTO, University of British Columbia

An Electrochemical and In-Situ Fluorescence Investigation of Role of Potential in Manipulating the Properties of an Adsorbed Lipid-Like Layer *

Lipid and lipid like molecules adsorbed onto perfectly polarizable metal electrode surfaces are studied by electrochemical and spectroscopic techniques. The influence of electrode potential on the state of the adsorbed molecules is described through electrochemical and fluorescence measurements. We have found that this class of molecules can be displaced from the electrode surface simply through control over the electric potential which changes the metal/electrolyte interfacial tension. Fluorescence microscopy has revealed some unique potential dependent behaviour of these molecules (adsorption & desorption). For example, we have been able to show, that when a fluorescent dye containing monolayer was desorbed, the added fluorescent dye forms aggregates which attenuate the observed fluorescence. Upon re-adsorption of the monolayer, the aggregated dye reverts to its monomer form and the subsequent fluorescence measured after desorption is 90% of the original value. This process is dependent on the fluidity of the monolayer, yelling a ten fold increase in rate of aggregation when comparing an adsorbed monolayer which is incompressible (octadecanol) to a more fluid compressible adsorbed monolayer (octadecenol). In addition, the use of two fluorescence probes have proven to be useful in describing the mechanism for the adsorption and desorption and potential dependent changes in the adsorbed monolayer organization. The in-situ two dye imaging has also proven useful in estimating the distance the desorbed molecules are from the electrode surface. Fluorescence imaging of the reductive or oxidative desorption process of a thiol self assembled monolayer produced with a fluorescent thiol molecule has shown that desorption occurs from regions on the electrode surface that are crystallographically specific. A summary of results for both physically adsorbed and alkyl thiol monolayers will be presented.

This work is being supported by NSERC

* In collaboration with J.L. Shepherd, University of British Columbia

MO-P5-2 **14h45**

LARRY D. UNSWORTH, McMaster University

End-Thiolated Monomethoxy PEO Molecular Architecture Evolution And Its Effect On Protein Adsorption: Investigated Using Neutron Reflectometry *

It is well known that end-tethered polyethylene oxide (PEO) reduces protein interactions at the tissue-material interface. The objective of this research is to determine the fundamental properties of PEO monolayers (*e.g.* chain density and structure) in order to further understand previously reported protein adsorption results [1]. For this purpose we have chosen a model system based on the chemisorption of chain-end thiolated PEO to gold (~1000 Å) coated Si wafers, where both incubation time and PEO solubility is manipulated in order to generate surfaces of variable, controlled PEO densities. Herein we report the influence of 750 MW monomethoxy-PEO film architecture, as determined using contrast matched '*in situ*' neutron reflectometry, on protein resistance. It was found that films formed using chemisorption solutions where PEO was marginally soluble had significantly higher PEO volume fractions and thicknesses compared to films formed using solutions where PEO was highly soluble. Furthermore, unlike films formed using solutions where PEO was very soluble, films formed under marginally soluble conditions required incubation times higher than 0.5 h before becoming 'static'. PEO volume fractions for surfaces formed under marginally solubility conditions after 0.5 and 4 h were ~0.37 and ~0.6, respectively. Radiolabelled fibrinogen adsorption yielded reductions in protein adsorptions of 82 ± 4 and 71 ± 3% (n>30), compared to unmodified controls, for these surfaces (0.5 and 4 h), respectively. Investigations are continuing, but it may be concluded from the data thus far that, contrary to expectation, the surface showing the greatest protein resistance is not necessarily the surface with the highest PEO chain density. Indeed these results suggest that design criteria for PEO based non-fouling surfaces should be based on precise knowledge of the protein resistance-chain density relationship.

Supported by the Natural Sciences and Engineering Research Council of Canada.

1. L.D. Unsworth; H. Sheardown; J.L. Brash. *Langmuir*, **3**;1036-41 (2005).

* In collaboration with Z. Tun [1], H. Sheardown [2], J.L. Brash [2], [1] NRC-NPMR, [2] McMaster University

15h15 **Coffee Break / Pause café**

MO-P5-3 **15h45**

DOMINIC RYAN, McGill University

Proximity-Induced Magnetisation of Palladium in Pd-Fe Multilayers *

A combination of bulk magnetisation, conversion electron Mössbauer spectroscopy (CEMS) and polarised neutron reflectometry (PNR) is used to show that in Pd/Fe multilayers at 4.5~K there is a slight (~10%) enhancement of the Fe moment at the Pd/Fe interface, and that the Pd is almost maximally polarised, with an average moment of 0.32 μ_B to a depth of about 20 Å from the Pd/Fe interface. The Pd polarisation is strongly temperature dependent.

* In collaboration with L. Cheng [1], Z. Altounian [1], J.O. Strom-Olsen [1], M. Sutton [1], Z. Tun [2], [1] McGill University and [2] NRC/CNBL.

MO-P5-4 **16h15**

RADENKA MARIC, National Research Council of Canada

Ceria Doped Materials As Electrolyte Materials For Low Temperature Solid Oxide Fuel Cells

Selection of the solid electrolyte for low solid oxide fuel cells (SOFC) depends on the chosen temperature of operation. The conductivity of the electrolyte should exceed 10^{-2} Scm^{-1} to be considered as a candidate at 500°C. The most well known oxygen ion conductors are those which have the fluorite structure or fluorite derivative structures. Ceria and ceria doped materials have been used as oxygen ion conductors at the Institute for Fuel Cells Innovation at NRC. Ceria doped nanopowders and thin films demonstrate several good characteristics that promise superior performance when used to fabricate electrolytes for low temperature SOFCs such as lower sintering temperature, high ionic conductivity at lower temperature and high mechanical properties. The effects of particle size, dopant, and sintering temperature on electrolyte morphology, density, and ac conductivity has been measured. For starting materials with a particle size of 10-50 nm it was possible to obtain a fully dense electrolyte at 1200°C for 2 h. The total conductivity at 500°C of Sm doped ceria $Ce_{0.8}Sm_{0.3}O_{3-x}$ (SDC) sintered at 1200°C for 2 h approached 0.02 S/cm for a thick electrolyte, 0.4 mm. By reducing the thickness of the electrolyte further improvement can be achieved. Fracture toughness of 1.6 MPa $m^{0.5}$ and Young's modulus of 230 GPa has been achieved for SDC.

16h45 **Session Ends / *Fin de la session***

[MO-P6] Biomedial Imaging / *Imagerie biomédicale*

(DMBP-DOP/*DPMB-DOP*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 - 17h00

SALLE / ROOM G279 ***Chair: B. Whelan, Ryerson University***

MO-P6-1 **14h15**

VESNA SOSSI, University of British Columbia

In-Vivo Detection of Early Compensatory Changes in Parkinson's Disease Using Positron Emission Tomography: A Physicist's Perspective *

Positron emission tomography (PET) images biological processes in vivo using positron labeled radiotracers following the tracer principle. One of the brain systems most often studied with PET, since related to motor function and reward mechanisms, is the dopaminergic system. Neurodegeneration of this system often results into Parkinson's disease, which affects approximately 300 per 100,000 of the general population. The origins and detail mechanism of this disease are only very poorly understood: however it has been observed that clinical symptoms only appear when approximately 50-80% of the dopaminergic neurons have died suggesting that the brain has a great ability of adaptation and compensation. Using PET and three different dopaminergic radiotracers together with novel data interpretation methods we provided in-vivo evidence for three compensatory mechanisms: increased ability of surviving neurons to synthesize the neurotransmitter dopamine, increase dopamine utilization and decrease of the dopamine membrane transporter, which is involved in dopamine metabolism. The imaging techniques and data analysis and interpretation methods that lead to these discoveries will be presented together with a short overview of high resolution brain positron emission tomography.

* This work is being supported by NSERC, MSFHR, CIHR, TRIUMF

MO-P6-2 **14h45**

ANNA CELLER, University of British Columbia / VGH

In Vivo Molecular Imaging - Quantitative and Dynamic SPECT Studies

Modern diagnosis can benefit greatly from medical imaging techniques that allow for non-invasive visualization of internal anatomy and investigations of normal and/or altered functions of a living organism. In particular, recent advances in molecular biology and genomic research have created an enormous demand for accurate, quantitative and functional *in-vivo* information about body physiology and metabolism on a molecular, cellular and organ level. This demand is well addressed by imaging techniques that use radioisotope-tagged molecules.

Over the years, members of the Medical Imaging Research Group (MIRG) at Vancouver General Hospital have developed several techniques aiming at generation of fully quantitative images from single photon emission computed tomography (SPECT) studies. We have also proposed a new technique for dynamic image reconstruction (dSPECT), which uses modern optimization methods to solve a highly underdetermined dynamic SPECT problem. In parallel, methods to display and analyze quantitative and multidimensional data sets resulting from these reconstructions are being investigated.

The talk will present basic principles of SPECT data acquisition and tomographic image creation; the underlying physics phenomena and factors that limit quantitation. The results of the MIRG projects will be discussed in the context of different clinical and molecular applications (cardiology, oncology, nephrology and others). Future research projects will be discussed.

15h15 **Coffee Break / Pause café**

MO-P6-3 **15h30**

KOSTADINKA BIZHEVA, University of Waterloo

Novel Biomedical Applications of Ultrahigh Resolution Optical Coherence Tomography *

Abnormal development of biological tissue, as well as the early stages of many diseases exhibit morphological changes occurring on cellular level, alterations in the local blood flow, and complex changes in the cellular biochemistry. Both biological science and current medical practice call for development of novel, minimally invasive methods capable of detecting these changes. The novel technologies can be used to provide understanding of the origins and the time course of development of different pathologies, as well as to diagnose diseases at early stages when treatment is most effective and irreversible damage can be avoided or postponed. This presentation introduces a novel non-invasive optical imaging technique, ultrahigh resolution optical coherence tomography (UHROCT) that permits *in-vivo* cross-sectional visualization of tissue morphology in superficial depths of 1-2 mm in non-transparent biological tissue with micrometer scale resolution. The principles of image formation in UHROCT and the possibility of extracting functional information (spectroscopic and flow measurements) about the imaged object will be reviewed. Current applications of UHROCT in ophthalmology, dermatology, neuroscience and neurosurgery will be discussed.

* In collaboration with B. Hermann, B. Povazay, A. Unterhuber, W. Drexler, Medical University of Vienna

MO-P6-4 **16h00**

Mueller Matrix Polarimetry and Biomedical Imaging*. **Melanie C.W. Campbell** [1], C.J. Cookson [2], J.J. Hunter [1], M.L. Kisilak [2], J.M. Bueno [3], Q. Liang [4], [1] *Physics & Optometry University of Waterloo, Guelph Waterloo Physics Institute*, [2] Physics, University of Waterloo, [3] Universidad de Murcia, Spain, [4] Optometry, University of Waterloo — Polarization techniques are potentially powerful for imaging tissue and the eye *in vivo*. We wish to understand the underlying tissue properties which interact with light to change its polarization state. Because ocular tissues diffusely scatter and partially depolarize incident light, a 16 element Mueller matrix is required to fully understand these properties. Here we describe Mueller matrix measurements coupled with confocal scanning laser ophthalmoscopy and confocal scanning laser microscopy. The Mueller matrix was determined as a function of pixel position using the Waterloo confocal scanning laser ophthalmoscope. Four polarization states of incident light were created using a generator. The polarization states of the recorded light for each generator state were sampled by an analyser in four positions. The Mueller matrix for each pixel within the image was calculated. Images were taken of the optic nerve head, and surrounding retinal nerve fiber layer (RNFL) at three different optical depths. Spatially resolved polarization properties, including degree of polarization (DOP) and diattenuation were then calculated from the Mueller matrices. We have used the differing Mueller matrix properties of selected features (including the lamina cribrosa and blood vessels) to differentially improve the contrast of their images. Diagnostic potential has been demonstrated. Improvement has also been shown in microscopy images of specular and diffuse objects. Polarization properties of different structures in the eye (including depolarization and diattenuation) also differ and may underlie the improvement in images of fundus structures using polarization methods.

* This work is being supported by PRO, NSERC

MO-P6-5 **16h15**

Constructing A New Spectrometer For Measuring The Excitation-Emission Matrix Of Skin Autofluorescence*. **Douglas M. Thiessen** [1], H. Lui [2], D.I. McLean [1], H. Zeng [1], [1] *BC Cancer Agency*, [2] UBC Division of Dermatology — Background*:* Tissue autofluorescence is the property of tissue to re-emit light at longer wavelengths after excitation by shorter wavelength photons. The emission spectrum is dependent on the wavelength of the excitation light. By systematically measuring successive emission spectra over a range of excitation wavelengths, a 3-D graph or 2-D contour plot, known as an excitation-emission matrix (EEM), can be produced. Fluorescence spectra are determined by the biochemical structure and composition of specific fluorescing compounds present within tissue known as fluorophores. ***Objective:*** Our goal is to construct a system for clinical cutaneous EEM spectroscopy measurements which can be used for the diagnosis of skin diseases. ***Results:*** We are developing a fast EEM spectrometer for measuring skin autofluorescence. The system uses acousto-optical tunable filters (AOTF) which can isolate any wavelength within a 500-1000nm range and are capable of switching wavelengths on a time scale down to 30ns. With these high-speed filters, a complete EEM spectrum can be acquired within 1 sec. This provides a system for fast, detailed, non-invasive measurements of skin tissue. ***Implications:*** EEMs provide a composite picture of all the fluorophores within a given tissue and could potentially yield far more diagnostic information than a conventional 2-D spectrum. These devices should complement other diagnostic techniques and tools used for non-invasive diagnosis of benign and malignant skin disease.

* This work is being supported by CIHR

MO-P6-6 **16h30**

CALUM MACAULAY, University of British Columbia/BC Cancer Centre

Optical Techniques In Early Cancer Management

The majority of cancers originate in epithelial tissue (~85%). The treatment of early cancers is usually much more successful than late stage cancers. Much of the epithelium is accessible to optical evaluation (spectral, imaging, temporal and combinations) and physical manipulation. Over the last decade our group has been involved in developing and evaluating optical technologies for the early detection and localization based on tissue autofluorescence and light remittance properties in the lung, cervix and oral cavities as well as the optical evaluation (quantitative microscopy based) of exfoliated and biopsied epithelium. Some of these technologies are currently in clinical use, some are in clinical trials and others are in the preclinical evaluation phases. When developing and evaluating a new technology it is compared with the current gold standard (usually histopathological interpretation of excised tissue), however when trying to improve upon the current clinically accepted methods additional biologically supporting information (genetic, expression and protein alterations believed to be the causal source of the disease) is extremely useful, as is actual patient and organ site long term outcome. The interaction and synergy of some of these emerging optical technologies and information available from emerging genomic technologies will be discussed.

17h00 **Session Ends / *Fin de la session***

[MO-P7] Condensed Matter Student Paper Competition
(DCMMP/*DPMCM*) ***Compétition étudiante pour le meilleur papier présenté***

MONDAY, JUNE 6
LUNDI, 6 JUIN
14h15 - 17h15

SALLE / ROOM IRC 2 (cap. 500) ***Chair: C. Bennett, Acadia University***

MO-P7-1 **14h15**

Epitaxial Fe Electrodeposited on GaAs(001) Substrates*. **Zhi Liang Bao**, Karen L. Kavanagh, *Simon Fraser University* — Single crystalline, body-centred-cubic Fe films have been electrodeposited on n-GaAs(001) substrates from ferrous ammonium sulphate [$FeSO_4$ $(NH_4)_2SO_4$] solutions as a function of temperature and composition. X-ray diffraction and transmission electron microscopy were used to characterize the structure of the epilayers and the abruptness of the Fe/GaAs interfaces. The quality of epitaxy was greatly improved by the addition of ammonia sulfate compared to pure ferrous sulfate solution. The highest purity films were obtained at a growth temperature of about 60C where a -0.04% lattice contraction is observed, likely due to oxygen impurities. Surface magnetic optical Kerr Effect measurements showed that strain-relaxed, electrodeposited Fe films have a magnetic easy axis along <100> crystal directions, as for bulk Fe.

* This work is being supported by NSERC

MO-P7-2 **14h30**

Andreev Bound States on the Edge of a Triangular Lattice: Pinning Down the Order Parameter Symmetry of the Cobaltates*. **Tami Pereg-Barnea** [1], H.-H. Lin Lin [2], [1] *University of British Columbia*, [2] National Canter for Theoretical Sciences, Taiwan — Andreev bound states on the edge of a triangular lattice: pinning down the order parameter symmetry of the cobaltates. Following the discovery of superconductivity in the 2D sheets of $Na_xCoO_2{\cdot}yH_2O$, the triangular lattice is revisited. I will discuss the conditions under which localized edge states appear on triangular lattices with a pairing potential. I will introduce an elegant way for finding zero energy states in semi-infinite systems using supersymmetric quantum mechanics (SUSY CM). It will be shown that Andreev edge states provide a fingerprint of the superconducting order parameter symmetry.

* This work is being supported by NSERC

MO-P7-3 **14h45**

Columnar Jointing: A Self-Organizing Fracture Pattern*. **Lucas Goehring**, S.W. Morris, *University of Toronto* — Columnar jointing is best known through geological formations such as the Giant's Causeway in N. Ireland, and the Devil's Postpile in California. Regular pillars are formed via the self-organization of a crack front as it penetrates a cooling lava. In cross section, the cracks form a predominantly hexagonal tesselation. This pattern is thought to be similar to hexagonal fractures in a wide range of cooled materials,

some drying mixtures, and in permafrost terrain. However, despite four centuries of scientific interest in this pattern, the process which drives the ordering remains largely mysterious. Our laboratory studies of columnar jointing in corn starch represent the first ever 3D study of columnar jointing. We will show how the surface fracture pattern quickly orders into a mature state, which thereafter maintains a constant degree of disorder. We will also discuss how the various length scales in the pattern depend on external driving parameters, such as cooling rate, or evaporation rate. We will conclude by showing how our results may be used to limit the many competing theories of columnar jointing.

* This work is being supported by NSERC

MO-P7-4 15h00

Subdiffusive Transport of Granular Mixtures in a Rotating Drum*, **Zeina S. Khan**, S,W. Morris, *University of Toronto* — Bidisperse granular mixtures rapidly size segregate when tumbled in a partially filled, horizontal drum. The smaller component moves radically toward the axis of rotation and forms a buried core. On a longer time scale, axial modulations of the core may develop and grow into a series of bands along the drum, which become visible upon breaking the surface. Using a narrow pulse of the smaller component as the initial condition, we observe that the axial transport of the radial core is a sub-diffusive front advancement process. The front motion is sub-diffusive in the sense that the radically integrated concentration forms a self-similar, compact axial pulse whose width grows as t^{α}, with $\alpha \sim 1/3 < 1/2$, and hence it spreads much more slowly than by diffusion in a mixture which does not exhibit axial banding. By colouring some of the larger grains, we find that the mixing and axial transport of the larger grains is similarly subdiffusive. We also report on the effects of changing drum diameter and relative grain size on the axial transport of grains. Axial band formation is enhanced in these cases.

* This work is being supported by NSERC

MO-P7-5 15h15

Ballistic Electron Emission Microscopy Studies of Au/molecule/n-GaAs Diodes*, **Wenjie Li** [1], K.L. Kavanagh [1], C.M. Matzke [2], A.A. Talin [2], F. Léonard [2], S. Faleev [2], J.W.P. Hsu [2], [1] *Simon Fraser University*, [2] Sandia National Laboratories — Investigation of electron transport across individual or a small number of organic molecules is motivated by both a technological promise of denser integrated circuits with broader functionality and the novelty of the underlying physics. This field has attracted a great deal of attention and controversy during the past five years. We present results on transport through a layer of organic molecules with nanometer spatial resolution, and an electric field that is three orders of magnitude lower than in conventional I-V measurement. Specifically, we use ballistic electron emission microscopy and spectroscopy (BEEM, BEES) to measure carrier transport across an interface consisting of a molecular layer: 1,8-octanedithol [$SH(CH_2)_8SH$] or [$CH_3(CH_2)_{11}SH$] sandwiched between a thin (~ 8 nm) Au electrode and a GaAs substrate. The presence of the molecule dramatically increases the BEEM threshold voltage and displays an unusual transport signature as compared to reference Au/GaAs diodes. Furthermore, BEEM images indicate laterally inhomogeneous interfacial structure. We present calculations that address the role of the molecular layer at the interface. Our results indicate that spatially resolved measurements add new insight to studies using conventional spatial-averaging techniques.

* This work is being supported by NSERC

15h30 Coffee Break / Pause café

MO-P7-6 15h45

Dynamics of Molecular Deuterium Released from the Dissociation of Heavy Water on a Zirconium Surface*, **Mohamed Musa** [1], G. Bussière [1], J. Hepburn [1], P.R. Norton [2], K. Griffiths [2], A. Brolo [3], [1] *University of British Columbia*, [2] University of Western Ontario, [3] University of Victoria — Water is known to dissociate on most metals, semiconductor and oxide surfaces. In the case of crystalline Zirconium surfaces, dissociation of water takes place at temperatures as low as 78K. Unlike other metals, dissociation products do not desorb upon subsequent heating of the Zr crystal. Instead both the hydrogen and oxygen resulting from the dissociated water molecules diffuse into the bulk. If, however, the Crystal is dosed with water while hot, molecular hydrogen is produced. In addition, no D_2 is observed when the crystal is dosed with D_2 instead of D_2O. The mechanism leading to this unexpected production of D_2 is found to involve the (transient) presence of oxygen on the Zr surface. Using heavy water (D_2O) and a Zr crystal in an UHV chamber, we detect the resulting D_2 product using a time of flight spectrometer and resonance enhanced multi photon ionization (REMPI) scheme. At a fixed surface temperature of *ca.* 800K, we find that the rotational distributions of both v"=0, 1 of the D_2 product fit Boltzmann distribution at T=450±50K. Using a heated effusive D_2 source at T=800K, we compare the v"=1 population resulting from the reaction with the heated source. We find that the population of v"=1 from the reaction is several times higher and fits a Boltzmann distribution at *ca.* T=1200K. Moreover, using an effusive D_2 source at room temperature, we find that the average translational temperature of the D_2 from the reaction is not very different from room temperature.

* This work is being supported by NSERC

MO-P7-7 16h00

Specific Heat and AC Susceptibility of $LiHo_xY_{1-x}F_4$*. **J.A. Quilliam**, C.G.A. Mugford, L. Lettress, J.B. Kycia, *University of Waterloo* — The diluted, dipolar-coupled, Ising spin system $LiHo_xY_{1-x}F_4$ has been found to have a very rich phase diagram and some unique magnetic properties. In particular, previous work has shown the existence of an unusual "anti-glass" phase at low Ho concentration in which the dynamics of the magnetic moments persist down to very low temperatures. Measurements have been performed on a variety of stoichiometries in this low-doped regime to refine the phase diagram of $LiHo_xY_{1-x}F_4$ and to better understand the nature of the "anti-glass" phase and its range. Specific heat and SQUID-based AC magnetic susceptibility results at dilution refrigerator temperatures will be presented.

* This work is being supported by NSERC, CFI

MO-P7-8 16h15

Chemical Smoke Rings*, **Michael C. Rogers**, S.W. Morris, *University of Toronto* — Buoyant pockets in a fluid under gravity develop into rising plumes with well-defined mushroom shaped heads. In normal plumes, overturning flow in the head entrains less buoyant fluid from the surroundings as the head rises, robbing the plume of its driving force. We consider here a new type of plume in which the source of buoyancy is an autocatalytic chemical reaction - the iodate-arsenous acid reaction. The reaction occurs at a sharp front which separates reactants from less dense products. In a plume created from this chemical reaction, entrainment assists the reaction, producing new buoyancy by delivering reactant into the accelerating plume head. When the head has grown to a critical size, it detaches from the upwelling conduit, forming an accelerating, buoyant vortex ring, rather like a smoke ring. The nearly complete detachment of the initial head causes a second-generation head to develop at the point of detachment. Depending on the viscosity and concentration of the reactant solution, successive detachments may form multiple generations of chemical plume heads from a single initiation event.

* This work is being supported by NSERC

MO-P7-9 16h30

Crystallization of $Bi_2Sr_2Ca_{1-x}Y_xCu_2O_y$ ($0 < x < 0.5$) Thin Films Prepared by a Spatial Composition Spread Approach*, **Robbie Sanderson**, K.C. Hewitt, *Dalhousie University* — Substitution of trivalent Y for bivalent Ca in $Bi_2Sr_2CaCu_2O_{8+\delta}$ changes the hole doping in the CuO_2 layers, thereby changing the properties of the material from a metallic superconductor to an insulator. We have developed a magnetron sputtering technique to produce thin-film samples with a spatially varying composition, x, in $Bi_2Sr_2Ca_{1-x}Y_xCu_2O_{8+\delta}$ (Bi2212) across a 75 mm linear dimension. The technique allows us to map phase space as densely as required in steps of $\Delta x=(x_{max}-x_{min})/57$ – our first choice being $0 \le x \le 0.5$ with $\Delta x=0.009$. X-ray diffraction (XRD) of the as-sputtered films shows an amorphous structure. Wavelength and Energy Dispersive Spectroscopy measurements demonstrate the effectiveness of a -20 V substrate bias in reducing oxygen re-sputtering effects to produce the correct stoichiometry. Post-annealing crystallizes Bi2212 ($0 \le x \le 0.5$) and Bi_2SrO_4 phases, which exhibit epitaxial growth on (100) MgO substrates. The results of a series of annealing regimes designed to prevent the formation of unwanted phases will be presented.

* This work is being supported by NSERC

MO-P7-10 16h45

Current-Voltage Scaling in Turbulent Electroconvection*. **Peichun Tsai**, S.W. Morris, *University of Toronto* — We experimentally investigated charge transport in electrically driven convection. The fluid is a 2D annular film of smectic A liquid crystal. Convection is driven by a surface charge density inversion that is similar to the mass density inversion in thermally driven Rayleigh Bénard convection. In electroconvection, the voltage V and the resulting current I correspond respectively to the imposed temperature gradient and the heat flux in thermal convection. At high forcing where the convection is turbulent, our measurements of the dimensionless current, known as the electric Nusselt number Nu, show a power-law dependence on the dimensionless control parameter, the Rayleigh number $Ra \sim V^2$,. The scaling exponent is either 0.25 ± 0.02 or 0.20 ± 0.03 in the range of $10^4 < Ra < 2 \times 10^5$, depending on the Prandtl number Pr which depends on the fluid properties and geometry. We found that the Nu-scalings also depend on the aspect ratio G of the annulus, a purely geometric parameter. The scaling exponents are consistent with a theoretical model which is analogous to the Grossmann-Lohse scaling theory for turbulent Rayleigh Bénard convection.

* This work is being supported by NSERC

MO-P7-11 17h00

Reconstructing DNA Replication Kinetics from Small DNA Fragments*. **Haiyang Zhang**, J. Bechhoefer, *Simon Fraser University* — In higher organisms, DNA replicates simultaneously from many origins. Recent *in-vitro* experiments have yielded large amounts of data on the state of replication of fragments of DNA that are fluorescently labeled so that one can distinguish between replicated and unreplicated segments. From measurements of the time dependence of the average size of replicated and non-replicated domains, one can estimate the rate of initiation of DNA replication origins. One problem with such estimates is that in the experiments, the DNA is broken up into small fragments (~200 kbases), whose finite size can bias down the measured averages. This has restricted the analysis to the middle of the replication cycle, where the size of replicated and non-replicated domains is small compared to the fragment size. In the work reported here, we present a systematic way of accounting for this bias. Our method yields accurate results even in cases where the average replicated (or non-replicated) domain is bigger than the average DNA fragment.

* This work is being supported by NSERC

17h15 Session Ends / *Fin de la session*

[MO-P8] Thermophysics and Thermal Sensors / *Thermophysique et senseurs thermiques*

(DIMP/*DPIM*)

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 - 17h30

SALLE / ROOM IRC 6 (cap. 226) ***Chair: L. Nicolaides, Therma Wave Inc.***

MO-P8-1 14h15

JUN SHEN, National Research Council of Canada, Institute for Fuel Cell Innovation

An Overview of Thermal-Wave Resonant Cavity Technique

Since the first experimental apparatus and application of thermal-wave resonant cavity (TWRC) technique was reported ten years ago, scientists have shown strong interest in this technique. Many papers on the subject of the theories, experimental apparatus, and applications of TWRC technique have been published. TWRC pyroelectrically detects the thermal wave propagation across the cavity between a pyroelectrical sensor (*e.g.*, PVDF) and a source of thermal wave. Cavity-length scan and thermal-wave frequency scan both produce the standing-wave resonant antinode patterns in the in-phase and quadrature channels of demodulated lock-in signal output. These resonant extrema can be used to precisely measure the thermal diffusivity of the intracavity medium (*e.g.*, gases). The theoretical expression describing the signal is straightforward and easy to use for data processing, such as curve fitting. The experimental apparatus is also easy to build. TWRC has been utilized mainly to measure thermophysical properties of gases and liquids. It was demonstrated that the thermal diffusivities of a variety of gases could be determined precisely with a standard deviation smaller than the 0.32% of the mean value of five consecutive measurements. The high precision of the measurements using TWRC technique, together with the simplicity of TWRC sensor fabrication, makes it extremely attractive in gas and liquid characterization. In this work, the theories, experimental apparatus, and applications of the TRWC technique are reviewed. Applications in kinetic studies are also discussed.

MO-P8-2 14h45

High-Precision and High-Resolution Measurements of Thermal Diffusivity and Infrared Emissivity of Water-Methanol Mixtures Using a Pyroelectric Thermal Wave Resonator Cavity*. **Andreas Mandelis**, A. Matvienko, *University of Toronto* — The thermal diffusivity and effective infrared emissivity of water-methanol mixtures were measured at atmospheric pressure and temperature using a pyroelectric thermal-wave resonator cavity. The applied frequency-scan method allows keeping the cavity length fixed, which eliminates instrumental errors and substantially improves precision and accuracy of the measurements. A theoretical model describing conduction and radiation heat transfer in the cavity was developed. The model prediction and the frequency-scan experimental data were compared, showing excellent agreement. The measurements were performed for the methanol volume fractions of 0, 0.5, 1, 2, 5, 10, 20, 40, 75 and 100 %. The fitted thermal diffusivity and effective emissivity vs. concentration of the mixtures was compared to the literature theoretical and experimental data. The maximum resolution of 0.5 % by volume of methanol in water by means of the thermal-wave cavity method is the highest reported to-date using thermophysical techniques. Semi-empirical expressions for the mixture thermal diffusivity and infrared emissivity as functions of methanol concentration have been introduced. The expression for infrared emissivity is consistent with the physical principle of Detailed Balance (Kirchhoff's law). The expression for thermal diffusivity was found to explain the data satisfactorily over the entire methanol volume-fraction range.

* This work is being supported by NSERC

MO-P8-3 15h00

JAVAD MOSTAGHIMI, University of Toronto

*Surface Tension Measurement of High Temperature Liquids**

We use atmospheric radio frequency inductively coupled plasma as the heat source in this containerless method to measure the surface tension of high melting point materials. We record the dynamics of heating, melting, droplet formation and detachment of a rod exposed to the high temperature rf plasma jet. Results from the experiments for copper will be reported and compared to other methods. Only a few of interfacial tension measurement methods can be implemented to melts at high temperatures. In spite of the existence of a variety of methods, measuring surface tension of very high melting point materials (*e.g.* zirconia, melting point 2600-2700 *K*) is still not possible. A brief review of the traditional methods shows their limitation in high temperature applications. Maximum bubble pressure method is one method recommended for measuring surface tension of melts. In the case of high melting point ceramics, preparing the required set up is not possible. Drop volume and pendant drop techniques are acceptable if it was possible to melt the material where at least one drop at the end of a vertical rod is formed. Another option could be the sessile drop method, in which besides the symmetry issues, not only stationary droplets should be generated but also an appropriate container with the melting point at least higher than the material under study is required. Problems such as contaminations, high cost, equipment limitations, and unexpected instabilities are the major reasons that make levitation method deficient for high melting point materials. Considering the limitations of the common techniques in addition to industrial need of the physical properties is a consequent motivation for developing new method. We are developing a new

technique to measure surface tension of high temperature ceramics. In this method, a rod of the desired material is exposed to the high temperature of rf ICP. Dynamics of the melting, formation of a drop and its detachment is recorded via a high speed video camera. The size of the droplet along with the measurement of the neck diameter will provide the surface tension.

* In collaboration with A. Moradian, University of Toronto

15h30 Coffee Break / Pause café

MO-P8-4 16h00

SHU-YI ZHANG, Lab of Modern Acoustics, Institute of Acoustics, Nanjing University

Characterization of Thermal Parameters of Materials by Scanning Thermal Wave Microscopies *

It is well known that thermal wave imaging techniques, such as photoacoustic, microwave-acoustic, electron-acoustic and ion-acoustic microscopies, *etc*., has been widely used to characterize micro- properties and structures and also laminated images of materials and devices by adjusting frequencies and/or phases of the thermal wave signals. In order to quantitatively determine the spatial resolution and analyze the laminated imaging by the thermal wave microscopies, the thermal diffusivities and /or thermal wavelengths of the materials at different frequencies must be evaluated simultaneously. Although there were several advanced photothermal techniques using different instruments for getting the thermal parameters, but which always cannot be used simultaneously with the thermal wave microscopy. In this paper, new methods using piezoelectric transducer (PZT) detection are presented to evaluate the thermal parameters of materials, which can be used simultaneously in thermal wave microscopies.

At first, a theoretical model of the experimental condition of the PZT detection in thermal wave microscopies is presented. Based on the thermal diffusivity equation and the thermo-elastic equation in solid sample and the elastic wave equation in the PZT, and also the corresponding boundary conditions, a finite element method (FEM) is employed to solve the temperature distributions in the sample, displacement fields and the output signals of the PZT. Using theoretically numerical simulations to the experimental results of the thermal wave microscopes, the thermal parameters of the sample can be obtained. For simplicity, a method based on one-dimensional thermal diffusivity equation and thermo-elastic theory of flexure vibration of thin plates can be used to calculate the output signals of the PZT in the microscopies. Then the thermal diffusivity and/or thermal wavelength can be evaluated from the amplitude and phase of the signals. For inhomogeneous materials, such as biological tissues, the thermal parameters evaluated by the simplified method are average (effective) values in the measured area. As examples, the thermal diffusivities and the laminated imagings of several biological tissues are evaluated and analyzed quantitatively by an electron-acoustic microscopy. Obviously, the methods of the evaluation of the thermal parameters and the quantitative analyses of the laminated images are available for other thermal wave microscopies using piezoelectric detections.

* In collaboration with J. Shen [1] and Chun-ming Gao [2], [1] Lab of Modern Acoustics, Institute of Acoustics, Nanjing University, [2] Institute of Acoustics, Nanjing University

MO-P8-5 16h30

I. DELGADILLO-HOLTFORT, Ruhr-Universitaet Bochum

Nondestructive Locally Resolved Characterization of Thermophysical Properties of NiTi Shape-Memory Alloys *

The alloy NiTi at near-equiatomic composition is one of the most promising shape-memory systems for application in medical areas as well as in technical disciplines. By process treatment and work cycling of NiTi-based devices, the martensitic phase transformation of NiTi, upon which the shape-memory effects and consequently the device functionality base, can be locally influenced. In this work, we use several nondestructive thermal wave techniques and time-dependent IR thermography to investigate both the lateral and depth-dependence of the thermophysical properties of polycrystalline NiTi-systems. The thermal wave techniques used for these studies include scanning thermal microscopy, photomodulated optical reflectance microscopy, photothermal infrared (IR) radiometry and for the first time combined photoacoustic and IR-radiometry studies [1]. Significant features of the photothermal methods used here and their potentialities and limitations for the local-resolved characterization of thermophysical properties are specifically discussed on thermally and mechanically cycled NiTi samples and devices.

1. J. Gibkes, W. Siegert, D. Dietzel, I. Delgadillo-Holtfort, B.K. Bein and J. Pelzl, "Local influence of material processing on phase transitions in NiTi shape memory alloys investigated by IR thermography", *Materials Science and Engineering A*, **378** (1-2): 175-179 (2004).

* In collaboration with J. Gibkes [1], D. Dietzel [1] , J. Fotsing [1] , B.K. Bein [1], J. Pelzl [1], [1] Ruhr-Universitaet Bochum.

MO-P8-6 17h00

ANDREW LEVICK, National Physical Laboratory

Temperature Measurement of Levitated Metal Drops using the Laser Absorption Radiation Thermometry (LART) *

Temperature is the most frequently measured variable in process engineering, and affects the product quality and energy consumption of the process. At the National Physical Laboratory (NPL), we have developed the Laser Absorption Radiation Thermometry (LART) method, which measures temperature independently of target emissivity, background reflected radiation and absorbing gases for opaque target materials. It is based on photothermal radiometry, and involves the detection of modulated thermal radiance from the target irradiated by modulated, focused laser beams of power 1 W. Two lasers are employed at wavelengths λ_1 and λ_2 and thermal radiation is detected at λ_2 and λ_1 respectively. The ratio of these two modulated thermal radiances is a function of temperature according to Planck's law, but not of target emissivity, extraneous reflected radiation or gas absorptions. The current LART instrument utilises a fiber optic bundle to convey laser and thermal radiation between the target and detection system (comprising of lasers, optics, electronics and photodiodes). This arrangement allows delicate detection system to be physically isolated from the imaging telescope which is in a "hostile" industrial environment. The instrument is capable of measuring target temperatures down to 600°C for λ_1 = 840 nm and λ_2 = 1320 nm. It can also measure thermophysical properties, e.g. thermal diffusivity and thermal conductivity. In this paper, we report the first temperature measurements using the LART method of radio frequency levitated metal drops with unknown surface emissivities. The levitator was developed as a containerless method to measure properties of metals (*e.g.* surface tension) under inert gaseous atmospheres. We have so far reported measurements for steel and iron drops over a temperature range of 950°C to 1600°C. The LART measurements were compared with values from a conventional two-colour radiation thermometer that simultaneously views the target, and we compare the results with other available data.

* In collaboration with M. Broussely, R. Brooks, National Physical Laboratory

17h30 Session Ends / *Fin de la session*

[MO-P9] (DSS) Frontiers in Surface Science / *Frontières en physique des surfaces*

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 -16h30

SALLE / ROOM IRC 5 (cap. 120) ***Chair: G. Lopinski, NRC***

MO-P9-1 **14h15**

ANDREAS K. SCHMID, Lawrence Berkeley National Laboratory

Exploring Magnetic Nanostructures By Spin Polarized Low Energy Electron Microscopy.

Magnetic properties of materials can change in interesting ways when one prepares structures with very small sizes. Spin-polarized low-energy electron microscopy is a useful tool to reveal details of the spin-resolved electronic structure in such nanostructured materials. We use a spin-polarized beam of electrons to illuminate sample surfaces, and monitor spin-dependent electron reflection to form images. The images contain information on sample structure as well as electronic and magnetic properties. Several examples including self-assembled magnetic nanodots, self-organized nanowire arrays, and epitaxial multilayer structures will be discussed to show how SPLEEM can be used to study magnetic phenomena in low-dimensional systems.

MO-P9-2 **14h45**

Self-Assembly of N-Terminated Porphyrin Molecules on Single Crystal Metal Surfaces*: **Alexander Weber**, W. Auwarter, A. Riemann, A. Schiffrin, J.V. Barth, *AMPEL, Department of Physics and Astronomy, University of British Columbia* — Studying the self-assembly of functional molecules at surfaces prepares the ground for the control and synthesis of low-dimensional supramolecular nanosystems, which are potentially useful for a variety of applications (*e.g.*, molecular electronics, sensing, nano-optics or molecular magnetic devices). Here we report Low-Temperature Scanning Tunneling Microscopy (LT STM) investigations on the bonding and ordering of tetrapyridil porphyrin ($C_{40}H_{26}N_8$) molecules on different single crystal metal surfaces. On Cu(111) we obtained chain segments along the 6-fold symmetry of the substrate surface, which show a marked influence on the surface electronic structure. The substrate-porphyrin interaction is dominant on the anisotropic Cu(110) substrate, where single molecules oriented along the substrate symmetry were observed, even following thermal annealing. In contrast, on Ag(111) densely packed molecular islands readily evolve already at low coverages, indicating appreciable molecular surface mobility and moderate substrate coupling. Investigations on metal-directed assembly, exploiting coordination interactions between the pyridil functional moiety and co-deposited metal atoms are in progress. This work is part of a strategy to fabricate metallosupramolecular networks with specific topologies and a high structural stability.

* This work is being supported by NSERC, CFI

MO-P9-3 **15h00**

Selection of Photodissociation Pathway for Orientationally Ordered CH_3I on Cu(110)-I at λ=308nm, 248nm and 222nm: **Erik T. Jensen**, *University of Northern British Columbia* — Various schemes [1] have been used to create orientationally aligned molecules in gas-phase experiments, such as the hexapole electrostatic lens used by Bernstein *et al* [2] to study CH_3I photodissociation. We have studied the photodissociation dynamics of aligned CH_3I adsorbed on a Cu(110)-I substrate at three dissociation wavelengths: 308nm, 248nm and 222nm. By taking advantage of the orientational ordering of CH_3I on this surface and by using polarized laser light, we have been able to selectively populate different excited states that lead to C–I bond fission. In the gas-phase, photodissociation of CH_3I in this wavelength range is dominated by the "A-band", a broad absorption that extends from 200nm to 320nm and peaks near 260nm. In the gas phase, the A-band has been understood in terms of 3 overlapping transitions to different dissociative excited states. By studying CH_3I/Cu(110)-I photodissociation at 308nm (red tail of the A-band), 248nm (near the peak) and 222nm (blue tail of the A-band), we are able to compare and contrast the photodissociation dynamics with that of gas-phase CH_3I. Although the photodissociation dynamics of CH_3I/Cu(110)-I at 308nm and 248nm are largely compatible with the picture that has emerged from gas-phase studies, we have found that at 222nm an excited state not implicated in gas–phase studies must be invoked in order to explain the observed dynamics.

1. See for example H. Stapenfeldt, *Phys. Scr.* **T110**, 132 (2004).
2. S.R. Gandhi, T.J. Curtiss, and R.B. Bernstein, *Phys. Rev. Lett.* **59**, 2951 (1987).

15h15 **Coffee Break / Pause café**

MO-P9-4 **15h30**

CHRISTIAN RATSCH, University of California Los Angeles

A Level-Set Method For Epitaxial Growth And Self-Organization Of Quantum Dots

We have developed an island dynamics model that employs the level-set technique to describe epitaxial growth. The motion of the island boundaries is described by the evolution of a continuous level-set function. Islands are nucleated on the surface and their boundaries are moved at rates that are determined by the adatom density, which is obtained from solving the diffusion equation. Thus, the individual islands on the surface are resolved, while the adatoms are treated in a mean-field picture. The typical simulation timestep can be chosen much larger than in an atomistic simulation. Therefore, we can simulate problems where microscopic rates with vastly different rates are relevant, such as problems with high reversibility. Results for the scaled island size distribution during submonolayer epitaxy will be shown. Our method is ideally suited to study the formation and self-organization of quantum dots, which is a strain driven phenomena. The large simulation timestep makes it feasible to solve the elastic equations at every timestep, and couple the solution of the elastic equations to the microscopic parameters in our model. Diffusion and attachment and detachment are spatially varying. Our results indicate that in a system with spatially varying diffusion rates one obtains regions of high and low island densities, and in particular regions with high island ordering.

MO-P9-5 **16h00**

Pattern Formation in Erroded Surfaces*: **Kevin Mitchell**, T. Tiedje, A. Ballestad, B. Lau, E. Nodwell, *University of British Columbia,* — The non-linear partial differential equation $\partial h_t = -\nabla^2 h - \nabla^4 h + (\nabla h)^2 + \nabla^2(\nabla h)^2$ is shown to describe the morphology of certain eroded surfaces of interest. Under suitable conditions, it predicts the formation of experimentally observed hexagonal, cusp-separated parabolic dimples in ion sputtered targets and structurally similar ablation hollows (or suncups) in high altitude snowfields. The equation is derived using transport theory to determine the proportion of sub-surface scattering that escapes as a function of the surface shape. With only the first three terms on the left hand side, the equation is known as the Kuramoto-Sivashinsky equation and has spatio-temporally chaotic solutions. However, the addition of the last term has a stabilizing effect allowing for the formation of a regular parabolic pattern with characteristic length scales and growth rate. The role played by the equation parameters in determining the qualitative and quantitative properties of these patterns is investigated with particular focus on the effect of the final non-linear term in large spatial domains where chaotic solutions emerge in the Kuramoto-Sivashinsky equation. In this regime, numerical simulations are the primary method of investigation but must be carefully undertaken as the cusps resulting from the parabolic patterns can lead to numerical instability. Suitable spectral methods are discussed and their non-localizing effects are argued to be physically reasonable in addition to practically necessary in ensuring numerical convergence.

* This work is being supported by Department of Physics and Astronomy

MO-P9-6 **16h15**

Structural Characterization of the Magnetic Trilayer System Fe/Pd/Fe Grown Epitaxially on GaAs(001)- 4 x 6 using XAFS*, **Petr Budnik**, R.A. Gordon, E.D. Crozier, *Simon Fraser University* — The small lateral dimensions of spintronic devices and high density memory bits require the employment of magnetic ultrathin metallic film structures. In magnetic trilayer systems of the form F/M/F the magnetic moments in the ferromagnetic film F are locked together by exchange coupling through the non-magnetic spacer layer M. The magnetic behaviour in these systems - the magnetic anisotropy and interlayer coupling - is strongly dependent on the thickness of the layers, the nature of the interface between layers, the strain in the layers and the extent of any interdiffusion or reaction between layers and substrate. Understanding the structure is a critical component of developing the correct interpretation of the magnetic behaviour. We present results of an *in situ* polarization-dependent XAFS study both above and below the critical angle for total reflection from Fe/Pd/Fe trilayers epitaxially grown on GaAs(001)-(4x6). The structure of iron grown on the Ga-terminated 4x6 reconstructed surface of the GaAs(001) substrate, for thicknesses greater than 6 monolayers, is tetragonally distorted from its natural bcc structure with contracted and expanded lattice constants in-plane and out-of-plane, respectively. The intermediate Pd layer shows distortion from its natural fcc structure, the extent of which depends on the thickness of the layer. The upper layer of Fe has a distorted structure as well. Fe and Pd are alloyed at both Fe/Pd and Pd/Fe interfaces. While at the first interface alloying thickness can be correlated to the roughness of the underlying iron, greater alloy thickness at the second interface is a result of the inter-diffusion between the upper Fe and the underlying Pd.

* This work was supported by the Natural Sciences and Engineering Research Council of Canada through major facilities access and operating grants. Research at the PNC-CAT beamline, Advanced Photon Source, Argonne National Laboratory is also supported by the US Department of Energy under contracts W-31-109-Eng-38 (APS) and DE-FG03-97ER45628 (PNC-CAT).

16h30 **Session Ends / *Fin de la session***

[MO-P10] (DASP/*DPAE*) Atmospheric and Space Contributed / *Papiers présentés en physique de l'atmosphère et de l'espace*

MONDAY, JUNE 6 / LUNDI, 6 JUIN

14h15 - 17h15

SALLE / ROOM FNSC 60 (cap. 119) ***Chair: J-M. Noel, RMC***

MO-P10-1 **14h15**

The CASSIOPE Enhanced Polar Outflow Probe (e-POP) Small Satellite Mission*. **Andrew W. Yau** [1], H.G. James [2], e-POP Science Team, [1] *University of Calgary* and [2] Communications Research Centre Canada — The Enhanced Polar Outflow Probe (e-POP) small satellite mission will be Canada's first mission contribution to the International Living with a Star (ILWS) initiative. It is scheduled for launch in 2007 as one of the two payloads on the multi-purpose CASSIOPE satellite, the companion payload being the CASCADE™ communications technology demonstration payload. A collaborative effort involving 10 Canadian and foreign universities and research institutes and co-funded by the Canadian Space Agency (CSA) and NSERC, the e-POP project is comprised of three important and interconnected components: a small-satellite component to investigate atmospheric and plasma flows and related wave-particle interaction processes in the topside ionosphere, a coordinated ground-based component and a theoretical assimilation component. Its scientific objectives are to quantify the micro-scale characteristics of plasma outflow and related micro- and meso-scale plasma processes in the polar ionosphere, explore the occurrence morphology of neutral escape in the upper atmosphere, and study the effects of auroral currents on plasma outflow and those of plasma microstructures on radio propagation, using the 8 scientific instruments onboard the e-POP Payload. In this paper, we present the current status of the e-POP project and discuss the scientific challenges and opportunities it presents, as well as collaborative opportunities with other current or planned satellite or ground-based programs.

* This work is being supported by NSERC, CSA

MO-P10-2 **14h30**

Joint Interpretation of Satellite and Ground-Based Data for Understanding Auroral Physics*. **Martin Connors** [1], E.F. Donovan [2], M. Moldwin [3], D. Boteler [4], C.T. Russell [3], H.J. Singer [5], [1] *Athabasca University*, [2] University of Calgary, [3] IGPP, UCLA, [4] NRCan, [5] NOAA Space Environment Center — Satellite overpasses can provide information about field-aligned currents in the auroral zone. Ground measurements allow determination of ionospheric currents through inversion of magnetic data and imaging to determine morphology and characteristics of particle precipitation. Good ground spatial coverage, with reliable inversion methods, is essential for both of these types of study. Magnetic inversion is best done along magnetic meridians, and a meridian chain has been lacking in eastern Canada to date. This will be remedied by the extension of the MEASURE chain northward through Québec in 2005. New technology UCLA magnetometers will have real-time data access and one second cadence. Data can be inverted using the new Automated Forward Modelling technique, most effective with meridian chains. In that mode it gives the current across the meridian along with latitudinal boundaries between which the current flowed. These parameters can be compared with results of low-altitude satellite overflights such as those expected for e-POP/CASSIOPE. The largest advance in ground-based imaging coverage in eastern Canada is expected through the NASA THEMIS MIDEX mission. Monochrome cameras will blanket the country and provide detailed images at five second cadence to complement space-based images from the constellation of THEMIS satellites. If the operational times of the ground-based networks and the satellite missions overlap properly, an important opportunity to sample the auroral zone for relevant physical parameters will take place. The sampling will range from deep space, through the constantly present GOES satellite conjugate to Poste-de-la-Baleine, to low orbit, and finally to the ground.

* This work is being supported by Canada Research Chairs

MO-P10-3 **14h45**

Old and New Experiments on Transionospheric HF Propagation*. **Gordon James** [1], P. Prikryl [2], R.G. Gillies [3], G.C. Hussey [3], [1] *Communications Research Centre*, [2] CRC, [3] ISAS, University of Saskatchewan — The enhanced Polar Outflow Probe (e-POP) is a scientific payload to be launched in 2007 on the Canadian Small Satellite CASSIOPE into an elliptical polar orbit with 80° inclination, 325-km perigee and 1500-km apogee. The Radio Receiver Instrument (RRI) of e-POP will be coordinated with ground transmitters to study the effects of plasma structures on radio propagation. This experiment will address the e-POP objective of understanding plasma dynamics in the high-latitude ionosphere. In 1978, an experiment on transionospheric propagation was carried out at 9.3 MHz using a ground transmitter at Ottawa and the ISIS-II sounder receiver. Through surveys of the resulting data, reproducible characteristics of transionospheric propagation have been classified. Square-pulse-modulated waves received equatorward of the transmitter occasionally exhibited periodic fades with beat frequencies between about 1 and 4 Hz. Transionospheric rays have been traced through ionospheric density models with latitudinally periodic structure based on tomographic images. Rays make small angles with the density gradients on the poleward side, hence suffer minimal refraction. The rays can be nearly perpendicular to the density gradients on the equatorward side, causing them to focus and cross. This result supports the idea that the same-mode fades were beats between two plane waves. In addition, equatorward propagation directions at the spacecraft came to within about 10° of the axis of the magnetic field for both cold-plasma modes O and X. Circular polarization is then expected, providing a necessary condition for a linear total electric field at the spacecraft and hence the observed Faraday fades.

* This work is being supported by Industry Canada and CSA

MO-P10-4 **15h00**

Transionospheric HF Propagation Modelling to the ISIS II and e-POP Satellites. **Robert G. Gillies** [1], Glenn Curtis Hussey [1], H.G. James [2], G.J. Sofko [1], D. Andre [1], [1] *University of Saskatchewan*, [2] Communications Research Centre Canada — The Enhanced Polar Outflow Probe (e-POP) satellite is to be launched in 2007. One of the 8 instruments it will carry is a radio receiver instrument (RRI). The RRI is a passive 2-axis radio frequency (RF) receiver. One RRI operational mode is to detect radio waves from the Saskatoon, SuperDARN ground based radar. The modification of the horizontal SuperDARN HF wave (*i.e.*, the transionospheric propagation characteristics) as it propagates through the ionosphere to the satellite will be the dominate scientific interest. These modifications of the radio signal due to propagation can be used to help characterize the ionosphere. Data from a similar experiment in 1978 using the ISIS II satellite has been studied. Raytracing simulations have been carried out to model the radar wave propagation from the Shirley's Bay ground transmitter, which was located in Ottawa, to the ISIS II spacecraft. The data received by ISIS II is compared to the results from the raytracing modelling. This comparison will be used as a basis to better understand e-POP data when it is available and HF transionospheric propagation and modelling in general.

MO-P10-5 **15h15**

New Discoveries with Artificial Auroras*. **Ludmila Kagan**, *University of Western Ontario* — I will talk about the discovery of a radiowave-induced red hydroxyl aurora, which is also the first artificial aurora observed below 100 km (Kagan *et al.*, PRL, 2005, in press). Altitudes of 90-150 km are the home of sporadic ionization that is best known for its possible effects on broadcasting,

radio communications and navigation. The only known midlatitude artificial aurora at these altitudes is a green artificial aurora from atomic oxygen near 120 km discovered recently by Djuth *et al.* (GRL, 1999) and Kagan *et al.* (PRL, 2000). Kagan *et al.* (2000) showed that this aurora was the footprint of sporadic ionization structure, thus giving us a powerful tool to measure this structure, which cannot be visualized by any other means. The new discovery of the artificial red hydroxyl aurora extends our limits for studying sporadic ionization to the possibility of visualizing ionization clouds that are not dense enough to reflect radiowaves but are able to change radiowave propagation by ray focusing. To create artificial auroras, scientists use powerful radiowave transmitters as a flashlight. Unlike natural northern lights, midlatitude artificial auroras are faint and can't be seen with the naked eye, so to observe them researchers use very sensitive optical cameras. I'll finish with recent high-latitude observations (Pedersen and Gerken, Nature, 2005) of radio-induced green-line emission of atomic oxygen produced in between bursts of a natural aurora. This was the first and the only case when an artificial aurora was bright enough to be seen by the naked eye.

* This work is being supported by NSERC

15h30 Coffee Break / Pause café

MO-P10-6 15h45

Do Ponderomotive Double Layers Exist?*. **James Laframboise** [1], D.D. Wallis [2], H.G. James [3], [1] *York University*, [2] Magnametrics, [3] Communications Research Centre —The Tether Current Monitor (TCM) voltmeter experiment on the OEDIPUS-C tethered payload provided a unique opportunity to compare the charging of two geometrically similar spacecraft, one of which, called "HEX", carried a high-voltage RF transmitter. The TCM voltmeter data showed a succession of positive overshoots in the floating voltage of the HEX sub payload following the first few RF pulses as the HEX transmitter was swept from lower to higher frequencies. As the background density decreased, these overshoots became less evident. The overshoots following the first pulse of early sweeps had time to reach maximum values and begin to decrease. Fitting exponential decay curves to the decreasing voltages, assuming that these decays are indications of the collapse of an enlarged disturbance-region produced by each RF pulse, and assuming that this collapse progresses inward at the ion-acoustic-wave speed, yields distances of roughly 40m for the characteristic scale of these disturbances. These are large compared with known spatial scales of our situation, which include the tip-to-tip length of the HEX V-dipoles (19m) and the calculated radius of the RF-enlarged sheath around the antennas, which is up to about 10m at the lowest HEX frequencies. This situation led us to investigate the structure of the "ponderomotive presheath" which extends beyond this sheath-edge radius. Our analysis predicts the existence of a ponderomotive double layer in the presheath when the driving frequency is less than the ambient electron plasma frequency. We discuss the extent to which the approximations made in our analysis may limit its validity.

* This work is being supported by NSERC Operating Grant A-4638

MO-P10-7 16h00

Interaction Between a Finite Cylinder and a Drifting Collisionless Plasma*, **John McMahon**, J.G. Laframboise, *York University* — The interaction between a finite cylindrical conducting object, representing a spacecraft or electrostatic probe, and a collisionless plasma through which it moves, is investigated numerically. The calculation is self-consistent, solving the coupled set of Boltzmann-Vlasov equations and Poisson equation in an iterative manner until convergence is achieved. The ion current collected, the ion density distributions, and the potential distributions surrounding the probe with the probe axis at various angles with respect to the drift are presented, for a length-to-diameter ratio of 1, corresponding to the dimensions of the proposed CASSIOPE spacecraft. The purpose of these calculations is to evaluate spacecraft-plasma interactions.

* This work has been supported by NSERC e-POP CRO grant 245394-01 (principal investigator A. Yau) and by NSERC operating grant A-4638.

MO-P10-8 16h15

MOPITT Acceleration Sensor as a Piezoelectric Particle Detector*, **F. Nichitiu** [1], J.R. Drummond [1], A. Vitcu [1], J. Zou [1], R. Deschambault [2], [1] *University of Toronto*, [2] COMDEV — The sensitivity of a quartz piezoelectric to particle radiation has been observed by analyzing the signals from the force sensors (quartz piezoelectric accelerometers) of the MOPITT instrument aboard the Terra spacecraft (launched in Dec 1999) now orbiting the Earth. The accelerometer sensors attached to the MOPITT cooler show occasional high level signals (single events) when Terra spacecraft passes over the South Atlantic Anomaly (SAA) region and the Polar region. These signals over the SAA and Poles lead to the conclusion that they are caused by the radiation environment. Moreover, it is also demonstrated that major Solar Particle Events also induce a high daily rate of MOPITT device single events (DSE) when the high-energy component (>100 MeV) of the solar proton flux reaches a large value. These MOPITT DSEs are, as expected, located at the Polar Regions. In this paper we will present details of the radiation sensitivity of MOPITT's quartz piezoelectric accelerometer sensors (QPAS) as well as some observations concerning the radiation environment at the Terra orbit altitude using this device as a new kind of particle detector. We have shown that the MOPITT QPAS are able to respond to particle radiation, independent of the level of mechanical vibrations. Using this device as a new kind of particle detector we show diurnal as well as seasonal radiation variations at the Terra orbit altitude.

* This work is being supported by CSA, NSERC

MO-P10-9 16h30

Preliminary Assessment of the SWIFT Instrument Performance*, **Peyman Rahnama** [1], Ian C. McDade [1], Yves J. Rochon [2], Alan Scott [3], [1] *York University*, [2] Meteorological Service of Canada, [3] EMS Technologies Canada Ltd. — The Stratospheric Wind Interferometer For Transport studies (SWIFT) is a satellite instrument designed to measure stratospheric winds and ozone concentration to improve our knowledge of the dynamics of the stratosphere, and the global distribution and transport of ozone. The instrument is currently under phase B study by the Canadian Space Agency (CSA) as the main payload for a Canadian small satellite scheduled for launch in 2009. The SWIFT instrument is an imaging, field-widened Michelson interferometer and the measurement technique is known as Doppler Imaging Michelson Interferometry. This paper briefly describes the current instrument model, the methodology and the observation simulation. Instrumental error analysis for line-of-sight wind and sample error analysis results for retrieved wind and ozone concentration are presented for the current design of the instrument.

* This work is being supported by CSA - NSERC

MO-P10-10 16h45

Tropospheric Be-7 Concentrations in Southern Alberta*, **Ann-Lise Norman** [1], M. Varner [1], A. Lim [2], [1] *University of Calgary*, [2] University of Toronto — Be-7 is produced by spallation reactions with energetic protons from cosmogenic particle bombardment of N and O atoms in the stratosphere and upper troposphere. Its production can be expected to vary with solar activity and latitude. Decay occurs due to electron capture emitting a gamma ray at 478 KeV and the half-life of Be-7 is 54 days. Previous studies at high and low latitudes have shown that atmospheric concentrations of Be-7 vary considerably (Vashenyuk *et al.*, 2003) and can be explained by vortexes close to an atmospheric front. Strong stratospheric-tropospheric exchange has been postulated as a source for ground-level ozone episodes in Alberta but little evidence exists to resolve this question. Aerosol samples collected at ground-level in Alberta, Canada, during a winter sampling campaign were analyzed for Be-7 concentration with the assumption that such measurements, combined with cosmic ray spectra routinely monitored at the University of Calgary as well as meteorological conditions, could be used to constrain tropospheric-stratospheric exchange. Be-7 content on the aerosol filter was readily detected at using High Purity Germanium Gamma Ray Detector (HPGe) and its activity was compared to the activity of 2 g of Uranium ore deposited on a similar aerosol filter to emulate sample geometry. Large variations in Be-7 were observed over the sampling campaign and their relation to a large solar event just prior to sampling will be discussed and described.

1. Vashenyuk, E.V. *et al.*, *XXVI Proceedings Annual Seminar*, **Apatity**, 169-172 (2003).

* This work is being supported by NSERC

MO-P10-11 17h00

The Waves Michelson Interferometer (WaMI) and an Atmospheric Dynamics Mission, **W.E. Ward** [1], G. Buttner [2], and the WaMI Advanced Study Team, [1] *UNB, Department of Physics*, [2] MDS, Richmond BC -- The Waves Michelson Interferometer (WaMI) is designed to measure wind, temperature and radiance of selected emissions from the stratopause to the lower thermosphere. These measurements are important for determining the wave signatures and unravelling their interactions and influence on the large scale wind and temperature fields in this region of the atmosphere. They also provide insights into the chemistry and transport at these heights. Of considerable importance for the interpretation of these observations, and understanding the dynamics of the middle atmosphere, are coupling processes which occur between different areas of the atmosphere. An atmospheric dynamics mission with wind/termperature measurements in the stratosphere and high spatial resolution constituent measurements is being proposed to complement the WaMI observations. This paper will describe the WaMI and discuss the motivation for and potential observations from an atmospheric dynamics mission.

17h15 Session Ends / *Fin de la session*

[MO-P11] The Precision Frontier in Particle Physics II
(PPD) *Les limites de la précision en physique des particules II*

MONDAY, JUNE 6
LUNDI, 6 JUIN
14h15 - 16h45

SALLE / ROOM CEME 1202 (cap. 119) ***Chair: M. Roney, U.Victoria***

MO-P11-1 **14h15**

ALEKSEY SHER, TRIUMF

KOPIO: Study of the CP-Violating Decay $K_L^0 \to \pi^0 \nu \bar{\nu}$

The KOPIO experiment at Brookhaven National Laboratory aims to discover and study the rare CP-violating process $K_L^0 \to \pi^0 \nu \bar{\nu}$. The $K_L^0 \to \pi^0 \nu \bar{\nu}$ is highly sensitive to the existence of physics beyond the standard model or to standard model CP violation parameters, if no new physics intervenes. The motivation, technique, and prospects for the KOPIO measurement of $K_L^0 \to \pi^0 \nu \bar{\nu}$ will be discussed.

MO-P11-2 **14h45**

The Latest Results of the K2K Experiment, **Issei Kato** [1], F.B. Berghaus [2], R.H. Helmer [1], P.K. Kitching [1], A.K. Konaka [1], S.O. Oser [2], [1] *TRIUMF*, [2] University of British Columbia — KEK-to-Kamioka long baseline neutrino experiment, the K2K experiment, have been performed to explore the neutrino oscillation suggested by atmospheric neutrino observations. The muon neutrinos produced by the 12 GeV proton synchrotron at KEK travel a distance of 250 km and are detected by Super-Kamiokande. With a fixed flight distance of neutrinos, the effects of the neutrino oscillation can be seen in a reduction of muon neutrino flux and a distortion of energy spectrum. A set of detectors is also installed at 300 m downstream the production target and the neutrino oscillation is explored by comparing the observations in Super-Kamiokande to the measurements in the near detectors. The K2K experiment started its data taking in June, 1999 and finished in Novemver, 2004. Up to now, we have observed the evidence of the neutrino oscillation. The latest results of K2K experiment is presented in this talk.

MO-P11-3 **15h00**

Status of the TWIST Measurement of the Muon Decay Asymmetry Parameter*, **Blair Jamieson**, *University of British Columbia* — Muon decay, a purely leptonic decay, is a relatively simple interaction to study when looking for physics not explained by the standard Vector minus Axial Vector theory of electroweak interactions. The TWIST spectrometer measures the doubly differential spectrum of decay positrons for a wide range in reduced energy and angle between muon and decay positron momentum. By measuring a large part of muon decay spectrum, TWIST is sensitive to the exact shape of the decay spectrum, and can simultaneously measure three of the muon decay parameters with a high degree of accuracy. I will review physics related to the muon decay asymmetry parameter $P_\mu \xi$, which can be used to set limits on right handed interactions. The status of analysis of systematic uncertainties in the measurement of $P_\mu \xi$ is presented.

* This work is being supported by NSERC

MO-P11-4 **15h15**

Track Impact Parameter Resolution of the BaBar Detector*, **David Asgeirsson**, *University of British Columbia* — The BaBar Experiment uses the asymmetric beam energies of the PEP-II collider to create pairs of *B* mesons which are boosted along the beam axis by $\beta\gamma = 0.58$. The B meson decay point separation distribution is several hundred microns wide and resolvable by the Silicon Vertex Tracker. An analysis of track impact parameter resolution was performed using 2-track events from radiative and non-radiative Bhabha, muon-pair, and two-photon events. A simple functional form with a Gaussian core and a power-law tail provides excellent agreement with the data. The power-law tail is consistent with large angle Coulomb scattering in the detector material. The GEANT4-based BaBar detector simulation agrees well with the data far out into the tails.

* This work is being supported by NSERC

15h30 **Coffee Break / Pause café**

MO-P11-5 **16h00**

High Energy Gravitons, **R.J. Slobodrian**, *Université Laval* — Considerable efforts have been devoted to the detection of gravitational wases, counterpart of electromagnetic waves, without success. Long range fields, electrostatic and gravitational, possess massless field particles according to quantum theory, photons and gravitons respectively. The latter carry two quanta of angular momentum to lowest order [1]. The gravitational field predominates on a cosmic scale as it originates in non polar sources (masses) and is governed by an invariant scale factor (the G constant). Therefore, masses can accumulate in ever increasing densities yielding black holes, primordial, mini-black and massive, the latter resulting from the gravitational collapse of giant stars. Black holes are found universally throughout galaxies in our universe, their growth and activity comes from the interactions with quasars [2]. Dark matter is surmised to predominate in the known universe (90 to 99 % is deemed to be dark). Its presence is deduced from large scale gravitational effects. Visible or dark matter at densities far beyond that of nuclei may emit high energy gravitons (HEG). Quantization of matter systems within the Planck scale allow to predict transition energies up to a range of 10^{21} eV carried away by HEGs. Among the sources one may cite the gravitational collapse of giant massive stars (supernovae), accretion of matter by neutron stars and by pulsars (the inverse Compton effect should produce HEGs), by black holes (massive or otherwise), by the collision of galaxies and cosmic strings. Matter densities may reach 10^{62} gr cm^{-3} for superbaryons and minisoliton stars [3]. At very high matter densities the emission of HEGs should come close to that of photons by an ordinary star and ought to be detectable by dedicated systems.

1. S.N. Gupta, *Phys. Rev.*, **96** (1954) 1683.
2. T. Di Matteo *et al.*, *Nature,* **433** (2005) 604.
3. T.D. Lee, in *From Particles to Plasmas*, Ed. J.W. van Dam, Addison Wesley (1989) N.Y.

MO-P11-6 **16h15**

Search for the $B \to K \nu \bar{\nu}$ Rare Decays, **Tulay-Cuhadar-Donszelmann**, *University of British Columbia* — Flavour-changing neutral-current (FCNC) processes are useful to search for new physics in *B* decays. Theoretically, the cleanest modes for these processes are the $B \to X_{s,d} \nu \bar{\nu}$ rare decays. The $B^+ \to K^+ \nu \bar{\nu}$ decay has been investigated using the *BABAR* detector at the PEP-II B-factory. Based on a data sample of 82 fb^{-1}, an upper limit of the branching ratio $B(B^+ \to K^+ \nu \bar{\nu}) < 5.2 \times 10^{-5}$ has been obtained at the 90% confidence level. In addition, a limit of $B(B^+ \to \pi^+ \nu \bar{\nu}) < 1.0 \times 10^{-4}$ has been set by modifying the particle identification requirement.

MO-P11-7 **16h30**

Models for the Origin of Ultrahigh Energy Cosmic Rays*, **Rainer Dick**, *University of Saskatchewan* — I will review the status of the various bottom-up and top-down models which attempt to explain the observed ultrahigh energy cosmic rays beyond the Greisen-Zatsepin-Kuzmin cutoff. Some models make very specific predictions for observations at the Pierre Auger observatory. First results from the Pierre Auger observatory are expected for the 29th International Cosmic Ray Conference in August.

* This work is being supported by NSERC

16h45 **Session Ends / *Fin de la session***

[MO-P12] Harriet Brooks: Early Canadian Nuclear Physicist
(CEWIP/*CEFEP*)

Harriet Brooks: Une physicienne nucléaire canadienne des premiers jours (plus discussion, film and business meeting)

MONDAY, JUNE 6
LUNDI, 6 JUIN
17h00 - 20h30

SALLE / ROOM Hennings 200 (cap. 200) ***Chair: B. Frisken, Simon Fraser University***

MO-P12-1 **17h00**

GEOFF RAYNER-CANHAM, Sir Wilfred Grenfell College

Harriet Brooks: Pioneer Canadian Woman Physicist

Ontario-born Harriet Brooks was Ernest Rutherford's first graduate student at McGill University. Among Brooks' several claims to fame was the first observation of the recoil of the radioactive atom. Brooks subsequently undertook research with J.J. Thomson and M. Curie. Her complex life reflected many of the challenges of women scientists of the time. Some of the same problems are still with us.

18h45 **Session Ends / *Fin de la session***

[TU-A1] Plenary Session
(DAMP/*DPAM*)

Session plénière

TUESDAY, JUNE 7
MARDI, 7 JUIN
08h15 - 09h00

SALLE / ROOM IRC 2 (cap. 500) ***Chair: W-K. Liu, University of Waterloo***

TU-A1-1 **08h15**

PAUL CORKUM, National Research Council of Canada

Attosecond Science

Sub-femtosecond photon or electron pulses were both achieved within the past few years. Experience teaches that the ability to make measurements in any new time regime opens new areas of science. In the case of attosecond pulses, the importance is not only "*attoseconds*", but the promise of combining sub-Angstrom spatial resolution with sub-femtosecond temporal precision (*Attoseconds&Angstroms*). I will describe how attosecond photon and electron pulses are produced and measured, emphasizing the common issues linking them. I will also show how electrons and photons combine to image electronic orbitals.

09h00 **Session Ends / *Fin de la session***

[TU-A2] Herzberg Medal Winner
(CAP/*ACP*)

Récipiendaire de la médaille Herzberg

TUESDAY, JUNE 7
MARDI, 7 JUIN
09h00 - 09h45

SALLE / ROOM IRC 2 (cap. 500) ***Chair: M. Morrow, Memorial University of Newfoundland***

TU-A2-1 **09h00**

ERIC POISSON, University of Guelph

Tidal Heating of Black Holes

It is well known that Io's volcanic activity is caused by gravitational tidal heating: The tidal field of Jupiter does work on Io and increases its internal energy, leading to a molten interior. In this talk I will describe how black holes can also be tidally heated by an external tidal force exerted, for example, by a companion body. In the case of a nonrotating black hole the work done by the tidal gravitational field increases both the hole's mass (total energy) and surface area (entropy). The situation for a rotating black hole is more complicated: While the surface area always increases, the angular momentum may increase or decrease depending on the sign of the applied tidal torque, and the mass may also increase or decrease in accordance with the first law of black-hole mechanics.

09h45 **Session Ends / *Fin de la session***

[TU-A3] Young Investigators I
[DCMMP/*DPMCM*]

Jeunes chercheurs I

TUESDAY, JUNE 7
MARDI, 7 JUIN
10h00 - 12h00

SALLE / ROOM IRC 3 (cap. 108) ***Chair: J. Sonier, Simon Fraser University***

TU-A3-1 **10h00**

CHRISTIAN LUPIEN, Université de Sherbrooke

Probing the Hidden Order of Cuprates Superconductors With Very Low Temperature Scanning Tunneling Microscopy *

After more than 15 years of intense study, the high-Tc superconductors are still not well understood. One reason is that the normal state, from which superconductivity arises is unusual, especially for the so called underdoped materials. It derives from a doped Mott insulator and shows a pseudogap behavior with possible hidden order. I will present scanning tunneling microscopy and spectroscopy (STM/STS) taken at very low temperature that examines a lightly doped member of the high-Tc family, the oxychloride Na-CCOC. That technique has revealed a strong atomic scale reorganization at low energy of the electronic structure. I will introduce the measurement technique and describe the results and their implications for the theories.

* In collaboration with T. Hanaguri [1], Y. Kohsaka [2], D-H. Lee [3], M. Azuma [4], M. Takano [4] and J.C. Davis [5], [1] Riken, Japan, [2] Cornell University, [3] UC Berkeley, [4] Kyoto University and [5] Cornell

TU-A3-2 **10h30**

YOUNG-JUNE KIM, University of Toronto

Inelastic X-Ray Scattering Study of Cuprate Superconductors

Extremely bright photons generated at the new generation of synchrotron light sources have made a huge impact on various scientific disciplines ranging from biology to materials science. One of the exciting new developments is the use of x-rays in the field of solid-state spectroscopy. Inelastic x-ray scattering, analogous to the well-known inelastic neutron scattering, is a powerful tool for studying momentum-dependent electronic excitations and phonons. In our recent high-resolution resonant inelastic x-ray scattering investigation of hole-doped cuprate superconductors, we were able to observe momentum dependent excitations due to doped charge carriers in the mid-infrared frequency region. How such electronic excitations evolve as a function of doping, and their implications for superconductivity will be discussed.

TU-A3-3 **11h00**

CHRISTOPHER WIEBE, Brock University

Quantum Phase Transitions as Routes to Strange Materials

It is fitting that in the year of physics, 2005, we are seeing a surge of activity in the field of quantum phase transitions - a field that Einstein himself played a role in starting. Einstein was one of the fathers of the quantum theory of solids, with one of his main contributions being the application of the new found rules of quantum mechanics to explaining how electrons behave at low temperatures. Over the last few decades, however, new materials have emerged which challenge these ideas – materials which have significant quantum fluctuations as the temperature approaches 0 K. Some of these materials have so-called quantum phase transitions (QPTs), where the constituent electrons behave in odd ways. In this talk, I will give an introduction to quantum phase transitions, and then discuss how materials often develop unusual ground states in the vicinity of these points. In particular, the heavy fermion metal URu_2Si_2 and the Ising dipole magnet $LiHoF_4$ will be discussed as candidates for QPTs.

TU-A3-4 **11h30**

ANAND YETHIRAJ, Memorial University of Newfoundland

Self-Assembly in Soft Matter: Structure and Kinetics in Colloids and in Surfactant Mesophases, and the Creation of Photonic Crystals *

Self-assembly is the formation of ordered structures (from simple ones, such as colloidal crystals as found in natural opals, to rather complex biological ones, such as ourselves) in a remarkably non-energy-intensive way. Self-assembling systems in soft-condensed matter physics, physical chemistry and biology – colloids, liquid crystals, polymers, surfactant mesophases - can all be thought of as *structured complex fluids*, and they typically owe their properties to connected structures or periodicity on *mesoscopic* lengthscales.

Model spherical colloids exhibit a thermodynamic phase behaviour analogous to that in atomic fluids and solids, and provide a wonderful medium to control self-assembly, by controlling colloidal interactions using external fields, solvent electrochemistry, and bounding surfaces. Surfactant mesophases produce structures with nanoscale building blocks, with structural transitions that can be driven by temperature, packing fraction and external fields.

I will describe quantitative confocal microscopy studies of the rich phase behaviour that arises from an unprecedented control of interactions in colloidal suspensions, and present studies of phase transitions, and preliminary kinetics studies of colloidal crystallization and melting. I will also describe quantitative measurements of nanoscale structure via diffusion in surfactant mesophases, probed by pulsed-gradient NMR spectroscopy.

Tuning self-assembly in these simple model systems will improve our understanding of the interplay between the interaction forces and structure formation. This interplay is likely also of importance in more complex biological systems. It can also provide a pragmatic way of designing large-area photonic band-gap materials.

* This work is being supported by NSERC

12h00 **Session Ends / *Fin de la session***

[TU-A4] Nuclear Structure / *Structure nucléaire*

(DNP/*DPN*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 12h45

SALLE / ROOM CEME 1204 (cap. 60) ***Chair: G. Ball, TRIUMF***

TU-A4-1 **10h00**

FRED SARAZIN, Colorado School of Mines

Halo Neutrons and the Beta-Decay of ^{11}Li

The beta-decay of halo nucleus ^{11}Li was investigated at ISAC-TRIUMF with the 8π spectrometer, an array of 20 Compton-suppressed Germanium detectors. In August 2002, a beam of about a thousand ^{11}Li atoms per second was delivered and implanted at the center of the 8π. The gamma spectrum resulting from the beta-decay of ^{11}Li shows remarkable features, namely Doppler-broadened line shapes arising from the decay of the excited states of ^{10}Be, populated by beta-delayed one-neutron emission. A Monte-Carlo simulation was developed to analyze these complex line shapes, from which it was possible to extract the lifetime of these excited states in ^{10}Be and some information about the neutron emitting states in ^{11}Be. Following the development of a more intense ^{11}Li beam at ISAC, the experiment was repeated in October 2004 with an enhanced experimental setup, comprising the 8π and Sceptar, a plastic scintillator array located in the inner volume of the 8π. The higher ^{11}Li yield and the capability of taking data in beta-gamma coincidences lead to higher quality line shapes, which are now being analyzed. I will present the results of the first experiment as well as some preliminary results of the second experiment.

TU-A4-2 **10h30**

WILFRIED NOERTERSHAEUSER, GSI

Electronic Eavesdropping on Nuclei: Determination of the ^{11}Li Charge Radius *

Even though the phenomenon of nuclear halos has been discovered more than 20 years ago and the most prominent halo nuclei ^{11}Li and ^{6}He have been studied in many experiments, there structure is still not fully understood. A particularly important question concerns the interaction between the neutrons that form the halo and the nuclear core. Information about this can be obtained from a measurement of the nuclear charge radius, a property that can be observed in a model-independent way via isotope shift measurements in an electronic transition. Small production rates for ^{11}Li and the necessity to isolate the small amount of charge-radius dependent field shift from the 10^5 times larger

mass shift that is caused by the difference in nuclear mass, requires combination of experimental and theoretical work, both at the forefront of today's capabilities. Using the sensitive technique of resonance ionization laser spectroscopy and the most accurate calculations of the mass-dependent isotope shift, we have recently measured the charge radius of ^{11}Li at the ISAC mass separator at TRIUMF. The result off this measurement will be presented and its implications for nuclear structure are discussed.

* In collaboration with ToPLiS Collaboration

TU-A4-3 11h00

Search for Isomers in the Neutron-Rich Cu and Zn Isotopes*. **Jennifer Jo Ressler** [1], D.S. Cross [1], N. Hoq [1], N. Mobrhan-Shafiee [1], A. Heinz [2], J. Qian [2], J.J. Valiente-Dobon [3], P.F. Mantica [4], A.D. Davies [4], S.N. Liddick [4], W.F. Mueller [4], A. Stolz [4], B. Tomlin [4], [1] *Simon Fraser University*, [2] Yale University, [3] University of Guelph, [4] Michigan State University — We have recently performed a search for short-lived isomers in the neutron-rich Cu and Zn region. The isotopes with N = 42, 44, 46, and 48 are suggested to have $19/2^-$ (Cu) or 8^+ (Zn) angular momenta arising from the maximally aligned coupling of a pair of $1g_{9/2}$ neutrons. For the Ni isotopes, the proton shell is closed and an 8^+ isomeric state has been firmly established in ^{70}Ni and suggested in ^{76}Ni. Similar structures have not yet been observed in the N = 44, 46 isotopes despite numerous searches. Using fragmentation of ^{86}Kr, we have extended the study to the higher-Z isotones of Cu and Zn. For these isotopes, the valence proton(s) are thought to fill the $2p_{3/2}$ orbital at low energy and therefore interact little with the neutron excitations. Results from the current experiment will be discussed and compared to other mass regions where similar isomers are expected and observed.

* This work is being supported by USDOE, NSERC

TU-A4-4 11h15

Beta Decay of Neutron-Rich ^{80}Ga. **Nafisah Hoq** [1], D.S. Cross [1], N. Mobrhan-Shafiee [1], P.F. Mantica [2], B.E. Tomlin [2], A. Stolz [2], A.D. Davies [2], S.N. Liddick [2], J.J. Ressler [1], A. Heinz [3], J. Qian [3], J.J. Valiente-Dobon [4], W.F. Mueller [2], [1] *Simon Fraser University*, [2] Michigan State University, [3] Yale University, [4] University of Guelph — We have recently investigated the beta decay of neutron-rich ^{80}Ga to levels in ^{80}Ge and compared the results to previous studies in beta decay and deep inelastic experiments. Deep inelastic measurements (A. Makishima *et.al,* PRC **59**, R2331(99); Zs. Pdolyak *et.al,* Int. J. Mod. Phys. E **13**, 123 (04)) have suggested the level at 3446 keV is largely a neutron $(g_{9/2})^2$ 8^+ configuration. Beta decay work of P. Hoff and B. Fogelberg (NPA **368**, 210 (81)) show a beta feeding of 1.14% (log ft=6.7 s) to this level from the proposed (3^+) ground state of ^{80}Ga. We provide new data for the beta decay of ^{80}Ga into ^{80}Ge, finding many new transitions that have been placed in a modified level scheme. The beta decay half life and level feeding have also been re-measured. Additionally, we have measured relative lifetimes for low-lying excited states in ^{80}Ge. These results will be compared with both the previous beta decay and the more recent deep inelastic measurements.

TU-A4-5 11h30

PAUL GARRETT, University of Guelph and TRIUMF

Gamma-Ray Spectroscopy with the 8π Array at TRIUMF-ISAC

The 8π spectrometer, which consists of 20 Compton-suppressed germanium detectors and various ancillary devices, was once the world's most powerful array for studies of nuclei at high angular momentum, but upon moving to TRIUMF-ISAC has been transformed into the world's most powerful device dedicated to β-decay studies. With the improvements made since 2001, and more currently planned, experiments can be performed where measurements of γ-ray singles, γ-γ coincidences, β-particles,conversion electrons, and lifetimes can be made simultaneously. The data acquisition system allows users to decide on the trigger to be used, and also has full control of beam pulsing and movement of a moving-tape-collector. A number of experimental programmes have been launched centred on studies with the 8π spectrometer, and highlights of these, demonstrating the capabilities of the spectrometer, will be presented.

TU-A4-6 12h00

Commissioning of TITAN's Gas Filled RFQ Ion Beam Buncher and Cooler. **Laura Blomeley** [1], J. Dilling [2], P. Bricault [3], J. Vaz [3], M. Smith [2], [1] *McGill University*, [2] TRIUMF/UBC, [3] TRIUMF — TITAN (TRIUMF's Ion Trap for Atomic and Nuclear science) is a high precision Penning Trap mass measurement system currently under construction. It will combine an EBIT (Electron Beam Ion Trap) to increase the charge state of ions with a high precision Penning Trap. The increased charge state will allow for increased precision mass measurements (Δm/m = 1x10^{-8}) at short half-lives ($T_{1/2}$ ~ 50 ms). These measurements will allow for improving theoretical corrections, crucial to testing the unitarity of the CKM quark-mixing matrix in the Standard Model. Furthermore, precise mass measurements permit testing and improvement of nuclear mass models and help map out a potential path for stellar nucleosynthesis, which is considered to happen far away from the valley of nuclear stability, in the regime where TITAN at ISAC has its largest impact. Efficiently injecting ions into the EBIT for charge breeding requires a bunched beam with low transversal emittance and longitudinal energy spread. In addition, because the system is designed to work with short-lived isotopes ($t_{1/2}$ ~ 50ms) provided by the ISAC facility at TRIUMF with typical kinetic energies of 60keV, the cooling process must be fast. This is accomplished using the linear RFQ, which consists of 4 segmented rod electrodes and is filled with an inert buffer gas for cooling via collisions. These electrodes provide a confining RF square wave axial potential and a longitudinal trapping potential. A new RF driver system, based on fast switching MOSFET devices is employed, which generates high amplitudes over a broad frequency range. This allows one to increase the space charge limit of the RFQ by a large factor. The system is presently in the commissioning stage using a stable ^{133}Cs source. Results from these offline tests of efficiency, space charge limit and emittance of the RFQ filled with He and Ne will be discussed.

TU-A4-7 12h15

Modifications on the HERACLES Array for the Energies at ISAC-II. TRIUMF*, **Francis Gagnon-Moisan**, *Université Laval* — The HERACLES array has been designed for studying reactions produced by 40 MeV/nucleon beams, meanwhile the beams available at ISACII will be in the range of 15 MeV/nucleon, at the end of 2006. This implies several important modifications on the array, for maximising data acquisition on events that will be produced in the reaction chamber. This work is essentially about tests for optimisation of light collection in the rings 4 and 5 of the array, composed of 16 CsI(Tl) detectors each coupled with a phototube by a light guide made of Lexguard©, a translucent polymer resin. To evaluate the possible modifications on each ring, some simulations (with the code GEANT4) and experiments have been carried out on these detectors.

* This work is being supported by René Roy

TU-A4-8 12h30

The ^{13}C($\vec{p}$,π^-)^{14}O Reaction in a *pn* → *pp*π^- Model. **Willie R. Falk** , *University of Manitoba* — Nuclear pion production induced by protons of a few hundred MeV has been shown to proceed primarily via a two nucleon process, *NN* → *NN* π. Confirming evidence for this has been demonstrated in the case of π^+ production in the context of a *pp* → *d*π^+ model. Here we discuss the development of a parallel model that incorporates as input the experimental data for the *pn* → *pp* π^- reaction. This model is used in the calculation of observables for π^- production on nuclei. An extensive set of measurements of the differential cross sections and analyzing powers exists for the ^{13}C($\vec{p}$,π^-)^{14}O reaction to which the model is applied. Another process that may be important to π^- production on nuclei is pion charge exchange. The role of (p, π^0) production (forming the analogue of the (p, π^-) state), followed by single charge exchange, is investigated.

12h45 Session Ends / *Fin de la session*

[TU-A5] Cooling and Trapping of Atoms and Molecules
(DAMP/*DPAM*) *Refroidissement et capture d'atomes et de molécules*

TUESDAY, JUNE 7
MARDI, 7 JUIN
10h00 - 12h15

SALLE / ROOM IRC 4 (cap. 135) ***Chair: R. Thompson, University of Calgary***

TU-A5-1 **10h00**

A. KUMARAKRISHNAN, York University *

Precision Measurements using Laser Cooled Atoms **

Atom interferometers (AIs) have the potential for obtaining one of the most precise measurements of the atomic fine structure constant a. We have used a single state time domain atom interferometer to measure the atomic recoil frequency $w_r = (h/4pm)(Dk)^2$ (which can be related to a) to a precision of 2.5 ppm by manipulating trapped ^{85}Rb atoms in the F=3 ground state. Here, h is Planck's constant, m is the atomic mass and Dk is the momentum transferred by laser fields to the atoms. Since the signal from the interferometer is modulated at w_r, the precision is related to measuring the modulation period on a time scale that is limited only by the transit time of cold atoms through the region of interaction. Our studies confirm that the measurement is insensitive to a range of common systematic effects such as AC Stark shifts, strength of atom field coupling, magnetic fields, magnetic field gradients and distribution of atoms in the magnetic sub-levels of the ground state. The measurement is in excellent agreement with the recoil frequency inferred from the accepted value of Planck's constant and previous measurements of transition wavelength and the atomic mass. We explore the possibility of improved measurements using PMT detection, and discuss the precision that can be achieved using an atomic fountain. Results of related experiments that measure the acceleration due to gravity and demonstrate the possibility for gradient sensing will also be presented.

* In collaboration with M. Weel, S. Beattie, I. Chan, E. Rotberg and A. Vorozcovs

** This work is supported by CFI, OIT, NSERC, PRO and York University..

TU-A5-2 **10h30**

Development of a Circularly Polarized Dipole Force Trap for Radioactive Isotopes*. **Erika Jane Prime** [1], M.R. Pearson [2], J.A. Behr [2, 1] *TRIUMF/University of British Columbia*, [2] TRIUMF — TRINAT is testing the standard model of the weak interaction through β decay experiments on radioactively decaying potassium isotopes trapped in a **M**agneto **O**ptical **T**rap (MOT). In order to test whether parity is fully violated, atoms of well defined polarisation are required. A high level of polarisation can be achieved with a **C**ircularly polarized **F**ar **O**ff **R**esonance dipole Force **T**rap (CFORT). Presented here is the first step in its development; successful loading of stable ^{39}K into a linearly polarized FORT from a MOT, where the atoms are pre-cooled to a temperature of a few hundred mK. The interaction between induced atomic electric dipole moments and a laser field, which is detuned below resonance, results in a negative AC Stark shift of the ground state energy level. A spatially inhomogeneous field, such as a focused laser beam, results in a potential well. Atoms can be trapped by the restoring dipole force, which points towards the region of highest field intensity, the focus. The FORT consists of one Watt of light from a Titanium Sapphire ring laser, linearly polarized and focused with a 200mm achromatic lens to a waist of 35microns. The light is detuned 1- 15nm to the red of the D1 transition and this gives rise to trap depths in the region of a few mK. A characterisation of the FORT lifetime and loading efficiency will be presented.

* This work is being supported by NRC through TRIUMF, NSERC

TU-A5-3 **10h45**

Towards an Ultra-Cold Bose-Fermi Mixture in Micro-Magnetic Trap*. **Seth Aubin**, S. Myrskog, M.H.T. Extavour, L.J. LeBlanc, A. Stummer, J.H. Thywissen, *University of Toronto* — We present progress towards quantum degeneracy of fermionic potassium (^{40}K) and bosonic rubidium (^{87}Rb) gases in a micro-magnetic chip trap. The two atomic species are cooled and trapped simultaneously in a vapor loaded magneto-optical trap (MOT). The cold two-species atomic cloud is transported in a quadrupole magnetic trap to the surface of a chip, where it is loaded into a micro-magnetic trap. We have loaded ^{87}Rb and ^{40}K simultaneously into the chip trap and have begun RF evaporation to quantum degeneracy. This approach to degeneracy requires only a single chamber, because the rapid evaporative cooling due to the tight confinement of the chip trap relaxes the stringent vacuum requirements of a traditional magnetic trap. Evaporative cooling requires elastic scattering between atoms to rethermalize the atomic cloud after the most energetic atoms have been selectively removed. At ultra-low temperatures, inter-atom interactions are limited to s-wave scattering. Since two identical fermions must have an anti-symmetric wavefunction, they cannot undergo s-wave scattering, and cannot rethermalize. The symmetric wavefunction of the bosons allows us to evaporatively cool the ^{87}Rb atoms, which then cool fermionic ^{40}K sympathetically. Chip-based traps can be used to create complex magnetic potentials to study 1-D gases, BEC-BCS pairing, many-body Bose-Fermi systems, interferometers, and quantum atom optics with Fermi statistics. In describing our experimental approach, we address the experimental challenges related to microtrapping fermions and future studies of cold Fermi gases.

* Work supported by CFI, NSERC, OIT, PRO, and the Research Corporation.

11h00 **Coffee Break / Pause café**

TU-A5-4 **11h15**

J.A. BEHR, TRIUMF

Weak Interaction Symmetries with Atom Traps *

We use a magneto-optical trap to capture radioactive atoms in a 1 mm-sized cloud. They beta decay, producing three products: a positron, a neutrino and a recoiling final nucleus. By detecting the positron and the nucleus, we can measure the (otherwise undetectable) neutrino momentum. The Standard Model predicts the angular distribution of the neutrinos with respect to the positrons, and by testing for deviations we have searched for new interactions. Our results setting the best limits on certain types of spin-0 exchange bosons will be shown. As the recoiling ions are not point particles, atomic physics corrections must be carefully measured. We have pioneered these techniques at TRIUMF/ISAC, and now are learning to polarize the nuclei, to test whether parity—-mirror symmetry—-is fully violated in the weak interaction. I.e., are there any right-handed neutrinos? Progress on various polarization techniques will be described

* For the TRIUMF Neutral Atom Trap collaboration. Support from NRC through TRIUMF, NSERC, the Israel Science Foundation, and WestGrid.

TU-A5-5 **11h45**

Quantum Solvation. Rotational Dynamics and Superfluid Response of Doped Helium Clusters. **Nikolay Blinov**, P.-N. Roy, *University of Alberta* — Rotational spectra of various molecules embedded into helium-4 clusters show similar spectacular size-dependent features. After an initial drop, the effective rotational constant begins to increase again for large clusters, indicating the decoupling between the molecule rotation and helium motion. This decoupling is a consequence of the bosonic symmetry of ^{4}He atoms, and is thus directly related to the onset of superfluidity at the microscopic level. In our study, we employ the path integral Monte Carlo technique to analyze the rotational dynamics of doped helium clusters. We obtain the effective rotational constant of a complex from imaginary time dipole-dipole correlation functions. Contrasting the results of simulations for Boltzmann and Bose-Einstein statistics allows us to conclude that exchange effects are responsible for the turnaround behavior of the effective rotational constant. We rationalize this finding by analyzing the local superfluid response, and the structural and thermal properties of complexes. We show that the variation of the effective rotational constant with cluster size correlates with the solvation structure of the helium surrounding the dopant molecule.

TU-A5-6 **12h00**

Q-Scan Mass Spectrometry And The Time Evolution Of Mixed Ion Species *, **Jeremie J Choquette** , R I Thompson , *University of Calgary* — Sympathetic laser cooling of trapped ions shows promise as a tool for low temperature studies of atoms and molecules. However, by its very nature it requires the generation and storage of mixtures of ions. Our work is currently focused on some of the issues and challenges associate with the generation, storage, and analysis of multi-species ion trapping, presently examining the low mass region including magnesium, noble gases, nitrogen, and other small molecular ions. This presentation will concentrate on two particular aspects our work. It will outline the 'q-scan' ion trap mass spectrometry techniques that we use to analyse our trapped samples, presenting theoretical and computational results that extend our understanding of this technique as it is applied to low mass ion samples, where the simple theoretical models of the ion evolution tend to break down. The second part of the presentation will outline experimental q-scan mass spectrometry data that illustrates the occurrence of charge transfer processes between trapped ions and background gas atoms and molecules, leading to a temporal evolution in the mass spectrum of the trapped ions, a physical process that must be understood and managed before trapped ion collision induced energy transfer studies can be carried out.

* This work is being supported by NSERC

12h15 **Session Ends / *Fin de la session***

[TU-A6] Particle Theory / *Théorie des particules élémentaires*

(DTP/*DPT*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 12h30

SALLE / ROOM IRC 1 (cap. 133) ***Chair: P. Lee, National Central University***

TU-A6-1 **10h00**

MARK WISE, Caltech

Naturalness and the Values of Cosmological Parameters

I discuss the implications of naturalness for some of the cosmological parameters that characterize our universe. I focus mostly on the generation of density perturbations in the early universe and on the on the value of the cosmological constant. A new method for generating density perturbations after inflation is reviewed.

TU-A6-2 **11h00**

MARIANA FRANK, Concordia University

Neutrino Masses and Mixings in Rank-5 Subgroups of E_6 *

We analyze neutrino masses and mixings in the context of effective rank-5 subgroups of E_6. We show that in their simplest form, these models always predict the lightest neutrino to be an $SU(2)_L$ singlet, as well as two extra neutrinos with masses of the order of the up-quark mass (per generation). In order to recover Standard Model phenomenology, additional assumptions in the form of discrete symmetries and/or new interactions are needed. These are classified as the Discrete Symmetry (DS), Higher Dimensional Operators (HDO), and Additional Neutral Fermion (ANF) methods. We analyze the effects of these methods in both the supersymmetric and non-supersymmetric versions of the model. We show that obtaining masses in agreement with solar and atmospheric neutrino data, and the sterile-active neutrino mixing favored by the LSND, is entirely non-trivial, though easier to achieve in the supersymmetric version.

* In collaboration with I. Turan [1], M. Sher [2], [1] Concordia University and [2] College of William and Mary

TU-A6-3 **11h30**

ALEX BUCHEL, University of Western Ontario/Perimeter Institute

Transport Properties of Strongly Coupled Gauge Theory Plasma

Hydrodynamics provides an effective description of a thermal system dynamics on length and time scales which are large compared to any relevant microscopic scales. Using the gauge/string theory correspondence, the hydrodynamics of finite temperature strongly coupled gauge theories can be mapped to the hydrodynamic behavior of the low energy fluctuations of certain black holes with planar horizons. We prove that in the limit of infinitely strong coupling (and for large number of colors) the ratio of the shear viscosity to the entropy ration of gauge theory plasma is universal. In the case of N=4 SU(N) supersymmetric Yang-Mills theory we compute the leading correction to the shear viscosity. We study the propagation of sound waves in gauge theory plasma, and obtain the first prediction for the bulk viscosity in (non-conformal) gauge theories.

TU-A6-4 **12h00**

R.M. WOLOSHYN, TRIUMF

Acting Chiral: Light Quarks in Lattice QCD

The recent success of staggered-fermion lattice QCD simulations depends crucially on the ability to approach the chiral (massless quark) limit. After a brief review of the various ways of dealing with fermions in lattice QCD we will discuss why light quark masses present a difficulty for Wilson fermion simulations. A new variation of the Wilson approach, called twisted mass QCD, offers a way to overcome these difficulties. The main features of twisted mass lattice QCD and some results of recent applications will be presented.

12h30 **Session Ends / *Fin de la session***

[TU-A7] DMBP Young and New Investigators / *Jeunes et nouveaux chercheurs en physique médicale et biologique*

(DMBP/*DPMB*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 11h45

SALLE / ROOM G279 -hos. (cap. 140) ***Chair: A. Pejovic-Milic, Ryerson University***

TU-A7-1 **10h00**

NANCY FORDE, Simon Fraser University

Using Optical Tweezers for Single-Molecule Biophysics Studies

Optical tweezers take advantage of the strong electric field gradient of a tightly focused laser beam to grab and hold refractive objects in a three-dimensional optical trap. For example, single cells can be trapped and manipulated in solution, as can polystyrene microspheres. By tethering single molecules between two microspheres, the elastic

response of these molecules can be characterized at nanometer resolution in response to picoNewton-scale forces. Knowledge of the elastic response of DNA allows us to study the force-dependence of DNA-dependent processes. In this talk, aimed at a general audience, I will discuss the physics behind optical tweezers and the application of this technique to studying the movement of single molecules of RNA polymerase along DNA in real time. RNA polymerase is a molecular motor that catalyzes the synthesis of an RNA polymer chain, converting chemical energy into mechanical force, resulting in directed movement along the DNA template. I will also discuss practical limitations on the spatial and temporal resolution of these measurements.

10h45 Coffee Break / Pause café

TU-A7-2 11h00

In Silico Mutations and Molecular Dynamics Studies on the Trp-Cage Folding. **Junmin Liu**, A. Linhananta, *Lakehead University* —Using the all-atom Go model, we studied the folding/unfolding kinetics of Trp-cage by weakening or strengthening the Helix structures (Helix, 3-10Helix) on. The two state transition has been produced in all the case and no significant change of the transition temperature is found. There is significant increase in the folding rate when the native contacts of 3-10Helix are strengthened meanwhile a unstable kinetic intermediate is observed. Based on the cluster analysis, the structures of intermediate state and transition state are discussed.

TU-A7-3 11h15

Quantum Dots as Voltage Sensitive Probes in Neurophysiology*. **Paul Cheung**, R.K. Khatchadourian, J.L.N. Nadeau, D.B. Bahcheli, S.C. Clarke, *McGill University* — Currently, neuronal interactions are studied through patch clamping which is very limited in scope since it only allows experiments on a small number of cells. A revolution in this domain would consist of a visible indicator that would react, by spectrum shifting or simply by intensity gradient, to action potential firing of a neuronal system. This tool, allowing the analysis of neuronal networks, would increase our understanding of diseases related to altered neuronal excitability, such as epilepsy, Alzheimer's disease, motor neuron disease, etc. We propose the use of Quantum dots (QDs), which are photoluminescent semiconductor nanocrystals with a broad absorption and a narrow emission spectra allowing for multi-wavelength labeling. The long-term goal being the creation of voltage sensitive QD probes for neurons *in vitro* and *in vivo*. However, the use of QDs in biological applications is still in its infancy. Barriers include their relatively large size, which limits entry into cells. This research will concentrate on two aspects of these challenges: integration of QDs into the cell membrane and visualization of their voltage sensitivity to action potentials. The former objective will be studied using fusogenic liposomes, conjugation to biomolecules, and pluronic surfactants. The hypothesis that voltage sensitivity is enhanced through FRET (fluorescence resonance energy transfer) will be investigated. Current results in our laboratory confirm that QDs conjugated to biomolecules can successfully enter bacterial strains. We have also tested a fusion of QDs with a neuronal cell line membranes with promising results.

* This work is being supported by McGill University

TU-A7-4 11h30

Equivalent Stochastic Dose (ESD): Quantifying the Impact of Dose Uncertainties on Radiotherapy Treatment Plans*. **Gavin Cranmer-Sargison** [1], S. Zavgorodni [2], [1] *University of Victoria*, [2] British Columbia Cancer Agency — The purpose of this study was to quantify the impact dose uncertainties have on radiotherapy treatment plans through the use of survival fraction. We considered the case, where the total dose to a volume element has an associated uncertainty. To distinguish between spatial and probabilistic dose heterogeneities, we define *equivalent stochastic dose* (*ESD*) as the dose that results in a mean survival fraction for a randomly deposited dose to a volume. For a probability density function, f(D), that represents the dose to a voxel, SF(*ESD*) can be calculated using the convolution technique. In the case where the probability density function follows a Gaussian distribution, an analytic expression has been derived for SF(*ESD*). The expression has been verified using the Monte Carlo method for various radio sensitivities and a /b ratios. The results show that survival fraction increases with an increased dose uncertainty and was found to be dependent on the radiobiological parameters. Using the analytic expression for SF(ESD), dose uncertainty can be evaluated for any voxel or group of voxels in the dose matrix, including those in an OAR and/or PTV. For spatially Gaussian dose distributions a statistical uncertainty of 2% was found to result in an average *equivalent uniform stochastic dose* (*EUSD*) of 98% with respect to the modelled mean dose. As the dose uncertainty increased beyond 5% the ratio of *EUSD* to prescribed dose dropped rapidly. The effect of dose uncertainty can easily be evaluated for any voxel in the dose matrix including the PTV and OAR volumes. This can be useful in the assessment of planned treatments when dose uncertainty estimates are known.

* This work is being supported by British Columbia Cancer Agency

11h45 Session Ends / *Fin de la session*

[TU-A8] Semiconductors / *Semiconducteurs*

(DCMMP/*DPMCM*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 12h15

SALLE / ROOM IRC 2 (cap. 500) ***Chair: S. Patitsas, University of Lethbridge***

TU-A8-1 10h00

DAVID COOKE, University of Alberta

Using Terahertz Pulses to Probe Ultrafast Carrier Dynamics in Semiconductor Nanostructures *

Carrier dynamics in semiconductor nanostructures has received much attention over the past several years, especially with regards to the development of new nano-photonic devices. The optimization of these devices relies heavily on understanding the transport properties of these nanoscale materials, which is not always easy to measure since applying contacts to nanometer-scale structures is often difficult and in some cases may even interfere with the measurement of the intrinsic transport characteristics. This talk discusses a non-contact, ultrafast technique known as time-resolved terahertz (THz) pulse spectroscopy which has the ability to measure the photoconductive response of semiconductor nanostructures over picosecond time scales. The THz pulses used in this technique can probe the decay of excited free carriers until they are localized in trap sites, making it ideal for measuring carrier capture dynamics. What makes the technique even more powerful is that a Fourier transform analysis of the time-domain THz waveforms allows one to determine the complex conductivity of a material in a frequency regime crucial to our understanding of carrier dynamics and transport in nanostructure systems. Examples showing how THz pulse spectroscopy can be used to probe ultrafast carrier dynamics in semiconductor nanostructures such as self-assembled quantum dots, nanowires, and nanocomposites will be discussed.

* In collaboration with F.A. Hegmann, University of Alberta

TU-A8-2 10h30

Generation and Characterization of Intense and Ultrashort Terahertz Pulses from Ion-Implanted Photoconductive Materials*. **Denis Morris** [1], V. Aimez [2], J. Beauvais [2], J. Beerens [2], D. Houde [3], B. Salem [2], [1] *Université de Sherbrooke*, [2] CRN2, Université de Sherbrooke, [3] Dept. médecine nucléaire, Université de Sherbrooke — In this work, we compare the characteristics of small-aperture terahertz antenna emitters fabricated on GaAs:As^{++}, GaAs:H^{+}, and GaAs:O^{-} ion-implanted substrates. Our photoconductive materials were prepared using multiple implants at different ion energies. Terahertz pulses are generated by exciting our devices with ultrashort laser pulses <150 fs, at 760 nm. Terahertz radiation was collected and refocused on our detector using a pair of off-axis parabolic mirrors. THz intensity signals have been measured using either a liquid-He cooled silicon bolometer (non coherent detection) or a GaAs:H+ photoconductive antenna detector (coherent detection). Ion implantation introduces nonradiative centers which reduce the carrier lifetime in GaAs and modify the shape of the terahertz pulses. In all cases, we have found ion implantation conditions at which better THz integrated intensity is

obtained as compared to emitters made on high-resistivity semi-insulating GaAs substrates. The introduction of charge defects also induces a redistribution of the electric field between the antenna electrodes. The overall process is optimized to better control the dynamical field screening effect which has a huge influence on the amplitude of the radiated terahertz field. Results obtained as a function of the laser excitation power is discussed and comparison of the performance of these devices with conventional small-aperture antennas is given. The THz pulses obtained using our GaAs:H+ antenna as detector show a large spectrum which extends from 0.1 to 2 THz, with a dynamic of at least two orders of magnitude above the noise background.

* This work is being supported by VRQ / CRSNG / FQRNT

TU-A8-3 10h45

Electron and Phonon Thermal Pulse Propagation in Semiconductors. **Yu. G. Gurevich** [1] and G.N. Logvinov [2], [1] Departamento de Física, CINVESTAV, IPN, México and [2] SEPI-ESIME-Culhuacán, IPN, México — Electron and phonon transient temperatures are analyzed in the case of non-degenerate semiconductors. An analytical solution is obtained for rectangular laser pulse absorption with arbitrary duration. It is shown that a thermal diffusion is the main energy relaxation mechanism in phonon subsystem. An electron energy relaxation mechanism depends on correlation between a sample length l and the electron cooling length l_ε. Energy relaxation occurs by means of an electron thermal diffusion in thin samples ($l << l_\varepsilon$), and by means of an electron -phonon energy interaction in thick samples ($l << l_\varepsilon$). Characteristic relaxation times are obtained for all cases, and analysis of these times is made. Electron and phonon temperature distributions are qualitatively and quantitatively analyzed for different correlations between laser pulse duration and characteristic times for thin and thick samples.

TU-A8-4 11h00

MARC M. DIGNAM, Queen's University

High-Order Nonlinearities in the Ultrafast Optical Response of Biased Semiconductor Superlattices *

Considerable effort has been devoted in recent years to developing an accurate and computationally-viable theoretical treatment of the response of semiconductor nanostructures to ultrashort optical pulses. Perhaps the largest challenge has been to develop a theory that is infinite-order in the optical field but also retains crucial electron-hole correlations. One structure that has been a particularly valuable testing ground for such theories is the Biased semiconductor superlattice (BSSL). This system is particularly interesting because: 1) the dynamics can be directly monitored via the THz emission arising from the strong intraband response and 2) the ultrafast optical response is very nonlinear. This high nonlinearity is largely the result exciton-exciton interactions: because the bias field polarizes the optically-generated excitons, these excitons interact via a dipole-dipole interaction, which results in an optical response which strongly depends on the exciton density, and hence on the optical intensity of the exciting pulse. I present our theoretical treatment of BSSLs based on our excitonic Bloch equations. By using an excitonic basis and truncating the dynamic equations via factorization, we are able to calculate the nonlinear optical response to infinite order in the optical field while retaining crucial intra-excitonic electron-hole correlations. I will discuss results of degenerate four-wave mixing (DFWM) and Terahertz emission calculations, highlighting nonlinear effects beyond fourth order in the optical field. In particular, I will present results for such effects as peak-oscillations in spectrally-resolved DFWM, the ultra-fast red-shift of Bloch oscillations, the non-adiabatic generation of Bloch oscillations, and superlattice plasma oscillations.

* In collaboration with M. Hawton [1], L. Yang [2], [1] Lakehead University, [2] Queen's University

TU-A8-5 11h30

Electronic and Optical Properties of InAs/InP Self-Assembled Quantum Dots on Patterned Substrates*, **Weidong Sheng**, Pawel Hawrylak, *Institute for Microstructural Sciences, National Research Council of Canada* — Recently Williams *et al* [1] reported high quality emission spectra close to 1.55 μm of single InAs quantum dots grown on InP pyramidal nanotemplate. This opens up the possibility of integration of single quantum dots into optical cavities, and hence reliable fabrication of single photon sources suitable for long distance transmission in optical fiber. The theoretical understanding of the effect of patterning on optical spectra is unknown, and we present here atomistic theory of electronic and optical properties of single InAs quantum dot grown on pyramidal InP nanotemplates. In this work, the electron and valence hole single particle states are calculated using atomistic effective-bond-orbital model with second nearest-neighbor interactions, coupled to separately calculated strain distribution via Bir-Pikus Hamiltonian. The optical properties of InAs dots embedded in InP pyramids are calculated by solving the many-exciton Hamiltonian for interacting electron and hole complexes using the configuration-interaction method. The effect of positioning of quantum dots using nanotemplate on their optical spectra is determined by a comparison with dots on unpatterned substrates, and with experimental results. The possibility of tuning the optical properties with the shape of the nanotemplate is demonstrated.

* This work is supported by the NRC HPC project, NRC-HELMHOLTZ grant, and Canadian Institute for Advanced Research.

1. R.L. Williams, G.C. Aers, J. Lefebvre, P.J. Poole and D. Chithrani, Physica E 13, 1200 (2002); D. Chithrani, R.L. Williams, J. Lefebvre, P.J. Poole, and G.C. Aers, *Appl. Phys. Lett.* **84**, 978 (2004).

TU-A8-6 11h45

Determination of the Isotopic Mass Dependence of the Lattice Parameter in Silicon using High Resolution Photoluminescence Spectroscopy. **Albion Yang** [1], H.J. Lian [1], M.L.W. Thewalt [1], M. Uemura [2], A. Sagara [2], K.M. Itoh [2], E.E. Haller [3], S.A. Lyon [4], [1] *Department of Physics, Simon Fraser University,* [2] Department of Applied Physics, Keio University, [3] Department of Materials Science and Engineering, [4] Department of Electrical Engineering, Princeton U — The strain-induced splitting of the bound exciton transitions in epitaxial layers of isotopically enriched ^{28}Si grown on silicon substrates of natural isotopic composition has been studied using high resolution photoluminescence (PL) spectroscopy. The slight difference in lattice parameter between the ^{28}Si epitaxial layer and the natural silicon substrate induces a biaxial strain in the epitaxial layer, which can be detected with remarkable sensitivity using low temperature PL. Measurement of the splitting of the bound exciton transitions in these epitaxial layers of ^{28}Si provides us a method for determining the isotopic mass dependence of the lattice parameter in silicon with unprecedented precision. The level of precision achieved is attributed to the fact that the bound exciton no-phonon transitions in isotopically enriched silicon are much sharper than in natural silicon. We also show that when the strain in the epitaxial layer is eliminated, by completely removing the substrate, splitting of the bound exciton transitions is no longer observed, as is expected.

TU-A8-7 12h00

Magnetic Susceptibility of Diluted Magnetic Semiconductors at Low Carrier Densities*, **Mona Inesa Berciu**, A. Kassaian, *University of British Columbia* — Using the Random Phase Approximation, we calculate the static longitudinal and the transverse dynamic magnetic susceptibilities of (III,Mn)V diluted magnetic semiconductors. We use a simple impurity band model, appropriate for the low charge carrier concentration regime. The magnetic susceptibilities are shown to depend sensitively on the amount of positional disorder of the Mn impurities. The results we obtain are consistent with previous studies of the spin wave spectrum and of the spatially inhomogeneous ferromagnetic order in these materials.

* This work is being supported by NSERC and Research Corporation

12h15 Session Ends / *Fin de la session*

[TU-A9] (DPP) Plasmionique Prize for Best Student Plasma Physics Presentation / *Prix Plasmionique pour la meilleure présentation par un étudiant en plasma*

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 12h15

SALLE / ROOM FNSC 50 ***Chair: A. Sarkissian, Plasmionique Inc.***

TU-A9-1 **10h00**

DMITRY V. ROMANOV, University of Alberta

Plasma Physics of Photoionized Gases by Short X-Ray Pulses *

A study of nonequilibrium plasma that is created by a femtosecond, linearly polarized x-ray pulse in a gas jet target is presented. The x-ray photoionized gas is described by the anisotropic electron distribution function (EDF) that exists on the picosecond time scale, *i.e.* until particle collisions establish isotropic velocity distribution. This EDF gives rise to electromagnetic Weibel instability and electrostatic two stream instability. Linear theory and nonlinear evolution of these instabilities are described analytically and by multidimensional particle-in-cell (PIC) simulations. Static magnetic field generation and terahertz nonmonohromatic video-pulse irradiation from such plasmas is predicted. The model accounts for thermo-EMF at the edge of a plasma and the anisotropic EDF due to photoionization. Results from 3-dimensional PIC simulations show new unexpected scenarios of Weibel and two-stream instability nonlinear evolutions in these anisotropic plasmas.

* In collaboration with V. Yu. Bychenkov [1], W. Rozmus [2], C.E. Capjack [2], R. Fedosejevs [2], [1] P.N. Lebedev Physics Institute, [2] University of Alberta

TU-A9-2 **10h30**

Study of Compact Torus Assisted Breakdown in the STOR-M Tokamak*, **D. Liu**, S. Livingstone, A.K. Singh, C. Xiao, A. Hirose, *University of Saskatchewan* — Development of assisted discharge breakdown techniques to reduce the consumption of the magnetic flux of an Ohmic transformer is crucial for small aspect ratio toroidal devices such as spherical tokamaks (ST) with limited room for a central solenoid. As a prove-of-principle experiment, compact torus (CT) assisted breakdown phenomena in the STOR-M tokamak have been studied for different gas fill pressures and Ohmic discharge bank voltages. Compared with the conventional gas breakdown assisted by thermionic electron emission and radio frequency waves, the CT assisted breakdown reduced the bank voltage from 110 V to 100 V for a reliable breakdown without any noticeable time delays. The CT assisted breakdown has achieved 20% to 25% savings on the transformer flux. The results suggest that the CT injection is a promising technique benefiting both discharge startup and fuelling in a fusion reactor.

* This work is being supported by NSERC

TU-A9-3 **10h45**

Modeling Solar Wind Plasma Transport into the Inner Magnetosphere, **Ding Li**, R.M. Marchand, K.K. Kabin, R.R. Rankin, *University of Alberta* — Solar wind plasma transport to inner magnetosphere, and its dependence on the IMF has been investigated in previous test particle simulations, which showed that reconnection regions have a significant impact on plasma transport. Recently, many observation results3 suggest the LLBL play a pivotal role in supplying plasma to the plasma sheet. We use a test particle approach coupled with a global MHD simulation (BATS-R-US) to show the process of plasma transport from the solar wind to the inner magnetosphere. From the results obtained during the northward IMF, we can recognize the main structures of the bowshock, the magnetosheath, the magnetopause, the cusp, the plasma sheet and the plasma mantle in the noon-midnight meridional plane. In the equatorial plane, it shows a high-density plasma region in dayside low latitude boundary layer (LLBL) and a ring current-like region. Particles in the LLBL drift through the flanks and populate the near-nightside plasma sheet, which is in qualitatively agreement with the DMSP observation results. In the future, we will use our model to calculate the plasma temperature distribution in the inner magnetosphere and the flux of particles precipitating into the ionosphere. These calculations will then be directly comparable with observations and help us to understand the plasma transport and acceleration mechanism in the global geophysical environment.

11h00 **Coffee Break / Pause café**

TU-A9-4 **11h30**

Hot Electrons and KeV X-Rays From Femtosecond Laser Produced Micro Plasmas*, **Cristina Serbanescu**, Y.Y. Tsui, D. Romanov, C. Capjack, W. Rozmus, R. Fedosejevs, *University of Alberta* — The scaling of hot electron generation in the intermediate intensity range of 10^{15} to 10^{17} W/cm^2 is very important for the generation of fast electrons and keV x-rays. Such intensities can be achieved with submillijoule 120fs Ti:Sapphire laser pulses focused to spots with diameters of a few microns producing microplasma sources of hot particles and x-rays. The absorption in this intensity range changes from resonant absorption [1-3] to vacuum heating as the intensity increases above $I\lambda^2 > 4\times10^{16}$ Wcm^{-2} mm^2 [4]. Other processes such as Raman heating at the quarter critical density surface can also become important for extended plasma profiles. Recently there have been reports of electron jets formed at these intermediate intensities in the target normal, specular and the E-field directions depending on the polarization and prepulse levels [5]. We report here a study to characterize the electron and keV x-ray generation in this intensity regime for 800nm, 120fs laser pulses focused to small spot diameters on the surfaces of solid targets. The goal is to better characterize the various mechanisms contributing to the hot electron generation, their propagation outwards from the small focal spot region and the subsequent generation of keV x-rays. Directional emission of electrons is observed which is dependent on the laser polarization and target geometry. Modeling of the interaction process is carried out with a 2D PIC code in order to better understand the generation mechanisms and explain the features observed in the experiments. Experimental and modeling results will be presented and compared.

1. K. Eidmann *et al.*, *Phys. Rev.*, **E 62**, pp. 1202-14 (2000).
2. R. Fedosejevs *et al.*, *Phys. Rev. 2. Lett.*, **64**, pp. 1250-53 (1990).
3. D.F. Price *et al.*, *Phys. Rev. Lett.*, **75**, pp.252-5 (1995)
4. F. Brunel, *Phys. Rev. Lett.*, **59**, pp. 52-55 (1987)
5. L.M. Chen *et al.*, *Phys. Rev. Lett.*, **87**, 225001 (2001)
* *This work is being supported by NSERC*

TU-A9-5 **11h45**

In Search of High Frequency Fluctuations Through Microwave Scattering in the STOR-M Tokamak*, **Stephen Livingstone**, A. Hirose, C. Xiao, A. Singh, *University of Saskatchewan* — Anomalous transport in fusion plasma research is generally attributed to turbulence and micro-instabilities. Although ion thermal diffusivities comparable with neoclassical predictions have been achieved, electron thermal diffusivity remains anomalously high. One possible candidate for these losses is the Electron Temperature Gradient mode (ETG); a very high frequency short wavelength instability. The scattering system design and initial results on attempting to measure this mode in the STOR-M Tokamak will be presented. The scattering system consists of a 12W 140GHz (2mm) Klystron set up in a simple bridge circuit. The system is capable of measuring small scale density fluctuations ($\tilde{n}_e(\mathbf{k},\omega)/n_e \sim 10^{-4}$) up to 50MHz.

* This work is being supported by NSERC

TU-A9-6 **12h00**

Molybdenum Isotope Abundance Variations in Selected Iron Meteorites*. **Mike Varner** [1], M.E. Wieser [1], J.R. de Laeter [2], [1] *University of Calgary*, [2] Curtin University of Technology — Isotopes of molybdenum are formed by many nucleosynthetic processes including the r-process (^{100}Mo), s-process (^{96}Mo), both r-and s-processes (^{95}Mo, ^{97}Mo and ^{98}Mo), and p-process (^{92}Mo). The relative isotope abundances of molybdenum are affected by nuclear fusion and neutron capture reactions. These nuclear processes occur over time scales ranging from seconds to millions of years in different stellar environments. Hence, the isotopic patterns record the occurrence and mechanisms of cosmochemical processes. It has been shown that molybdenum contained in the bulk material of some primitive meteorites is significantly different than the average Solar System value and may have originated from diverse stellar sources. The extent of molybdenum isotope variations in iron meteorites is not clear. Recent papers report anywhere from no difference compared to terrestrial abundances to enrichments ranging from ~ 0.5 to 2.5e for various Mo isotopes in IA, IIAB, IIIAB, IIICD, IVA and IVB irons. This study will present the latest results of the molybdenum isotopic compositions of selected iron meteorite samples measured by thermal ionization mass spectrometry.

12h15 **Session Ends / *Fin de la session***

[TU-A10] Biotechnologies and Biothermophotonic Instruments and Methods I / *Instrumentation et techniques en biotechnologie et biophotonique I*

(DIMP/*DPIM*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 12h30

SALLE / ROOM FNSC 60 (cap. 119) ***Chair: B. Whelan, Ryerson University***

TU-A10-1 **10h00**

CHANDRA PATEL, UCLA and Pranalytica, Inc.

Optical Techniques for High Sensitivity, High Selectivity Detection of Chemical Warfare Agents *

With terrorism on the rise all over the world, there is a clear need for early, sensitive, and unambiguous detection of the chemical and biological threats. We explore the opportunities for the use of optical techniques to meet chemical warfare agent (CWA) sensing requirement. We provide a general technique for evaluating the performance of an optical sensor for the detection of CWAs in realistic environments and present data from a simulation model based on a field deployed discretely tunable $^{13}CO_2$ laser photoacoustic spectrometer (L-PAS). Results show the sensor performance in terms of detection threshold as a function of probability of false positives (PFP). The false positives arise from the presence of many other interferent gases in the ambient air. Using the L-PAS as it exists today, we can achieve a detection threshold of about 4 ppb for the CWAs while maintaining a PFP of less than 1:10^6. Our simulation permits us to vary a number of parameters in the model to provide guidance for performance improvement. We find that by using a larger density of laser lines (such as those obtained through the use of tunable semiconductor lasers), improving the detector noise and maintaining the accuracy of laser frequency determination, optical detection schemes can make possible CWA sensors having sub-ppb detection capability with <1:10^8 PFP. We also describe the results of a preliminary experiment that verifies the results of the simulation model. Finally, we discuss the use of continuously tunable quantum cascade lasers in L-PAS for CWA detection.

* In collaboration with M.B. Pushkarsky [1], M.E. Webber [2] and T. Macdonald [1], [1] Pranalytica and [2] Pranalyitca

TU-A10-2 **10h30**

MARKUS W. SIGRIST, Swiss Federal Institute of Technology (ETH)

Laser Spectroscopy in Trace Gas Analysis

In numerous applications sensing aspects are of pivotal interest. Important examples concern the monitoring of trace species in various areas such as in ambient air, industrial process control, agriculture, food industry, volcanology, workplace safety, medical diagnostics, *etc*. Laser-spectroscopic sensing devices offer the potential for high sensitivity and selectivity, multi-component capability, large dynamic range, robustness and ease of operation. This talk discusses the development and implementation of tunable mid-infrared laser sources and their combination with various spectroscopic detection schemes for analytical applications in trace gases. The performance of such laser spectrometers in point monitoring is illustrated with various recent examples. Detection limits at the sub-ppb concentration level and isotopic specificity could be achieved. In measurement campaigns we also demonstrated the potential for field sensing, *e.g.* by on-line recording of traffic emissions. New applications concern trace gas measurements for industrial applications, analyses of doping agents in sports as well as human breath analysis for non-invasive medical diagnostics.

11h00 **Coffee Break / Pause café**

TU-A10-3 **11h30**

JOSÉ ABRAHAM BALDERAS-LÓPEZ, UPIBI-IPN

Thermal-Wave Photoacoustic Setup, High Precision Technique for Thermal Diffusivity Measurements: Applications to Foods

The close relation between the thermal-wave-length concept and the thermal diffusivity it is used to provide of a photothermal methodology for the direct measurement of thermal diffusivity for liquid samples. The analytical solution for the one-dimensional heat diffusion problem, for a three-layered model, involving a harmonic light source (in the surface absorption limit), is used for this goal. A photoacoustic setup is implemented to test on the capabilities of the presented methodology. Some preliminary studies on the application of this methodology to the detection of adulteration in foods are finally shown.

TU-A10-4 **12h00**

SHMUEL MALKIN, Weizmann Institute of Science

Photoacoustic Signals From Plant Leaves - Markers of Photosynthetic Activity

Photoacoustic measurements in plants' leaves are interpreted in terms of two types of contribution to the photoacoustic signal: 1) a modulated thermal signal, resulting from the conversion of modulated light energy to thermal energy and its propagation as a thermal wave. 2) modulated photosynthetic oxygen evolution, which propagates as a diffusion wave in the plasmatic medium. Under special conditions oxygen uptake and carbon dioxide uptake, which are intimately connected to the photosynthetic process, also contribute to the photoacoustic signal. Valuable information on the photosynthetic process is obtained from the dependence of the photoacoustic signal on the wavelength, modulation frequency, light intensity, time and the type of sample. Together with fluorescence measurements the photoacoustic technique is a valuable non-destructive monitor of photosynthesis.

12h30 **Session Ends / *Fin de la session***

[TU-A11] The Energy Frontier in Particle Physics I / La limite en énergie en physique des particules I

(PPD)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

10h00 - 12h30

SALLE / ROOM CEME 1202 (cap. 119)

Chair: D. O'Neil, Simon Fraser University

TU-A11-1 **10h00**

MANUELLA GRETA VINCTER, Carleton University

Into The Unknown: TeV Physics With The ATLAS Detector *

The ATLAS experiment is one of two multipurpose detectors at the Large Hadron Collider (LHC), that will study the structure of matter at the 0.00000000000000000001m scale! The LHC, based in Geneva, Switzerland, will collide protons at center of mass energies of 14 TeV. Studies with the ATLAS detector will include detailed measurements of Standard Model parameters, searches for clues into the origin of mass, and perhaps revelations of new physics beyond the Standard Model of Particle Physics. First data are expected in 2007. I will briefly discuss the ATLAS detector focusing on the contributions from the Canadian groups on ATLAS, and explain some of the exciting physics planned with this detector.

* This work is being supported by NSERC

TU-A11-2 **10h30**

ANDREAS WARBURTON, McGill University

Recent Results from the Collider Detector at Fermilab *

The Tevatron collider at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois is providing symmetric collisions of protons on antiprotons at a centre-of-mass energy of 1.96 TeV, making it the highest energy particle accelerator currently in operation. The upgraded Collider Detector at Fermilab (CDF II) is one of two multipurpose detectors examining the outcome of these high-energy hadronic collisions. The CDF collaboration has been pursuing a broad and exciting physics program while acquiring physics quality data over the past three years. This talk will treat key performance aspects of the upgraded collider and CDF II detector, followed by a presentation of recent results obtained by the CDF collaboration. Emphasis will be given in areas having Canadian contributions. Prospects will also be discussed for other interesting measurements made possible by future Tevatron running.

* This work is being supported by NSERC

TU-A11-3 **11h00**

ATLAS 2002 Test Beam Energy Reconstruction*. **Claudiu Cojocaru** , *Carleton University* — A combined beam test took place in 2002 at CERN in order to study the performance of the electromagnetic and hadronic liquid-argon end-cap calorimeters in the ATLAS experiment. Modules of the two calorimeters were exposed to beamsof electrons, muons and pions with energies from 6 to 200GeV at different impact points. A cell clustering algorithm is used to reconstruct the energy of electrons and pions. Results on the energy reconstruction are presented including the calculation of the electromagnetic constant for the electromagnetic calorimeter, as well as energy linearity and resolution.

* This work is being supported by ATLAS Canada

TU-A11-4 **11h15**

The Littlest Higgs in Anti-de Sitter Space. **Itay Yavin**, J.T. Thaler, *Harvard University* — We implement the Littlest Higgs model in a slice of 5D Anti-de Sitter space bounded by a UV brane and an IR brane. Like the original Littlest Higgs, this model exhibits collective breaking in that two interactions must be turned on in order to generate a Higgs potential. In AdS space, however, collective breaking does not appear in coupling constants directly but rather in the choice of UV brane boundary conditions. We match this AdS construction to the known low energy structure of the Littlest Higgs and comment on some of the tensions inherent to this choice of UV physics. We calculate the 5D Coleman-Weinberg effective potential for the Higgs and find that collective breaking is manifest. In a simplified model with only the SU(2) gauge structure and the top quark, the physical Higgs mass can be of order 200 GeV with no considerable fine tuning (25%).

TU-A11-5 **11h30**

Measurement of the Top Anti-Top Production Cross Section in the Dilepton Channel Using Lepton+Isolated Track*. **Teresa Spreitzer**, *University of Toronto* and the CDF Collaboration — We present an updated top anti-top cross section measurement in the dilepton channel using 360 inverse pb of Run II data. We measure the top anti-top cross section in events with 1 identified lepton, one isolated track, missing transverse energy and 2 or more jets.

* This work is being supported by NSERC

TU-A11-6 **11h45**

Experimental Signatures of Radiatively Broken Electroweak Symmetry*. **Victor W. Elias**, F.A. Chishtie, *University of Western Ontario* — In recent explorations of radiatively broken electroweak symmetry, a Higgs boson mass of order 200 GeV is found to be accompanied by a scalar-field self-interaction coupling constant l five to six times larger than the value $\lambda = M_H^2/[2\ (vev)^2]$ anticipated from conventional spontaneous symmetry breaking. This elevation in λ leads to striking enhancements in cross-sections $W_L^+W_L^- \rightarrow (W_L^+W_L^-, Z_LZ_L)$ in the 400 GeV – 2 TeV energy range, as well as elevated rates for $H \rightarrow (WW,ZZ)$ decay processes characterizing such a heavy Higgs boson.

* This work is being supported by NSERC

TU-A11-7 **12h00**

Search for Electroweak Single Top Quark Production with CDFII*. **Bernd Stelzer**, P. Savard, W. Trischuk, *University of Toronto* — Electroweak single top quark production is predicted by the Standard Model of particle physics but still lacks experimental observation. Different to the QCD pair produced top quarks, discovered in 1995 at the Tevatron, single top quarks are produced through an electroweak vertex and provide the only direct way to measure the CKM matrix element Vtb.

This talk will present first results on our search for single top quark production at the Tevatron using $162pb^{-1}$ of data collected with the CDFII experiment. Moreover, the use of maximal information based on matrix element methods is discussed in the context of an optimized search for single top.

* This work is being supported by University of Toronto

TU-A11-8 **12h15**

Search for ttH Production at CDF*. **Stanley Lai**, P.K. Sinervo, *University of Toronto* — The search for the elusive Higgs boson is an important goal for hadron collider experiments. The Fermilab Tevatron, with a centre-of-mass energy of 1.96 TeV, is currently the only collider that has the potential to produce Higgs bosons. We present a search of $p\bar{p} \rightarrow t\bar{t}H$ production at the Collider Detector at Fermilab (CDF). Though such a signal has a very small cross section, the final event topology is quite distinct, making it an interesting channel to study. In addition, we are able to put constraints on final states consisting of two top quarks and two bottom quarks. This measurement complements other searches for the Higgs boson using different channels at CDF.

* This work is being supported by NSERC, Province of Ontario

12h30 **Session Ends / *Fin de la session***

[TU-A12] Applications of Photonics / Applications de la photonique

(DOP)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

11h00 - 12h00

SALLE / ROOM IRC 6 (cap. 226) ***Chair: R. Roy, Université Laval***

TU-A12-1 **11h00**

All Fiber-Based Electric Field Sensors for the Power Utilitv Industrv*. **Sameer Chandani**, N.A.F. Jaeger, *University of British Columbia* — D-shaped optical fiber allows access to the evanescent optical field and replacement of all or part of the cladding with a material sensitive to a measurand which, in turn, allows for modulation of this optical field. We are investigating the use of Sm A* liquid crystals, which respond linearly to electric fields, for the design of electric field sensors. The propagation characteristics of the D-shaped optical fiber, with varying distances between the fiber core and D-flat and varying external refractive index are investigated. We present initial theoretical and measurement results of such a D-fiber sensor. These results confirm the feasibility of designing and implementing such optical sensors. Such sensors could have an entirely fiber-based sensor-head. The specific targeted application is the measurement of high-voltages in harsh environments such as power substations.

* This work is being supported by NSERC-eMPOWR

TU-A12-2 **11h15**

ROGER A. LESSARD, Université Laval

Holographic Memories

From the discovery of Holography by Dennis Gabor in 1948, many applications were proposed. The first application of Laser was for sure the realisation of a Hologram. Emmet N. Leith and Juris Upatnieks were proposing in one of their first paper the use of a hologram to record and retrieve information. Mulitplexing information was then born and, of course, holographic memories were seen as the most promising way to store information. Where is the development of this technique in 2005? A Presentation of the state of the art in Holographic Memory and discussion of the different proposed techniques that will probably permit the realization of Holographic Disks Memories in 2006 will be done.

TU-A12-3 **11h45**

Multiple Soliton Formation in Short Lengths of Photonic Crystal Optical Fibre. **Mohamad Banaee**, Jeff F. Young, *University of British Columbia* — Sub-picosecond pulse propagation through a polarization maintaining photonic crystal fibre of 1 μm core diameter is investigated. When pumping the fibre with 130 fs pulses from a Ti-Sapphire laser operated near 800 nm with average powers up to 120 mW, time-averaged spectroscopy shows that the incident spectrum evolves to contain several (up to three) red-shifted (beyond 1 μm) and well-separated spectral components after propagating through 1 m of fibre. Many of the observed nonlinear features can be reproduced by numerically solving a generalized nonlinear Schrodinger equation that includes high-order linear dispersion, and Raman scattering. The various regimes in which multiple "fundamental" self-shifting Raman solitons can be generated in this system will be discussed.

12h00 **Session Ends / *Fin de la session***

[TU-P1] CAP Achievement Medal Winner / *Récipiendaire de la médaille pour contributions exceptionnelle a la physique*

(CAP/*ACP*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

13h30 - 14h15

SALLE / ROOM IRC 2 (cap. 500) ***Chair: M. Morrow, Memorial University of Newfoundland***

TU-P1-1 **13h30**

DEREK YORK, University of Toronto

*In Search of Lost Time **

Just 100 years ago, Ernest Rutherford, the young Professor of Physics at McGill University, made one of the most important of his many remarkable discoveries – how to tell geological time. He explained this initially at the World's Fair in St. Louis in 1904, and refined the approach the following year in a Silliman Lecture at Yale University. While it took over 50 years of nuclear research for this clock to become even remotely well calibrated, in the second half of the 20th century it has come to revolutionize our knowledge of the age of the earth and the timescale of the earth's biological and physical evolution. Out of 45 years of collaborative research in the University of Toronto's Department of Physics, I will focus on how the combination of mass spectrometry, laser irradiation and neutron bombardment of mm-size crystals has helped build the timescales of lunar, human and feathered dinosaur evolution. All the ages found are based on the radioactive decay of ^{40}K to ^{40}Ar, which provides a remarkable Rutherfordian clock, useful for ages ranging from over 4 billion years down to roughly 5 thousand years, thus overlapping with carbon dating at the recent end of its range.

* This work is being supported by NSERC

14h15 **Session Ends / *Fin de la session***

[TU-P2] String Theory / *Théorie des cordes*

(DTP/*DPT*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

11h00 - 16h45

SALLE / ROOM IRC 1 (cap. 133) ***Chair: M. Wise, Caltech***

TU-P2-1 **14h15**

ROBERT MYERS, Perimeter Institute

Warped Superstring Cosmology

Currently one of the best proposals to realize inflationary cosmology in superstring theory makes use of "warped" compactifications. We examine the effects of strings for inflation and reheating in such constructions.

TU-P2-2 **14h45**

MARK VAN RAAMSDONK, University of British Columbia

An Analytical Study of Confinement/Deconfinement in Four Dimensional Gauge Theory

Quantum Chromodynamics (the accepted theory of the strong force) is believed to show confinement at low temperatures (with all quarks and gluons bound into particles with no color charge), but to be in a deconfined state (the quark-gluon plasma) at high enough temperatures. In pure Yang-Mills theory (QCD with gluons but no quarks), these two regimes must be separated by a sharp phase transition, and when the number of colors is 3 or more, it is believed to be first order. Unfortunately, the theory is very strongly coupled at the transition temperature, and there are no available analytic methods for studying the transition. In this talk, I'll show that by considering the theory at small enough finite spatial volume (on a sphere instead of flat space), it is possible to demonstrate analytically the existence of a first order deconfinement transition in the case where the number of colors is large."

15h15 **Coffee Break / Pause café**

TU-P2-3 **15h45**

MOSHE ROZALI, University of British Columbia

Helicity Amplitudes in Supersymmetric gauge Theories

We describe progress in calculating helicity amplitudes in supersymmetric gauge theories, using twistor-inspired ideas.

TU-P2-4 **16h15**

JUAME GOMIS, Robarts Research Institute

to be announced

16h45 **Session Ends / *Fin de la session***

[TU-P3] DMBP Contributed / *Papiers présentés en physique médicale et biologique*

(DMBP/*DPMB*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h45

SALLE / ROOM G279 -hos. (cap. 140) ***Chair: A. Linhananta, Lakehead University***

TU-P3-1 **14h15**

AFM Imaging of Three-Way DNA Junctions*. **Connie Roth**, Shun Lu, Yuekan Jiao, Carlo Sankar, Yi-Jeng Huang, Dipankar Sen, John Bechhoefer, *Simon Fraser University* — Three-way junctions that are designed to bind a target molecule are being explored as potential biosensors. Here, we report studies of three-way-junction DNA by atomic force microscopy (AFM). Three-way junctions of DNA have three double-stranded segments formed from three single strands designed to provide overlapping complementarity. If, at the junction, there are unpaired DNA bases, the three-way junction is flexible, whereas if there are no unpaired bases, the junction is believed to be more rigid (based on fluorescence resonance transfer experiments). Here, we report AFM studies of these systems. We find that three-way-junction DNA lies flat on substrates and all three branches may be clearly resolved. By contrast, junctions with no unpaired bases show a more compact, higher topography signal. The topographical image is consistent with the three-dimensional structure that one expects a more rigid junction to have. These studies show that AFM is a useful tool for exploring the global shape changes to DNA induced by small changes in the underlying base sequence.

* This work is being supported by NSERC NanoIP, AFM Net

TU-P3-2 **14h30**

The Equilibrium Properties and Folding Kinetics of an all-atom Go Model of the Trp-Cage*, **Apichart Linhananta**, J.B. Boer, I.M. MacKay, *Lakehead University* — The ultra-fast folding 20-residue Trp-cage protein is quickly becoming a new benchmark for MD studies. Already several all-atom simulations have probed its equilibrium and kinetic properties. In this work an all-atom Go model is used to accurately represent the side-chain packing and native atomic contacts of the Trp-cage. The model reproduces the hallmark thermodynamics cooperativity of small proteins. Folding simulations observe that in the fast-folding dominant pathway, partial -helical structure forms before hydrophobic core collapse. In the slow-folding secondary pathway, partial core collapse occurs before helical structure. The slow folding rate of the secondary pathway is attributed to the loss of side-chain rotational freedom, due to the early core collapse, which impedes the helix formation. A major finding is the observation of a low-temperature kinetic intermediate stabilized by a salt bridge between residues Asp-9 and Arg-16. Similar observations (R.Zhou, Proc. Natl. Acad. Sci. 100, 13280 (2003))were reported in a recent study using an all-atom model of the Trp-cage in explicit water, in which the salt-bridge stabilized intermediate was hypothesized to be the origin of the ultra-fast folding mechanism. A theoretical mutation that eliminates the Asp-9-Arg-16 salt bridge, but leaves the residues intact, is performed. Folding simulations of the mutant Trp-cage observe a two-state free-energy landscape with no kinetic intermediate, and a significant decrease in the folding rate, in support of the hypothesis.

* This work is being supported by NSERC

TU-P3-3 **14h45**

Elasticity and Stability of an Elastic Helical Rod*, **Zicong Zhou** [1], P-.Y.L. Lai [2], B. Joós [3], [1] *Tamkang University, Taiwan*, [2] National Central University, Taiwan, [3] University of Ottawa, Canada — We derive the general shape equations in terms of Euler angles for a uniform elastic rod with spontaneous torsion and curvatures and subjected to external force and torque. Our analytic based results show that the extension of a helical rod may undergo a one-step discontinuous transition with increasing stretching force. This

agrees quantitatively with experimental observations for a helix in a chemically defined lipid concentrate. The larger the twisting rigidity, the larger the jump in the extension. The effect of torque on the jump is however dependent on the value of the spontaneous torsion. In contrast, the increasing spontaneous torsion encourages the continuous variation of the extension. An "over-collapse" behavior is observed for the rod with asymmetric bending rigidity, and an intrinsic asymmetric elasticity under twisting force is found.

* This work is being supported by NSC of ROC, NSERC of Canada

TU-P3-4 15h00

Characterization of a Nanosensor for Trans-Membrane Identification of Single Nucleic Acid Molecules. **Matthew Wiggin**, Jonathan Nakane, Andre Marziali, *University of British Columbia* — We present the construction and operation of a self-assembling nanosensor for sequence-specific oligonucleotide detection across a lipid bilayer. The sensor is constructed of two main components: a single alpha-hemolysin nanopore self-assembled into a lipid bilayer, and a DNA probe complementary to the analyte oligonucleotide at one end and tethered to avidin at the other end. The sensor is assembled by electrophoretic insertion of the probe into the cis-side of the nanopore. Hybridization of the probe to analyte on the trans- side of the pore traps the probe in place, and increases the time constant for probe exit on subsequent voltage reversal. Probe insertion and exit are observable as changes in electrical impedance through the pore. The present round of experiments have examined the interaction between the probe molecule, pore, and target molecules. We have varied factors such as the length of the probe molecule, and both holding potential and the length of time the probe is allowed to reside in the pore while 'fishing' for analyte molecules. The results of these experiments highlight performance characteristics, and allow optimization of the system. The nanosensor shows promise for applications such as single nucleotide polymorphism detection, concentration measurements of biomolecules and potentially, for in vivo detection of specific RNA sequences.

TU-P3-5 15h15

Selective Pre-Concentration of Nucleic Acids by Synchronous 2-D Non-Linear Electrophoresis*. **Andre Marziali**, D. Broemeling, J. Pel, N. Shah, S. Inglis, C. Cowdell, J. Hale, E. Holtham and L.A. Whitehead , *University of British Columbia* — We have demonstrated that a novel form of multi-dimensional non-linear electrophoresis can be used to selectively transport, concentrate and purify charged molecules in solution. Generally, electrophoretic current fields are divergence free, which prevents spatial concentration of DNA by standard electrophoresis in uniform, non-binding media. However, exploiting the field-dependence of DNA mobility, combinations of alternating dipole and quadrapole fields can achieve DNA concentration from dilute solutions to a stable electrode-less focusing point in a pre-cast agarose gel. An existing limitation of extracting low abundance nucleic acids from varied samples limits in part the practicality, affordability, and sensitivity of assays in fields such as the identification of cancer DNA biomarkers or pathogen detection from blood serum or bodily fluids, as well as the identification of environmental pathogens for human health and food and water safety. Our method represents an enabling technology to pre-concentrate this DNA from raw, unfiltered samples for many of these existing assays. Extraction methods we have also developed based on non-linear electrophoresis can be used to remove this concentrated DNA into a buffer solution, without any chemical or sample handling steps such as centrifugation. The DNA pre-concentration technology is a purely electrophoretic demonstration of a general form of particle transport based on Synchronous Coefficient of Drag Alteration (SCODA), so the theory behind this concept, current results and several other envisioned applications will be presented.

* This work is being supported by NIH

TU-P3-6 15h30

Influence of Frequency Noise on the Analysis of NMR Free Induction Decays*. **Jason Louis Hobson**, C.P. Bidinosti, M.E. Hayden, *Simon Fraser University* — Fluctuations in the magnetic field can complicate the analysis of data from magnetic resonance experiments that involve long spin coherence times. For example, in our experiments with polarized ^{3}He gas we routinely observe transverse nuclear relaxation times (T_2^*) well in excess of 10^2 seconds. At this level, a 100 pT change in the field is sufficient to cause the accumulation of phase shifts greater than 2p over the nuclear induction signal lifetime. We have recently undertaken a numerical study that examines the accuracy of non-linear least squares fit parameter extraction from model FID time-series data in the presence of Gaussian distributed amplitude and frequency noise. In particular, we compare the reliability of fit parameters that are extracted from a model function involving a complex damped sinusoid to those that are extracted from a simple exponential decay. The latter approach is analogous to a conventional power spectrum analysis, which is known to change the character of the amplitude noise to a Rician distribution and thereby bias fit parameters under low signal-to-noise ratio (SNR) conditions. A summary of our work to date and its implications will be presented.

* This work is being supported by NSERC, BCASI

TU-P3-7 15h45

Power Absorption by a Spherical Phantom in the Context of Low-Field MRI*, **Erin Chapple**, C.P. Bidinosti, M.E. Hayden, *Simon Fraser University* — Low-field magnetic resonance imaging (MRI) with hyperpolarized noble gases is a relatively new field, which has many practical aspects that remain to be characterized. In particular, it is necessary to re-examine fundamental signal-to-noise ratio (SNR) limitations and safety issues related to the absorption of electromagnetic power in this regime. For this purpose, we studied the effects of eddy currents induced in a weakly conducting spherical phantom (NaCl solution) by a uniform oscillating magnetic field over the frequency range 100 kHz - 1 MHz. We have built upon the approach taken by Carlson to derive analytical expressions for the magnetic field and effective resistance of the sphere. Components of the magnetic field were measured as a function of frequency and position using a small probe coil, while the effective resistance was measured as a function of frequency and sphere radius using cavity perturbation. Our results agree with the functional dependence of the independent variables as predicted by the model. The conductivity of the solution was determined by fits of the model to the data, and is consistent with two independent determinations of the DC conductivity. These experiments verify that our technique can be used to accurately measure induced losses in human subjects at low frequencies.

* This work is being supported by NSERC, BC ASI, SFU

TU-P3-8 16h00

Daily Ultrasound Guided IMRT of Prostate Cancer. **Albert Y.C. Fung**, C.A. Enke, K.M. Ayyangar, *Nebraska Medical Center* —Prostate cancer treatment utilizing intensity modulated radiation therapy (IMRT) with daily ultrasound targeting and localization techniques has been a routine procedure at the Nebraska Medical Center since 2000. Targeting and localization were verified by the radiation oncologist after the initial laser and skin mark setup. Positional adjustments were completed by moving the couch to align for daily positional variances. Directional prevalence of isocenter adjustment and prostate motion was analyzed from 4154 ultrasound alignment fractions on 130 prostate patients. Polar histograms in 3 cardinal views show the prevalence of prostate motion in superior-posterior directions. The average direction is about 27º from the superior axis. The average changes of prostate position in SI, AP, LR directions and in radial distance are 0.25, -0.13, 0.03, and 0.92 cm respectively, with positive directions toward superior, anterior, and left. The Pearson linear correlation coefficients for LR-SI, AP-SI, LR-AP directions are 0.027, 0.11, 0.078 respectively. Scatter plots infer slight preponderance along posterior and superior directions. Daily displacement may be due to variable filling of bladder and rectum, or the pressure of the ultrasound probe on the patient's abdomen. The result also suggests more geometrical planning margins around the clinical target volume on the posterior and superior directions. In conclusion, pre-treatment ultrasound guidance indicates a prevalence of prostate shift from planning position in the superior-posterior direction, with an average closer to the superior axis. Ultrasound localization is a useful technique in precise delivery of radiotherapy.

TU-P3-9 16h15

A Statistical Analysis of the Initial Biodistribution of ^{153}Sm-EDTMP in a Canine*. **Eduardo Galiano**, M. Stradiotto, *Laurentian University* — ^{153}Sm ($t_{1/2}$ = 46 hours) emits a 103 keV gamma photon and two medium energy beta particles [1]. Five mCi of ^{153}Sm-EDTMP were administered to a clinically normal dog and whole body scans were obtained at 15 minutes, 2 hours, and 24 hours post injection (PI) closely following a method suggested by Lattimer *et al* [2]. Regions of interest (ROI's) were drawn representing abdomen, knee, rib, vertebral bodies, bladder, kidney, and liver, in each image. For each ROI, the mean intensity and standard deviation were computed, and a histogram was created. Clinically significant increased uptakes were found in liver and kidney.

1. F.H. Attix, W.C. Roesch, and E. Tochlin, 1968. *Radiation dosimetry*. New York, Academic Press: pp 109.
2. J.C. Lattimer, L.A. Corwin, J. Stapleton *et al.*, 1990a., "Clinicopathologic findings in normal beagle dogs given 153Sm-EDTMP", *J Nucl Med*; **31**:586-593.

* This work is being supported by Laurentian University

TU-P3-10 **16h30**

Modeling Nano-Particle Rotation in Magnetocarcinotherapy*. **J. Carl Kumaradas** [1], M. Rihaoui [2], R.H. Kraus Jr. [2], B. Wright [2], [1] *Ryerson University*, [2] Los Alamos National Laboratory, Los Alamos, NM — The challenge in minimally invasive therapies such as thermal ablation and coagulative therapy, photodynamic therapy, and Brachytherapy remains the localization of the treatment dose to the tumour while sparing nearby critical tissue. Magnetocarcinotherapy (MCT) is a new approach being developed that combines the detection, imaging, and treatment of cancer into a single modality. It involves binding nanoparticles of magnetic superalloys to monoclonal antibodies and other molecules that selectively target cancer cells. These nanoparticles are systemically delivered into a patient through the blood stream and will preferentially collect in tumours as a consequence of the targeting molecules binding to receptors uniquely expressed by cancer cells. Focal concentrations of these particles in tissue can be imaged using a Superconducting Quantum Interference Device (SQUID) array. Once detected, the tumours can be immediately destroyed by applying a rotating external magnetic field that causes the nanoparticles to rotate resulting in localized heating at the tumor site (primarily as a consequence of viscous drag). Models are being developed to study the MCT concept. One of these models is of the rotational motion of the nanoparticles. The analysis of the motion was done by simulating the individual motion of several particles. When using a Stokes model of viscous drag in a low Reynolds number fluid and including the magnetic interaction between particles the simulations indicate an unexpected rise in heating rate as a result of particle-particle interactions. These details of this model and the latest results from it will be presented.

* This work is being supported by Los Alamos National Laboratory

16h45 **Session Ends / *Fin de la session***

[TU-P4] Strong Field Physics and Spectroscopy / *Physique et spectroscopie en champ fort*

(DMBP/*DPAM*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h45

SALLE / ROOM IRC 6 (cap. 226) ***Chair: J. Sanderson, University of Waterloo***

TU-P4-1 **14h15**

ANDRÉ D. BANDRAUK, Université de Sherbrooke

Molecules in Intense Laser Fields and Electron-Nuclear Dynamics from Femto to Attosecond Time Scales

The photophysic of atoms with high intensity lasers is dominated by the process of electron ionization and laser induced electron recollision, with the parent ion [1]. The recollision time can be tuned as a function of laser frequency to span few femtoseconds (fs) (10^{-15} sec) to attoseconds (asec) (10^{-18} sec) times. Molecules introduce a new complexity, nuclear time scales which for protons occur in the region 8-10 fs. In intense fields, dissociative ionization, allows for molecules to reach large internuclear distances where Charge Resonance Enhanced Ionization (CREI) occurs thus increasing by several orders of magnitude ionization rates [2-3]. During recollision in molecules, electrons will undergo Coulomb refocusing. Both nonlinear effects, enhanced ionization and refocusing of the recollision electron leads to new efficient sources of high order harmonic generation (HOHG) from symmetric and nonsymmetric molecules [4]. Molecular electron recollision can lead to Laser Induced Electron Diffraction (LIED) [5] and molecular orbital tomography by inversion of HOHG spectra [6]. Finally, using asec pulses synthetized from HOHG spectra [7], one can create coherent molecular electron wavepackets. These are localized on asec time scales on various nuclei. Methods of detection and characterization of such electron wavepackets in molecules will be proposed from numerical solutions of the time-dependent Schroedinger equation for the molecular ion,[8].

1. P.B. Corkum, *Phys. Rev. Lett.* **71**, 1994 (1993).
2. T. Zuo, A.D. Bandrauk, *Phys. Rev. A* **52**, 2511 (1995).
3. T. Seideman, M.Y. Ivanov, P.B. Corkum, *Phys. Rev. Lett.* **75**, 2819 (1995).
4. G. Lagmago Kamta, A.D. Bandrauk, P.B. Corkum, *Phys. Rev. Lett.* (submitted 2005).
5. T. Zuo, A.D. Bandrauk, P.B. Corkum, *Chem. Phys. Lett.* **259**, 313 (1996).
6. J. Itatani *et al.*, *Nature* **432**, 867 (2004).
7. A.B. Yedder *et al.*, *Phys. Rev. A* **69**, 041802 (2004).
8. G. Yudin *et al.*, (submitted to *Phys. Rev. Lett.* 2005).

TU-P4-2 **14h45**

C.D. LIN, Kansas State University

Probing Dynamics of Molecules with Few-Cycle Intense Laser Pulses *

When molecules are exposed to intense laser pulses, they can be aligned or/and ionized by the lasers. By using laser pulses with durations of less than 10fs, the effect of laser alignment of molecules can be neglected. For such short pulses the alignment dependence of the ionization rates directly reflects the geometric distributions of the electronic density of the highest occupied molecular orbital. Recent studies from such experiments will be presented. By following the time dependence of the ionization dynamics, it is shown further that the time of ionization bursts can be determined to sub-fs accuracy by measuring the kinetic energy of the molecular fragments.

* In collaboration with M. Bolduc, X.M. Tong, Kansas State University

15h15 **Coffee Break / Pause café**

TU-P4-3 **15h45**

THOMAS BRABEC, University of Ottawa

Many Body Dynamics in Strong Fields

Whereas substantial progress has been made in ground state calculations of complex materials not much is known about the dynamics of these systems. Examples of complex materials in strong fields are: ionization of molecules and clusters in strong laser fields, electron transport in single molecule transistors and quantum dots, etc. Theoretical treatment of the above systems combines two of the hardest problems of theoretical physics, which are multi-electron dynamics and non-perturbative phenomena. In my talk experimental and theoretical progress in this exciting, new area of physics will be reviewed.

* In collaboration with L. Ramunno, University of Ottawa

TU-P4-4 **16h15**

Relativistic Shifts of α_μ in Muonic Atoms*, **Jess H. Brewer** [1], A.M. Froese [2], B.A. Fryer [3], [1] *TRIUMF*, [2] University of British Columbia, [3] Chatelech Secondary School — Precise measurements of the magnetogyric ratios of negative muons in the ground states of muonic atoms of ^{12}C, ^{16}O, ^{24}Mg, ^{28}Si, ^{32}S, ^{40}Ca, ^{nat}Ti, ^{nat}Zn, ^{nat}Cd and ^{nat}Pb have been achieved in high field μ^- spin precession experiments using a backward muon beam with a substantial transverse spin polarization. The precision for $^{12}C\mu^-$ is ± 23 ppm, of which only 6 ppm is statistical; for $^{nat}Zn\mu^-$ the precision is ± 269 ppm and for $^{nat}Pb\mu^-$ it is ± 0.23%. Such results may provide a new testing ground for quantum electrodynamics in very strong Coulomb fields.

*This work is being supported by NSERC, NRC and CIAR

TU-P4-5 **16h30**

High Temperature Near-Infrared Emission Measurements of $HC^{15}N$*. **Adriana Predoi-Cross** [1], D. Hemsing [1], G. Ch. Mellau [2], [1] *University of Lethbridge,* [2] Justus-Liebig-Universität Giessen, Germany — Since HNC was first discovered by accident in radio telescope observations of interstellar space, it has been the subject of many millimeter-wave laboratory measurements, but very few infrared studies. The near-infrared emission spectrum of $HC^{15}N$ has been measured in the 6050-6500 cm^{-1} spectral range. The experiments were carried out at the Physikalisch-Chemisches-Institut, Justus-Liebig-University using a Bruker IFS 120 HR high resolution FT-IR spectrometer and a quartz cell filled with *gas* and heated to 1400 K. Several levels containing more than one quantum of n_2 were observed for the first time. High rotational levels up to J = 60 were observed as well as vibrational levels up to ν_2 = 6. The molecular constants for the ground state were known from previous studies. We have used the spectroscopic analysis software package Symath to analyse and interpret our spectra. The lineshape analysis feature of the software allowed us to accurately identify overlapping transitions.

* This work is being supported by NSERC

16h45 **Session Ends / *Fin de la session***

[TU-P5] Correlated Electrons: Superconductivity / *Électrons corrélés: supraconductivité*

(DCMMP/*DPMCM*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h45

SALLE / ROOM IRC 2 (cap. 500) ***Chair: A. Damascelli, University of B.C.***

TU-P5-1 **14h15**

HAE-YOUNG KEE, University of Toronto

Anisotropic Spin Excitation in High Temperature Superconductors: Signature of Electronic Nematic Order *

Recently it has been proposed that quantum analog of liquid crystal states — dubbed as electronic smectic and nematic phases — may play an important role in physics of strongly correlated systems. We will present the behaviors of spin and charge susceptibilities in the *d*-wave superconducting state whose the underlying electronic dispersion is anisotropic due to the formation of the electronic nematic order. We will show that the amplitude of the incommensurate peaks in the spin susceptibility reveals a pronounced anisotropy in the momentum space. The relevance of our findings to the magnetic scattering pattern observed in recent neutron scattering measurements on untwinned optimally doped high temperature cuprates will be discussed.

This work is being supported by NSERC, CIAR, Alfred P. Sloan

* In collaboration with Y-J. Kao, University of Toronto

TU-P5-2 **14h45**

Vortex Vibrations and NMR T_2 Relaxation in YBCO*. **Rachel Wortis**, T. Lu, *Trent University* — The similarity of spin echo decay rates for planar and apical oxygen in the vortex state of YBCO suggest that T_2 is dominated by vortex motion. We present a calculation of T_2 assuming over damped harmonic vibrations in an anisotropic 3D superconductor with the field applied parallel to the c axis. The time dependence of the spin echo decay as well as the field, temperature and position dependence of the decay rate are compared with available data, and we examine the sensitivity of results to parameters such as the vortex viscosity and mean-square deviation from equilibrium.

* This work is being supported by NSERC

TU-P5-3 **15h00**

Coexistence of Magnetism and Superconductivity in Ultraclean Underdoped $YBa_2Cu_3O_{6.37}$*. **Roger Miller** [1], R.F.K. Kiefl [2], J.H.B. Brewer [2], F.D.C. Callaghan [3] , J.E.S. Sonier [3], D.A.B. Bonn [4], R.L. Liang [4], W.N.H. Hardy [4], [1] *TRIUMF*, [2] University of British Columbia/TRIUMF/CIAR, [3] Simon Fraser University, [4] University of British Columbia/CIAR — Muon spin rotation and magnetization measurements in ultra clean single crystals of heavily underdoped superconducting $YBa_2Cu_3O_{6+x}$ ($x \approx 0.37$) are presented. The materials show a sharp superconducting transition below T_c = 20K. By field cooling and shifting the applied field, we show that the superconducting state pins magnetic flux and develops a flux lattice below T_c, indicating that the superconducting state exists throughout the sample on a microscopic scale. The superfluid density is estimated and shown to be small. At similar temperatures T < 20 K, a disordered antiferromagnetic state appears on a nanoscale with at least one well-defined internal field probed by the muon. The internal field has a magnitude close to that seen in the antiferromagnetic parent compound and is present throughout the bulk of the sample. These two states therefore coexist on a nanometer lengthscale and over a narrow region of oxygen doping.

* This work is being supported by NSERC

TU-P5-4 **15h15**

Magnon Dispersion of the Half-Filled Hubbard Model: A Comparison with Neutron Scattering on La_2CuO_4*. **Walter Stephan**, *Bishop's University* — The magnon dispersion relation of the half-filled Hubbard model in intermediate coupling is calculated via a combination of effective Hamiltonian and exact-diagonalization techniques. The magnon disperion along the magnetic Brillouin zone boundary is shown to differ significantly from that of the simple nearest neighbour Heisenberg model, and is in good agreement with experimental neutron scattering measurements on La_2CuO_4 for parameters near U/t=10. This coupling strength is consistent with that required to explain the angular resolved photoemission spectra of the doped Mott insulators.

* This work is being supported by NSERC

15h30 **Coffee Break / Pause café**

TU-P5-5 **15h45**

JEFF E. SONIER, Simon Fraser University

Hole-Doping Dependence of the Effective Magnetic Penetration Depth and Vortex Core Size in $Y_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ *

We report the first systematic study of the hole-doping dependence of the internal magnetic field distribution in the vortex state of single crystal $Y_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ by the muon spin rotation (μSR) technique. From an analysis of these measurements we have determined the doping dependence of both the effective in-plane magnetic penetration depth λ_{ab} and the vortex-core size. The latter reflects the hole-doping dependence of the in-plane coherence length ξ_{ab}, a fundamental length scale that has been notoriously difficult to measure. Our measurements of λ_{ab} indicate that if there is a universal scaling of the superfluid density ($\propto 1/\lambda_{ab}^2$) with the superconducting transition temperature (T_c), it deviates substantially from the linear relation of the so-called *Uemura* plot. We also find that the coherence length ξ_{ab} increases in the underdoped region. As possible sources of this behaviour we discuss the flexibility of the vortex cores, and the relationship of ξ_{ab} to experimentally determined magnetic field scales in the high-temperature cuprates.

* In collaboration with F.D. Callaghan [1], J.H. Brewer [2], M. Laulajainen [1], C. Kaiser [1], D.A. Bonn [2], R. Liang [2], W.N. Hardy [2], W.A. Atkinson [3], [1] Simon Fraser University, [2] University of British Columbia, [3] Trent University

TU-P5-6 **16h15**

Muon Spin Rotation Measurements of the Vortex Core Size in Single-Gap and Multi-Gap Type-II Superconductors*, **Fergal Callaghan**, M. Laulajainen, C.V. Kaiser, J.E. Sonier, *Simon Fraser University* — We present muon spin rotation (μSR) measurements of the vortex core size in the single-gap superconductor V_3Si and the multi-gap superconductor $NbSe_2$. Both temperature and applied magnetic field strongly affect the electronic structure of the vortex cores in these type-II materials, which in turn affects the spatial extent of the cores themselves. Increasing temperature causes excitations of the localized quasiparticle core states, whereas increasing magnetic field results in a delocalization of the core states. We show that the measured behavior of the vortex core size in these materials is fully explained in terms of these effects, and a comparison to recent theoretical work is made.

* This work is being supported by NSERC

TU-P5-7 **16h30**

Exact Summation of Vertex Corrections to the Penetration Depth in d-Wave Superconductors*, **Andrew Iyengar,** M. Franz, *University of British Columbia* — A variety of experiments suggest that in the cuprates, the low-energy superconducting quasiparticles undergo forward scattering from extended impurity potentials. We argue that when such potentials dominate the scattering, the penetration depth may be computed in a simple zero-angle scattering approximation (ZSA), in which the vertex corrections to the Meissner effect may be summed exactly. We find a remarkably simple relationship between the normal fluid density and the quasiparticle density of states of the disordered system which holds for every realization of the disorder. We expect this result to be relevant to the ab-plane penetration depth in high-purity single crystals of underdoped YBCO.

* This work is being supported by NSERC, CIAR, Sloan Foundation

16h45 **Session ends / *Fin de la session***

[TU-P6] Materials: Growth and Characterization / *Matériaux: croissance et caractérisation*

(DCMMP/*DPMCM*)

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h30

SALLE / ROOM IRC 3 (cap. 108) ***Chair: K. Robbie, Queen's University***

TU-P6-1 **14h15**

Two Magnon Scattering on Self-Assembled Network of Misfit Dislocations*, **Bret Heinrich**, O.M. Mosendz, B.K. Kardasz, *Simon Fraser University* — The development of magnetic devices based on magnetic ultrathin films operating at microwave range of frequencies requires a thorough understanding of the mechanism of magnetic relaxation. The Ferromagnetic Resonance (FMR) linewidth is a sensitive tool to investigate structural defects. The static and dynamic properties of magnetic Fe/Pd-Au/Fe(001) ultrathin film crystalline structures prepared on GaAs(001) templates were investigated by FMR from 4 to 73 GHz. The samples were prepared by Molecular Beam Epitaxy (MBE). It will be shown that the formation of a self-assembled nanoscale network of misfit dislocations in crystalline structures can be detected during the growth by fan-out diffraction features in reflection high electron energy diffraction (RHEED) and in situ STM. The network of misfit dislocations results in a strong extrinsic damping. The out-of-plane FMR measurements of the FMR linewidth have revealed that the extrinsic damping is caused by two-magnon scattering. The contribution to the FMR linewidth from two-magnon scattering is strongly anisotropic and follows the rectangular symmetry of the glide planes of the misfit dislocation network. It will be shown that the observed strong anisotropy in two-magnon scattering can be interpreted by Fourier components of magnetic defects, and a strong anisotropy in damping is caused by channeling of spinwaves along the network of misfit dislocations. In magnetic bi-layers the rf spin momentum can be exchanged by spin pumping and spin sink mechanism. It will be shown that the propagation of the spin current in Pd/Au(001 spacers is affected by a partial reflection of spin current at the Pd/Au interface.

* This work is being supported by NSERC

TU-P6-2 **14h30**

Giant Isotope Effects in H- and D-ion Implanted Semiconductors, **B. Terreault**, *INRS-EMT* -- We report the insights gained by the use of of isotope substitution in the study of ion implantation induced defects in semiconductors. While investigating blistering by low-keV ions (aiming at "ion-cutting" sub-100-nm layers), we discovered a giant isotope effect in both Si and GaAs: blistering with low-keV D ions required 2 to 3 times higher doses than with H ions. This effect contradicts our intuitions based on hydrogen chemistry and ion implantation physics, and raises fundamental questions about hydrogen interactions in semiconductors. Si-H/D bonding and radiation defects were then studied by Raman scattering, Rutherford Backscattering-Channeling and Positron Annihilation Spectroscopies. Modeling of ion implantation and H/D interactions with defects was pursued using kinetic lattice Monte-Carlo calculations. Both the experiments and the calculations surprisingly show that, although D ions do produce more Frenkel pairs than H ions, dynamic annealing during the room-temperature implantation leaves FEWER defects in D-irradiated than in H-irradiated Si. High vacancy/ion ratios (as with D) favour the formation of incompletely passivated multivacancies, whereas low vacancy/ion ratios lead to highly passivated and stable monovacancies.

TU-P6-3 **14h45**

T. TIEDJE, University of British Columbia

Surface Dynamics During MBE Growth of GaAs on Patterned Substrates *

Studies of surface shape evolution during MBE homoepitaxial growth on patterned GaAs substrates have led to an understanding of how the evolution of substrate topography during growth can be used to obtain information about the diffusion of adatoms and their interactions with step edges, and even to control the lateral migration of deposited adatoms. In-situ light scattering measurements and ex-situ atomic force microscopy experiments on flat and patterned GaAs surfaces, show that adatoms respond to surface slopes as if there were a potential barrier at step edges that favours the downhill migration of adatoms. Using this concept we are able to describe the complex shape evolution observed during growth on patterned GaAs (100) surfaces using coupled rate equations for the adatom dynamics and the surface height [1]. Similar shapes are also observed in kinetic Monte Carlo simulations of a solid-on-solid model that incorporates the same physical processes. In the limit of low surface slopes and small amplitudes we show that the rate equations reduce to a conservative version of the nonlinear Kardar-Parisi-Zhang equation. This derivation leads to expressions for the coefficients in the growth equation in terms of the parameters which describe the adatom diffusion and interactions with surface steps. These parameters can be determined from measurements of surface topography during growth.

1. A. Ballestad *et al.*, *J. Cryst. Growth,* **271**, 13 (2004); Phys. Rev. Lett. 93, 159604 (2004)

* In collaboration with A. Ballestad, J.H. Schmid, B. Lau, University of British Columbia

TU-P6-4 **15h15**

Crystallization and Electro-Optical Properties of In_2O_3 and ITO Thin Films*, **Frederick Ojo Adurodija**, Lynne Semple, R. Bruening, Mount Allison University — Amorphous thin films of indium oxide (In_2O_3) and 10-wt% tin doped indium oxide (ITO) thin films were prepared by pulsed-laser deposition. These films were crystallized upon heating in vacuum at a rate of 0.2°C/s, while the evolution of the structure was observed by *in-situ* X-ray diffraction measurements. Fast crystallization of the films is observed in the temperature ranges 165-210°C and 185-230°C for the In_2O_3 and ITO, respectively. The crystallization kinetics are well described by a Kissinger model, with activation energies of 2.30±0.04 eV and 2.44±0.08 eV and frequency factors of $9x10^{22}$ Hz and $1.2x10^{22}$ Hz for the In_2O_3 and ITO films, respectively. Variations in the resistivity of the films depend on the evolution of the structure, the oxygen content and the activation of tin dopants in the films. A low of $3.7x10^{-4}$ Ω cm was obtained for In_2O_3 film at 100°C. The structures of the films observed here during heating are compared with those obtained upon film growth at different temperatures.

* This work is being supported by NSERC

15h30 **Coffee Break / Pause café**

TU-P6-5 **15h45**

The Characterization of Temporary Extrusion Failures in Accelerated Electromigration Tests of Cu Metallization*. **Yan Zhang** , J.H. Choy , G.H. Chapman, K.L. Kavanagh, *Simon Fraser University* — The transition from Al metallization to Cu metallization brings new reliability problems to integrated circuit technology. Accelerated electromigration tests with Cu 0.13 μm inteconnects have revealed a novel failure mode, short-lived extrusions that induce a "soft failure" instead of the traditional, permanent "hard failure" induced by voids. Under both DC and AC stress, extrusions exist temporarily, self-healing after a short-lived short circuit failure. Our results support the widely held view that in Cu metallization, diffusion along the top surface of Cu lines is the major atomic transport mechanism rather than diffusion along internal grain boundaries true for Al. Our electrical measurements are supported by back-scattered scanning electron images showing extrusions along the Cu/capping dielectrics interface. A two-dimensional numerical model of the diffusional shape evolution of these extrusions under DC stress has been developed and shows that capillary forces alone can rupture a thin and narrow copper extrusion in order to reduce the interfacial free energy, healing the short circuit failure. Furthermore, the addition of the electron wind force across the extrusion accelerates such healing processes in agreement with our experimental observations. Our findings suggest continuous monitoring of the leakage current between the test line and neighboring circuits and a high data-sampling frequency are necessary to detect this soft failure mode.

* This work is being supported by BC Advanced Systems Institute

TU-P6-6 **16h00**

Modeling the Surface Shape Evolution of Flat and Patterned GaAs (001) Substrates During Epitaxial Growth. **Anders Ballestad**, T. Tiedje, M. Whitwick, B. Lau, J. Schmid, *University of British Columbia* — Continuum models describe the shape of GaAs(001) surfaces during vapour deposition in the limit of low surface slopes (<5%) [1], but break down for surfaces with larger slopes that are of interest for lateral pattern formation and device fabrication [2]. We have investigated the evolution of such surface shapes during MBE growth, using a combination of *in-situ* optical monitoring, ex-situ structural characterization and theoretical modeling. Earlier, we showed that this material system was stable during epitaxy, and that rough starting surfaces smooth out during growth [1]. This experimental fact can most easily be explained by an inverse ES barrier at the step edges that favour downhill adatom-migration. This mechanism is incorporated into a new growth model that also includes adatom diffusion, island nucleation, and step attachment/detachment [3]. It gives excellent agreement with the complex surface shapes that are observed in regrowth on patterned GaAs surfaces as a function of layer thickness and growth temperature for surface slopes up to ~50%. The model is highly non-linear for large surface slopes, consistent with experiments. It correctly predicts the peak-to-valley amplitude overshoot reported in Ref. 2, and also the asymptotic behavior for low slopes [1]. Experimental results will be presented on surface shapes as a function of growth rate and pitch of the substrate surface pattern (200 nm - 3 microns).

1. A. Ballestad, *et al.*, *PRL***86**, 2377 (2001); *PRB***65**, 205302 (2002)
2. Shah *et al.*, *APL***83**, 4330 (2003); H.-C. Kan *et al.*, *PRL***92**, 146101 (2004)
3. A. Ballestad *et al.*, *J. Cryst. Growth,* **271**, 13 (2004)

TU-P6-7 **16h15**

The Bandgaps of the Quaternary Dilute Nitride Alloys $GaN_xAs_{1-x-y}Bi_y$ and $Ga_{1-y}In_yN_xAs_{1-x}$*. **Scott E. Webster** [1], S. Tixier [1], E.C. Young [1], T. Tiedje [1], S. Francoeur [2], A. Mascarenhas [2], P. Wei [3], F. Schiettekatte [3], [1] *University of British Columbia*, [2] National Renewable Energy Laboratory, [3] Université de Montréal — We report strong room temperature photoluminescence and electroreflectance from $GaN_xAs_{1-x-y}Bi_y$ alloys (x < 1.6%, y < 2.6%) grown by molecular beam epitaxy. The nitride-bismide alloys were grown with an RF plasma source for N at a temperature of 380°C and Ga:As flux ratio » 1 in order to incorporate Bi. The bandgap of this alloy can be approximated by the band-gap of GaAs minus the reduction in gap associated with the effects of N and Bi alloying individually. An improvement to this approximation is presented in the form of a general one-parameter method for fitting the composition dependence of the bandgaps of quaternary semiconductor alloys. The model is in excellent agreement with data for $Ga_{1-y}In_yN_xAs_{1-x}$ with a standard deviation of 28~meV for 9 data points. The model predicts the possibility of emission beyond 1.55 μm for GaNAsBi grown on GaAs with 3% N and 3% Bi.

* This work is being supported by NSERC

16h30 **Session Ends / *Fin de la session***

[TU-P7] (DPP) General Plasma Physics / *Physique générale des plasmas*

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h30

SALLE / ROOM IRC 4 (cap. 135) ***Chair: Y.Y. Tsui, University of Alberta***

TU-P7-1 **14h15**

HOUYANG GUO, University of Washington

A Unique High-Beta, Sustainable Plasma Confinement Configuration *

The Field Reversed Configuration (FRC) is a self-organized high-beta plasma with the tendency to assume a preferred plasma state. This has been demonstrated in the Translation, Confinement and Sustainment (TCS) experiment where high temperature FRCs are produced by translating energetic plasmoids formed in the normal theta pinch manner into a confinement chamber. The plasmoids survive the violent dynamics of supersonic reflections off magnetic mirrors, producing a high-beta, near-FRC state with the magnetic helicity approximately preserved. Theta pinch formed FRCs are, however, limited to only tens of mWb fluxes and sub-msec lifetimes. TCS has demonstrated, for the first time, formation and steady-state sustainment of standard, flux-confined FRCs using Rotating Magnetic Fields (RMF). The RMF also appears to provide stability to the interchange modes, which are ubiquitous instabilities present in FRCs and other low magnetic shear confinement configurations, such as spheromaks and reversed field pinches. One of the principal worries about RMF sustainment is that the transverse field would open up all the field lines and prevent good confinement. This issue has recently been addressed by using an anti-symmetric RMF configuration. It has been demonstrated that the energy confinement is dramatically improved for the FRCs sustained by anti-symmetric RMF drive about the midplane of the FRC due to reduced conduction and convection losses. A 2D field line tracking code shows that field lines are kept close even at the edge for the TCS experimental conditions. This is extremely important for future use of RMF drive on hotter FRCs.

* On behalf of the RPPL Team, University of Washington

TU-P7-2 **14h45**

Plasma Ion Implantation of Silicon for Electroluminescent Device Applications*. **Michael P. Bradley**, J.T. Steenkamp, *University of Saskatchewan* — This talk will review our group's initial steps toward the goal of creating visible-light luminescence centers in silicon via the technique of plasma ion implantation. In this technique the silicon sample is immersed in a hydrogen-ion inductively-coupled plasma (ICP) sustained by a high-power RF generator. The hydrogen ions are implanted below the silicon surface by applying a pulsed negative bias voltage to the silicon sample. Large pulse-count high-voltage implants should result in a high dose of hydrogen buried below the silicon surface. The buried hydrogen is then diffused out via a high temperature (600 Celsius) furnace annealing step. In this process it is well known that as the hydrogen rapidly diffuses out it can leave behind voids with diameters ~ 10 nm; recently some workers have found that silicon samples containing such buried voids can exhibit visible-light electroluminescence. Our goal is the production of electroluminescent devices based on this material. The instrumentation we use for performing plasma ion implants will be reviewed, and the design philoso-

phy behind our custom-made IGBT-based high-voltage switching unit will be presented. Concepts for prototype electroluminescent devices based on the "buried porous silicon" material will also be discussed. [This work is supported by grants from NSERC and the CFI New Opportunities Fund.]

* This work is being supported by NSERC & CFI

TU-P7-3 **15h00**

3D Modelling of Shear-Compressional Waves in Earth Magnetosphere*. **Richard Marchand**, K. Kabin, R. Rankin, J.Y. Lu, T. Keeler, *University of Alberta* — Results are presented from 3D simulations of shear and compressional waves in Earth magnetosphere. The model is based on the ideal MHD description of the plasma. and it uses a finite element discretization of the governing partial differential equations. One feature of our approach is that it makes use of an unstructured tetrahedral mesh that is aligned along the magnetic field. This allows our simulations to accurately capture strongly anisotropic processes in magnetized plasmas, such as thermal transport or the propagation of shear modes along the magnetic field lines. Without a field aligned mesh, the simulation of such processes would suffer from unacceptable spurious numerical diffusion across magnetic field lines. Our model is also constructed on numerically generated magnetosphere configurations obtained from the BATS-R-US global MHD code. Specifically, solutions from that model (stationary or time dependent) are used to construct field aligned meshes and simulate the propagation and coupling of shear and compressional waves. Results are given for shear Alfvén wave driven by compressional waves the magnetosphere, as computed with the global circulation MHD model BATS-R-US.

* This work is being supported by CSA and NSERC

15h15 **Coffee Break / Pause café**

TU-P7-4 **15h45**

TUDOR WYATT JOHNSTON, INRS-EMT

KEEN Waves: A New Nonlinear Wave Phenomenon in the Interaction of Waves With Plasmas *

To date, KEEN waves (Kinetic Electron Electrostatic Nonlinear waves), after having been seen in an experiment of Montgomery *et al*, have been exhaustively studied in Vlasov fluid models, using ponderomotive generation. Essentially, KEEN waves are a singular result of driving the plasma at frequencies and wave vectors which are not in the pantheon of normal modes. They are in fact the ultimate answer to early questions of the ultimate fate of Landau-type damping of electrostatic plasma waves sinusoidally driven up by a source (rather than being the result of an initially imposed sinusoidal state). More recently KEEN waves have been produced in computer simulations, both by numerical iteration from an initial guess, by an unusual resonance in a plasma slab and by beat wave sources operating in a large, nonuniform plasma with a parabolic density profile. In the most recent work of all, in a remarkable achievement, KEEN waves have been produced and measured in an actual driven-plasma experiment, which used a pair of nearly counter-propagating laser beams (a pump and a Raman-shifted idler). From all this there is now a good understanding of KEEN wave essentials (which are here reviewed). The main practical question is how widespread are the KEEN wave phenomena in laser-plasma interactions and in the ionosphere (where KEEN-like structures have been seen as "electron holes").

* In collaboration with B.B. Afeyan [1], Y. Tyshetskiy [2], V. Shevchenko [1], K. Won [1], A. Ghizzo [3], [1] Polymath Research, Pleasanton, CA, [2] INRS-EMT, Varennes, QC, [3] Univ. Henri-Poincaré, Nancy, FR

TU-P7-5 **16h15**

On q Dependence of Thermal Diffusivities in Tokamaks*. **A. Hirose**, *University of Saskatchewan* — Analysis based on a gyro-kinetic ballooning stability code predicts that both the ion and electron thermal diffusivities due, respectively, to the ion temperature gradient (ITG) and electron temperature gradient (ETG) modes, increase with the safety factor q almost linearly. In the case of ITG driven ion thermal diffusivity, the q dependence originates from the coupling to the ion acoustic mode [1], and in the case of to the electron thermal diffusivity due to the ETG mode [2], it emerges from coupling to the skin size drift mode [3]. In the ETG mode, charge neutrality does not hold for typical tokamak discharges, and mixing length estimates yields a thermal diffusivity large enough to be relevant to experiments.

* This work is being supported by NSERC

1. A. Hirose, *Phys. Fluids* **B 3**, 1125 (1991).
2. A. Hirose, *Phys. Rev. Lett.* **92**, 025001 (2004).
3. A. Hirose, *Phys. Fluids* **B 3**, 1599 (1991).

16h30 **Session Ends / *Fin de la session***

[TU-P8] (DIMP/DPIM) Biotechnologies and Biothermophotonic Instruments and Methods II / Instrumentation et méthodes en biotechnologie et biothermophysique II

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h30

SALLE / ROOM FNSC 60 (cap. 119) ***Chair: A. Mandelis, University of Toronto***

TU-P8-1 **14h15**

WILLIAM M. WHELAN, Ryerson University

Interstitial Optical Radiance Measurements: A New Approach to Guiding Laser Thermal Therapies *

Laser interstitial thermal therapy (LITT) has been developed to destroy diseased tissue in a minimally invasive manner. Optical energy is delivered to the tumour site via thin, flexible fibers and tissues are heated to greater than 55 ºC, resulting in coagulative necrosis. During thermal therapy, tissue temperatures are typically measured using point sensors (*e.g.* thermocouples) that yield temperature information at specific spatial locations. The use of point temperature measurements is complicated by the time delay in the conduction of thermal energy from a heating source to a temperature sensor, which can result in important optothermal events not being detected. Hence, we are investigating point optical measurement (fluence and radiance) strategies that take advantage of the significant changes in tissue optical scattering that occurs when tissues are coagulated. In this work, the utility of interstitial optical measurements for sensing the formation of a coagulation volume surrounding a cylindrical light source is demonstrated in a series of phantom experiments and in vivo rabbit studies. Low optical contrast between coagulated and native tissue as well as significant biological noise from blood flow was observed when using fluence sensors *in vivo*. Directional optical measurements (radiance) offered improved sensitivity over integrated optical measurements (fluence) in determining the location of the coagulation boundary. Furthermore, we show that radiance measurements coupled with a P3 approximation optical model can be used to recover unique optical properties of a turbid medium. The talk will also describe new instrumentation under development, specifically an interstitial variable-angle rotational probe.
Research funded by NSERC, CFI, National Cancer Institute of Canada (with funds from the Canadian Cancer Society) and the Ontario Innovation Trust.

* In collaboration with L.C.L. Chin [1], M.M.J. Brookshaw [2], I.A. Vitkin [3], [1] Medical Biophysics, University of Toronto, [2] Engineering/Physics, University of Prince Edward Island, [3] Medical Physics, Ontario Cancer Institute

TU-P8-2 **14h45**

BORIS MAJARON, Jozef Stefan Institute

Toward Photothermal Imaging for Medicine *

We will discuss the potential of pulsed photothermal radiometry (PPTR) for non-invasive depth profiling and three-dimensional imaging of highly scattering biological tissues, in particular human skin. Such an imaging modality would enable systematic studies - and perhaps allow individual optimization - of laser therapy of vascular lesions such as port wine stain birthmarks, which currently presents a big challenge in both biomedical optics and pediatric dermatology. Key elements of our PPTR system are a pulsed dye laser, fast infrared (IR) camera with appropriate optics, and image reconstruction software. The detection band is limited to 4.5–5 mm, which justifies neglecting of the spectral variation of tissue IR absorption coefficient in the image reconstruction process. By combining two excitation wavelengths (585 and 600 nm), we exploit spectral differences between the two main chromophores in human skin (epidermal melanin and hemoglobin in red blood cells) to separate the epidermal and vascular contribution to the radiometric signals prior to image reconstruction. Such dual-wavelength-excitation PPTR enables imaging of vascular structures in close proximity to the epidermis. A novel approach to the ill-posed inverse problem of image reconstruction, which combines the advantages of truncated singular value decomposition with the non-negativity constraint to the solution, will be discussed. The system performance will be analyzed in detailed numerical studies, measurements on animal models, and measurements on port wine stain patients.

* In collaboration with W. Verkruysse, B. Choi, J.S. Nelson, Beckman Laser Institute, Univ. California, Irvine

15h15 **Coffee Break / Pause café**

TU-P8-3 **15h45**

ROGER M. LEBLANC, University of Miami, Department of Chemistry

Spectroscopy and Imaging of Peptide-Capped Quantum Dots to Study Amyloid Aggregation *

Alzheimer's disease (AD) is the most common form of mental disorder among elderly people. It is known to form amyloid plaque which is insoluble in aqueous media. We investigated the amyloid plaque formation through surface chemistry methodologies. To simulate plaque formation a synthetic peptidolipid (C18-IIGLM-OH) having the neurotoxic sequence Aβ(31-35) as headgroup was used. The surface pressure-area isotherm reveals a plateau at low surface pressure. The compression-decompression isotherm has a huge hysteresis which is a direct proof that aggregation is present. We monitored the aggregation of the peptidolipid by means of IRRAS at air-water interface and on hydrophobic quartz slides. A linear relationship is found between the absorption intensity and the number of layers deposited. Visualization of the aggregation process using epi-fluorescence microscopy was successful using 1% octadecanoylamino-fluorescein resulting in fibril-like structures. To investigate the fibril formation the CdSe/ZnS quantum dots were modified with Cys-Cys-Gly-Ile-Ile-Gly-Leu-Met-OH. As a control experiment similar size quantum dots were modified with Cys-Cys-Gly-Gly-Gly-Gly-Gly-OH. The aggregation was investigated monitoring the absorption and emission of the modified quantum dots. We have shown that the Aβ (31-35) peptide has an affinity to form aggregates compared with the control peptide. For the Aβ (1-42) amyloid peptide circular dichroism was used. Aβ (1-42) was visualized using water soluble quantum dots. Epifluorescence microscopy was successfully employed for the visualization on the peptides with fluorophores or quantum dots showing the feasibility of fluorophores replacement by quantum dots in imaging.

* In collaboration with C. Li, X. Ji, D. Naistat and J. Orbulescu , University of Miami, Department of Chemistry

TU-P8-4 **16h15**

Proposal for a Canadian National High Magnetic Field Laboratory. **Calvin H. Winter** [1], J.F. Carolan [2], D.C. Healey [1], T. Templeton [1], [1] *Quantum Technology Corp.*, [2] University of British Columbia — High magnetic fields are needed for many research and industrial applications including: fusion energy, solid state physics, astrophysics, materials science, ion cyclotron resonance mass spectroscopy, nuclear magnetic resonance and technical applications such as magnetic resonance imaging, superconducting materials, permanent magnet materials and industrial processes. The USA has a continuous field laboratory in Talahassee Florida with 20 Tesla superconducting magnets, 45 Tesla resistive magnets and a facility in Los Alamos New Mexico with 100 Tesla 10millisecond pulsed magnets. We propose the development of a Canadian National High Magnetic Field Laboratory as a multi-user facility which would serve the needs of scientists and industry for high magnetic fields. As a national facility, conventional constant field superconducting and hybrid magnets will be available to scientists. The laboratory will also develop extremely high field pulsed magnets with a target of achieving 600 Tesla for 10milliseconds with a 1Hz pulse repetition rate. The magnetic pressure at 600 Tesla (140GPa) is similar to the pressure at the center of the earth! Inertial confinement has produced microsecond extreme magnetic fields. In our approach the inertia of a long metal hammer is used to achieve the high pressures. The duration of the compressive pressure pulse depends on the length of the metal hammer and the velocity of sound in metal. This new facility will be revolutionary and will allow experiments which up to now have not been possible anywhere on earth. The next step is for interested researchers to coalesce and lobby for the construction of the facility.

16h30 **Session Ends / *Fin de la session***

[TU-P9] (DIMP/DPIM) Laser Ultrasonics and Photoacoustics for Materials Characterization / Caractérisation ultrasonique et photo-acoustique des matériaux par laser

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 17h15

SALLE / ROOM FNSC 50 ***Chair: M. Sigrist, Swiss Federal Inst. of Technology***

TU-P9-1 **14h15**

MASAHIDE TERAZIMA, Kyoto University

Time-Resolved Study of Refractive Index Change After Irradiation of Ultra-Short Laser Pulse Inside Glasses

When a femtosecond laser pulse is tightly focused inside a transparent material such as a glass, a structural change and the refractive index change occurs at a small volume in the material, which must be caused by the nonlinear interaction between the material and the strong laser field. This is an interesting phenomenon and there have recently been many reports on the applications to the fabrication of various kinds of 3D micro-optics. However, the mechanism of the refractive index change has not been well understood so far. Recently we are developing a technique to monitor the time development of the refractive index change after light irradiation in a wide time scale, from femtosecond to second. We have been applying this technique to the studies of reaction mechanism of biological proteins. Here, we investigated the temporal and spatial developments of the refractive index change in a focal region of a femtosecond laser pulse inside a glass by the transient lens (TrL) method with a time resolution of sub-picosecond. In the TrL signal, damped oscillation with about an 800 ps period was observed. In order to explain the oscillation, the thermoelastic response of a heated material by a short pulsed laser is calculated. The essential feature of the oscillation can be explained in terms of the pressure wave creation and propagation to the outward direction from the irradiated region. Based on this model, the temporal evolution of the refractive index distribution inside a glass is retrieved from the probe beam deformation (TrL image) at various delay times between the pump and probe pulses.

TU-P9-2 **14h45**

HANS A. SCHUESSLER, Texas A&M University

DIMP Business Meeting / Réunion d'affairs DPIM *Linear and Nonlinear Laser Opto-Acoustic Measurements in Solids From the Macro- to the Nano-Scale* *

Recent developments of laser technology provide a unique opportunity to study elastic properties of materials at different scales ranging from centimeters to nanometers. In this talk some examples of these studies will be presented that include measurements with focused and straight-crested surface acoustic waves (SAWs) and femtosecond measurements of acoustic oscillations in nanoparticles. We studied the changes of the pulse shape and the phase of the spectral components in converging SAW pulses excited with a femtosecond laser via the thermoelastic mechanism. The phase absolute value of the spectral components after the passage of the focal region experienced a change close to $\pi/2$ rad (Gouy phase shift). These observations were confirmed by analytical and numerical calculations based on the two-dimensional wave equation for surface acoustic waves. The nonlinear propagation of very high-amplitude surface acoustic wave (SAW) pulses (Mach numbers about 0.01) in polycrystalline metals, dielectrics and semiconductors was also studied. A nonlinear compression and an increase of the SAW pulse amplitude have been observed. SAW pulses were numerically simulated with a nonlinear evolution equation including local and nonlocal nonlinear terms. Recently, nanoparticles of different sizes (from a few to tens of nanometers) and shapes in solutions and solid crystalline and amorphous matrixes were fabricated. The optical, mechanical and thermodynamic properties of nanoparticles are size-dependent and the possibility to investigate them with a femtosecond pump-probe technique by exciting confined acoustic oscillations was demonstrated.

* In collaboration with A.A. Kolomenskii, S.N. Jerebtsov, Texas A&M University

15h15 **Coffee Break / Pause café**

TU-P9-3 **15h45**

KIRK H. MICHAELIAN, Natural Resources Canada

Signal Recovery in Step-Scan Photoacoustic Spectroscopy *

The use of step-scan mirror movement in a Fourier Transform Infrared (FT-IR) spectrometer creates a particular need with regard to signal detection in photoacoustic (PA) spectroscopy. Modulation of the incident radiation, which is necessary for the occurrence of the PA effect, must be provided externally; oscillation (dithering) of the mirror at each resting position yields a phase-modulation interferogram that is the first derivative of the conventional result. Fourier transformation produces spectra in which the usual blackbody contribution is multiplied by low-order Bessel functions. Signal recovery is most commonly effected using DSP (digital signal processor) demodulation, available as part of commercial FT-IR software. We have compared this conventional technique with lock-in detection, and found the latter approach to be superior at modulation frequencies above 100 Hz. The in-phase and quadrature signals recovered with a lock-in amplifier, analogous to those in amplitude-modulation experiments, yield the so-called real and imaginary spectra. This permits calculation of modulus (power) and phase spectra as well as the use of a linearization method that incorporates both intensity and phase information to produce a more accurate representation of the spectrum.

* In collaboration with P. Arenillas, Natural Resources Canada

TU-P9-4 **16h15**

PETER KORPIUN, PA-Group Scheyern, Germany

Photoacoustic Detection of Sorption and Diffusion in Thin Layers of Porous Materials *

Porous materials like charcoal and zeolite have large internal surfaces on which gases can be adsorbed. The amount of gas adsorbed depends on its temperature and pressure. At the photoacoustic effect the temperature of the sample periodically varies because of the absorption of modulated light. Due to that temperature oscillation in a porous sample gas molecules periodically are adsorbed and desorbed, respectively. They can be considered as a concentration wave running from inside the sample to the gas which causes a pressure variation in addition to that created by the heat wave. Both can be detected by a microphone. The thickness of the layer of the sample involved in this process of sorption during one period is one mass diffusion length which approximately is equal to the square root of twice the ratio diffusion coefficient to angular modulation frequency. In our experiments it varied between 120 nm in zeolite and 50 microns in charcoal. We describe in which way the photoacoustic signal depends on the diffusion coefficients and other quantities characterising the sorption. We present measurements for the sorption of various gases and water vapour on zeolite and charcoal varying temperature, pressure and modulation frequency.

* In collaboration with B. Buechner, PA- Group Scheyern

TU-P9-5 **16h45**

ROMAN GR. MAEV, University of Windsor

Physics and Art: Look Inside *

Proper evaluation for the prevention of different art objects, including wooden, bronze and marble sculptures, frescoes, and paintings (on canvas, wood, metal and glass) is very important for purposes of conservation. Various advanced physics methods for analysis and assessment of art objects can bring about drastic changes in the regular evaluation and inventory carried out by museums, and can bring advanced, powerful and new techniques for objective assessment of physical conditions of museum resplendence. Using these methods, it will be possible to plan ad hoc repair works on art objects, and, as a result, we will preserve cultural heritage. The goal of this paper is to introduce recent advances in imaging techniques for the evaluation of art objects. The main part of this presentation will be focused on high resolution acoustic imaging. Physical principles as well as experimental fundamentals for quantitative characterization of the contrast response in the acoustic imaging, together with the recent results of the technical developments in this field will be discussed. Based on the most successful research results, examples of different applications will be provided. In particular, an air-coupled technique for NDE of wooden paintings, developed in the Center for Imaging Research and Advanced Material Characterization at the University of Windsor, will be presented in detail, together with some interesting results. The importance of physics to nondestructively test, characterize and evaluate is self evident. Aim of the work is to challenge the researchers to portray more results in an easily understood visual format. These powerful techniques will enable us to collect more information for this unique area of application and, as a result of our involvement, will give the artistic world more advanced ways of protecting its masterpieces.

* In collaboration with Antonino Siddiolo [1], Anna R. Maeva [2], and Robert E. Green Jr. [3], [1] University of Palermo, Italy, [2] University of Windsor and [3] Johns Hopkins University, USA

17h15 **Session Ends / *Fin de la session***

[TU-P10] (PPD) The Energy Frontier in Particle Physics II / *Les limites en énergies en physique des particules II*

TUESDAY, JUNE 7 / MARDI, 7 JUIN

14h15 - 16h45

SALLE / ROOM CEME 1202 (cap. 119) ***Chair: M. Vincter, Carleton University***

TU-P10-1 **14h15**

DUGAN O'NEIL, Simon Fraser University

Latest Results from the D0 Experiment *

The D0 experiment is currently taking data from 1.96TeV proton-antiproton collisions at the Fermilab Tevatron. So far in this data-taking run (Run II), we have accumulated 5-10 times the integrated luminosity present in the previous dataset (Run I). This opens new possibilities for discovery and precision measurements throughout the D0 physics programme. This programme includes studies of the top quark, direct searches for new phenomena, B-physics, EW precision measurements and QCD. An overview of the status of

the experiment, the Canadian contribution and recent physics highlights will be presented.

* In collaboration with R. Moore, W. Taylor, B. Vachon, M. Vetterli

TU-P10-2 **14h45**

FRANCOIS CORRIVEAU, IPP / McGill University

ZEUS Gets Polarized

The HERA accelerator at DESY has entered its last phase of data taking, which will last until the summer of 2007. With luminosity higher than ever and the availability of electron (positron) polarisation, new insights on e-p deep inelastic scattering processes are coming out. The ZEUS analyses and cross section results will be presented, together with a status of the current work on QCD and an overview of the rest of the research program.

TU-P10-3 **15h15**

Search for Single Top Quark Production at DØ in Run II*: **Yann Coadou**, *Simon Fraser University* — A search for the electroweak production of single top quarks at the DØ experiment of the Fermilab Tevatron proton-antiproton collider at $\sqrt{s}$ = 1.96 TeV using Run II data is presented. Individual top quarks are expected to be produced in association with bottom quarks through the exchange of a *W* boson (*s*-channel), or the *W*-gluon fusion process (*t*-channel). After applying pre-selection criteria to the data, the signal-to-background ratio is improved with an algorithm to identify jets originating from a *b* quark. On the remaining data, several techniques were used, including cut-based and artificial neural network analyses, for both production channels. No evidence for a single top signal was found. Upper limits on the production cross section of the *s*- and *t*-channels are presented.

* This work is being supported by NSERC

15h30 **Coffee Break / Pause café**

TU-P10-4 **15h45**

Measurements of α_s at the HERA Accelerator*: **Jeff Standage**, *York University* — The HERA *ep* collider at DESY is an ideal place for QCD studies. The ZEUS detector has been used to make precise measurements of the QCD parameter, α_s. Access to several large scales (jet E_t, high Q^2, *etc.*) allows us to make these measurements through various techniques. I will describe these methods, with an emphasis on the analysis with inclusive jets. The results are compared with other world measurements.

* This work is being supported by NSERC

TU-P10-5 **16h00**

Measurement of the Top Quark Mass with Simultaneous Determination of the Jet Energy Scale Using In Situ W->$q\bar{q}$ decays at CDF: **Jean-Francois Arguin**, P.K. Sinervo, S. Xie, *University of Toronto* — We present a preliminary measurement of the top quark mass using data from $p\bar{p}$ collisions at $\sqrt{s}$ = 1.96 TeV collected by the CDF detector. We select $t\bar{t}$ events where one W boson decay leptonically and the other hadronically. The hadronic W boson decay is used to reduce the largest systematic uncertainty: the jet energy scale. The top quark mass and hadronic W boson mass distributions reconstructed in data are compared to Monte Carlo expectations to determine simultaneously the top quarkmass and the jet energy scale.

TU-P10-6 **16h15**

An Investigation of Top Quark Pair Production Mechanisms* **Shabnaz Pashapour**, P.K. Sinervo, *University of Toronto* — Following the discovery of top quark, various studies have been dedicated to understanding of the properties of this heavy particle. We will report on studies of the production mechanisms of top quark pairs using the data collected at the Collider Detector at Fermilab (CDF) experiment at the Fermilab Tevatron. Top quark pair production is expected to be via either quark-antiquark annihilation or gluon-gluon fusion, and so we are measuring the ratio of $\sigma(gg \to t\bar{t}\,/\,q\bar{q} \to t\bar{t})$. This measurement provides a test of the QCD predictions for this pair-production mechanism, and a technique to test for unexpected source of top quark production. According to standard model calculations, in $p\bar{p}$ collisions at $\sqrt{s} \approx 2$ TeV, top quarks are pair-produced about 15% of the time through gluon-gluon fusion and about 85% through quark-antiquark annihilation. The challenge is to distinguish between these two production channels, given the same final-state $t\bar{t}$ decay . We report on the status of this analysis and estimate the precision of a measurement using a Run II sample of approximately 500 pb^{-1}.

*This work is being supported by NSERC

TU-P10-7 **16h30**

Search for Large Extra Dimensions with the CDFII Detector*: **Pierre Savard**, *University of Toronto & TRIUMF* — We present preliminary results of a search for large extra dimensions using 400 pb^{-1} of ppbar collision data collected by the Collider Detector at Fermilab. The experimental signature for this search is a high energy jet and large missing transverse momentum.

* This work is being supported by NSERC

16h45 **Session Ends / *Fin de la session***

[WE-A1] CAP-CRM Medal Winner / *Récipiendaire de la médaille ACP-CRM*

(CAP/ACP)

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
08h15 - 09h00

SALLE / ROOM IRC 2 (cap. 500) ***Chair: B. Joos, University of Ottawa***

WE-A1-1 **08h15**

ROBERT MYERS, Perimeter Institute

Cosmic Superstrings

Modern string theory provides a rich array of objects which could have been produced in the early universe and then been stretched to a cosmic size today. I discuss conditions which allow this to occur as well as their observable signatures. These cosmic superstrings may provide a spectacular window into the microphysics of string theory through astronomical observations.

09h00 **Session Ends / *Fin de la session***

[WE-A2] CAP Industrial and Applied Medal Winner
(CAP/ACP) *Récipiendaire de la médaille industrielle et appliquée*

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
08h15 - 0900

SALLE / ROOM IRC 4 (cap. 135) ***Chair: D. Lockwood, National Research Council***

WE-A2-1 **08h15**

ANTHONY SPRINGTHORPE, National Research Council of Canada

III-V Compound Semiconductor Epitaxy:- Then and Now

The technology of epitaxy, the oriented overgrowth of a crystalline layer on a single crystal template, has changed significantly over the last half century. From its humble beginnings as an esoteric method for the preparation of small areas (<1cm^2) of relatively pure III-V compound semiconductors, with poor thickness control, it has morphed into its present form where hundreds of sq. cm. of complex multi-layer, multi-component, semiconductor alloys can be routinely deposited with atomic precision. With some confidence it can be stated that this transformation has affected all our lives, and that we now take for granted the products of an advanced epitaxial science that underpins modern telecommunications and display technologies.

In this presentation I will attempt to trace the development of III-V compound semiconductor epitaxy since its inception. Emphasis will be given to the interdisciplinary nature of the advances that have been made, and which are dependent on contributions form Physics, Chemistry, Materials Science, Electrical and Mechanical Engineering and Computer Science.

09h00 **Session Ends / *Fin de la session***

[WE-A3] Plenary Session
(CAP/ACP) *Session plénière*

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
09h00 - 09h45

SALLE / ROOM IRC 2 (cap. 500) ***Chair: J. Barth, UBC***

WE-A3-1 **09h00**

DONALD EIGLER, IBM Almaden Research Center

Single-Atom Spin-Flip Spectroscopy *

We demonstrate the ability to measure the g-value of single adsorbed atoms by inelastic electron tunneling spectroscopy (IETS). A low-temperature, high-magnetic-field scanning tunneling microscope (STM) was used to measure the spin excitation spectra of individual Mn atoms adsorbed on Al_2O_3 islands on a NiAl surface. We find pronounced variations of the spin-flip spectra for Mn atoms in different local environments. Combined with the STM's capability to fabricate, image and modify atomically precise structures, this technique provides a powerful new tool for studying and engineering the local magnetic properties of nanometer-scale systems.

* Work done in conjunction with Andreas Heinrich, Chris Lutz, Jay Gupta and Bruce Melior

09h45 **Session Ends / *Fin de la session***

[WE-A4] Instrumentation for Nuclear Physics
(DNP/DPN) *Instrumentation en physique nucléaire*

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
10h00 - 12h45

SALLE / ROOM CEME 1204 (cap. 60) ***Chair: J. Dilling, TRIUMF***

WE-A4-1 **10h00**

REINER KRÜCKEN, Technische Universität München

Recent Results from REX-ISOLDE

REX-ISOLDE is now in routine operation at the ISOLDE facility at CERN. Beams of short lived nuclei produced at the ISOLDE targets are accelerated to about 3 MeV/u after collection, bunching and charge breeding. In this contribution preliminary results from Coulomb-excitation experiments on $^{30;32}$Mg, $^{74;76;78}$Zn and $^{122;124;126}$Cd using the MINIBALL array as well as plans for the upgrade of REX-ISOLDE will be presented.

WE-A4-2 **10h30**

TIM CHUPP, University of Michigan

Electric Dipole Moment Measurements with Radioactive Beams *

An electric dipole moment (EDM) is a separation of electric charge along the angular momentum axis of a system. A non-zero electric dipole moment signals a violation of time reversal invariance (T) and CP invariance, and is thus expected at some level. So far, no EDM has been observed in any system in spite of decades of searches using molecules, atoms and the neutron. This manifestation of CP violation is thus very small, but the cosmological dominance of matter over antimatter may be explained by CP violation that would induce EDMs much large than the Standard Model predictions. There remains very strong motivation to search for and discover EDMs and the need to measure in several systems to clarify the presence of CP violating interactions. The EDM arises due to the electrical polarisation of a system along the angular momentum axis, and enhancements are expected systems with greater polarisibility, including heavy atoms with octupole-deformed nuclei. Several candidates have been considered and experimental investigations are underway with ^{225}Ra using neutral atom trapping techniques (at Argonne National Lab) and with ^{223}Rn collected in a cell (at TRIUMF). These experiments will measure the change in the magnetic resonance frequency of the nuclei as an applied electric field is changed with goals of detecting frequency shifts as small as nanohertz, and a myriad of systematic effects must be addressed. In this talk, I will discuss the motivations, techniques, and challenges of this new generation of EDM experiments.

This work is being supported by NSF/DOE

* In collaboration with S. Nuss-Warren [1], E. Tardiff [1], J. Behr [2], M. Pearson [2], M. Hayden [3], C. Svensson [4], G. Sprouse [5], N. Pietralla [5], J. Sell [5], R. Lefferts [5], G. Ball [2], G. Hackman [2], [1] University of Michigan, [2] TRIUMF, [3] Simon Fraser University, [4] Guelph University, [5] SUNY Stony Brook

WE-A4-3 **11h00**

A Digital RFQ for TITAN*. **Mathew Smith** [1], J. Dilling [2], J.V. Vaz [2], L. Blomeley [3], [1] *University of British Columbia/TRIUMF*, [2] TRIUMF, [3] McGill — The TITAN (TRIUMF's Ion Traps for Atomic and Nuclear science) experiment will carry out Penning trap mass spectrometry on the radioactive isotopes produced at TRIUMF's ISAC facility. The resolution of such measurements is proportional to the charge of the ion in consideration; hence, the system will use an EBIT (Electron Beam Ion Trap) in order to prepare the ions in a high charge state before injection into the Penning trap. This will make it possible to carry out high precession mass measurements ($\delta m/m = 1x10^{-8}$), for short-lived ($t_{1/2} \sim 50$ ms) $0^+ \rightarrow 0^+$ superallowed beta emitters, that are required for tests of the CVC (Conserved Vector Current) hypothesis and CKM matrix unitarity. In order to obtain efficient injection of the ISAC beam into the EBIT it will be necessary to use an RFQ (Radiofrequency Quadrupole) cooler and buncher to modify it's emittance. Unlike previous such coolers, which have been driven sinusoidally, the RFQ developed for TITAN is driven with a large amplitude ($V_{pp} = 400$ V) high frequency (f = 1 MHz) square-wave. This overcomes the problem of limited bandwidth associated with sinusoidally-driven traps, making broadband operation of an RFQ cooler possible for the first time. Based on the results of simulations the RFQ has been designed and built along with an off-line test system. This includes an ion source and four-way switching unit, as well as beam injection and extraction optics. Results from the simulation and off-line testing of the system will be presented.

* This work is being supported by NSERC

WE-A4-4 **11h15**

Control of Systematic Errors in the Q_{weak} Experiment at Jefferson Lab*, **Jim Birchall**, *University of Manitoba* — The Q_{weak} experiment at Jefferson Lab is a precision determination of the weak charge of the proton via a measurement of parity violation in electron scattering from hydrogen at low momentum transfer. As the parity-violating asymmetry is to be measured to an uncertainty of $5x10^{-9}$, control of systematic errors is essential. An overview will be given of the sources of systematic error and how their effects will be kept under control.

* This work is being supported by NSERC

WE-A4-5 **11h30**

JENS LASSEN, ISAC/TRIUMF

Resonant Ionization Laser Ion Source - Application of Laser Spectroscopy in Nuclear and Particle Physics

Resonant ionization laser spectroscopy is a tool that is applied whenever high sensitivity as well as high selectivity is required. This trace-detection capability is ideally suited to the conditions under which exotic, short lived isotopes from the ISAC isotope production target are to be extracted. RILIS (resonant ionization laser ion source) provides the highest element selectivity in ionization, and opens up elements that are difficult for conventional surface-, or gas discharge ion-sources. Thus, in combination of the ISAC mass separator rare isotope beams can be provided in unprecedented purity and intensity. At TRIUMF RILIS is established with an all solid state, state of the art laser system. This system consists of 3 simultaneously pumped, tunable, Q-switched, high repetition rate TiSa lasers. The presentation will outline the principles and challenges of resonance ionization laser spectroscopy and describe the current research with TRILIS.

WE-A4-6 **12h00**

CHRIS PEARSON, TRIUMF

Gamma Ray Tracking in Segmented Germanium Detectors *

A gamma ray tracking algorithm, for the purpose of Compton suppression and doppler shift correction, has been implemented and tested, using simulated data, for gamma rays with energies between 0.1 and 2 MeV, interacting in a 90 mm long, 60 mm diameter, cylindrical, 36 (6x6) segment detector. It was found that for gamma-rays of energies around 1 MeV, a ratio of photopeak counts to total counts of 2:3, using the tracking algorithm could be obtained, with only a 2% reduction in detection efficiency, compared to the untracked data. Approximately 80% of first interaction points could be correctly identified, enabling a good Doppler shift correction. Real data was obtained using a detector of the type simulated, together with a compact PCI digital data acquisition system comprising 36, 12 bit, 40 MHz flash ADCs, and 6 200 MHz DSPs. The performance of the tracking algorithm on this real data is comparable to its performance on simulated data.

* In collaboration with J.J.V. Dobon [1], P.R. Regan [1], P.J. Sellin [1], E. Morton [1], P.J. Nolan [2], A. Boston [2], M. Descovich [2], J. Thornhill [2], J. Cresswell [2], I. Lazarus [3], J. Simpson [3], [1/2] University of Surrey, [2] University of Liverpool, [3] Daresbury Laboratory

WE-A4-7 **12h30**

Investigation of Optimal Compton Suppression Schemes for TIGRESS. **Michael A. Schumaker**, for the TIGRESS Collaboration, *University of Guelph* — The TRIUMF-ISAC Gamma-Ray Escape-Suppressed Spectrometer (TIGRESS) is a new gamma-ray detector array being developed in order to take advantage of the radioactive ion beams to be delivered by the new ISAC-II facility at TRIUMF. When complete, TIGRESS will consist of twelve large-volume 32-fold segmented HPGe clover detectors, fitted with 20-fold segmented Compton-suppression shields. The high efficiency of TIGRESS, predicted to be ~18% in the "high-efficiency" and ~10% in the "optimized peak-to-total" configurations for 1 MeV gamma rays, will make it ideal for experiments with low-intensity radioactive ion beams. However, photopeak efficiency and peak-to-total responses degrade quickly as the multiplicity of the emitted gamma rays increases, due in part to a large increase in the probability of false suppression. In order to counteract this problem, the high segmentation of the Compton suppression shield will be utilized. Suppression schemes, in which the suppression of events is based on analysis of which crystals and suppressor segments are hit, have been developed. In order to accomplish this, data taken from a prototype TIGRESS detector was used to validate the results of a GEANT4 simulation of the full TIGRESS array. This simulation was used to examine the changes in peak-to-total and efficiency that result from the use of different suppression schemes. The results of this search, and the methodology behind it, will be presented.

12h45 **Session Ends / *Fin de la session***

[WE-A5] (PPD) Instrumentation for Particle Physics / *Instrumentation en physique des particules*

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

10h00 - 12h30

SALLE / ROOM CEME 1202 (cap. 119) ***Chair: K. Ragan, McGill University***

WE-A5-1 **10h00**

Radiation-hard ASICs for Optical Data Transmission in the ATLAS Pixel Detector.* **Paul Douglas Jackson** [1], K.K. Gan [1], H. Kagan [1], R. Kass [1], A.M. Rahimi [1], S. Smith [1], M. Ziolkowski [2], [1] *The Ohio State University* and [2] Universitaet Siegen — We have developed two radiation-hard ASICs for optical data transmission in the ATLAS pixel detector at the CERN Large Hadron Collider (LHC). The first circuit is a driver chip for a Vertical Cavity Surface Emitting Laser (VCSEL) diode for 80 Mbit/s data transmission from the detector. The second circuit is a Bi-Phase Mark decoder chip to recover the control data and 40 MHz clock which is received optically by a PIN diode on the detector side. During ten years of operation at the LHC, the ATLAS optical link circuitry will be exposed to a maximum total fluence of 10^{15} equivalent n/cm^2. We have successfully implemented both ASICs in deep submicron (0.25 micron) CMOS technology using enclosed layout transistors and guard rings for increased radiation hardness. The driver and the decoder

chips are four-channel devices compatible with common cathode PIN and VCSEL arrays. We present comprehensive results from the final engineering run and from irradiation studies of both circuits with 24 GeV protons up to a total dose of 62 Mrad.

* This work is being supported by The Ohio State University

WE-A5-2 10h15

Resolution Studies of a GEM – TPC in a High Magnetic Field*. **Gabe Rosenbaum**, D. Karlen, P. Poffenberger, T. Michailopoulos, *University of Victoria* — The University of Victoria time projection chamber (TPC) has been constructed as a prototype for the central tracking detector for the International Linear Collider. This TPC uses gas electron multipliers (GEMs) for electron gain in the gas. Tests over the last two years have been conducted in high magnetic fields at TRIUMF (Vancouver) and DESY (Hamburg) using cosmic rays and a UV laser to produce ionization tracks. Results of these tests will be presented that demonstrate the excellent tracking resolution of a GEM-TPC.

* This work is being supported by NSREC,TRIUMF,UVIC

WE-A5-3 10h30

Development of Water-Bearing Scintillating Liquid and Gel Detectors for the T2K Neutrino Oscillation Experiment*. **Stanley Yen** [1], S. Oser [2], A. Konaka [1], J. Coulombe [2], J.M. King [3], P. Bonnick [4], [1] *TRIUMF*, [2] University of British Columbia, [3] TRIUMF/University of Regina, [4] TRIUMF/University of Guelph — The T2K neutrino oscillation experiment requires construction of a fine-grained near detector to complement the existing Super-Kamiokande far detector. Thenear detector should be a scintillator, to enable detection of low energy recoil protons produced by quasi-elastic charged current interactions on neutrons in the target material. It should also have a high water content to match the Super-K far detector, in order to reduce systematic uncertainties due to the different nuclear responses between oxygen and other target materials. The Canadian T2K collaborators have been working on developing water-bearing scintillating liquid and gels, and testing the chemical compatibility of structural materials. This talk will report on the progress we have made.

* This work is being supported by NSERC

WE-A5-4 10h45

A Time Projection Chamber for the Near Detector of the T2K Experiment*. **Juergen Wendland**, *University of British Columbia* — The T2K experiment is an upcoming long-baseline neutrino experiment being designed for precision neutrino oscillation measurements. The experiment will use the 50GeV proton accelerator in Tokai, Japan to create a high intensity muon neutrino beam which will be aimed at Super-Kamiokande 295km from Tokai. The beam properties near the proton target will be measured by a near detector 280m downstream. The detector includes a time projection chamber (TPC) primarily for muon tracking. This presentation will introduce the T2K near detector and focus on the design of the TPC.

* This work is being supported by NSERC

WE-A5-5 11h00

The K2K Calibration Source Manipulator*. **Rich Helmer** [1], F. Berghaus [2], S. Chen [1], C. Holmberg [1], I. Kato [1], P. Kitching [1], A. Konaka [1], M. Lenckowski [1], D. Morris [1], S. Oser [2], [1] *TRIUMF*, [2] University of British Columbia — The K2K experiment is searching for neutrino oscillations using SuperKamiokande as the far detector. A near detector, consisting of a 1 kt tank of water located after the beam dump, is used to normalize the near/far ratio expected in the absence of oscillations. Cherenkov light, produced by neutrino interaction products passing through the water, is detected by 684 photomultiplier tubes viewing the detector volume. Part of the optical calibration of the detector is accomplished by placing an isotropic light source at various positions within the water. Since only a limited set of positions have been accessible in the past, we have built a manipulator system that will allow a much larger volume of the detector to be sampled, including the entire fiducial volume. The manipulator consists of a vertical column suspended in the detector, with a three-jointed articulating arm mounted from the bottom of the column. The source is mounted at the outer end of the third arm. Four motors are used to rotate the column and drive the arm segments so as to position the source in the desired location. It is of paramount importance to be able to position the source accurately and to prevent any impact between manipulator components and the photomultiplier tubes. The control system incorporates innovative feedback of arm positions using submersible position sensors and redundancy in the feedback system to achieve these goals. Details of the design and operation of the manipulator will be described, and results from the first data-taking run will be presented.

* This work is being supported by NSERC

WE-A5-6 11h15

LSTs to the Rescue: Saving BaBar's Beleaguered Muon Detection System*. **Bryan Fulsom**, *University of British Columbia* — BaBar is the detector for the SLAC PEP-II asymmetric e^+e^- B Factory. In the summer of 2004, it began the repair of its failing resistive plate chamber (RPC) muon detection system. One third of the instrumented flux return (IFR) barrel was replaced by limited streamer tube (LST) technology, with the balance to be replaced in 2006. A description of this new detector subsystem will be presented, along with a summary of the construction, installation and commissioning activities undertaken this past year. The performance of the LST system and the improvement of BaBar's muon detection capability in the current colliding beam run will be shown.

* This work is being supported by University of British Columbia

WE-A5-7 11h30

Spatial Resolution of a Micromegas readout TPC Using the Charge Dispersion Signal*. **Alain Bellerive**, *Carleton University* — The Time Projection Chamber (TPC) for the future International Linear Collider will need to measure nearly 200 track points with a resolution of better than 100 microns. The resolution goal, close to the fundamental limit from ionization electron statistics and transverse diffusion in gas, is nearly two times better than has been achieved by conventional wire/pad TPCs. A TPC with a Micro Pattern Gas Detector (MPGD) readout could, in principle, reach the target resolution. However, it may require sub-millimeter width pads resulting in a significant increase in the number of electronics channels and detector cost and complexity over conventional TPCs. We have recently developed a new readout concept based on the phenomenon of charge dispersion in MPGDs with a resistive anode. With charge dispersion wider pads similar to the ones used for the wire/pad TPC readout can be used without sacrificing resolution. As proof of principle, a small prototype TPC with a resistive anode GEM readout endcap was built. In cosmic ray tests with no magnetic field, the measured dependence of resolution on drift distance was consistent with the diffusion limit. The resistive anode GEM in the TPC endcap was recently replaced with a resistive anode Micromegas. Our first results on the TPC resolution with the resistive anode Micromegas will be presented and compared to the GEM results.

* This work is being supported by NSERC and PREA

WE-A5-8 11h45

Improvements to the Optical Calibration Methods for the Final Phase of the Sudbury Neutrino Observatory Experiment*. **Olivier Simard**, *Carleton University* — The optical calibration methods at the Sudbury Neutrino Observatory (SNO) have been modified before the experiment enters its final phase of data taking. Optical calibrations are necessary to make *in-situ* measurements of the media attenuations and response of the photomultiplier tubes (PMTs). The addition of neutral current detector counters (NCDs) in the central heavy water volume complicates the analysis of the Cherenkov light propagation in the detector. Improvements were made in both the analysis and calibration methods to ensure the optical response of the detector is comparable to the previous phases of the experiment. Analytic and Monte Carlo studies of the reflections on the acrylic vessel containing the heavy water made possible a full analysis of the optical data taken in a fiducial volume of 550 cm in radius, a 25% increase compared to previous analysis methods. The ultimate goal of the calibration methods of the SNO detector is to provide the best energy resolution, over the full fiducial volume, for the reconstruction of solar neutrino events and the investigation of matter enhanced neutrino oscillation scenario(s).

* This work is being supported by Carleton University

WE-A5-9 **12h00**

Evaluation and Simulation of the Response Function in the TWIST Experiment*. **Robert MacDonald**, *University of Alberta*, The TWIST Collaboration — The decay of the muon is a purely leptonic process, $\mu \rightarrow e + \nu_e + \bar{\nu}_\mu$, and as such is an excellent process with which to study the details of the weak interaction. The shape of the decay spectrum, in terms of the energy and direction of the decay positron, can be described by four parameters, and the TWIST experiment aims to determine three of these parameters to precisions of a few parts in 10^4. The decay parameters are measured by comparing data against simulation (currently GEANT3), an approach which not only permits blind analysis in a simple and straightforward manner, but also directly accounts for the effects of the detector response function—-provided the simulation accurately reproduces this response function. To ensure this, the simulation must be tested against data, using methods which are independent of the measurement of the decay parameters. The testing and tuning of the GEANT3 simulation to meet the needs of the TWIST experiment are discussed, and some results are presented.

* This work is being supported by NSERC, NRC, US DOE, *et al.*

WE-A5-10 **12h15**

Jet Response in the D0 Calorimeters*. **Dag Gillberg**, *Simon Fraser University* — The DØ detector is currently studying collisions provided by the Tevatron collider, located at Fermi National Accelerator Laboratory near Chicago. The dominant physics process at the Tevatron is jet production. Understanding the jet energy calibration in the DØ calorimeters is therefore crucial for many studies such as particle mass and cross section measurements. The most important part of the jet energy calibration is the jet response of the calorimeters. At DØ, this jet response is measured from the transverse momentum imbalance in gamma+jet events. In this talk the jet response measurement method will be described and results from the last official jet response measurement in December 2004 will be presented. Special attention will be given to the response of jets with low E_T (15 — 25 GeV).

* This work is being supported by DØ

12h30 **Session Ends / *Fin de la session***

[WE-A6] Ultrafast Science and Applications / *Science et applications des processus ultrarapides*

(DAMP-DOP/*DPAM-DOP*)

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

10h00 - 12h30

SALLE / ROOM IRC 4 (cap. 135) ***Chair: R. Schiell, Trent University***

WE-A6-1 **10h00**

SEE L. CHIN, Université Laval

*The Physics of Femtosecond Laser Filamentation and its Potential Applications**

Self-focusing and filamentation of a powerful femtosecond laser pulse in an optical medium evolves through the following inter-playing physical processes: self-focusing, group velocity dispersion, free electron generation, intensity clamping, conical emission, self-steepening and supercontinuum generation. The final pulse is a chirped white light laser pulse. Increasing the energy of the pulse would lead to multiple re-focusing. Most of the time, because of intrinsic imperfection of the laser wave front, multiple filamentation through self-focusing along the 'warm' zones of the wave front would easily occur. In air, the consequence is a long streak of filament(s) which could reach up to many km. We call this a self-guided hot light pulse. The physics of such filamentation and self-transformation process are reviewed. Its capability to melting glasses inside the filaments is observed which explains the physics of wave guide writing and which provides a systematic way to distinguish good or bad wave guides. Its potential applications in atmospheric sensing will be discussed.

* In collaboration with Q. Luo[1], W. Liu[1], S.A. Hosseini[1], F. Theberge[1], A. Saliminia[1], T. Nguyen[1], M. Sharifi[1], R. Vallee[1], O.G. Kosareva[2], V.P. Kandidov[2], N. Akozbek[3], A. Becker[4], H. Schroeder[5], J. Liu[5], [1] Center for Optics, Photonics and Laser (COPL) & Department of Physics, Engineering Physics and Optics, Laval University, [2] International Laser Center, Physics Department, Moscow State University, Moscow, Russia, [3] Time Domain Corporation, Cummings Research Park, Huntsville, USA, [4] Max-Planck-Institute for the Physics of Complex Systems, Germany, [5] Max-Planck-Institute for Quantum Optics, Germany

WE-A6-2 **10h30**

JUN YE, JILA, NIST and University of Colorado

*Ultrafast-Based Precision Measurements and Control in Ultracold World **

The application of precisely phase-controlled, broadband, femtosecond lasers on cold atomic samples has yielded precise measurement of atomic structure and dynamics, leading to a qualitatively new regime in high resolution and time-dependent spectroscopy. We will also report recent progress in exploring neutral atoms for the development of optical atomic clocks. Precise phase control of ultra-wide-bandwidth optical frequency combs has produced remarkable and unexpected progress in precision metrology and ultrafast science. We are conducting an experiment utilizing a femtosecond laser for precision two-photon spectroscopy in ultracold ^{87}Rb atoms. The wide-bandwidth, phase-coherent optical comb spectrum leads to precise and efficient measurement of the global atomic structure with level separations ranging from optical, terahertz, to radio frequency domains. Coherent pulse accumulation, quantum interference, and incoherent optical pumping effects, with the resultant dynamic evolution of population transfer among the multiple atomic states, are all monitored in real time. Mechanical actions of the optical frequency comb interacting with the cold atoms are explored and controlled, leading to implementation of precision spectroscopy with a significant reduction in systematic errors. The powerful combination of frequency domain precision and time domain dynamics represents a new paradigm for spectroscopy. Our effort in the development of ultra-stable optical frequency standards for optical atomic clocks relies on ultracold Sr atoms. Using a cooling transition with a natural linewidth of 7.5 kHz, comparable to the single-photon recoil shift of 4.7 kHz, we have recently obtained a sub-recoil temperature (250 nK) directly in an optical trap without invoking any atomic coherence in the ground state. The atom cloud displays distinctive thermo-mechanical dynamics. Results of precision spectroscopy performed on these ultracold samples will be reported, including the density-related frequency shift and broadening on the clock transition, development of Hz-linewidth ultrastable CW laser, and an absolute optical to microwave frequency link. We will also discuss a new scheme for a controllable, ultrastable, and highly accurate optical clock transition.

* In collaboration with M. Stowe, T. Ido, M. Boyd, A. Ludlow, T. Zelevinsky, S. Blatt, A. Marian, R.J. Jones, JILA

WE-A6-3 **11h00**

OLGA SMIRNOVA, National Research Council / Vienna University of Technology

*Attosecond Measurements Without Attosecond Pulses: Using Particle Correlation **

We describe how time and energy correlations between the electrons can be used to trace the dynamics of correlated two-electron ionization with sub-femtosecond precision, without using sub-femtosecond pulses. The approach is illustrated using the example of Auger or Coster-Kronig decay triggered by photo-ionization with an XUV (eXtreme Ultra Violet) pulse. It requires correlated measurements of angle-resolved energy spectra of both the photo- and Auger electrons in the presence of a laser pulse. Neither the XUV, nor the laser pulse have to be short compared to the decay time. One essential requirement, however, is temporal stability of the probe pulse relative to the pump: their relative jitter degrades time resolution. Fortunately, modern few-cycle infrared (IR) femtosecond pulses can be phase-stabilized with incredible attosecond precision over very long times, naturally leading to attosecond stabilization of XUV pulses which they generate [1]. We envision using these pulses as pump (XUV) and probe (IR). Our approach can be used for

any process resulting in the emission of two charged particles with fixed total energy. Examples are shake-off in one-photon two-electron ionization, photo-induced Auger or Coster-Kronig decay, etc. Ultrafast stages of such processes which can be time-resolved with our approach can also include Zeno and anti-Zeno stages of decay, core rearrangement, non-exponential decay due to structured continuum, etc.

This work is being supported by Austrian Research Fund ADLIS

1. R. Kienberger *et al.* Nature **427**, 817, (2004)

* In collaboration with V.S. Yakovlev[1], M. Ivanov [2], [1] Vienna University of Technology, Austria, [2] NRC, Steacie Institute for Molecular Sciences

WE-A6-4 **11h30**

JOSEPH SANDERSON, University of Waterloo

Controlling and Imaging Molecules with Ultrashort Laser Pulses

Controlling the properties of molecules with ultrafast laser pulses has taken many shapes in recent years, from the most deterministic interferometer based pulse shaping to feedback schemes designed to generate arbitrary pulse shapes through spectral and phase content. These schemes have met with varying degrees of success, and have employed various diagnostic methods. Meanwhile the effort to image molecules and molecular processes using intense laser pulses has made significant progress, particularly with the advent of few femtosecond pulses. The exciting prospect of combining these control and diagnostic technique will be discussed, with particular reference to current and future efforts at Waterloo.

WE-A6-5 **12h00**

Precision Optical Frequency Measurements Using a 1.5um Infrared Frequency Comb*. **Alan A. Madej** [1], A.J. Alcock [2], J.E. Bernard [1], S. Chepurov [3], A. Czajkowski [4], [1] *Institute for National Measurement Standards, NRC, Ottawa,* [2] Institute for Microstructural Sciences, NRC, [3] Institute for Laser Physics, Novosibirsk, Russia, [4] Department of Physics, University of Ottawa — The science of precision counting of optical frequencies in the 10^{14} – 10^{15} Hz range has been revolutionized recently by the use of mode-locked femtosecond lasers. With such devices, a regular comb of optical reference frequencies spanning a significant portion of the spectrum can be generated. To date, most work has centered on Ti:Sapphire mode-locked laser systems to create frequency combs centered in the near infrared and visible region of the spectrum. We describe the precision measurement of frequency intervals in the 1510 to 1550 nm region using a Cr:YAG mode-locked laser frequency comb. The laser operates in the 1500 nm region and can mode-lock using Kerr-lens mode-locking or with a semiconductor saturable absorber mirror (SESAM). With the SESAM in place, reliable mode-locking of the pulses is achieved with pulse widths below 100 fs and >50 mW output power. Phase locking of the cavity repetition rate to a reference RF signal has been obtained together with a demonstration of Hz level frequency interval measurement using the comb. Work is underway to use two diode lasers, stabilized to reference saturated absorption lines in acetylene, as frequency references from which the Cr:YAG system will be used to measure frequency intervals over spans of several THz. The measurements of the precision frequency separations of reference acetylene lines will be performed to provide a high accuracy grid of known wavelengths across the optical telecommunication spectrum for standards, telecommunication, and scientific applications.

*This work is being supported by CIPI/ICIP

WE-A6-6 **12h15**

Applications of a 1.5 Micron Frequency Standard for Precision Measurements*. **A. Czajkowski** [1], F. Stone [1], A.A. Madej [2], J.E. Bernard [2], [1] *University of Ottawa* and [2] Institute for National Measurement Standards National Research Council Canada, — We have successfully completed development and characterisation of an acetylene stabilised frequency standard at 1.5 micron. The system was demonstrated to lock to saturated absorption features of various lines of isotopic acetylene. The laser frequency showed a stability of 4×10^{-12} in 1 s and a reproducibility of better than 1 kHz. The most spectacular demonstration of the system performance included the measurements of frequencies of the P(10), P(11), P(14), P(15), P(16), P(20), and P(21) transitions in the $\nu_1 + \nu_3$ overtone band of $^{13}C_2H_2$ using an optical frequency comb generator. One of the research directions being pursued is the characterisation of a broadband frequency standard, based on an ultra-low expansion (ULE) glass Fabry-Perot interferometer, designed for telecom laser calibrations in the region of 1450 nm to 1600 nm. Several new projects focussed on applications of the 1.5 micron standard to the precision measurements of artificial atom systems will also be presented.

* This work is being supported by NSERC/CIPI/NRC

12h30 **Session Ends / *Fin de la session***

[WE-A7] Quantum Information / Computing
(DTP/*IDPT*) ***Information / ordinateur quantique***

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
10h00 - 12h30

SALLE / ROOM IRC 1 (cap. 133) ***Chair: R. MacKenzie, Université de Montréal***

WE-A7-1 **10h00**

ASHWIN NAYAK, University of Waterloo, and Perimeter Institute for Theoretical Physics

Near Optimal Quantum Test of Group Commutativity *

We consider the computational problem of testing whether an implicitly specified group is commutative. The group is defined by its *k* generators, and a procedure that implements group operations. The computational complexity (in terms of *k*) of this problem was first considered by Pak (2000). We construct a quite optimal quantum algorithm for this problem whose complexity is in $\tilde{O}(k^{2/3})$. The algorithm uses and highlights the power of the quantization method of Szegedy (2004). For the lower bound $\Omega(k^{2/3})$, we introduce a new technique of reduction for quantum query complexity. We also prove an $\Omega(k)$ lower bound for classical algorithms, which shows that the algorithm of Pak is optimal.

* In collaboration with Frédéric Magniez , CNRS—LRI, Université Paris-Sud

WE-A7-2 **10h30**

MOSHE SHAPIRO, University of British Columbia

Principle of Coherent Control and the Detection and Automatic Repair of Mutations by Coherent Light

We discuss the principles of Coherent Control as a means of controlling future events and the limitations imposed by quantum mechanics on such endeavors. One of the striking applications of coherent control is that it allows for the detection and automatic repair of mutations in nucleotide pairs. We illustrate this concept via computations in which we construct a laser pulse sequence that can detect the occurrence of a mutation caused by a double proton transfer between hydrogen-bonded nucleotide pairs and automatically repair it by converting the mutated nucleotide-pair to the non-mutated one.

WE-A7-3 **11h00**

GILLES BRASSARD, Université de Montréal

Quantum Foundations in the Light of Quantum Information *

Consider the two great physical theories of the twentieth century: relativity and quantum mechanics. Einstein derived relativity from very simple principles such as: "The speed of light in empty space is independent of the speed of its source" and "Physics should appear the same in all inertial reference frames". By contrast, the foundation of quantum mechanics is built on a set of rather strange, disjointed and *ad hoc* axioms. Why is that? Must quantum mechanics be inherently less elegant than relativity? Or is it rather that the current axioms of quantum mechanics reflect at best the history that led to its discovery by too many people (compared to one person for relativity), over too long a period of time? The purpose of this talk is to argue that a better foundation for quantum mechanics lies within the teachings of quantum information science. We postulate that the truly fundamental laws of Nature concern *information*, not waves or particles. For example, it has been proven, from the current axioms of quantum mechanics, that "Nature allows for the unconditionally secure transmission of confidential information", but "Nature does *not* allow for unconditionally secure bit commitment" (this is a standard classical cryptographic primitive). We propose to turn the table around, start from these two theorems and possibly a few others, *upgrade them as axioms*, and ask how much of quantum mechanics they can derive. This provocative talk is meant as an eye-opener: we shall ask far more questions than we shall resolve!

* In collaboration with C.A. Fuchs, Bell Labs

WE-A7-4 **11h30**

KARL-PETER MARZLIN, Institute for Quantum Information Science, University of Calgary

Applications of Electromagnetically Induced Transparency in Quantum Information *

Electromagnetically induced transparency (EIT) has been used to slow down and store light pulses coherently. Since decoherence is suppressed in this process, EIT is an interesting technique to manipulate quantum states of light. In this talk I will present recent work done at the Institute for Quantum Information Science on using EIT to process quantum information. One project is concerned with the detection of atomic entanglement. If atoms are cooled by the method of velocity-selective coherent population trapping, they settle in an entangled superposition of electronic and center-of-mass degrees of freedom. We predict that this entanglement will give rise to a coherently backscattered light pulse if the gas is probed with a weak laser pulse. A second project is the manipulation of single-photon states by means of an adiabatic Raman technique in a Lambda system with multiple excited states. We have shown that in such a system exactly one superposition of photonic modes can exhibit EIT. By changing the control fields this superposition can be changed and allows to manipulate the quantum state of light.

* In collaboration with M. Kiffner [1], J. Appel [2], A. Lvovsky [2], B.C. Sanders [2], [1] Max-Planck Institute, Heidelberg, [2] Institute for Quantum Information Science

WE-A7-5 **12h00**

MICHELE MOSCA, University of Waterloo/St. Jerome/Perimeter Institute

Quantum Phase Estimation

Consider a phase shift gate u_ϕ acting on one qubit that induces a relative phase shift of $e^{i\phi}$, that is, $0 \rightarrow 0$ and $1 \rightarrow e^{i\phi} 1$. Estimation of the phase ϕ is a widely studied problem with many important applications. I will discuss new and old results regarding quantum algorithms for phase estimation, including optimal techniques for estimating ϕ given N copies of the phase gate.

12h30 **Session Ends / *Fin de la session***

[WE-A8] Nanoscale Physics / *Physique nanométrique*

(DCMMP/*DPMCM*)

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
10h00 - 12h00

SALLE / ROOM IRC 2 (cap. 500) ***Chair: M. Dignam, Queen's University***

WE-A8-1 **10h00**

JOHANNES V. BARTH, University of British Columbia

Supramolecular Architecture at Surfaces: Control of Matter at the Nanoscale

The fabrication of highly organized molecular systems using programmed organic building blocks opens up new vistas for the control of matter and the design of novel functional materials. In recent years significant progress was made in their assembly at solid surfaces, which can be directed and monitored in exquisite detail using physical nanoscience methods. Moreover, this approach facilitates integration in environments structured at a higher level. Here we concentrate on molecular-level control and atomistic understanding of low-dimensional supramolecular nanosystems at metal substrates. Versatile building blocks proved to be species with planar p-systems. Variable-temperature scanning tunneling microscopy observations provide direct insight into their binding, interactions and organization principles. On close-packed noble metals we followed the self-assembly of H-bonded one-dimensional nanogratings, two-dimensional sheets and open honeycomb networks. On the square Cu(100) surface the formation and dynamics of mononuclear metal-organic compounds were monitored. Furthermore one-dimensional coordination polymers and ribbons, and nanoporous two-dimensional metallosupramolecular networks with specific topologies and a high structural stability were engineered. Their tailoring and functionalization allows for the steering of molecular organization and sorption, as demonstrated with the accommodation of C_{60} and other guest molecules. Last not least, metal-organic linkages between metal clusters were obtained using nanopatterned substrates.

WE-A8-2 **10h30**

ROLAND BENNEWITZ, McGill University

Observing Atoms at Work

The development of Scanning Force Microscopy has provided us with tools to study friction and wear on the nanometer scale. The atomic granularity of matter shows up in the lateral force which is necessary to slide a small contact over a flat surface. Also, mechanical damage of a sample surface can be monitored with monolayer resolution. The aws which determine the dependence of friction on normal load or velocity differ from the ones we have learned to describe macroscopic friction. For small scales, a regime of ultra-low friction has been suggested and experimentally realized. I will discuss differences between macroscopic and microscopic friction, review recent experimental results, and present models which have been used to explain these results.

WE-A8-3 **11h00**

Mechanical Properties of Multiwalled Carbon Nanotubes*. **Jeffrey L. Hutter**, G. Guhados, X.(A.) Sun, W.K. Wan, *The University of Western Ontario* — Carbon nanotubes (CNTs) have received increasing attention for applications such as nanometer-scale electrical devices, sensors, and energy storage. Some of their earliest applications exploit their high mechanical strength to reinforce polymer composites. While theoretical estimates of the strength of CNTs abound, relatively few direct measurements have been performed. The atomic force microscope (AFM), with its ability to sense piconewton forces, is an ideal tool for probing the mechanical properties of nanomaterials. Here, we describe its use to measure the elastic moduli of suspended multiwalled CNTs. Previous similar studies have applied a force near the centre of a suspended fibre and derived its Young's modulus via an assumed elastic model. We have extended this technique by measuring the cantilever deflection at several points along the tube, allowing us to discriminate between potential elastic models and to determine moduli with increased precision. We find that the deflection of multiwalled CNTs cannot be adequately described by a simple bending model, indicating the existence of an additional deflection mechanism such as by internal shear. We estimate a Young's modulus of E = 750 GPa and a shear modulus of G = 2 GPa. This value of E is smaller than some theoretical predictions, but consistent with previous experimental findings; the value of G is considerably lower than theoretical predictions and represents the first direct experimental measurement of the shear modulus of multiwalled CNTs.

* This work is being supported by NSERC

WE-A8-4 **11h15**

Magnetization Dynamics Depending on As-Patterned Magnetic States in Submicron Elements*. **Byoung C. Choi** [1], J. Ho [1], Y.K. Hong [2], H. Han [2], S.H. Gee [2], G.W. Donohoe [2], [1] *University of Victoria*, [2] University of Idaho — Studies of magnetization configuration and ultrafast switching mechanism of patterned magnetic elements at nanoscale have become subjects of great interest, both due to the scientific interest and future technological applications in magnetic sensors and nonvolatile magnetic random access memory (MRAM) devices. In order to investigate the appropriate MRAM element shape for a well-defined magnetization switching, we have investigated the magnetization configurations and switching dynamics of submiron "Pac-man"-shaped $Ni_{80}Fe_{20}$ elements with conventional and modified (*i.e.*, elongated) geometry using magnetic force microscopy (MFM), magneto-optical Kerr effect (MOKE), and micromagnetic simulations. It was found that the sensitive interplay between exchange, demagnetizing, and shape anisotropy energies leads to distinct magnetization configurations, even though the geometric shape of elements is only slightly modified. In a particular case, such as 40 % elongated element, vortex-driven magnetic switching is replaced by well-defined coherent reversal. Micromagnetic simulations based on Landau- Liftshitz-Gilbert (LLG) equation have been carried out in order to understand how the magnetic switching dynamics is influenced by distinct as-patterned magnetization state for given element geometries, when the elements undergo ultrafast magnetization reversal. It was found that the switching dynamics is little dependent on as-patterned domain configurations. For all elements investigated, the fast reversal leads to very complex nonequilibrium domain configurations. In general, the magnetization reversal starts in the central part of the sample, while the sample edges are reluctant to reverse and lead to the formation of vortices. The switching is, however, strongly dependent on the relative time delay between word and digital pulses.

* This work is being supported by CFI, NSERC, BCKDF, ARFL

WE-A8-5 **11h30**

Molecular Spintronics: Theory of Spin-Dependent Electron Transport Between Iron Nano-Contacts Bridged by Organic Molecules and Fe Atomic Chains*. **Hugh Dalgleish**, G. Kirczenow, *Simon Fraser University* — Recent experiments [1] have lent support to theoretical predictions [2] that organic molecules connecting nickel nano-contacts may exhibit pronounced spintronic phenomena such as giant magneto-resistance and spin-valve effects. In this talk we present theoretical predictions of spintronic phenomena in another class of ferromagnetic nano-systems in the form of pairs of Fe nano-contacts bridged by single conducting or insulating molecules or chains of Fe atoms. Model Hamiltonians describing the electronic structure of these systems are constructed based on semi empirical considerations and the known electronic structure of bulk Fe as well as ab initio density functional (DFT) calculations for some simple model systems involving thiol groups and Fe nano-clusters. Using Lippmann-Schwinger and Green's function techniques, together with the Landauer formalism, significant magneto-resistance is predicted in these systems. Under appropriate conditions, novel device characteristics such as negative magneto-resistance are also predicted to emerge.

1. J.R. Petta, S.K. Slater, D.C. Ralph, *Phys. Rev. Lett.* **93**, 136601 (2004).
2. E.G. Emberly and G. Kirczenow, *Chem. Phys.* **281**, 311 (2002); R. Pati, L. Senapati, P.M. Ajayan, S.K. Nayak, *Phys. Rev.* **B 68**, 100407 (2003); W.I. Babiaczyk, B.R. Bulka, *J. Phys.-Cond. Matt.* **16**, 4001 (2004); K. Tagami, M. Tsukada, *J. Phys. Chem.* **B 108**, 6441(2004).

* This work is being supported by NSERC and CIAR

WE-A8-6 **11h45**

Two-Probe Theory of Scanning Tunneling Microscopy of Single Molecules*. **John W. Buker**, George Kirczenow, *Simon Fraser University* — Experiments in scanning tunneling microscopy of single molecules adsorbed on substrates have produced topographic maps showing how electron flow through a molecule depends on the position of the STM tip above the molecule. However, in some experimental situations, very different topographic maps are obtained when a molecule is adsorbed at different locations on the substrate (X.H. Qiu, G.V. Nazin, and W. Ho, *Science* **299**, 542 (2003)). This suggests that the tip position is not the only important determining factor for electron flow through the molecule: It is possible that electron flow also depends strongly on the details of the coupling between the molecule and the substrate. However, theoretical work on STM imaging to date has focussed primarily on the role of the tip-molecule coupling. In this talk we re-examine scanning tunneling microscopy of molecules, treating the tip-molecule coupling and the molecule-substrate coupling on the same footing. Treating both the tip and substrate as probes coupled to the molecule, we find that the STM image of a molecule can be sensitive to the geometry of the molecule-substrate coupling. We obtain distinct topographic maps for various configurations of the stationary probe with respect to the molecule, and explain their differences in terms of the molecular orbitals that mediate electron flow in each case.

* Work supported by NSERC and the Canadian Institute for Advanced Research.

12h00 **Session Ends / *Fin de la session***

[WE-A9 (DIMP/*DPIM*) Semiconductor and Thin Film Characterization II / *Caractérisation des films minces et des semi-conducteurs II*

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

10h00 - 12h15

SALLE / ROOM IRC 6 (cap. 226) ***Chair: M. Terazima, Kyoto University***

WE-A9-1 **10h00**

Contactless Characterization of Photo-Carrier Recombination Processes in Si Using Rate-Window Photo-Carrier Radiometry*. **Andreas Mandelis**, University of Toronto — A rate-window photo-carrier radiometry (PCR) method has been developed for the study of recombination lifetimes in semiconductor materials. The method combines the high signal-to-noise ratio features of lock-in detection and the simplicity of interpretation of laser-generated PCR signal transients in terms of recombination lifetimes. This is achieved through repetition-time scans of square-wave time-gated laser pulses and the detection of PCR transients by a lock-in amplifier tuned to the fundamental component of the Fourier series that represents the repetitive pulse. Both theoretical and experimental results with Si wafers will be presented and surface and bulk recombination lifetimes will be measured as a function of temperature.

* In collaboration with C-H. Wang [1], I. Delgadillo-Holfort [2], M. Pawlak [2], J. Pelzl [2], [1] University of Toronto, [2] Ruhr University-Bochum

WE-A9-2 **10h15**

TETSUO IKARI, University of MIYAZAKI

Characterization of the Semiconductor Thin Film Quantum Structures by Using a Piezoelectric Photo-Thermal Spectroscopy (PPTS)

Piezoelectric Photo-thermal Spectroscopy (PPTS) is a developed methodology for investigating optical properties of semiconductor thin films from the point of view of nonradiative electron transition. High sensitivity of the PPTS technique allows us to observe definite absorption spectra in semiconductor quantum well structure of GaInNAs with the thickness of 3 nm. Two dimensional density-of-states and excitonic structure were clearly observed. Proton induced crystal defects were also studied at room temperature in CuInSe2 chalcopyrite solar cell semiconductors. Furthermore, we could obtain a defect signal, which is usually hard to detect by conventional optical measurements, in the micro- and the polycrystalline semiconductors by using a fact that the diffusive light scattering does not affect the PPT signal. Oxygen vacancy complex in ZnO transparent conducting oxide and dangling bond in microcrystalline Si films were detected by this PPT spectroscopy. In this presentation, I would like to introduce advantages of the PPTS method for characterizing the thin film quantum structure for the optoelectronic device application.

10h45 **Coffee Break / Pause café**

WE-A9-3 **11h15**

ANTONIO MANSANARES, Physics Institute, University of Campinas, Brazil

Sensitivity Enhancement in Thermo-Reflectance Microscopy of Semiconductor Devices Using Suitable Probe Wavelengths

In this paper we present an experimental and theoretical study of the thermo-reflectance response as a function of the probe wavelength for layered microelectronics structures. The investigated sample consists of a poly-crystalline silicon conducting track grown on a SiO_2 coated Si substrate. Thermo-reflectance measurements were carried out in the wavelength range from 450 to 750 nm with the track biased in modulated regime. An oscillating pattern is observed in the spectral region where the upper layer is transparent. Such oscillations are due to the interference that results from the multiple reflections at the interfaces. Using a thermo-optical model, we show that the optical constants (n and k) of the materials, which are wavelength dependents, as well as their temperature derivatives (dn/dT and dk/dT), strongly influences the thermo-reflectance signal. The optical thicknesses of the layers, determined by the real part of the refractive indexes, define the period of oscillation. On the other hand, the imaginary part of the refractive indexes establishes the cutoff wavelength of the oscillations. Below this cutoff wavelength, the probe light does not penetrate the material, and the upper surface reflectance dominates the signal, resulting in lost of sensitivity in this wavelength range, as observed in the experiments.

WE-A9-4 **11h45**

A.A. MAZNEV, Philips Advanced Metrology Systems

Measuring Microelectronic Thin Films with Transient Grating Photoacoustics *

The laser-induced transient grating technique offers an effective tool for probing mechanical and thermal properties of thin films. We will present a review of recent developments in the technique and its applications in the microelectronics area. Phase-controlled optical heterodyne detection, now incorporated in commercially available instruments, has greatly enhanced the capabilities of the transient grating method. Another area of development has been the extension of the acoustic wavelength range, which now permits closing the gap between laser ultrasonics and Brillouin scattering measurements. For industrial microelectronics applications, most attention continues to be on thickness measurements, both of continuous films and of more complex structures such as copper damascene line arrays. We will review these and other promising applications, such as measuring elastic properties of low-k dielectric films and the electrical resistivity and grain size of electroplated copper.

* In collaboration with A. Mazurenko and M. Gostein, Philips Advanced Metrology Systems

12h15 **Session Ends / *Fin de la session***

[WE-P1] Plenary Session / *Session plénière*

(CAP/*ACP*)

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

13h30 - 14h15

SALLE / ROOM IRC 2 (cap. 500)

Chair: C. Virtue, Laurentian University

WE-P1-1 **13h30**

BORIS KAYSER, Fermilab, Chicago

The neutrinos: Discoveries and open questions

Abstract not available

14h15 **Session Ends / *Fin de la session***

[WE-P2] QCD in Nuclear Physics / *QCD en physique nucléaire*

(DNP/*DPN*)

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

14h15 - 17h00

SALLE / ROOM CEME 1204 (cap. 60)

Chair: G. Huber, University of Regina

WE-P2-1 **14h15**

C.A. MILLER, TRIUMF

Studying Quark Confinement in the Nuclear Environment with Deeply Inelastic Scattering

One of the unsolved mysteries associated with confinement in QCD is how an energetic quark ejected from a hadron in a hard collision becomes incorporated into a new hadron together with quarks found in the vacuum. When this process called hadronization or quark fragmentation occurs in the nuclear environment, it becomes possible to study the sequential stages of this process via the dependence of the effects of the nuclear medium on the nuclear size and the kinematics of the process. The understanding of quark propagation in the nuclear medium is crucial for the interpretation of ultra relativistic heavy ion collisions. Deeply Inelastic Scattering (DIS) of charged leptons is an ideal tool for

this study, as it provides direct measurement of the kinematic properties of the struck quark. It turns out the ideal range of energy transfer to the struck quark is 10 to 20 GeV, where the hadron formation length is similar to a typical nuclear size. Hence the HERMES experiment in the 27.5 GeV HERA electron ring at DESY is well placed to pursue these studies. The experiment is equipped with a dual-radiator ring-imaging Cerenkov detector that identifies hadrons over the full kinematic acceptance. Recent hadron multiplicity data from several nuclear targets will be compared to various model predictions.

WE-P2-2 **14h45**

DIPANGKAR DUTTA, Duke University/TUNL

From Quarks to Nuclei: The Search for Signatures of QCD in Nuclei

Understanding the interactions and the structure of nucleons and nuclei in terms of the quark-gluon degrees of freedom of QCD is one of the important unsolved problem of the standard model of nuclear and particle physics. Mapping the transition from the nucleon-meson to the quark-gluon degrees of freedom is an integral part of any attempt to address this problem. One of the popular approaches involves searching for the onset of various phenomena which are naturally predicted in QCD. Exclusive processes on nucleons and nuclei play an essential role in these searches. We will examine a few topics of current interest in this field, looking at the QCD predictions, the status of experimental searches for these signatures of QCD, and proposed future experiments.

15h15 **Coffee Break / Pause café**

WE-P2-3 **15h30**

RANDY LEWIS, University of Regina

Recent Successes and Future Directions in Lattice QCD

There is substantial activity within the international lattice field theory community that is relevant to the research interests of the CAP's Division of Nuclear Physics. A number of current examples will be discussed. Progress in the development of lattice techniques will be mentioned, but the emphasis will be on phenomenology.

WE-P2-4 **16h00**

DAVID HORNIDGE, Mount Allison University

The Magnetic Moment of the $\Delta(1232)$ Resonance

The magnetic moment of a baryon, μ_b, is due to the quark spins and the average of the quark currents. As a result, the measurement of μ_b gives a simple, elegant, and senstive way of testing the theoretical hadron description in the non-perturbative region of QCD. We have just recently finished taking data at the Mainz Microtron to measure the five-fold differential cross section and photon asymmetry for the reaction $\vec{\gamma}\, p \to \gamma \pi^0 p$ in the region of the Δ resonance (E_γ = 300 – 500 MeV). Using this data and a theoretical model, we hope to make an accurate determination of the magnetic dipole moment of the Δ^+ (1232) resonance. Preliminary results will be presented.

WE-P2-5 **16h30**

The Strange Form-Factors of the Proton and the G0 Experiment. **Jeffery W. Martin**, *University of Winnipeg* — Parity violation in elastic electron scattering arises through the interference of Z^0 and g exchange. Measurements of parity-violating asymmetries in elastic electron-proton scattering therefore allow the determination of the neutral weak form factors of the proton. The known weak couplings allow the unambiguous separation of the electromagnetic and neutral weak form factors into contributions from each quark flavor. In this way the contribution of strange quark-antiquark pairs to the form factors may be determined. Measurements of parity-violating asymmetries at both forward and backward angles must be performed in order to separately determine the strange electric and magnetic form factors. It is the aim of the G^0 experiment at Jefferson Lab to extend the work of previous experiments and perform the complete separation for Q^2 in the range 0.1 to 1.0 $(GeV/c)^2$. The G^0 forward-angle measurements were completed in 2004 and preliminary results from the analysis of those data will be presented. The first of the G^0 backward-angle measurements will take place in late 2005. Preparations for those measurements are underway and will be discussed.

WE-P2-6 **16h45**

Search for $K^{-}pp$ nuclei with FINUDA*. **Arthur Olin** [1], G.A. Beer [2], for the FINUDA Collaboration, [1] *TRIUMF/University of Victoria*, [2] University of Victoria, [3] FINUDA Collaboration — The initial 2004-5 run of the FINUDA experiment at DAFNE received ~ 250pb^{-1} of beam at the ϕ resonance, and the low energy K^- from ϕ decay were stopped in thin targets. The spectrometer's large solid angle and low energy threshold enable a search for deeply bound kaonic nuclei. Λs are cleanly identified through their π^- p invariant mass distribution. Then back-to-back Λ p are observed with invarient mass below the free particle masses. A further run is planned in 2006 with an improved apparatus to confirm this measurement.

* This work is being supported by NSERC

17h00 **Session Ends / *Fin de la session***

[WE-P3] Membranes and Vesicles / *Membranes et vésicules*

(DMBP/*DPMB*)

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
14h15 - 15h45

SALLE / ROOM G279 -hos. (cap. 140) ***Chair: A. Rutenberg, Dalhousie University***

WE-P3-1 **14h15**

MICHAEL WORTIS, Simon Fraser University

Biomechanics of Human Red-Cell Shapes: The Stomatocyte-Discocyte-Echinocyte Sequence *

It has been known for more than 50 years that the normal, biconcave shape of the resting discocyte changes reversibly under treatment by membrane-active chemical agents to exhibit a universal sequence of deformed shapes. We have shown that this sequence is a simple consequence of the mechanical properties of the complex cell-membrane material. The plasma membrane and the membrane skeleton both play crucial roles. The upshot is a description in which, to a good approximation, a single parameter associated with the area difference between the inner and outer leaves of the bilayer drives the cell through a series of shape transformations.

* In collaboration with G. Lim, Baylor College of Medicine

WE-P3-2 **14h45**

JOHN KATSARAS, National Research Council

Spontaneously Forming, Varying Polydispersity Unilamellar Lipid Vesicles *

Over the past decade "bicellar" lipid mixtures composed of the long-chain dimyristoyl phosphatidylcholine (DMPC) and the short-chain dihexanoyl PC (DHPC) molecules have emerged as powerful media for studying membrane-associated, biologically-relevant macromolecules and assemblies. Depending on temperature, lipid concentration, and composition, these lipid mixtures can assume a variety of morphologies. Recently, we have observed the spontaneous formation of path-dependent monodisperse and polydisperse phospholipid unilamellar vesicles (ULV) from two different equilibrium morphologies, specifically disc-like micelles and lamellae, respectively. On heating beyond a temperature Tc, low temperature disc-like micelles, or so-called bicelles, transform into lamellae. Dilution of the lamellar phase, results in a complete unbinding transition and the formation of polydisperse ULV, demonstrating the instability of lamellar phase. On the other hand, heating of dilute bicelle solution above Tc, results in monodisperse ULV. Today's seminar will deal with the suggestion that the ULV morphology is most likely thermodynamically stable and not kinetically as suggested by some, and that ULV size distribution depends on the equilibrium precursor morphology. Moreover, the use of spontaneously forming ULV in pharmaceutical and biomedical applications will be elaborated.

* In collaboration with M.-P. Nieh [1], V.A. Raghunathan [2], T.A. Harroun [1], [1] National Research Council, [2] Raman Research Institute

WE-P3-3 **15h15**

EVAN EVANS, University of British Columbia

From Innate Immunity to Cell Death: Exploring the Energy Landscape Governing Membrane Permeation by Small Peptides with Dynamic Tension Spectroscopy *

Biomembranes are nature's ubiquitous design for encapsulation and protection of the precious chemical processes in living cells. However, biomembranes are soft-liquid materials and, when stressed, fail through a thermally-activated process of hole nucleation (2-D cavitation). Moreover, holes can open up spontaneously in biomembranes when exposed to amphiphilic peptides like those that provide the first line of immune defense in organisms or that arise with break down of mitochondrial structure in cell death. We have developed a simple micro-mechanical method to probe the energy landscape governing of this nucleation process (Evans *et al.*, Biophys. J. 85, 2003). Applying ramps of dilatation stress (tension) to rupture macroscopic membrane vesicles, the statistics of rupture provide a spectroscopic image of the kinetics of nucleation under stress, yielding the size of the critical nucleus that couples to tension and reduces the energy barrier to hole nucleation. In fluid membranes, the critical nucleus size diminishes with increase in speed of loading, approaching a minimum limit at very fast loading, and indicating a crossover of the kinetic energy barrier from that of a deformable mesoscopic hole to that of a stiff molecular defect. Surprisingly, rupture of single vesicles in an isolated environment containing sub-lytic peptide concentrations shows that, depending on lipid composition, even very low concentrations significantly alter the energy landscape governing hole nucleation. The change of critical nucleus size with change in peptide chemical potential characterizes the susceptibility to peptide permeation at a particular level of tension.

This work is being supported by CIHR

* In collaboration with W. Rawicz, B. Smith , University of British Columbia

15h45 **Session Ends / *Fin de la session***

[WE-P4] General Relativity and Gravitation / *Relativité générale et gravité*

(DTP/*DPT*)

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

14h15 - 16h45

SALLE / ROOM IRC 1 (cap. 133) ***Chair: M. Paranjape, Université de Montréal***

WE-P4-1 **14h15**

JOHN W. MOFFAT, Perimeter Institute for Theoretical Physics/Waterloo University

Gravitational Theory, Galaxy Rotation Curves and Cosmology Without Non-Baryonic Dark Matter

Einstein gravity coupled to a massive skew symmetric third rank field, leads to an acceleration law that modifies the Newtonian law of acceleration. A framework of non-perturbative renormalization group equations and an effective action allow for the running with momentum or space and time of the effective gravitational constant G, the coupling constant for the gravity-skew symmetric field interaction and the mass of the skew field. Strong infrared renormalization effects occur at large distance scales and lead to an increase in the effective gravitational constant G at large galactic and cosmological distances. Fits to galaxy rotation curves are obtained and compared to the fits using Milgrom's phenomenological MOND acceleration formula. The fits assume that galaxies are not dominated by non-baryonic dark matter. Predictions are made for galaxy and cluster lensing. The gravitational predictions for the solar system agree with observations. An FLRW cosmological model with an effective gravitational constant G running with time can lead to consistent fits to cosmological data without assuming the existence of exotic cold dark matter.

WE-P4-2 **14h45**

JACK GEGENBERG, University of New Brunswick

Quantization of Dilaton Gravity *

I will outline the procedure for constructing a quantum theory of two dimensional dilaton gravity. The quantum theory, in common with the methods of Loop Quantum Gravity, will have a non-standard quantum phase space topology. The relation of this quantum theory to the usual one will be discussed, focusing on the issues surrounding black hole physics.

* In collaboration with Gabor Kunstatter, University of Winnipeg

WE-P4-3 **15h15**

HANS-PETER KUNZLE, University of Alberta

*Spherical Symmetry of Generalized Einstein-Yang-Mills-Higgs Fields**

The classical interaction of gravitational and gauge fields in the form of Einstein-Yang-Mills theory has been studied quite extensively over the last almost 20 years. Most of the work was done in the spherically symmetric case and has led to some interesting new phenomena like the coloured black holes. In this talk the notion of spherical (and more general) symmetry groups) on systems with quite general gauge and generalized Higgs fields will be discussed in the mathematical framework of group actions on principal and associated fibre bundles. The possible spherically symmetric models are classified and the corresponding field equations analyzed.

*In collaboration with B.F. Viaud [1], T.A. Oliynyk [2], [1] University of Alberta, [2] University of Alberta (now Albert-Einstein-Inst.)

WE-P4-4 **15h45**

KRISTIN SCHLEICH, University of British Columbia

Topological Censorship and Beyond: Black Holes and Singularities in Dimension Greater Than 4

The topological censorship theorem implies the existence of eternal black holes for spacetimes with nontrivial fundamental group. However it does not indicate whether or not other topological structures collapse. Recent work shows that such collapse occurs for certain such structures; spacetimes in 5 or more dimensions with trivial fundamental group but non zero A-hat genera must be singular. This talk will discuss this and other work toward this issue and its implications for classical relativity in higher dimensions.

WE-P4-5 **16h15**

MATTHEW W. CHOPTUIK, University of British Columbia / CIAR Cosmology and Gravity Program

Numerical Relativity in the World Year of Physics

Fueled by Moore's Law and the development of sophisticated algorithms, numerical relativity has entered an exciting new era, where the approximate solution of rather generic, and astrophysically relevant, solutions to the vacuum Einstein field equations—-describing for example the late phases of the inspiral of a black hole-black hole binary—-have begun to appear. I will discuss the state-of-the-art of this rapidly developing field, as well as near-term prospects, and will include animations of representative calculations from various numerical relativity efforts around the world.

16h45 **Session Ends / *Fin de la session***

[WE-P5] Soft Matter / *Matière molle*

(DCMMP/*DPMCM*)

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
14h15 - 17h00

SALLE / ROOM IRC 2 (cap. 500) ***Chair: J. Bechhoefer, Simon Fraser University***

WE-P5-1 **14h15**

JOHN R. DE BRUYN, University of Western Ontario

Penetration of Spheres Into Loose Granular Media *

We study the penetration of steel spheres dropped vertically into a container of loosely packed, small glass beads. We find that the penetration depth of the spheres increases linearly with the incident momentum of the projectile, but with a zero-momentum intercept. This behavior can be understood by modeling the granular medium as a non-Newtonian fluid with a yield stress and an effective viscosity. We derive the scaling behavior of the viscosity and find agreement with our experimental results.

* In collaboration with A.M. Walsh, Memorial University of Newfoundland

WE-P5-2 **14h45**

Effects of Quenched Porosity Fluctuations In Nonlinear Reaction-Diffusion Porous Systems*, **Ivan L'Heureux**, *University of* Ottawa — In many disciplines (chemical and petroleum engineering, soil science, hydrology, geochemistry), one is interested in studying nonlinear reactive transport in porous random media. Here, we investigate the effects of quenched porosity fluctuations on the dynamics of a reaction-diffusion porous system described by nonlinear kinetics. We adopt the weak noise approximation and a mean-field assumption to obtain an effective reaction-diffusion equation describing the dynamics of the average concentration of the reacting species. We find that the reactive transport is characterized by a smaller effective diffusion coefficient and by the presence of supplementary nonlinear reactive terms. We present explicit results for Gaussian and long-ranged fluctuations. Comparisons with simulations in a one-dimensional system are also presented.

* This work is being supported by NSERC

WE-P5-3 **15h00**

Conformational Changes of Adsorbed Proteins*, **Scott G. Allen**, R. Yada, J.R. Dutcher, *University of Guelph* — The adsorption of bovine serum albumin (BSA) and pepsin to gold surfaces has been studied using surface plasmon resonance (SPR) and quartz crystal microbalance (QCM). Proteins are adsorbed from solution onto a gold surface and changes in the conformation of the adsorbed proteins are induced by changing the buffer solution. We selected pH and ionic strength values for the buffer solutions that are known from our circular dichroism measurements to cause conformational changes of the proteins in bulk solution. We find that for both BSA and pepsin the changes in conformation are impeded by the interaction of the protein with the gold surface.

* This work is being supported by NSERC, AFMNet

15h15 **Coffee Break / Pause café**

WE-P5-4 **15h45**

JOHN PAGE, University of Manitoba

The Squishy Physics of Dough and Bread *

Dough and bread are two very familiar examples of soft materials, with unusual physical properties that are strongly influenced by their mesoscopic pore structures. For example, the entrainment of bubbles into dough during mixing has profound effects on its mechanical properties, and understanding these effects quantitatively is a challenging problem in soft condensed matter physics due, in part, to the viscoelastic character of the dough matrix. Unraveling the contributions of bubbles and matrix to dough properties is also important to the baking industry, because the bubbles ultimately grow into the voids (gas cells) that determine the structural integrity of bread, and hence its quality. In this talk I will summarize recent progress in investigating the structure and dynamics of wheat flour dough and bread using ultrasonic techniques, which we show to be sensitive probes not only of the number of pores and their distribution in size, shape and orientation, but also the properties of the matrix in which they are embedded. The interpretation of these results with quantitative theoretical models gives new insights into these complex materials, as well as providing the basis for novel non-destructive methods of evaluating both dough processing behaviour and the bread making potential of different flours.

This work is being supported by NSERC.

* In collaboration with M.G. Scanlon, H.M. Elmehdi, K. Mehta, Y. Fan, University of Manitoba

WE-P5-5 **16h15**

Negative Refraction of Acoustic Waves in a 2D Phononic Crystal*, **Alexey Sukhovich** [1], J.H. Page [1], Z. Liu [2], M. Kafesaki [3], [1] *University of Manitoba,* [2] Wuhan University, China, [3] IESL-FORTH, Heraklion, Crete, Greece — We investigate the propagation of ultrasonic pulses through a 2D prism–shaped phononic crystal, made of 1-mm-diameter stainless steel rods assembled in triangular 2D crystal lattice and immersed in water. According to theoretical predictions of Multiple Scattering Theory, in the frequency range

between 0.75 and 1.0 MHz, the wave vector and group velocity point in opposite directions inside the crystal. As a result, an obliquely incident acoustic wave in this frequency range is expected to refract negatively upon crossing crystal–water interface. Our experimental results convincingly demonstrate the negative refraction of ultrasonic pulses in this frequency range. Using the usual condition on the continuity of the tangential component of the wave vector at the interface (Snell's law), and the magnitude of the wave vector inside the crystal determined from Multiple Scattering Theory, we calculate the predicted angles of refraction, obtaining remarkably good agreement between theory and experiment.

* This work is being supported by NSERC, U of M Grad. Fellowship

WE-P5-6 16h30

Swelling and Surface Modification of Ultrathin Chitosan Films*. **C.A. Murray**, J.R. Dutcher, O. Stukalov, A. Jacina, *University of Guelph* — Chitosan is a biodegradable polysaccharide derived from seashell waste products. The high water absorbency and biocompatibility of chitosan have enabled its use as a hydrogel in specialty biomedical applications. We present the results of several experiments focused on characterizing properties of ultrathin films of chitosan critical to their use in techniques such as wound dressings, medical implants and drug delivery systems. Uniform thin films with thicknesses of 15 to 600 nm and rms roughness on the order of 1 nm were prepared using techniques previously developed in our research group. The swelling of these films in the presence of high humidity has been characterized using reflection ellipsometry, atomic force microscopy and quartz crystal microbalance techniques. The effects of exposure to elevated temperature and UV/ozone (a common surface modification technique) on the surface properties such as hydrophobicity are described.

* This work is being supported by NSERC, PREA

WE-P5-7 16h45

Effects of Thermal Fluctuations on Transport in Quasi-1D Systems. **Alexander Plyukhin**, *University of Saskatchewan* — In conventional theory of electronic hopping transport in disordered systems positions of localized states are assumed to be fixed, and thermal fluctuations enter the theory only through the notion of phonons. However in variety of soft matter systems thermal fluctuations not only supply carriers with energy to jump (as in conventional phonon-assisted hopping) but also result in temporal fluctuations of hopping rate parameters (dynamic disorder) or even large-scale diffusion of local centers. I discuss possible role of these effects in electronic transport in disordered quasi-1D systems where fluctuations prevent formation of long-range order. The central result is that Landau-Peierls instability may lead to unusual (non-activated) temperature dependence for the electronic mobility. In particular, I shall discuss mechanisms of the temperature-independent mobility observed in columnar liquid crystals, anisotropic organic crystals, and DNA.

17h00 Session Ends / *Fin de la session*

[WE-P6] Correlated Electrons: Mostly Thin Films / *Électrons corrélés: surtout sans accélérateur*

(DCMMP/*DPMCM*)

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

14h15 - 17h00

SALLE / ROOM IRC 3 (cap. 108) ***Chair: G. Williams, University of Manitoba***

WE-P6-1 14h15

Nuclear Spins as Local Probes for the Quantum Dynamics of Single-Molecule Magnets*. **Andrea Morello** [1], O.N. Bakharev [2], H.B. Brom [2], L.J. de Jongh [2], [1] *University of British Columba,* [2] Leiden Univeristy (NL) — Single-molecule magnets (SMMs) are nanometer-scale molecular compounds, consisting of identical high-spin magnetic clusters bound in a crystalline structure, with very small magnetic interactions between each molecule. Because of their size and their symmetry, the magnetic behavior of SMMs is at the border between quantum and classical phenomena. In particular, SMMs can show quantum tunneling of the magnetic moment, where the tunneling takes place through a classically impenetrable magnetic anisotropy barrier. The tunneling rate is easily tunable by an external magnetic field; if tunneling could be made coherent [1], SMMs would be excellent candidates for magnetic qubits for quantum computation. Perhaps the most essential - and virtually unavoidable - source of decoherence is the coupling to nuclear spins. I will discuss the results of ultralow temperature ($T \sim 20$ mK) NMR experiments [2] that elucidate the role of electron-nucleus coupling in the Mn_{12}-ac compound, and show that one can effectively use the ^{55}Mn nuclear spins as local probes for the quantum dynamic of the molecular spin. In particular, the nuclear spin-lattice and spin-spin relaxations provide precious information about the details of the mechanisms that trigger the tunneling of the electron spins in the incoherent regime. Moreover, for the first time it is demonstrated that tunneling - despite being a quantum, *T*-independent mechanism - is able to relax the nuclear spin temperature to the lattice temperature.

1. P.C.E. Stamp and I.S. Tupitsyn, *Phys. Rev.* **B 69**, 014401 (2004)
2. A. Morello *et al.*, *Phys. Rev. Lett.* **93**, 197202 (2004)

* This work is being supported by Stichting FOM (Netherlands)

WE-P6-2 14h30

Local Ordering Effects in Exchange-Coupled Thin Films*. **Johan van Lierop** [1], B.W. Southern [1], K.-W. Lin [2], [1] *University of Manitoba* and [3] National Chung Hsing University — Conventional wisdom holds that exchange-coupling can only occur when ferromagnetic (FM) spins couple to antiferromagnetic (AFM) spins at and below the Néel temperature, and that the coupling strength is dominated by the magnetocrystalline anisotropy of the AFM layer. We present results on $Ni_{80}Fe_{20}$/Co-oxide bilayers. Similar exchange-coupling strength is observed when the AFM layer is either CoO or Co_3O_4, although there is a factor of five difference in the bulk magnetocrystalline anisotropy. Additionally, in the Co_3O_4 based film exchange-coupling occurs at temperatures well above the bulk AFM transition temperature.

* This work is being supported by University of Manitoba

WE-P6-3 14h45

Magnetic Properties of Nanozigzag Cobalt Films Fabricated by Glancing Angle Deposition. **Cristina Buzea**, K. Robbie, S. Webster, C. Gorla, C. Dean, *Queen's University* — Nanomagnets exhibit substantially different properties than their parent bulk materials. In a nanomagnet, magnetic anisotropy depends not only on the band structure of the material, but also on the shape of the nanomagnet. Glancing angle deposition (GLAD) has the ability to engineer nanostructures by manipulating their size and shape at the atomic scale. The recent development of this fabrication method led to an increased interest in nanosculptured films due to their special morphology, composed of a columnar structure that follows the direction of the incident vapour. Here we report, for the first time, the control of magnetic properties of GLAD films through their nanostructure shape, and size - which is comparable to key magnetic length scales, such as exchange length and magnetic domain walls. We show hysteresis magnetic measurements for fields applied in the plane of the substrate, parallel and perpendicular to the incidence plane, for zigzag nanostructured cobalt films. Grain analysis and Fourier transforms of scanning electron images reveal that the magnetic properties are qualitatively correlated to the morphological characteristics of nanostructured films. Understanding the influence of shape on magnetic properties of nanostructured films opens the way to designing new nanomaterials whose magnetic properties can be tailored to a particular application, such as magnetic recording media, sensors, or other devices.

WE-P6-4 15h00

Investigating In-plane Anisotropy of Ultrathin Fe Films on GaAs(001)-4x6*, **E. Daryl Crozier**, R.A. Gordon, *Simon Fraser University* — Iron films of thickness 2 monolayers and 5 monolayers prepared on Ga-terminated GaAs(001)- 4x6 reconstructed surfaces were studied in-situ at the PNC-CAT beamline by polarization-dependent X-ray Absorption Fine Structure methods to investigate structural anisotropy in the plane of the films and compare with theoretical predictions. These two thicknesses are on either side of the transition from island to layer-by-layer growth modes and provide insight into possible structural origins of in-plane uniaxial magnetic anisotropy observed in this magnetic film system. While first-principles calculations suggest a splitting in the nearest neighbour distances of the body-centered tetragonal iron could be as large as 0.04 Angstroms, depending on

the extent of arsenic migration to the film surface, we observe a value less than 0.01 Angstroms.

* This work is being supported by NSERC

WE-P6-5 **15h15**

Dynamic Magnetic Domain Configurations Assisted by Thermally Excited Spin Fluctuations*. **Byoung C. Choi** [1], G. Arnup [2], J. Ho [3], M.R. Freeman [2], [1] *University of Victoria,* [2] University of Alberta — Nonequilibrium behavior in the evolving structure of domains in mesoscopic ferromagnets undergoing ultrafast magnetization reversal was studied with time-resolved Kerr microscope and micromagnetic modeling. The samples investigated are 15 nm thick polycrystalline $Ni_{80}Fe_{20}$ elements with the size of 10 × 10 μm^2, fabricated using electron beam lithography. The time-resolved magnetization images reveal complex nonequilibrium domain configurations, when a magnetic element is excited by applying a short switchng field pulse (24 kA/m) to reverse the magnetization. At the initial stage, the magnetization reversal starts at the element ends with faint branchlike fine structures, which run orthogonal to the average magnetization direction, formed in the interior regions. With increasing time, domain patterns evolve out of these fine structures. The result implies that the magnetization reversal enters a fully dynamic regime when the external field conditions are changed much faster than the magnetic element is able to respond. In order to better understand the physical origin of the observed complex domain configuration, micromagnetic simulations have been carried out with the sample temperature varied. The simulations agree well with the experiment. In particular, the experimentally observed fine structure formed in the initial state of the magnetization reversal becomes clearly visible in the modeling, when carried out at 300 K. The evolution of the simulated domain configurations reveals that the complex domain structures evolve out of these fine structures, in agreement with experimental observations. This result implies that the thermally excited magnons at finite temperatures are effectively involved in the formation of complex nonequilibrium domain structures.

* This work is being supported by CFI, NSERC, BCKDF, AFRL

15h30 **Coffee Break / Pause café**

WE-P6-6 **16h00**

Spontaneous magnetisation in Quantum Dots*. **Keith Edmonds**, *University of British Columbia* — This thesis analyses magnetism in quantum dots for both isolated dots and lattices of dots. The formalism used is Spin Density Functional Theory in the local density approximation with the correlation functional from the paper by Attaccalite *et al.* (2002). A six electron parabolic quantum dot is found to have a transition between the zero spin ground state and the spin one ground state relative to coupling and ellipsoidal deformation. A lattice of similar dots display anti-ferromagnetic behavior for all lattice constants investigated. 7 electron isotropic dots are modeled collectively in a lattice. A transition between metallic, ferromagnetic and anti-ferromagnetic is found relative to the lattice constant and coupling. A crude estimate of the magnetic moment and field for basic lattices is given.

* This work is being supported by Stephanie Reimann

WE-P6-7 **16h15**

Measurements of the 1/f Noise in Josephson Junctions for Potential Use as QUbits*. **Chas Mugford** [1], J.B. Kycia [1], M. Muck [2], M. Korn [2], J. Clarke [3], [1] *University of Waterloo,* [2] University of Giessen, [3] UC Berkeley — Critical current fluctuations can be a major source of intrinsic decoherence of qubits based on Josephson junctions. We have measured the 1/f noise due to critical current fluctuations in macroscopic Josephson junctions. We directly measure changes in the critical current Ic of a voltage biased junction and find the critical current to fluctuate by about 10E-5 at a frequency of 1 Hz. A second way in which we determine 1/f flux noise due to critical current fluctuations is by measuring the flux noise of either dc or rf SQUIDs. In order to not exceed the critical current of the Josephson junction, we operate the rf SQUID in the dispersive mode. By using the same device as dc or rf SQUID, we can compare the 1/f noise of voltage biased and non-voltage biased Josephson junctions.

* This work is being supported by NSERC OTI CFI

WE-P6-8 **16h30**

Generalized Proximity Effect*. **Lucian Covaci**, Frank Marsiglio, *University of Alberta* — Using the Hubbard Hamiltonian on a two dimensional lattice and the self consistent Bogoliubov de Gennes equations, we revisit the problem of the interface between a normal metal and a superconductor or between two different superconductors. We show that, contrary to the conventional proximity effect, there are differences in the Cooper pair leaking distance between a normal metal and a superconductor above its Tc. We present calculations for a S1-S2-S1 sandwich, where S1 and S2 are s-wave superconductors with different critical temperatures. The temperature dependence of the Josephson critical current for such a structure implies that the Cooper pair leaking distance is larger than the one expected from a conventional proximity effect.

* This work is being supported by CIAR, iCore

WE-P6-9 **16h45**

Manipulation of Nanoscale Spin and Charge Textures in Diluted Magnetic Semiconductors Using Superconducting Vortices*. **Mona Berciu** [1], T. Rappoport [2], B. Janko [2], [1] *Univeristy of British Columbia*, [2] Notre-Dame University — All spintronics applications are faced with formidable challenges in providing fast and efficient ways to create, detect, control and manipulate spin textures and currents. Here we show how most of these operations can be performed in a relatively simple manner in a hybrid system consisting of a superconducting film and a paramagnetic diluted magnetic semiconductor (DMS) quantum well. The giant Zeeman response of the magnetic semiconductor in conjunction with the highly non-uniform magnetic field of the superconductor create local spin and charge textures in the DMS, leading to effects such as Bloch oscillations, an unusual Quantum Hall Effect, etc. The substantial recent progress in manipulating the magnetic vortices in superconductors also suggest how these can be used to create, manipulate and control the spin textures in DMS.

*This work is being supported by NSERC and Research Corporation

17h00 **Session Ends / *Fin de la session***

[WE-P7] (PPD) Non-Accelerator Particle Physics / *Physique dees particules sans accélérateur*

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

14h15 - 17h30

SALLE / ROOM IRC 6 (cap. 226) ***Chair: D. Sinclair, Carleton U.***

WE-P7-1 **14h15**

FRASER DUNCAN, Queen's University/SNOLAB

SNOLAB

SNOLAB is a new facility for deep underground science presently under construction in the Creighton Mine in Sudbury Ontario. An expansion of the existing SNO facility, SNOLAB will allow important extensions of the work of SNO into the areas of neutrino-less double beta decay, dark matter searches, and measurement of low energy solar neutrinos. This talk will describe the facilities being developed, and outline the process by which the scientific program is being defined.

WE-P7-2 **14h45**

CARSTEN KRAUSS, Queen's University

Results Of The Picasso Experiment And Development Towards A Large Scale SNOLAB Dark Matter Detector.

I will present the improved limit for the spin-dependent interaction of cold dark matter WIMPs with nuclei. The PICASSO experiment took data with an integrated exposure of 1.98 kgd in the Sudbury Neutrino Observatory during 2004. So far no evidence of WIMP-nucleon interactions was found. I will also present the future plans of the PICASSO collaboration to build a large scale dark matter detector in the underground space that is currently being developed in SNOLAB.

WE-P7-3 **15h15**

Latest Results from the CERN Axion Solar Telescope (CAST). **Michael D. Hasinoff**, *University of British Columbia*, plus collaborators from Athens, CERN, Chicago, Darmstadt, Frankfurt, Freiburg, Garching, Moscow, Munich, Patras, Saclay, South Carolina, Thessaloniki, Vancouver, Zagreb, Zaragosa — Using a decommissioned LHC test magnet (L=9.3m, B=9.0T) the CAST collaboration is searching for hypothetical axion-like particles emitted from the sun. The expected signature is a low energy x-ray with an average energy of ~4 keV. Three different x-ray detectors are being utilized in this search — a 10 cm thick conventional TPC, a thin micromesh gas detector, and a small Si CCD detector which is situated at the focal plane of an x-ray mirror telescope system. The latest results will be presented along with our upgrade plans for extending the axion mass range above 0.02 eV.

WE-P7-4 **15h30**

The Search for a Periodic Solar Neutrino Rate at the Sudbury Neutrino Observatory*. **Louise Heelan**, *Carleton University* — The presence of a periodic solar neutrino rate could indicate solar and/or neutrino properties beyond that predicted by current models. The Sudbury Neutrino Observatory (SNO) detects solar neutrinos via three specific interactions on a heavy water medium. To date, SNO has completed the first two phases of the experiment, spanning the calendar dates of November 2, 1999 to May 27, 2001 (~306 live-days), and July 26, 2001 to August 28, 2003 (~391 livedays). The three signals yield a total of 2924 and 4722 candidate neutrino events in the first and second phases, respectively. The Lomb-Scargle periodogram is used to search for periodic behaviors in the neutrino rate as a function of time. In this analysis 7300 frequencies are scanned in the range of 2 to 3650 days. Monte Carlo (MC) simulations of neutrino events occurring during these neutrino runs are generated to study the characteristic Lomb-Scargle periodograms for both a constant and periodic neutrino rate. These MC studies show the sensitivity of the Lomb-Scargle technique as applied to SNO data.

* This work is being supported by Carleton University

15h45 **Coffee Break / Pause café**

WE-P7-5 **16h00**

MARK C. CHEN, Queen's University

SNO+: SNO with Liquid Scintillator

We are investigating the possibility of filling the Sudbury Neutrino Observatory with liquid scintillator (called SNO+) after the physics program with heavy water is completed at the end of 2006. Located in the deepest underground site for neutrino physics, SNO+ has unique capabilities, including detection of pep and CNO solar neutrinos. SNO+ could also detect geo-neutrinos — neutrinos from radioactivity in the Earth — and is favourably located for such a measurement since it is surrounded by the Canadian Shield, a simple geological configuration. In addition, double beta decay isotopes might be deployed in the liquid scintillator resulting in a competitive next-generation search. The prospects are being studied and will be presented.

* In collaboration with A.L. Hallin [1], A.B. McDonald [1], E.D. Hallman [2], C.J. Virtue [2], R.J. Ford [3], [1] Queen's University, [2] Laurentian University and [3] SNOLAB

* This work is being supported by NSERC

WE-P7-6 **16h30**

KENNETH J. RAGAN, McGill University

On to VERITAS

The VERITAS detector is an array of four large imaging telescopes currently under construction at the Kitt Peak National Observatory in Arizona, designed to utilize the proven Atmospheric Cherenkov Technique (ACT) to study astrophysical sources of high-energy gamma rays. World-wide, it is one of four new "second-generation" ACT instruments which have already started to revolutionize the field of ground-based gamma-ray astrophysics. This talk will focus on the instrumentation and techniques that make this new generation of instruments so powerful, and will discuss the current status of VERITAS and present data from the first telescope of the array.

WE-P7-7 **17h00**

Improved Spin Dependent Limits from the PICASSO Dark Matter Search Experiment*. **Ubi Wichoski**, PICASSO Collaboration , *University of Montreal* — PICASSO is an experiment searching for cold dark matter through the direct detection of weakly interacting massive particles (WIMPs) via their spin-dependent interactions with nuclei. It uses a superheated fluorocarbon, C_4F_{10}, as the active material and searches for WIMP interactions on ^{19}F. The PICASSO experiment is installed at a depth of 2070 m in the Sudbury Neutrino Observatory. In this talk we are going to report on the status of the experiment and present our latest limits for the existence of cold dark matter WIMPs interacting via spin-dependent interactions with nuclei.

* This work is being supported by NSERC, LADD (CFI)

WE-P7-8 **17h15**

Multiple Ring Fitter for the Sudbury Neutrino Observatory. **Marc Bergevin**, J. Law, *University of Guelph* — The Sudbury Neutrino Observatory is a heavy water Cherenkov detector. There are several algorithms to reconstruct Cherenkov events arising from solar neutrino and muon interactions. However, so far no method has been produced to reconstruct multiple Cherenkov events. In this talk, a method that separates multiple Cherenkov events through the use of a pattern recognition algorithm, my modified Circular Hough Transform, will be presented. This method will be particularly useful in the search of exotic phenomena which produces multiple Cherenkov rings.

17h30 **Session Ends / *Fin de la session***

[WE-P8] (DOP) Advances in Optics and Photonics / *Progrès en optique et photonique*

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

14h15 - 16h15

SALLE / ROOM IRC 5 (cap. 120) ***Chair: M" Campbell, University of Waterloo***

WE-P8-1 **14h15**

Optimization of Depth-Graded Multilayer Reflectors for EUV and X-Ray Optics. **Richard Hodgson**, *University of Ottawa* — Current interest in extreme ultraviolet (EUV) and soft x-ray optics is driving a great deal of work on new methods for optimizing the design of multilayer mirrors. The performance of depth-graded multilayers can be calculated numerically with reasonable precision using the well-known recursive methods based on the Fresnel formulae. It is the inverse problem which is of interest here, i.e. calculating the bilay-

er thicknesses which provide the best approximation to the required shape of the reflectivity curve as a function of wavelength or angular range. This investigation reports on the effectiveness of a few different stochastic optimization methods as applied to this problem.

WE-P8-2 14h30

Analysis of Thickness Modification of Polymers Layers Under Light Illumination*. **Eve Ouellet-Bélanger** [1], R.A. Lessard [1], N. Achourbekov [2], [1] *Laval University*, [2] LumiStor, Inc. — Thickness evaluation of layers of polymers represents a crucial stage in the analyzing process of the thickness modification of polymers layers under light illumination. To analyze the modification of these layers, we presently use a method which consists in measuring the full width half maximum of the peak of diffraction efficiency obtained from the angular selectivity of a volume hologram. Our project aims the development of a new measuring method for the evaluation of the shrinkage of polymers. The selected methodology for this purpose uses Michelson, Mach-Zehnder and Fabry-Perot interferometers. Those interferometers offer a promising potential to propose a new analyzing method of thickness modification of polymers layers under light illumination with a good precision.

* This work is being supported by LumiStor, Inc.

WE-P8-3 14h45

The Use of Relief Gratings to Control and Observe Surface Plasmon Propagation*. **Paul Rochon**, L. Lévesque, *Royal Military College* — Surface plasmons (SP) are generated on a doubly corrugated gold covered polymer surface. The corrugations were obtained by direct holographic inscription of surface relief gratings on an azopolymer film. This method permits the superposition of multiple surface profiles with easy control of the grating spacing and depth. One grating is inscribed to act as coupler for the incident light to generate the SP and a second grating is inscribed to produce a gap in the SP dispersion curve at a prescribed frequency. The coupling and the gap can be observed by measuring the reflectivity of the gold surface as a function of the angle of incidence and the wavelength of the probe beam. The resulting SP dispersion curve can be draw including the gap region. Multiple gratings can be written to produce multiple couplers and gaps, this generates complex.

* This work is being supported by NSERC

15h00 Coffee Break / Pause café

WE-P8-4 15h30

Quantum Path Interference in Spontaneous Emission in Dielectric Microstructures*. **Marc Michael Dignam** [1], D.P. Fussell [2], C.M. de Sterke [2], R.C. McPhedran [2], [1] *Queen's University*, [2] University of Sydney — One of the central goals underlying photonic crystal and dielectric microcavity research is to modify and control the spontaneous emission properties of atoms and quantum dots by tailoring the resonances in these structures. Much of the work in this area has focused on simple single-resonance cavities, where the enhancement of the spontaneous emission rate relative to vacuum can be simply expressed in terms of the ratio of the Q of the resonance to the volume of the resonant mode. In this work, we consider cavities that have resonant modes that overlap in frequency and space. Using a Green function approach, we calculate the ratio of the rate of spontaneous emission and the quality factors and mode volumes of the resonances. We show that, in general, the spontaneous emission rate in the structure cannot be determined simply from the properties (Q and V) of the individual resonances alone. Rather the spontaneous emission is strongly affected by quantum path interference of emission into the different cavity modes. The result of this is that the spontaneous emission is greatly enhance at some locations and greatly reduced at others. We demonstrate our results by modelling defect modes in a finite two-dimensional photonic crystal with two defects placed asymmetrically in the structure. These results have implications for the design of coupled-cavity systems for quantum information technologies.

* This work is being supported by NSERC

WE-P8-5 15h45

Colloidal Nanocrystalline PbSe Coupled to Si-based Photonic Crystal Microcavities*. **Andras G. Pattantyus-Abraham** [1], T.S. Wang [1], J.F. Young [1], J.W. Stouwdam [2], F.C.J.M. Van Veggel [2], [1] *Dept. of Physics and Astronomy, University of British Columbia*, [2] Dept of Chemistry, University of Victoria — The coherent coupling between electronic states and photonic states is of interest for a number of reasons [1], including the creation of photonic qubits for quantum computation. Long-lived photonic states (Q up to 600,000) have been observed in 2-D photonic crystal microcavities [2] and these may be coupled to electronic resonances in ensembles of semiconductor quantum dots [3]. Here we propose to use solution-grown colloidal PbSe nanocrystals and atomic force microscopy-based lithography to controllably introduce a single semiconductor nanocrystal at a well-defined location within a photonic crystal microcavity. Chlorine- and fluorine-based reactive ion etching techniques are used to etch photonic crystal patterns into the Si layer of a silicon-on-insulator substrate. Further standard processing techniques yield 195 nm-thick free-standing photonic crystal membranes. Oleate-capped colloidal PbSe nanocrystals are prepared using optimized synthesis conditions, and are stable over several months when stored in the dark, in solution. A scheme for site-selective grafting of the nanocrystals on the photonic crystals, using well-established Si surface reactions [4] and scanning probe-based oxidation of the Si surface [5], will be presented.

1. K.J. Vahala, *Nature* **424**(6950):839-846, 2003.
2. Y. Akahane *et al.*, *Nature* **425**(6961):944-947, 2003.
3. T. Yoshie *et al.*, *Nature* **432**(7014):200-203, 2004.
4. J.M. Buriak, *Chem. Rev.* **5**(102):1271-1308, 2002.
5. Q. Li *et al.*, *Langmuir* **19**(1):166-171, 2003.

* This work is being supported by NSERC, D-Wave Systems

WE-P8-6 16h00

Ultrafast Optical Tuning of Photonic Crystals*. **Henry van Driel** [1], H.W. Tan [2], J.E. Sipe [2], S. Schweizer [2], R. Wehrspohn [2], [1] *University of Toronto* and [2] University of Paderborn — The tuning of photonic crystal (PC) optical properties may allow this class of materials to be used for a variety of active, nano-optical components. We have investigated a number of ultrafast tuning methods of 2-D silicon photonic crystals using 800nm or 1500 nm, 150 fs optical pulsed excitation and tuning of PC eigenmodes in the 1100-1900 nm region. Index changes in the silicon backbone are induced via the optical Kerr effect or Drude effect with free carriers generated via single or two-photon absorption. Tuning of a mode by as much as 30 nm has been observed in the case of free-carrier induced index changes. A simple perturbation approach has been developed to allow one to assess how the index changes associated with a pump eigenmode 's spatial characteristic can determine the tuning magnitude of a probed mode. We have also developed a simple theory to treat two photon absorption and Kerr nonlinearities in photonic crystals. In terms of temporal characteristics, depending on the pump eigenmode, we observe virtually instantaneous recovery of refractive index changes, or relaxation on a 10 and 700 ps time scale, associated with free carrier diffusion and surface recombination, respectively.

*This work is being supported by NSERC and PRO

16h15 Session Ends / *Fin de la session*

[WE-P9] Analytical Techniques and Sensors / *Techniques analytiques et senseurs pour la physique et l'évaluation non-destructive*

(DIMP/*DPIM*)

WEDNESDAY, JUNE 8
MERCREDI, 8 JUIN
14h15 - 16h30

ROOM / *SALLE IRC 4 (cap. 135)* ***Chair: M. Rodriguez, Univ. Nacional Autonoma de Mexico / S-Y. Zhang, Nanjing Univ.***

WE-P9-1 14h15

J.F. POWER, McGill University

Raman Effect Light Profile Microscopy *

Light profile microscopy (LPM) [1] is a recent technique of optical inspection that returns direct images of material cross sections with micron scale resolution and with minimum sample preparation. In an LPM inspection, a thin film under test is sliced open to reveal a depth (thickness) cross section, and the cross sectional view surface is polished to provide a window for optical radiation. A focused excitation beam is aligned behind the view surface and propagated through the material along the depth (thickness) axis. An optical

microscope forms an image of the beam intersecting the material based on contrast from scattering, photoluminescence and other emission mechanisms in the sample. The LPM method returns essentially direct images of film cross sections, and shows striking contrast for subtle interfacial structures that are invisible to conventional techniques of microscopy. Image contrast is available based on photoluminescence, elastic scatter and more recently, Raman scattering. Raman LPM micrographs of thin films may be recovered at low cost as line images of the sample's depth structure, recorded and dispersed as a function of wave number using an imaging spectrograph. Area images of the sample may also be recovered in parallel using the novel technique of planar LPM illumination [2] and a liquid crystal tunable filter element, to select a narrow band of scattering wavelengths. A recent diffraction theory of LPM image formation has made it possible to predict both image resolution and Raman scattering levels detectable in the images. Experimental Raman LPM line profiling measurements have been carried out on a variety of samples of industrial interest, including thermally degraded plastics and blow extruded thin film assemblies.

US Patent No. 6.614,532 Apparatus and Method for Light Profile Microscopy
J.F. Power, US Patent Pending

* In collaboration with L. Ramunno [1] , [1] McGill University

WE-P9-2 14h45

JUN SHEN, National Research Council of Canada, Institute for Fuel Cell Innovation

Methanol Concentration Sensors for Direct Methanol Fuel Cell Systems: A Review *

Direct methanol fuel cells have been the subject of considerable research in the last decade. Performance levels realized in cells, stacks, and systems show that this technology is a promising power source for a wide range of portable applications. A direct methanol fuel cell (DMFC) operates directly on a methanol fuel stream typically supplied as a methanol/water vapour or as an aqueous methanol solution in liquid feed DMFCs. The fuel streams in DMFCs are usually recirculated in order to remove carbon dioxide and to re-use the diluent and any unreacted fuel in the depleted fuel stream exiting the DMFC. The concentration of methanol in the fuel circulation loop is an important operating parameter because it determines the electrical performance and efficiency of the direct methanol fuel cell system. The methanol concentration in the circulating fuel stream is usually measured continuously with a suitable sensor, and fresh methanol is admitted in accordance with the signal from the sensor. There are many factors to consider in developing a methanol sensor suitable for DMFCs. These factors include sensitivity, cost, size, simplicity, reliability, longevity, concentration range, and dynamic response. In particular, reliability and low cost should be addressed. Methanol concentration sensors measure methanol concentration by means of detecting the variations of physical/chemical properties of the solution. In this work, methanol concentration sensors based on electrochemistry, electric-capacitance measurement, infrared sensing, ultrasound sensing, and other techniques are reviewed to discuss their advantages and disadvantages.

* In collaboration with J. Zhang, D.P. Wilkinson, H. Wang, C. Gu, National Research Council of Canada

WE-P9-3 15h15

Two-Photon Excitation in Nuclear Magnetic Resonance*, **Philip Eles**, C.A. Michal, *University of British Columbia* — Nuclear magnetic resonance (NMR) is traditionally performed by on-resonance irradiation of a two-level nuclear spin system, where level splittings are due to the Zeeman interaction between the spins and an externally applied magnetic field. Modern pulsed NMR experiments involve strong rf irradiation followed by detection of the weak free induction signal. In unfavorable circumstances, receiver dead-time due to long probe ring-down may outlast the signal, or more often, result in distortions in the signal. We have recently introduced a new method for exciting NMR by applying rf at either half the resonance frequency or at two frequencies which sum to or differ by the NMR frequency. We describe this process, analogous to absorption of two photons, using average Hamiltonian theory and demonstrate it experimentally in several simple systems. We discuss some unique advantages to excitation outside the detection bandwidth, namely the ability to detect free induction signal during excitation, entirely eliminating receiver dead-time. In nuclear quadrupole resonance (NQR) experiments, we show that the appearance of free induction signals is in a direction perpendicular to the excitation axis, and that multiple quantum coherences are also excited by such irradiation. We discuss the limitations of this technique and consider future practical applications.

* This work is being supported by NSERC, Paetzold

WE-P9-4 15h30

Feedforward Control of Scanning Stages*. **John Lawrence Bechhoefer**, *Simon Fraser University* — Feedforward is a standard technique in control theory that is little appreciated in the physics community. One area of application is to the control of motion, an important requirement in many physics experiments, particularly in scanning probe microscopy. The problem is that the actual motion of a translation stage (often a piezoelectric element) is different from the desired motion. In feedforward control, one uses *a priori* knowledge about the system's dynamics to constuct a modified input whose distortions are just such that the system undoes them. The actual motion then matches the desired motion. As a bonus, if the control signal is known in advance, one can design an *acausal* feedforward filter: the information about the future can be used to make the output of the stage have no phase lag with respect to the input. This keeps in register the images assembled from right and left scans. I apply these concepts to the control of a piezoelectric flexure stage used in atomic force microscopy, obtaining a five-fold increase in usable bandwidth as a result.

* This work is being supported by NSERC

WE-P9-5 15h45

Determination of the Activity Concentration of a Pu-238 Solution by the Defined Solid Angle Method Utilizing a Novel Dual Diaphragm-Detector Assembly*, **Eduardo Galiano** [1], J.C. Aguiar [2], P. Arenillas [2], [1] *Laurentian University*, [2] Argentine Atomic Energy Comission — The activity concentration of ^{238}Pu solution was measured by the determined solid angle method employing a novel dual diaphragm-detector assembly which has been previously described [1]. Due to the special requirements of the detector, a new type of source holder was developed based on the method suggested by Lally *et al*, which consisted of sandwiching the radioisotope between two organic films called VYNS [2]. It was experimentally demonstrated that the VYNS films do not absorb α particles, but reduces their energy by about 22 keV. A mean activity concentration for ^{238}Pu of 359.10 ± 0.8 kBq/gm was measured.

1. J.C. Aguiar, and E. Galiano, 2004,"Theoretical estimates of the solid angle subtended by a dual diaphragm-detector assembly for alpha sources". *Appl Rad Isot.* **61**, 1349-1351.
2. A.E. Lally, and K.M. Glover, 1984, "Source preparation in alpha spectrometry". *Nucl. Instr. & Meth. Phys. Res.* **223**, 259-265.

* This work is being supported by Laurentian University

WE-P9-6 16h00

HERACLES Detectors Array Adaptation for Low Energies Experiments. **Jérôme Gauthier**, R. Roy, F. Gagnon-Moisan, D. Theriault, F. Grenier, *Université* Laval — The HERACLES detectors array was use in the past to study heavy ions reactions at intermediate energies(30-100 MeV/nucleon). We now expect to use it at TRIUMF with exotic beams soon delivered by ISAC-II. Na isotopes at low energy(15MeV/nucleon) will be used to study the asymmetric behaviour of the nuclear potential. So we must adapt the detectors for these lower beam energies. The CsI(Tl) and Phoswich detectors, and BaF_2 prototype have been recently tested with a 1.7MeV/nucleon ^{21}Ne beam. Good identification and resolution have been achieved even at this low energy for light charged particles. Results will be presented and discussed. The gathering and the testing of electronics are underway. Technical and mechanical work should begin immediately after the confirmation of geometries and the number of detectors used at lower detection angles what is being optimized with GEANT4 simulations.

WE-P9-7 16h15

Current Mode Electronics for the Q_{weak} Experiment*. **W.D. Ramsay**, *University of Manitoba* — The Q_{weak} experiment aims to measure the parity violating longitudinal analyzing power, A_z, in electron proton scattering at low momentum transfer and small scattering angle, with a statistical precision of $\pm 5 \times 10^{-9}$ in approximately 2000 hours. To do this, eight quartz detectors each operating at a counting rate equivalent to ~ 700 Mhz will be used. This is too high for conventional particle counting, so Q_{weak} will run in current mode. A synchronous data acquisition system will integrate the detector current signals over each spin state and extract the helicity correlated, parity violating component.

Specialized linear low noise analog electronics and precision VME based digital integrators are being designed and built at TRIUMF for this purpose. The spin flip rate will be 250 Hz, and the digital integrators will record the integral over each spin state as four 1 ms integrals. The RMS electronic noise on the 1 ms integrals should be less than ~ 5 x 10^{-6}. This is very small compared to the shot noise under data taking conditions and will allow beam-off control measurements to be made quickly.

* This work is being supported by Natural Sciences and Engineering Research Council, TRIUMF, and U.S. Department of Energy

16h30 **Session Ends / *Fin de la session***

[WE-P10] Quantum Coherence, Relaxation and Theory / *Cohérence quantique, relaxation et théorie*

(DAMP/*DPAM*)

WEDNESDAY, JUNE 8 / MERCREDI, 8 JUIN

14h15 - 16h15

SALLE / ROOM CEME 1202 (cap. 119)

Chair: W-K. Liu, University of Waterloo

WE-P10-1 **14h15**

CHITRA RANGAN, University of Windsor

Coherent Control and Quantum Information Processing in Rydberg Atoms

We present the theory of quantum information processing in Rydberg alkali atoms via their control with terahertz pulses. Information stored in the wavefunction of a Rydberg electron can be manipulated both in one-dimension and two-dimensions, allowing for single and correlated register data processing. In one dimension, information is stored, processed and retrieved in a radial wave packet centered at n~20. In two-dimensions, both the radial and angular components of the Rydberg electron wavefunction can be manipulated with an impressive degree of fidelity. The goal is to perform complex quantum algorithms in a multi-level atomic system. Comparisons will be made to experimental data.

WE-P10-2 **14h45**

ALEXANDER LVOVSKY, University of Waterloo

Homodyne Tomography for Quantum Information: A New Application for an Old Method

I will present a series of experiments in which we create, manipulate, characterize and apply new quantum states of the electromagnetic field for applications in quantum information processing. Our approach is unique in the way it combines traditionally discrete-variable quantum states (photons and optical qubits) as the object of investigation with homodyne tomography, a continuous-variable method of quantum state measurement. This method, based on phase-sensitive measurements of quantum noise statistics of the electromagnetic field, is technically more challenging, but provides much more accurate information about optical ensembles than traditional photon-counting based techniques. By applying our approach to more and more complex quantum optical states, we not only develop new tools of quantum information technology, but also answer some important questions of fundamental nature.

WE-P10-3 **15h15**

TAKAMASA MOMOSE, University of British Columbia

Relaxation Dynamics of Molecules in Quantum Crystals *

Solid hydrogen, known as a quantum crystal, is the simplest and most fundamental molecular crystal. Each hydrogen molecule in the crystal exhibits almost free rovibrational motion retaining the rotational quantum number J as a good quantum number. It has been shown that optical transitions to such quantized rotation-vibration states show extremely sharp linewidths. The narrowest lineiwdth so far observed was as narrow as 4 MHz for impurity D2 transitions in solid parahydrogen. The sharp linewidthes were also observed for molecules embedded in parahydrogen cryslats. The lineshape and width of such narrow transitions gives us rich information on relaxation dynamics of excited states. Here, we discuss relaxation dynamics of vibrational excited states of molecules in solid parahydrogen. Detailed studies of temperature dependence of linewidths revealed that the pure dephasing is a dominant relaxation mechanism at very low temperatures. However, there is a clear discrepancy between the theory and experiment on the temperature dependence of the dephasing. In addition, it was found that there is some contribution of pure dephasing at the limit of 0 K. We discuss the origin of the dephasing in the quantum crystal at low temperatures.

* This work is being supported by CREST (JST)

WE-P10-4 **15h45**

When is Teleportation 'Quantum'?*. **Somshubhro Bandyopadhyay**, B.S. Sanders, *University of Calgary* — Ideal quantum teleportation is designed to transmit quantum information through de coherent channels by sending classical information and consuming shared entanglement instead. If quantum teleportation is not ideal, then the quantum information is degraded by the process, and, with enough deterioration, the protocol is comparable to a classical, random counterpart. Quantum teleportation is thus determined by a performance threshold, typically described by the average fidelity of the teleportation of all allowed input states. The quantum threshold has been investigated but always for a state of an isolated system, which is teleported in its entirety. In fact teleportation is required, not just for teleportation of isolated systems, but also for components of states for which the teleported portion may be entangled or correlated with un-teleported components. We establish rigorous bounds for the performance threshold, given by the fidelity of the resultant state with respect to the input state, for teleportation of arbitrary states without the artificial, but ubiquitous, assumption of isolated systems. Our fidelity reduces to standard results in the appropriate limits and provides the ultimate criteria for deciding whether teleportation is quantum or classical. This analysis is conducted in the context of an omnipotent verifier whose role is to check whether the teleportation device exceeds the classical limit. As the verifier is powerful, a restriction to an isolated system is clearly an unwanted, artificial constraint. Note that the verifier must recombine the un-teleported portion of the state with the teleported portion to determine the fidelity, and we treat two cases: the verifier is able to perfectly teleport the remainder of the state to determine the fidelity; or the verifier must rely on a second teleportation scheme to send the remainder of the state. In addition to establish rigorous requirements to claim 'quantum' teleportation, we also establish the precise entanglement resource requirements for the teleporting to prove to the verifier that they are performing genuine 'quantum' teleportation.

* This work is being supported by ICORE

WE-P10-5 **16h00**

A Simple Phenomenological Model for Metastability Exchange Optical Pumping of Helium*. **Josie L. Herman** [1], T.R. Gentile [2], M.E. Hayden [1], [1] Simon Fraser University, [2] *National Institute of Standards and Technology* — Metastability exchange optical pumping of ^{3}He gas at 1083nm can be used to produce very high (non-equilibrium) nuclear spin polarizations. A complete microscopic description of the polarization process requires detailed knowledge of the distribution of atoms among the numerous sublevels of the 2^3S-2^3P manifold. We have developed a simple phenomenological model for the absorption of 1083nm radiation by a gas of ^{3}He atoms subjected to a weak RF discharge. Preliminary com-

parisons with experimental data suggest that this model captures several essential features of this process, and thus could prove useful in optimizing the polarization of ^{3}He gas. Our interest in this problem lies its connection to the efficient production of hyperpolarized 3He for applications such as magnetic resonance imaging of human lung airspaces.

* This work is being supported by NSERC

16h15 **Session Ends / *Fin de la session***

2005 CONGRESS POSTER SESSION ABSTRACTS
RÉSUMÉS DES SESSIONS D'AFFICHES - CONGRÈS 2005

The poster session abstracts presented here will be on display in this order in the Student Union Building (SUB) Ballroom at the University of British Columbia in Vancouver, B.C. from 19h00 - 22h00 on Monday, June 6th. *Les résumés présentés en affiches publiés ci-après seront en montre de 19h00 à 22h00, le lundi, 6 juin dans le SUB Ballroom à l'Université de la Colombie-Britannique, Vancouver.*

[MO-POS] ATMOSPHERIC AND SPACE PHYSICS / *LA PHYSIQUE ATMOSPHÉRIQUE ET DE L'ESPACE* — Monday / *Lundi*

MO-POS-1

Ionospheric Structure Reconstruction using HF Radio Wave Propagation for the e-POP Mission*. **Lan Wang**, J.W.M. MacDougall, *University of Western Ontario* — The Enhanced Polar Outflow Probe (e-POP) will be launched on CASSIOPE satellite in 2007 for exploring the plasma and atmospheric outflow process in polar region. Whether one can determine the properties of large-scale ionospheric structures by studying the HF radio wave signals received at the e-POP satellite from the ground base transmitters such as the Canadian Advanced Digital Ionosonde (CADI, a HF pulse radar) is our research interest. Our recent approach is to use radio tomography technique for imaging the ionospheric plasma over altitude-versus-latitude planes. Measurements of the line integral of the electron density along ray paths from ground transmitter to satellite, *i.e.* total electron content (TEC), are inverted in a reconstruction algorithm to create an image of the spatial distribution of the density over the region of interest. The application of computerized tomography to ionospheric imaging was first investigated using TEC data measured from UHF/VHF signals. Theoretical simulations and experimental observations have demonstrated the capabilities of radio tomography technique in the mapping and modeling the ionized atmosphere. The nature of HF propagation in the ionosphere introduces dramatic effects on signal amplitude, angle of arrival, propagation time and Doppler frequency. The combination of radio tomography technique and HF measurements will provide us a new tool to study the ionosphere.

* This work is being supported by CSA

MO-POS-2

Legendre Coding for Digital Ionosondes*. **Jing Huang**, J.W. MacDougall, *University of Western Ontario* — As an active radar, the Canadian Advanced Digital Ionosonde (CADI) is used to probe the structure and motion of the ionosphere, such as virtual height, drift velocity, angle of arrival, echo intensity, *etc*. In order to achieve a better Signal-to-Noise Ratio (SNR) and reduce the peak transmission power, the CADI system is using the direct sequence code modulation, one kind of pulse compression technique. A 1019 bit Legendre code was evaluated for use in digital ionosondes, and experimental testing was done using the CADI system. Theoretically, the 1019 Legendre code autocorrelation function of this new sequence has very low Peak Sidelobe Level (PSL) of -32.6dB, and the system SNR will be improved by 30dB compared to a single pulse code. Field experiments were done near London, Ontario using two CADIs in a bistatic arrangement with 20km spacing. The experimental results agreed with the theoretical estimation (with ~1dB error), but a 10Hz frequency difference between the two computers' reference frequencies, which showed up as a Doppler shift in ambiguity function necessitated additional signal processing to get optimal performance. The experimental measurements showed that the system was able to get ionospheric echoes with very low power transmission (1W peak) at a quiet receiving site due to the high system SNR.

* This work is being supported by NSERC

[MO-POS] ATOMIC AND MOLECULAR PHYSICS / *PHYSIQUE ATOMIQUE ET MOLÉCULAIRE* — Monday / *Lundi*

MO-POS-3

Lineshape Modeling of Inter-Branch Intensity Transfer in Q-Branches of Carbon Dioxide*, **Adriana Predoi-Cross** [1], Y. Baranov [2], [1] *University of Lethbridge*, [2] Optical Technology Division, NIST — An adjustable band shape calculation model based on the strong collision approximation with inter-branch coupling has been applied to predict line mixing in the $20^00 \leftarrow 01^10$, $12^20 \leftarrow 01^10$ and in the $11^10 \leftarrow 00^00$ Q-branches of carbon dioxide. In this approach, the band shape is calculated using an adjustable parameter to account for line mixing effects, in addition to the usual set of spectral parameters used to describe the band shape. The good quality of the model is proven by comparisons with experimental spectra recorded at room temperature over a wide pressure range (1 to 21 atm). All spectra were recorded using a Fourier transform spectrometer and 25 cm long temperature controlled cell. The values obtained for the adjustable parameter for the three Q-branches are discussed.

MO-POS-4

Improved Measurements of Atomic Recoil Using Atom Interferometry*, **Scott Beattie**, M. Weel, I. Chan, E. Rotberg, A. Kumarakrishnan, *York University* — We have recently used a single state time domain atom interferometer to make a measurement of atomic recoil frequency in cold ^{85}Rb atoms precise to 2.5 ppm. The interferometer involves excitation by off-resonant standing wave pulses applied at $t = 0$ and $t = T$. The pulses diffract and recombine a superposition of momentum states corresponding to the same internal state. This results in a population grating "echo" in the vicinity of $t = 2T$. The grating was detected using an off resonant readout pulse. This pulse results in a backscattered signal detected using a heterodyne technique. Our measurement of the recoil frequency is in excellent agreement with the value of the recoil frequency obtained from previous measurements of the transition wavelength, atomic mass, and Planck's constant. We present improved measurements using PMT detection, reducing the effect of magnetic field gradients, and increasing the spatial extent of our interferometry beams. We also investigate the role of decoherence due to stray light and collisions on the lifetime of our echo signal.

* This work is being supported by CFI, OIT, NSERC, PRO, York University

MO-POS-5

Precise Measurements of Atomic G Factor Ratios Using Trapped Rb Atoms*. **Iain Chan**, M. Weel, S. Beattie, E. Rotberg, A. Vorozcovs, A. Andreyuk, A. Kumarakrishnan , *York University* — We have measured the dephasing time of a coherence grating and inferred the temperature of a cloud of trapped atoms. The grating involves a spatially periodic superposition of adjacent magnetic sublevels of the F = 3 ground state in 85Rb. The dephasing exhibits Larmor oscillations in the presence of a magnetic field. We initially measured the frequency of Larmor oscillations to a precision of ~0.1% using pulsed magnetic fields. We have improved the precision by over two orders of magnitude by using steady B fields. A precise measurement of the Zeeman shift of the atomic levels would require an absolute measurement of the B field at the location of the trap. Nevertheless, we show that it is possible to measure of the g factor ratios for ^{85}Rb and ^{87}Rb that are precise to ~50 parts per million.

* Work supported by CFI, OIT, NSERC, PRO and York University.

MO-POS-6

Nanosecond Spectroscopy of Trapped Ion Samples in a Linear Paul Trap*. **Louis Poirier**, R.I. Thompson, J.J. Choquette, *University of Calgary* — This work will examine the use of nanosecond laser pulses to characterize trapped ion samples through the application of laser-induced fluorescence (LIF) spectroscopy techniques. A XeCl pumped dye laser system is used to produce tunable nanosecond laser pulses in the visible and ultraviolet region of the spectrum. The LIF spectra, detected at 105° to the incident laser path, can be used to non-destructively identify trapped ion species, and to determine some physical characteristics of the species, such as temperature. Experiments currently on-going in the laboratory include using LIF for ion-trap mass spectrometry (ITMS) calibration, and attempting to directly measure the rotational temperature of trapped CO^+ via ro-vibronic spectroscopy of the X – A transition near 455 nm.

* This work is being supported by NSERC

MO-POS-7

A Precision Measurement of Atomic Recoil Frequency Using Grating Echoes*. **Matthew Weel**, S. Beattie, I. Chan, E. Rotberg, A. Vorozcovs, A. Kumarakrishnan, *York University* We have used a time domain atom interferometer to measure the atomic recoil frequency to a precision of 2.5 parts per million by manipulating trapped ^{85}Rb atoms in the F = 3 ground state. Our studies confirm that the measurement is insensitive to a range of common systematic effects such as AC Stark shifts, strength of the atom field coupling, magnetic fields, field gradients and the distribution of atoms in the magnetic sub-levels of the ground state. The measurement is in excellent agreement with the recoil frequency inferred from previous measurements of transition wavelength and the atomic mass. Our studies suggest that significant improvements can be achieved in an atomic fountain. We also discuss measurements of gravity and sensitivity to magnetic field gradients.

* This work is being supported by NSERC, CFI, OIT, PRO, York U

MO-POS-8

High Precision Theory and Spectroscopy for ^{3}He*, **Gordon W.F. Drake** [1], Q. Wu [1], D.C. Morton [2], [1] *University of Windsor* and [2] Herzberg Institute for Astrophysics — In previous work, a combination of theory and high precision measurements for the transition energies of ^{4}He has yielded absolute ionization energies (IE) accurate to about 1 MHz or better for most states except for the ground state. In the present work, these IEs are combined with accurate calculations of the isotope shift, including relativistic recoil and quantum electrodynamic corrections, to obtain similarly high precision data for the entire singly-excited spectrum of the rarer isotope ^{3}He. The hyperfine structure is also calculated and compared with experiment. In most cases, the theoretical results are expected to be definitive values that are considerably more accurate than the available experimental data.

* This work is being supported by NSERC and SHARCnet

MO-POS-9

Oscillator-Strength Measurements in Sm II, Nd II, and Pr II*, **Richard A. Holt**, R. Li, S.J. Rehse, S.D. Rosner, T.J. Scholl, *University of Western Ontario* — Singly-ionized lanthanides are of astrophysical interest in connection with studies of nucleosynthesis, stellar interiors, and cosmochronology. Complementing our previous measurements of lifetimes in Sm II, Nd II, and Pr II, we have now measured branching ratios by means of fast-ion-beam laser spectroscopy. We use 420-460-nm cw laser light to excite a 10-keV ion beam collinearly and collect laser-induced fluorescence with two optimized fiberoptic arrays, each directed to a monochromator-photomultiplier unit. One detector system views the strongest branch to feedback-lock the laser frequency, while the other scans the spectrum. Doppler modulation is used to remove background from the signal. The monochromator-photomultiplier detection efficiency is calibrated against a NIST-traceable quartz-tungsten-halogen lamp. The combined branching ratio and lifetime data are used to infer oscillator strengths.

* This work is being supported by NSERC

MO-POS-10

Possible Ar- Lines in the CRDS Spectrum of an Argon-Microwave Discharge*, **Clayton Winslade** [1], R.L. Brooks [1], R.H. deLaat [2], N.P.C. Westwood [2], [1] *Guelph-Waterloo Physics Institute*, [2] Guelph-Waterloo Centre for Chemistry and Biochemi — When performing cavity ring-down spectroscopy (CRDS) on a microwave discharge in argon gas, 73 neutral argon lines have been identified in the spectrum from 605-677 nm. In addition, besides Balmer-K of hydrogen, 7 fairly strong, isolated, and broad lines were observed which could not be identified. None of them could be attributed to a positive ion of argon or to an air impurity, and the breadth of the lines argued against any other atomic impurity. We were left with three possibilities to consider. The first was that they were caused by an argon dimer. The second was that they were caused by transitions from doubly-excited states of neutral argon. And the third was that they were transitions in the negative argon ion which is known to have a suitably long-lived, metastable, quartet level from which absorption would be possible. The reasons for concluding that the latter possibility was the most likely (at time of writing) will be presented.

* This work is being supported by NSERC

MO-POS-11

Measurement of Rubidium Excited State Lifetime*, **Eric Rotberg**, M. Weel, S. Beattie, I. Chan, A. Kumarakrishnan, *York University* — In this experiment we are producing a photon echo in a Doppler broadened atomic vapor and using it to measure the lifetime of Rubidium excited state. Two optical pulses are introduced into the medium. The first pulse induces a macroscopic dipole moment that de phases with time. The second pulse reverses the direction of the de phasing process and at time equals to 2T, where T is the time between the first and second pulses, the system re phases and echo is being generated. The amplitude of the generated photon echo is solely dependant on the decay rate of the Rubidium exited state and thus it provides an accurate, less sensitive to systematic errors technique to measure it.

* This work is being supported by CFI, OIT, NSERC, PRO, York University

MO-POS-12

Collision Induced Superfluorescence*. **A. Kumarakrishnan** [1], S. Chudasama [1], X.L. Han [2], [1] *York University*, [2] Butler University — We have studied superfluorescence (SF) in Ca vapor evolving on the $3d4s\ ^3D_J$-$4s4p\ ^3P_{J-1}$ transitions at 1.9 mm by exciting the $4s^2\ ^1S_0$-$4s4p\ ^1P_1$ with a pulsed dye laser. SF is generated following population transfer by spin changing collisions with an inert gas Ar from the $4s4p\ ^1P_1$ and $3d4s\ ^1D_2$ levels. We show for the first time that the time delay for SF evolution follows the $\frac{1}{\sqrt{N}}$ dependence expected for the case of uniform excitation of the vapor column by collisional transfer. Here, N is the number of participating atoms which was measured directly from the photon yield. The measured photon yield for the signal as a function of Ar pressure was found to be consistent with rate equations that simulate the buildup of populations in the ^3D_J levels based on known collisional rates. This suggests that collisional rates can be directly inferred on the basis of SF photon yields and the atomic level populations. The pulse shapes for SF show temporal oscillations that depend on two distinct factors. The first is the presence of a number of independently evolving regions in the gain medium and the second is the presence of spatial modes. Temporal ringing is a well known effect related to the exchange of energy between the atoms and the radiation field during pulse propagation. However, the temporal ringing observed in this experiment is far more pronounced than in previous SF experiments due to a particular choice of evolution parameters. This should make it feasible to compare our results with detailed numerical simulations that have been carried out previously.

*This work is being supported by CFI, OIT, NSERC, PRO, YorkU

MO-POS-13

Spectroscopic Properties of Pr^{3+} Ion in a Quasi-Icosahedral Environment. **Karine Le Bris**, C. Reber, *Université de Montréal* — $K_2Pr(NO_3)_5(H_2O)_2$ crystals have been of interest these past years because of their high second harmonic generation intensities which make them interesting new frequency doubling materials. While the non-linear properties of this crystal are well known, its other spectroscopic properties had not yet been studied. One of the particularities of this crystal is that the polyhedron around the rare earth is a distorted icosahedron. Absorption and luminescence spectra of the 4f-4f transitions are reported at various temperatures for different concentrations of Pr^{3+} ion. The degeneracy lifting at low temperature implies a C_3 symmetry, sub-group of an icosahedral symmetry. The influence of the Pr^{3+}-Pr^{3+} interactions on the population of the excited levels is demonstrated. The energy levels of the 4f-4f transitions have been used to estimate the crystal field parameters acting on the Pr^{3+} ion in its host crystal.

MO-POS-14

Dirac Fermions in Optical Lattices*. **Thomas Davis**, M. Franz, *University of British Columbia* — Two dimensional interacting Dirac fermions arise in many different contexts in condensed matter physics and are simmultaneously of great interest in elementary particle physics. We propose methods of constructing Dirac fermions in atomic gas systems in the presence of optical lattices. At the mean field level, the effective Hamiltonian admits a 'chiral symmetry breaking' phase transition between a gapped antiferromagnet and a gapless semimetal when the on-site Hubbard interaction is varied. We show that this transition will have an experimental signature in the density-density correlation spectrum. Close to the criticality, the nontrivial exponents of this quantum phase transition can be experimentally probed.

* This work is being supported by NSERC

MO-POS-15

Tunable Diode Laser Measurements of N_2- and O_2-Pressure Broadening and Pressure-Induced Shifts for $^{16}O^{12}C^{32}S$ Transitions in the ν_3 Band. **R.M. Lees** [1], L.-H. Xu [1], M.A. Koshelev [2], M. Yu. Tretyakov [3], [1] *CIPI/CLAMS/University of New Brunswick*, [2] Institute of Applied Physics of Russian Academy of Science, [3] Russian Academy of Sciences — Nitrogen and oxygen pressure broadening and pressure-induced shift coefficients for 42 transitions of $^{16}O^{12}C^{32}S$ with quantum number m from –25 to 49 in the P and R branches of the ν_3 band at 2062 cm^{-1} have been measured at room temperature using a high-resolution tunable diode laser spectrometer. Air-broadening and shift parameters have also been calculated from the N_2 and O_2 measurements. The dependence of the broadening and shifting on rotational quantum number is discussed. The results are compared to previous measurements in the ν_1 and $2\nu_3$ bands and to the parameters for the ν_3 band that are reported in the HITRAN database.

MO-POS-16

MOT Measurements of Electron Impact Cross Sections in Cesium*. **Bill McConkey [1],** M. Lukomski [1], J.A. MacAskill [1], D.P.Seccombe [1], C. McGrath [1], S. Sutton [1], J. Teeuwin [1], W. Kedzierski [1], T.R. Reddish [1], W.A. van Wijngaarden [2], I. Bray [3], [1] *University of Windsor*, [2] York University, [3] Murdoch University, Australia — We report new results of our ongoing [1] investigation of electron collisions with cesium atoms localized in a Magneto-Optical Trap (MOT). This trap loss technique, pioneered by Lin and co-workers [*e.g.* 2], does not require knowledge of the absolute target density. The choice of an appropriate pulsing scheme has enabled total cross sections for the ground (Cs 6 $^2S_{1/2}$) and 6 $^2P_{1/2}$ excited states to be determined. Furthermore, preliminary results of total ionisation cross sections will also be presented. Our earlier studies [1] covered a 100-400eV energy range for the incident electrons. Recent significant modifications to the apparatus have resulted in a more efficient data acquisition rate and have enabled us to extend the energy range down to below 20eV. This low energy capability is important as in this region the discrepancies with other experimental work become apparent. We will also report theoretical results obtained using the converged close coupling (CCC) approach. Good agreement between experiment and theory is observed over a wide energy range.

* We are pleased to recognize support from NSERC, CIPI, and CFI, Canada and the Australian Research Council.

1. J.A. MacAskill, W. Kedzierski, J.W. McConkey, J. Domyslawaska, I. Bray, *J. Elect. Spect. and Rel. Phen.*, **123** , 173 (2002).
2. R.S. Schappe, P. Feng, L.W. Anderson, C.C. Lin, T. Walker, *Europhys. Lett.*, **29**, 439, (1995).

MO-POS-17

Coherent Control of Multi-Photon Ionization With Ultra-Short Laser Pulses*. **Qun Zhang**, C. Li, V. Milner, J.W. Hepburn, M. Shapiro, *University of British Columbia* — Controlling internal quantum states of atoms and molecules using coherent properties of light-matter interaction has been in the focus of much experimental and theoretical work. Recent progress in producing ultra-short laser pulses of extremely broad spectral bandwidth resulted in efficient control of single- and multi-photon processes by tailoring (or shaping) the temporal characteristics of an excitation pulse on a femtosecond time scale. Enhancement and suppression of single- and two-photon absorption in simple atomic systems due to the interference of multiple excitation paths that reach the same final bound state has been recently demonstrated. In this work we apply the pulse-shaping technique to the control of multi-photon ionization of atomic sodium. Here, the final "target" state of an atom belongs to the continuum of energy levels above the ionization threshold. As a result, coherent superposition of many states, rather than a single final state, is controlled by accurate timing and spectral shaping of excitation pulses.

* This work is being supported by NSERC

MO-POS-18

Application of Diode Laser Optoacoustic Detection in Infrared and Near Infrared Spectral Range. **Li-Hong Xu** [1], R.M. Lees [1], V. Horka [2], S. Civis [2], J. Heyrovsky [2], [1]*CIPI/CLAMS/University of New Brunswick*, [2] Academy of Science of Czech Republic — The new technique of high resolution optoacoustic detection based on diode lasers has been developed. This method was tested using identical optoacoustic instrumentation (cell and microphone) in four different spectral regions. Gas absorptions in the following spectral ranges were studied: (1) the infrared range – 2100 cm^{-1}, CO and OCS fundamental bands (PbSe); (2) the middle infrared range – 3200 cm^{-1}, NH_3 and C_2H_2 fundamental bands (InAsSb /InAsSbP); (3) the range of 4200 cm^{-1}, CH_4 and NH_3 overtones (GaAs); and (4) the near infrared range – CO, CO_2 and NH_3 overtones (InGaAs). Several types of diode lasers operating at room and liquid nitrogen temperatures were compared. For all studied gases the detection limits were estimated and the optimum gas pressures for maximum sensitivity of the absorption signals were found. The sensitivity of the developed system was tested on trace-gas detection of ammonia and CO_2 in car exhaust for different types of cars and gasoline.

* Work supported by Bunge

MO-POS-19

Magnetic Field Effect on Resonant Electric Dipole-Dipole Interactions Between Cold Rydberg Atoms*. **P. Bohlouli-Zanjani**, K. Afrousheh, A. Mugford, M. Fedorov, and J.D.D. Martin, *University of Waterloo* — Using high-resolution microwave spectroscopy, the influence of magnetic field on resonant electric dipole-dipole interactions between cold Rydberg atoms [1] was investigated. Laser-cooled ^{85}Rb atoms in a magneto-optical trap (MOT) were optically excited to $45d_{5/2}$ Rydberg states. A microwave pulse transfers a fraction of these Rydberg atoms to the $46p_{3/2}$ state. A second microwave pulse then excites atoms in the $45d_{5/2}$ state to the $46d_{5/2}$ state and is used as a probe of interatomic interactions. Due to the strong resonant electric dipole-dipole interaction between $45d_{5/2}$ and $46p_{3/2}$ Rydberg atoms, the presence of $46p_{3/2}$ Rydberg atoms increases the spectral width of the two-photon probe transition. The inhomogeneous magnetic field inherent in the MOT Zeeman shifts the energy levels of Rydberg atoms. The average Zeeman shifts are relatively large compared to the strength of dipole-dipole interactions between pairs of atoms. Therefore only those two-atom states that are exactly degenerate are strongly coupled. Thus the magnetic field may reduce the electric dipole-dipole interactions between atoms. The inhomogeneous magnetic field was switched off and stray magnetic fields were precisely compensated using one-photon microwave transitions between $34s_{1/2}$ to $34p_{1/2}$ Rydberg states. With no magnetic field the dipole-dipole interactions become stronger, whereas application of a homogeneous magnetic field (~ 0.35 G) reduces the strength of the interactions.

1. K. Afrousheh *et al.*, *Phys. Rev. Lett.* **93**, 233001 (2004).

* Work supported by NSERC, CFI and OIT.

[MO-POS] CONDENSED MATTER AND MATERIALS PHYSICS / PHYSIQUE DE LA MATIÈRE CONDENSÉE ET MATÉRIAUX — Monday / Lundi

MO-POS-20

Dilute Nitride GaN_xAs_{1-x} MBE-Films Grown Under Different Operating Modes of the Helical Resonator Nitrogen Plasma Source*. **Nikolaj Zangenberg**, D. Beaton, E. Nodwell, S.E. Webster, M.B. Whitwick, E.C. Young, T. Tiedje, *University of British Columbia* — With the technological interest in wide band gap oxide, nitride, and dilute nitride semiconductors, plasma-assisted molecular beam epitaxy has erupted as an important process. The operation of the different types of plasma sources regarding plasma stability, effective nitrogen or oxygen incorporation, and minimizing film defects is the subject of much research. The helical-resonator rf plasma source has several attractive features relative to other plasma sources: no matching network is required, tuning is 1-D, and it ignites at normal operating pressures. However, it is still unclear how the electric fields are distributed inside the structure, how this is affected by the operating conditions, and what the effect is on the grown films. We present results on N-incorporation and optical quality of GaN_xAs_{1-x} as a function of plasma source operating conditions. The plasma contains N and N_2 as ions and in excited states. The debate about what is the important species for (In)GaNAs growth focuses on N_2* or atomic N whereas ions have been shown to be detrimental to the optical quality of the films. The helical plasma source can be operated either at a high-Q resonance with a relatively large N atom density as observed in the plasma emission spectrum or at a low-Q maximum in the forward power where emission from N_2 dominates the spectrum. We present evidence that operating the plasma source in the molecule-rich mode increases the N incorporation into the films for the same net power and gas flow and, furthermore, improves the optical quality.

* This work is being supported by NSERC

MO-POS-21

Growth of Dilute Nitride InGaNAs on InP Substrates by Solid Source Molecular Beam Epitaxy. **Mario Beaudoin** [1], E. Young [1], N. Zangenberg [1], M. Whitwick [1], T. Tiedje [1], M.L.W. Thewalt [2], A. Yang [2], H.J. Lian [2], [1] *University of British Columbia*, [2] Simon Fraser University — Dilute nitride GaInNAs, grown on GaAs substrates, is commonly used in active optoelectronic devices at the telecom wavelengths (1310 nm and 1550 nm). For gas sensing and other environmental applications, wavelengths between 1600 nm and 3000 nm are desirable. An attractive idea consists in extending the well-established InP based technology to longer wavelengths by introducing nitrogen into strained layer InGaAs. As a first step towards achieving this material system, bulk InGaNAs layers have been grown nearly lattice matched to InP by solid source molecular beam epitaxy using an RF plasma nitrogen source. The substrates were thermally desorbed under an As2 flux. High resolution X-ray diffraction (HRXRD) measurements and fitting using dynamical diffraction theory show an InAsP transition layer of a few monolayers at the substrate/film interface attributed to the arsenic-only overpressure during oxide desorption. A Vegard's law analysis shows that 0.4% nitrogen was incorporated into nearly lattice matched InGaAs under our growth conditions. Photoluminescence measurements at room and liquid nitrogen temperature shows a bandgap shrinkage of 25 meV for 0.4% nitrogen with a room temperature bandgap of 1760 nm. This is consistent with a bandgap bowing that is less important than in low In content InGaNAs. For comparison, the bandgap of GaAsN with 0.4% N shrinks by about 90 meV in comparison to GaAs. The photoluminescence intensity of the InGaNAs alloy is also reduced from that of InGaAs by a factor of 3 at room temperature.

MO-POS-22

Raman Study of $GaAs_{(1-x)}Bi_x$/GaAs Epilayers Grown by Molecular Beam Epitaxy. Li-Lin Tay [1], **D.J. Lockwood** [1], E. Young [2], T. Tiedje [2], [1] *National Research Council* and [2] University of British Columbia — The addition of small amounts of Bi to GaAs strongly reduces the bandgap, likely by increasing the energy of the valence band, which has potential applications in the small bandgap devices. We have studied the incorporation of Bi in GaAs epilayers grown by molecular beam epitaxy at 360 °C and also its action as a non-incorporating surfactant during the growth of $GaAs_{1-x}N_x$ layers at 430 °C. Careful comparison between the spectra obtained from $GaAs_{1-x}N_x$ grown with and without Bi surfactant suggested no Bi was incorporated in the epilayer during growth. Raman studies of GaAsBi epilayers containing 1.2% Bi reveals peaks associated with GaAs-like transverse optical (TO) phonon mode at 268.1 cm^{-1} and longitudinal optical (LO) phonon mode at 290.7 cm^{-1} and a broader GaBi-like (LO) mode at 166 cm^{-1}. Reducing the penetration depth of the incident laser light by changing the laser wavelength results in the observation of a Raman peak at 141 cm^{-1}, which is attributed to Bi clusters lying on the surface of the sample. Also, the GaBi-like mode shifts up in frequency nearer the surface of the sample indicating a Bi composition gradient. Our results, in general, resemble those obtained earlier by P. Verma *et. al.* [1], but our value for the GaBi-like mode frequency is different from theirs for a similar Bi composition. At the higher growth temperatures, the Raman spectrum shows no evidence of Bi surfactant cluster formation on the epilayer surface.

1. P. Verma, *et al.*, *J. Appl. Phys.*, **89**(3), 1657, 2001.

MO-POS-23

Phase Transition in Amorphous Si Grown by Molecular Beam Epitaxy. **D. Lockwood**, L. Tay, J.-M. Baribeau, G.I. Sproule, *National Research Council* — Silicon films were grown by molecular beam epitaxy (MBE) at different temperatures (98 to 572 °C) on both clean and oxidized Si(001) substrates as well as quartz substrates. Films grown on crystalline Si (c-Si) exhibit a characteristic limiting thickness for Si epitaxy followed by a transition to an amorphous upper layer, which is in contrast to the amorphous Si (a-Si) growth occurring directly above the oxidized or quartz substrate surfaces. We employed Raman spectroscopy to probe both short-range and intermediate-range disorder in these MBE grown a-Si films at various growth temperatures. The onset of the phase transition of a-Si into c-Si at higher growth temperature is identified by the appearance of the polycrystalline and c-Si bands in the Raman spectrum as well as from high-resolution transmission electron microscopy. The crystalline Raman bands enabled a quantitative analysis in the crystalline volume fraction present in the films undergoing a phase transition from a-Si to c-Si. The onset of the phase transition for films grown on c-Si occurred at approximately 280 °C, which is in contrast to the transformation at ~ 400 °C for films grown on both surface oxidized Si and quartz. For all the films undergoing a phase transition, we will present the crystalline volume fraction at the different film growth temperatures and compare the results obtained from films grown on the different substrates. Impurity incorporation during growth, as studied by secondary ion mass spectroscopy, and defection formation during the film growth will also be discussed.

MO-POS-24

Low-Field Electron Mobility in InGaN Lattice-matched to GaN*, **Hadi Arabshahi**, *Tarbiat Moallem University* — Electron drift and Hall mobility in $In_xGa_{1-x}N$, lattice-matched to GaN is calculated for different temperatures and compositions. The two-mode nature of the polar optic phonons is considered jointly with deformation-potential acoustic, piezoelectric, alloy, ionized-impurity and electron-electron scattering. The theory takes into account conduction-band non-parabolicity, s and p wave-function admixture and electron Fermi statistics. The solution to the Boltzmann equation in the presence of a magnetic field is cast into the form of a contraction mapping and solved iteratively using the currently established values of the material parameters. The agreement with the available experimental data is found to be satisfactory.

* This work is being supported by Tarbiat Moallem University

MO-POS-25

Selectively Targeted Modification of the Tribological Properties of Aluminium and Alloys using Oxygen Plasma Source Ion Implantation*. **Bernard Terreault**, A. Reguer, M. Bolduc, *INRS-EMT, Université du Québec* — Improvements in the tribological properties of aluminum and alloys have been obtained by oxygen plasma source ion implantation (OPSII). This process produces oxide nanoprecipitates which enhance the hardness up to 3 times in the surface layer and cause reductions in the scratch depths and the friction coefficients by similar factors. A spectrum of tribological properties can obtained. Low temperature (≤150 °C) implantations with optimal O-ion doses produce a ~50-nm thick, smooth, and extremely fine-grained metal-alumina nanocomposite. The resulting surface is hard and stiff but non-brittle, and displays high scratch resistance and low friction. In pure Al, this can be further improved using radiation-enhanced diffusion of the oxygen through coimplantation with Ar ions. High temperature (~400 °C) implantation has different effects on pure Al and alloy AA7075-T651. On pure Al, it produces a very hard but brittle Al_2O_3 layer for which yield points are observed at critical load values. On AA7075, extreme radiation-enhanced Mg surface segregation occurs; the MgO crystallites form a thick layer (>100 nm) and the surface shows a slightly smaller hardness increase than at low temperature. OPSII is ideally suited to MEMS fabrication.

* This work is being supported by NSERC, FQRNT, CQRDA

MO-POS-26

The Fractal Geometry of Thin Films*, **C. Elliott**, K. Musselman, T.Brown, K. Kaminska, K. Robbie, *Queen's University* — As atomic vapour condenses onto a substrate forming a thin film, interaction and competition between the arriving atoms yields a coating material that varies greatly with the vapour chemistry, energy, and impingement geometry. The resulting thin films are used in countless industrial applications with crystallinity, composition, *etc.* optimized with processing recipes that are derived from exhaustive experimentation. While the aggregation of atoms onto a flat surface is conceptually quite simple, a general predictive model of thin film growth does not exist. The stochastic chaos of the aggregation process can creates fractal geometries where resulting film morphology depends on a complex blend of long-range collective competition effects, and the inter-atomic interaction of chemical bonding. At glancing vapour incidence competitive shadowing dominates, resulting in an atomically porous structure that exhibits scale-invariant or fractal geometry. A study is presented, of the scaling behaviour in fractal thin films, that provides new insight into atomic condensation and suggests new directions for the development of predictive thin film growth models. Scanning electron and probe microscopies, combined with effective medium modeling of spectroscopic ellipsometry measurements, provide the first accurate measurements of scaling exponents in films prepared at grazing incidence, in agreement with models assuming negligible atomic-scale annealing and dominant long-range shadowing. Remarkable crystallographic effects in some materials clearly violate this condition, and research is ongoing to clarify the relationship between atomic-scale interactions and collective scaling behaviour.

* This work is being supported by NSERC, CIPI

MO-POS-27

Nickel Nanowires and Arrays in Graphite*, **Kevin Robbie**, C. Dean, *Queen's University* — Layered ceramics exhibit quite extraordinary physical phenomena not fully understood by science. Reduced dimensionality enhances ordering effects to produce high temperature superconductivity in layered oxides, and a wealth of exotic behaviour in the system of graphite intercalation compounds (where a secondary chemical species, the intercalant, penetrates between the carbon layers of a graphite crystal). The remarkable capacity for lithium intercalation into graphite energizes the batteries in most portable electronic devices today. We report the fabrication and characterization of nickel and cobalt intercalated graphite, grown epitaxially on single crystal silicon carbide. Microscopy reveals flat-topped islands whose top surfaces are arrays of metal atoms commensurate with a graphite lattice, but exhibiting long-range order and one-dimensional geometries. The resulting nanowires and associated ordering phenomena will be discussed as possible candidates for molecular electronics or computation. The first x-ray diffraction measurements of these new compounds reveal a crystal periodicity slightly larger than the plane spacing in graphite.

* This work is being supported by NSERC, MMO

MO-POS-28

Fabrication of Nanoparticles with Glancing Angle Deposition, **Jian Yang**, K. Robbie, C. Elliott, R. Dariani, *Queen's* University — The design and fabrication of powders composed of nanometer-scale engineered particles is an important next step in the technology of nanomaterials. Controlled deposition of porous thin films with pre-designed nanostructures (pillars, helices and so on) advanced rapidly in the last few years with the Glancing Angle Deposition method. We have now demonstrated that it is possible to use GLAD to fabricate separable nanoparticles. Material is deposited at an oblique angle, creating a porous thin film then removed from the substrate and separated into individual particles; the resulting nanopowder is characterized with a scanning electron microscope. Properties and possible applications of these nanoparticles are discussed.

MO-POS-29

A Survey of Bismuth Overlayer Structures on Si(001) and Si(111)*, **A.B. McLean**, J.M. MacLeod, *Queen's University* — Bismuth overlayers on silicon surfaces are of considerable interest because of their surfactant properties in epitaxial germanium growth. Careful control of bismuth deposition parameters can result in a number of different surface structures, from the irregularly spaced, one-dimensional bismuth line system on Si(001) to the different phases of the $\sqrt{3} \times \sqrt{3}$-R30° reconstruction on the Si(111) surface. Lattice mismatch between the overlayer and the substrate is extremely important because the covalent radii of Bi (146 pm) and Si (117 pm) differ by 25%. We will explore the evolution from the 2xn reconstruction on (001) to the bismuth line surface, and illustrate the large-scale domain structure of the line system. A new type of defect structure on the bismuth-covered Si(111) surface will be described and examined in the context of surface strain.

* This work is being supported by NSERC

MO-POS-30

Gold Induced Atomic Chains on Vicinal Silicon Surfaces*, **L.J. Pedri**, L. Toppozini, M.C. Gallagher, *Lakehead University* — Atomic scale wires on semiconductor surfaces are an attractive system to study one-dimensional metallic conduction. Self assembled atomic chains can be produced by depositing sub-monolayer amounts of gold onto vicinal Si(111) surfaces. The dimensionality of these chains can be tuned by varying both the silicon miscut angle and the gold coverage. For one particular miscut (Si(111) miscut 8.5° towards $[1\bar{1}2]$), we have used scanning tunneling microscopy (STM), low energy electron diffraction (LEED) and Auger electron spectroscopy to investigate how the surface structure varies with gold coverage. Over a wide range of gold coverage (0.18 ML – 0.32 ML) this surface exhibits Si(775) termination as previously reported [1]. The Si(775) surface is characterized by a periodic array of chain structures running along $[1\bar{1}0]$ spaced 21.3 Å apart. Higher coverage results in a Si(332) surface with a chain spacing of 17.5 Å. At still higher coverage, the surface facets and exhibits alternating Si(553) and Si(111) faces. Below 0.18 ML LEED and STM measurements indicate a mixed (111)/(775) surface.

1. Crain *et al.*, Phys. Rev. B **69**, 125401 (2004).

* This work is being supported by NSERC

MO-POS-31

Fabrication of Nanopores in Freestanding Si_3N_4 Membranes*, **Andre Marziali**, D. Trivedi, *University of British Columbia* — Biological nanometer-scale pores have been used to analyze physical properties of biomolecules with emphasis on single molecule chemistry, polymer dynamics and force spectroscopy. Given the limited lifetime of biological nanopores, efforts have been made by several groups to fabricate synthetic nanopores. In addition to greater stability, synthetic nanopores could facilitate high throughput diagnostics. We present recent progress on the development of nanometer-scale pores in freestanding Si_3N_4 membranes. We have been able to create 50nm – 80nm pores in 75nm thick Si_3N_4 membranes using a focused ion beam (FIB) and irradiating these holes with an electron beam from a transmission electron microscope (TEM). This work is currently being extended to both SiO_2 and Si_3N_4 free standing membranes on the order of 10nm thick, with pore diameters on the order of 1nm - 5nm.

* This work is being supported by NSERC

MO-POS-32

Proton Conductive Membranes from the Self-Assembly of Surface-Charged Latex Nanoparticles*, **David Lee** [1], J. Gao [1], Y. Yang [2], S. Holdcroft [2,3], B.J. Frisken [1], [1] *Department of Physics*, [2] Department of Chemistry, *Simon Fraser University*, [3] Institute for Fuel Cell Innovation — Proton conductive membranes form the heart of the polymer electrolyte membrane fuel cell (PEMFC), but the relationship between structure and fuel cell performance is not well understood. Here we explore a novel model system designed to test this relationship that is based on the use of surface-charged latex nanoparticles. These nanoparticles are synthesized via free-radical water co-polymerization of two hydrophobic monomers (Butyl Acrylate (BA) and Methyl Methacrylate (MMA)), a charged monomer (Sodium Sulfonate Styrene (NaSS)), and a crosslinker (N, N' - Methylene-Bis-Acrylamide (BIS)). The resulting nanoparticles are characterized by a combination of static and dynamic laser light scattering to obtain information about the hydrodynamic radius, molecular weight, and solid density. Proton exchange membranes are formed through a process of concentrating dilute particle dispersions followed by annealing the partially dried film at 110°C. Physical and chemical properties such as conductivity, water-uptake, and charge content of the resultant membranes are measured. These membranes possess a higher conductivity than amorphous films (sulfonated BA-MMA-Styrene copolymer chains) and gel films (BA-BIS-MMA-NaSS). TEM micrographs provide evidence of particulate and film

structure and suggest the existence of continuous hydrophilic channels naturally formed through the close-packing of surface-charged nanoparticles. Neutron scattering confirms the presence of particles within the membranes.

* This work is being supported by NSERC

MO-POS-33

Multicanonical Basin Hopping Method and its Application to Nanoclusters and Protein Folding*, **Lixin Zhan**, W.-K. Liu, J.Z.Y. Chen, *University of Waterloo* — Our recently proposed multicanonical basin hopping (MUBH) method is a new optimization algorithm, which uses a multicanonical (MUCA) weight in the basin hopping (BH) Monte Carlo procedure. It was found to be very efficient for global optimization of large scale systems such as Lennard-Jones clusters containing more than 150 atoms. Based on the intrinsic properties of the Monte Carlo method, an asynchronous parallellization of MUBH using message passing interface (MPI) is implemented to take the advantage of parallel computation in optimizing larger systems. For a Cobalt nanocluster consisting of N atoms, we have applied the asynchronous multicanonical basin hopping (AMUBH) method (for $181 < N \leq 200$), MUBH method (for $150 \leq N \leq 180$), together with BH (for $2 \leq N < 150$) to search for the molecular configuration of the global energy minimum. The application of this method to protein folding problem in predicting the stable protein configuration from a known amino acid sequence is shown to be successful as well.

* This work is being supported by NSERC

MO-POS-34

Characterization of Conducting Polymer (Polypyrrole) at Different Doping Levels Using NMR Spectroscopy, **Jenny Chien-Hsin Tso** and Carl Michal, *University of British Columbia* — Conducting polymer is a modern material that has been shown to be utilized in many different applications such as actuators, transistors, wires, super capacitors and strain gages with potentially cheaper and lighter advantages. The working mechanism behind these applications lies on the change of dopant ion intercalation due to the applied voltage causing the corresponding structure change. We present the direct and quantitative measurements of ion content at different doping levels of PF6-doped polypyrrole and the ion diffusion coefficient inside the polymer using NMR spectroscopy in order to fully understand the actuation mechanism and be able to optimize its performance. Due to the amorphous nature of polymers, we demonstrate the NMR spectroscopy as a useful tool to characterize conducting polymers. In the future, we hope to further study the structure change at different doping levels to gain insights on the electron transport mechanism which will help developing a better conducting material.

MO-POS-35

Self Consistent Mean Field Theory for Binary Bilayers, **Nan Zheng** [1], M. Whitmore [2], [1] *Memorial University of Newfoundland*, [2] University of Manitoba — We first present a general self-consistent mean field theory for fully hydrated layered system with two kinds of lipids in equilibrium with excess solvent, then apply it to a simplified bilayer model, which embeds a bilayer into a diamond lattice and simplifies the interactions as nearest-neighbor approximation and extra energy associated with gauche isomers. Effective measures are introduced to incorporate hard-core repulsions, which, together with the connectivity of the lipid molecules, lead to the anisotropy of the effective fields acting on each of the hydrocarbon segments. Besides, the introduction of the interactions between hydrocarbon units and vacancies, as well as solvent molecules and vacancies makes the bilayer in our model compressible, which enables us to study the effects of pressure on bilayers as well as the density change of bilayers under various conditions. With the theory, we can calculate a broad range of thermodynamic propensities of bilayers, and with also the help of propagators, we can calculate various structural properties such as particle density distributions, bond density distribution, orientational order parameter, gauche isomer distribution, segment distribution, and etc. Among them, the inhomogeneous particle and bond density distributions throughout the bilayer interior, along with the effective fields, are first determined through numerical, self-consistent field calculations, and then the other properties. The above theory is realized by computer programs, with which we calculated a series of bilayer properties such as free volume, orientational order parameter, gauche isomer distribution, hydrocarbon distribution and bond distribution, as well as the influence of composition, temperature, and pressure on bilayer properties. All the results were compared with relevant experiments, and show at least qualitative agreement with the experiments. Our results show also many interesting aspects. For example, they support the assumption that the components of a mixture tend to have the same area per lipid, and they not only show the second plateau in the smoothed orientational order parameter profiles for the long chains in a binary bilayer, but also give the distribution of each hydrocarbon unit and gauche isomers, which will help to interpret the reason for such second plateaus.

MO-POS-36

Liquid Crystal Phase Transitions of Semiflexible Hard-Sphere Chains, **Hanif Bayat Movahed** [1], R.C.H. Hidalgo [2], D.E.S. Sullivan [2], [1] *University of Guelph and Guelph-Waterloo Program for Graduate Work in Physics*, [2] University of Guelph — We present a self-consistent theory for describing phase transitions in liquid crystals by using the Onsager second-virial approximation to the free energy. We focus on semiflexible hard-sphere chains. Key ingredients of this theory are the generation of chain conformations and calculation of the pair excluded volume and excluded area by Monte Carlo methods. In this work, the distribution of chain conformations in all phases is coupled to the thermodynamic state of the system. We solve by iteration methods the self-consistent equation for the single-chain probability density. From the probability density, we calculate various structural and thermodynamic variables such as the nematic order parameter (S) and pressure (P), and examine their variation with volume fraction $\eta = p \times V_{mol}$, where p and V_{mol} represent the number density and the molecular chain volume, respectively. From the behavior of S and P vs. η, we can detect the isotropic-nematic phase transition in the hard-sphere chain system. Currently, we are trying to extend the theory to account for a smectic-A phase in the model. In the latter algorithm, we assume that a smectic-A solution for the probability density is a small perturbation around the nematic solution obtained previously.

MO-POS-37

Experimental Studies on Impact of Film Deposition Technique on Bio- and Haemo-Compatibility of Carbon Coated PTFE*, **Andranik Sarkissian** [1], F. Boccafoschi [2], M. Foursa [3], C. Côté [3], A. Hirose [3], D. Mantovani [2], V.N. Vasilets [4], C. Xiao [3], [1] *Plasmionique Inc*, [2] Laval University, [3] University of Saskatchewan, [4] Moscow Institute of Transplantology — PTFE is a widely used material in medical prosthesis; however improving its biocompatibility and haemocompatibility could significantly increase its useful life and decrease the long-term complications that are inherent in the implants made of PTFE. Carbon-based coating of PTFE, using plasma-based deposition techniques, has been studied as possible route to improve the bio- and haemocompatibility of PTFE implants. Carbon-based coatings were deposited on PTFE samples using Plasmionique's magnetron sputtering system, and University of Saskatchewan's hot filament reactor. Pure and nitrogen doped carbon-based coatings were deposited using both techniques. Bio- and Haemo-compatibility tests were carried out at Biomaterial Institute of Laval University and the Transplantology Institue at Moscow. The effects of coating techniques and film composition on bio- and haemo-compatibility of deposited samples will be studied and compared with pure PTFE samples, and results will be presented and discussed.

* This work is being supported by NSERC & Plasmionique Inc

MO-POS-38

Drag Force in Complex Fluids*, **John R. de Bruyn**, N.P. Chafe, *Memorial University of Newfoundland* — We present measurements of the transient and steady-state drag force on a sphere moving through foam and a bentonite clay suspension. Both of these materials are yield-stress fluids; they behave as soft elastic solids at low stress but flow when the stress exceeds the yield stress of the material. The drag force for these materials behaves quite differently from that for a Newtonian fluid. The build-up of the force when the motion of the sphere starts and its decay when the motion stops provide information about the processes involved in the storage and dissipation of energy in these complex fluids. The steady-state drag, measured as a function of speed, gives an estimate of the yield stress and flow curve of the material. We relate our measurements to the microscopic structure and dynamics of the fluids.

* This work is being supported by NSERC

MO-POS-39

A Visible-Infrared Sum-Frequency Study of Surfactant Head Group Orientation at the Air/Water Interface, **Dennis K. Hore**, D. Beaman, G. Richmond, *University of Oregon* — Surface-active molecules have received much attention on account of their industrial, biological, and academic interest. The details of the interaction between surfactants in solution is a fundamental question for the design of new molecules for engineering applications, and also to understand existing molecules which have proven themselves to be useful in technology or well-designed by nature. We have used vibrational sum-frequency spectroscopy to investigate the head group orientation of sodium dodecylsulfate (SDS) at the

air/water interface. The sum-frequency spectra are used to arrive at all participating elments of the second-order susceptiblity tensor. We provide a scheme for the determination of all elements of the hyperpolarizability tensor for the vibrational mode of interest. Then we compare these macroscopic and microscopic quantites to arrive at a quantitative description of the head group orientation. Our results also have interesting implications on the conformational order of the hydrophobic tails. We propose the presence of systematic gauche defects, early in the chain, close to the head groups. Since our method is completely general, our procedure may be used to study any adsorbate at a vapour/liquid or liquid/liquid interface.

MO-POS-40

Critical Behavior in Quantum Heisenberg Chains with Power-Law Interactions. **Nicolas Laflorencie**, I.A. Affleck, M.B. Berciu, *University of British Columbia* — Antiferromagnetic spin-1/2 chains with non-frustrated long ranged couplings J(r) is investigated for the one-dimensional Heisenberg Hamiltonian $H = \sum_{i,j} J(|i-j|)\ \vec{S}_i \cdot \vec{S}_j$ with $J(r) = \begin{cases} \frac{\lambda}{r^\alpha}(-1)^r & \text{if } r>1 \\ 1 & \text{otherwise} \end{cases}$.

For $\alpha = \infty$, the problem is reduced to the well-known spin chain Hamiltonian with nearest neighbor antiferromagnetic exchange which exhibits, in the S = 1/2 case, a critical quasi-long-ranged ordered (QLRO) ground state. On the other hand, the situation for $\alpha = 0$ is trivial because the model is an infinitely connected mean-field problem for which the ground state is a classical Néel state. Consequently, a critical value α_c of the exponent is expected, separating two different phases: the Néel regime for $\alpha < \alpha_c$ and the QLRO regime for $\alpha < \alpha_c$. This quantum phase transition has been studied using different theoretical tools. Using bosonization and a perturbative Renormalization Group treatment of the long range term governed by λ, a line of non-trivial quantum critical points has been identified, as well as a complete set of critical exponents. Taking advantage of the non-frustrated character of the spin Hamiltonian, these critical properties have also been studied using extensive Quantum Monte Carlo simulations which allowed us to study the ground state behavior for systems up to 1000 sites. A very good agreement has been found between both methods.

MO-POS-41

Microstructural Characterization of Martensitic Phases in Ni-Mn-Ga Ferromagnetic Shape Memory Alloys. **Craig Bennett** [1], M. Han [1], M.D. Robertson [1], C.V. Hyatt [2], M. Gharghouri [3], J. Chen [4], X. Wu [3], [1] *Acadia University*, [2] Defence R&D Canada- Atlantic, [3] National Research Council, [4] Dalhousie University — Ni-Mn-Ga ferromagnetic shape memory alloys (FSMA) are a new class of actuator materials which develop large strains when exposed to a magnetic field. The phenomenon combines the advantageous aspects of traditional magnetostrictives (high frequency operation) and conventional shape memory alloys (strains up to 10%). However, in the case of FSMA, the strains result from a novel magnetic field induced reorientation of variants in the martensitic phase.

MO-POS-42

A Modified Stability Criterion for Continuous/Second-order Magnetic Phase Transitions and its Application to Sequential Transitions in Ni-Mn-Ga Heusler Alloys*. **Gwyn Williams**, X. Zhou, W. Li, and H. Kunkel, *University of Manitoba* — An extension of the well established criterion for the stability of continuous/second-order phase transitions - a modified "Banerjee criterion" - is proposed, and this modified criterion is shown to be able to establish the order of sequential phase transitions in Ni-Mn-Ga Heusler alloys.

* This work is being supported by NSERC

MO-POS-43

Effects of a Uniform External Magnetic Field on the Magnetic Properties of a Pure Dipolar Planar System*. **A.M. Abu-Labdeh** [1], A.B. MacIsaac [1], J.P. Whitehead [2], K. De'Bell [3], M.G. Cottam [1], [1] *University of Western Ontario*, [2] Memorial University of Newfoundland, [3] University of New Brunswick at Saint John — The effects of a uniform external magnetic field, h, on the magnetic properties of a pure dipolar planar system on a square lattice have been investigated for both zero and finite temperature, T. From Monte Carlo simulations, the magnetic phase diagram for this system has been determined as a function of both h and T with different lattice sizes. At low temperatures and for low values of h this phase diagram shows a dipolar antiferromagnetic phase in which the spins are aligned perpendicular to h, while for large values of h the phase diagram shows a ferromagnetic phase in which the spins are aligned parallel h. The results also show that the phase boundary separating these two ordered phases appears to be a first-order transition involving a small amount of hysteresis. Moreover, the Monte Carlo results show that the phase boundary separating the antiferromagnetic phase from the paramagnetic phase appears to be a second-order transition.

* This work is being supported by in part by the NSERC

MO-POS-44

Effects of Anisotropies on Lattice Charge Distributions*. **J.M. Tipper**, K.J.E. Vos, *University of Lethbridge* — Copper Oxide planes are a common element of nearly all high-Tc superconductors. Many of the compounds that contain these planes have a degree of anisotropy present in the planes that causes a disparity between hopping parameters in the x- and y-directions, as well as in the (x+y)- and (x-y)-directions. Most theoretical models do not account for this anisotropy, since in most cases the degree of the disparity is small. However, even small amounts of anisotropy can result in a preferred direction in the planes, which can lead to a variety of results. These results include incommensurate magnetic peaks due to spin modulation on the planes, and charge distributions with a distinctly one-dimensional character. Such charge distributions have been theorized from experimental results, and are referred to as stripe phases. Results from an exact diagonalization study of the t-J model will be presented that illustrates the anisotropic effects on charge and spin distribution on the planes, with emphasis being placed on those properties pertinent to stripe phases. The computational infrastructure was provided by Westgrid.

* We acknowledge NSERC of Canada for financial support.

MO-POS-45

Self-Flux Growth of Tl-2201 Single Crystals*. **Darren C. Peets** [1], R. Liang [1], D.A. Bonn [1], W.N. Hardy [1], M. Raudsepp [2], *University of British Columbia*, [1] *Dept. of Physics and Astronomy*, [2] Dept. of Earth and Ocean Sciences — We report the growth of millimetre-sized single crystals of Tl-2201, using a reproducible, well-controlled copper-rich self-flux technique. The crystals were annealed under carefully controlled oxygen partial pressures and characterized. The issue of copper substitution onto the thallium sites is addressed, and the interplay between this, the oxygen content, orthorhombicity, and superconducting properties is discussed.

* This work is being supported by NSERC

MO-POS-46

Spectral Signatures of Competing Antiferromagnetic and Superconducting Phases in Cuprate Superconductors*. **William Atkinson**, *Trent University* — One of the most interesting aspects of the cuprate superconductors is that, with doping, one can tune them from a metallic to a Mott-insulating phase. The details of how the electronic structure evolves as one dopes are poorly understood, and a considerable range of theories (including competing order, phase fluctuations, and spin-fluctuation models) have been proposed. Scanning tunneling microscopy (STM) experiments provide important experimental constraints on the proposed models, but are not yet well understood. In this talk I will outline recent efforts to understand the STM experiments within a semi-phenomenological model of competing phases, and discuss in general terms what STM experiments appear to tell us about the viability of competing-phase models.

* This work is being supported by NSERC, Research Corporation

MO-POS-47

Sulfur Isotope Shift of the Gap of PbS. **Haijun Lian** [1], A. Yang [1], M.L.W. Thewalt [1], R. Lauk [2], M. Cardona [2], [1] *Simon Fraser University*, [2] Max Planck Institut für Festkörperforschung — PbS is one of the oldest known semiconductors, occurring naturally as the mineral galena. One of its interesting properties is a strong increase of the band gap energy with increasing temperature, opposite in sign to almost all other semiconductors. We report on the isotope shift of the band gap energy between natural PbS (containing mostly ^{32}S) and PbS made with enriched ^{34}S, measured using low temperature photoluminescence spectroscopy. The observed isotope shift is also opposite to the "normal" expectation of larger band gap for the heavier mass. In addition, we report on improved measurements of the temperature dependence of the band gap energy measured using absorption spectroscopy, to study the expected connection between isotope shift of energy band gap and temperature.

MO-POS-48

Symmetry of the Order Parameter in Non-Centrosymmetric Superconductors: Implementation for $CePt_3Si$ and $Cd_2Re_2O_7$*. **Ivan A. Sergienko** [1], S.H. Curnoe [2], [1] *Oak Ridge National Laboratory*, [2] Memorial University of Newfoundland — In noncentrosymmetric metals, the spin degeneracy of the electronic bands is lifted by spin-orbit coupling. We consider general symmetry properties of the pairing function $\Delta(k)$ in noncentrosymmetric superconductors with strong spin-orbit coupling (NSC). We find that $\Delta(k) = \chi(k)\ t(k)$, where $\chi(k)$ is an even function which transforms according to the irreducible representations of the crystallographic point group and $t(k)$ is a model dependent phase factor. We consider tunnelling between a NSC and a conventional superconductor. It is found that, in terms of thermodynamical properties as well as the Josephson effect, the state of NSC resembles a singlet superconducting state with gap function $\chi(k)$. We propose the gap functions which may account for the experimental properties of the heavy fermion compound $CePt_3Si$ and the distorted pyrochlore $Cd_2Re_2O_7$.

* This work is being supported by NSERC

MO-POS-49

DC SQUID Measurement of a Stochastic Two-Level System*. **Santosh Gupta**, *University of British Columbia* — We consider a two-level system represented by a spin ½ system with associated magnetic moment and measured by a DC SQUID inductively coupled to it. The fluctuations of the spin are reflected in the fluctuations of the screening current in the SQUID loop. Using a random telegraph noise model for the former, I calculate the correlation function and the spectral density of current noise in the loop and compare it to thermal noise from the external circuit's impedance and quasiparticle currents in Josephson junctions of the SQUID. The conditions for the detection of two-level system's fluctuations are established.

* This work is being supported by Research Student Assistantship

MO-POS-50

Ellipsometric Studies of Electrochromic WO_3 Thin Films*. **Pandurang Ashrit**, Venkata Madhuri, G. Bader, *Université de Moncton* — Tungsten Trioxide (WO_3) has been extensively investigated for its application in the electrochromic devices such as smart windows, rare view mirrors, large area displays and more. In these multilayered devices the WO_3 layer is employed as optically active layer on which hinges the overall performance of the device. Hence, the knowledge of the optical constants over the wavelength region of coloration is highly desirable for an efficient device design. Optical constants of WO_3 films prepared on glass substrates by the thermal deposition technique were obtained from spectro-photo ellipsometric measurments over the spectral wavelength range 305 - 795 nm as a function of Lithium inserted into the WO_3 films. The optical constants of the intercalated WO_3 films were extracted from the experimental data using a laboratory developed transmission/reflection theoretical model and the corresponding software (OPTIKAN) for thin film analysis. From the results we have been able to understand the bronze formation kinetics inside the WO_3 thin films. From this study it is shown that this type of ellipsometric study can be employed as a powerful, precise and non-destructive tool for thin film dynamics.

* This work is being supported by NSERC, AIF, U de M

MO-POS-51

Bound Exciton Luminescence of Molybdenum Disulphide Intercalated with Chlorine*. **Tyler Dumouchel**, L. Charron, E. Fortin, *University of Ottawa* — Steady state photoluminescence of 2H-MoS_2 synthetic single crystals intercalated with chlorine have been previously observed [1]. Chlorine is used as a transport agent for growing synthetic MoS_2 single crystals by vapour transport and during the process it becomes embedded between the layers of the crystal. The photoluminescence is produced by bound exciton recombinations which are related to the chlorine molecules situated in the van der Waals gap. Here we report on MoS_2 commercial powders and natural single crystals treated in a chlorine atmosphere that have been found to exhibit a similar photoluminescence as the synthetic single crystals.

1. L. Kulyuk, L. Charron, E. Fortin, (2003). *Phy. Rev. B*. **68**, 75314.

MO-POS-52

Muon Spin Rotation Measurements on Vanadium Single Crystals*. **Mikko Laulajainen**, J.E. Sonier, F.D. Callaghan, C.V. Kaiser, *Simon Fraser University* — Here we report muon spin rotation measurements on a superconducting vanadium single crystal. The measured magnetic field distribution in the vortex state is modelled for the first time using a precision Ginzburg-Landau (G-L) solution [1], which is applicable for low kappa type-II superconductors. The vortex lattice is studied across the entire field-temperature phase diagram.

1. E.H. Brandt, *Phys.Rev.Lett.*, **78**, 1997, 2208

* This work is being supported by NSERC

MO-POS-53

A Theoretical Examination of the RF Field Induced Lineshape Phase Transitions in ^{8}Li β-NQR Experiments*. **Sydney Kreitzman**, *TRIUMF* — The β-NMR/NQR program at TRIUMF relies heavily on the sub-surface implantation of ^{8}Li nuclei into condensed matter systems. ^{8}Li, with life time of 0.84 s, spin S = 2, gyromagnetic ratio γ = 6.3MHz/T, and quadrupole moment Q = 32mbarn can be prepared and implanted with a high degree of nuclear polarization characterized by >80% occupancy of either the m = +/-2 spin state at rates in excess of 10^8/s. Such conditions allow the real time accumulation of β- NMR/NQR spectra, and an appreciation of theoretical line shapes involved is important. This work outlines the calculation of the lineshapes in zero external field, *i.e.* ^{8}Li β-NQR resonance, for electric field gradients and applied RF magnetic fields of arbitrary asymmetry and strength respectively. The line shape function is shown to pass through a "phase transition" in the region where the applied RF magnetic field in the "rotating frame" exceeds the quadrupolar asymmetry coupling, thereby destroying the degeneracy and wave function symmetry inherent when no RF fields are present.

* This work is being supported by TRIUMF

MO-POS-54

Continuum Elastic Calculation of Acoustic Phonon Frequencies in Spherical Noble Metal Nanoparticles with Strongly Anisotropic Elasticity*. **Daniel B. Murray**, A.S. Laarakker, L.M.L. Murray , *Okanagan University College* — Acoustic phonons are confined in spherical nanoparticles when the boundary conditions are for no surface stresses. These phonons can be observed in low frequency Raman spectra. For larger nanoparticles, it is plausible to use the elastic constants of the bulk material to estimate the vibrational frequencies of the various modes. This is valid for the lowest acoustic phonon modes for which the wavelength is much greater than the interatomic spacing. However, classical solutions of the elastic mechanical problem to find the mode frequencies are available only for materials with isotropic elasticity, that is, with the two Lamé elastic constants. Cubic crystals have three elastic constants, C_{11}, C_{12} and C_{44}, due to their elastic anisotropy. This is quite pronounced for the noble metals: gold, silver and copper. We employ Fourier transforms of molecular dynamics simulations of a finite element model that correctly reproduces the bulk elasticity, and calculate the frequencies of some representative modes including those that are expected to be Raman active. This method was reported by our group in Physical Review B Vol. 69, 113402 (2004). The most important Raman active mode is the one categorized as spheroidal (*i.e.* nonzero divergence in the displacement field) with angular momentum l = 2. For isotropic elasticity, it is five-fold degenerate. The cubic elastic anisotropy breaks the degeneracy into a group of three degenerate modes and another group of two degenerate modes. A similar result is found for the l=2 torsional (i.e. zero divergence) modes. Modes with l=1 remain degenerate.

* This work is being supported by NSERC, OUC Grant-in-Aid

MO-POS-55

Effect Of Remote Band Coupling And Boundary Conditions On Recombination Currents In Type-II Heterostructures. **Andre Botha**, *University of South Africa* — Exact analytical expressions for the eigenvalues and eigenvectors of the 6-band $\mathbf{k} \cdot \mathbf{p}$ matrix Hamiltonian for narrow-gap III-V semiconductors are derived. The transmission coefficient is calculated for a type-II heterojuction, including the effects of the remote band coupling via two Luttinger-type parameters, γ_1 and $\bar{\gamma}$. Numerical calculations are then performed to calculate the effect of the remote band coupling on the net recombination current density in an InAs/GaSb heterojunction as a function of temperature and applied voltage. Ohmic

behavior in the recombination current is found for small applied voltages, but at higher voltages, the recombination current increases non-linearly with respect to the applied voltage. This behavior is consistent with recent experimental observations. The inclusion of the remote band coupling also allows a comparison to be made between the electron to heavy-hole and electron to light-hole recombination currents. It is found that the electron to heavy-hole recombination current constitutes approximately one tenth of the net recombination current at room temperature.

MO-POS-56

The Physics of Chocolate*, Suresh S. Narine and **Laziz Bouzidi,** Agri-Food Materials Science Centre, *University of Alberta* — Beyond the urge to enjoy the escape into delightful indulgence of the senses, away from that persistent quantum mechanical solution, the average Physicist's interest in chocolate is less than academic. However, during the manufacture of chocolate, structure is carefully designed to impart a multitude of degradation and mechanical deformation responses, which are all-important to the quality of the experience of enjoying a chocolate bar. Indeed, in order to understand the sensations perceived from a bar of chocolate, one is required to understand a significant amount of fundamental Physics. This poster provides a light-hearted introduction to Chocolate Physics, 101.

* Work supported by Bunge

MO-POS-57

Quantitative Friction Measurements By Longitudinal Atomic Force Microscope Imaging*. **Eric Karhu** and Jeffrey L. Hutter, *University of Western Ontario* — The atomic force microscope (AFM) generates topographical images of surfaces by measuring the deflection of a weak cantilever spring due to contact forces exerted on a sharp tip. When imaging is performed in a direction parallel to the long axis of the cantilever, frictional forces acting on the tip can lead to artefacts. Lateral force microscopy is a technique that takes advantage of the frictional forces by moving the cantilever in a direction perpendicular to its long axis and measuring the resulting torsion in the cantilever arm. However, the difficulty in calibrating the torsional response of the system remains an obstacle to the quantitative determination of friction. It has been previously suggested that the parallel scan direction can also be used to obtain frictional information. This approach has been largely neglected because of the dependence of the normal force on the friction force in this mode, which complicates the analysis. We show that a quantitative understanding of the effect of frictional forces on longitudinal imaging can be developed. Our model allows us to extract friction data from topographical images acquired in the usual longitudinal direction. An understanding of these forces allows frictional artefacts to be corrected. Most importantly, comparing this information with results from the lateral force mode provides an accurate calibration of the torsional response of the AFM.

* Supported by NSERC

MO-POS-58

Discontinuous Molecular Dynamics Simulations of a Polymer in a Solvent. N.G. Abou Risk, S.B. Opps, and **J.M. Polson**, *University of Prince Edward Island* — In this study, we employ the discontinuous molecular dynamics (DMD) simulation method to study the equilibrium dynamics and the thermodynamics and kinetics of the coil-globule collapse transition for a homopolymer chain in a solvent. We investigate the effects of varying the pair potentials, the polymer chain length and the solvent density on these processes. The model uses interparticle pair potentials composed of a combination of hard-core and square-well interactions. The good-solvent equilibrium dynamics and the non-equilibrium collapse dynamics of the polymer are probed by monitoring the time-dependence of the Rouse coordinates, while an analysis of the static structure factor is used to determine the conformational state of the chain. The simulation results are compared to theoretical predictions. In addition, we present a comparison of the efficiency of the DMD method used in in this study with that of standard molecular dynamics simulations on a comparable model system.

MO-POS-59

Curvature-Density Functional Theory of Shape Transformations in Vesicles of Two-Component Lipid Systems. **Ian MacKay** and Apichart Linhananta, *Lakehead University* — Lipid rafts are small (<100 nm) inhomogeneous regions of lipids found on cell membranes, and are associated with biological signaling pathways. Physicists have modeled lipid rafts as coexisting liquid domains in vesicles. The seminal work of Julicher and Lipowsky[1] derived a curvature-functional free energy, which has predicted or verified many of the experimentally observed behaviors. One aspect that has not been well explored is the density variation of the liquid domains. In this work, the model of Julicher and Lipowsky is modified to include couplings between the curvature and density. The method of Lagrange multipliers is used to derive a new set of shape equations. Solutions of the shape equations are found by the software Mathematica. The properties of liquid domains, including surface-density variations and the domain size variation with temperature are presented.

1. *Phys. Rev. E*, **53**, 2670, (1996)

[MO-POS] INDUSTRIAL AND APPLIED PHYSICS / *LA PHYSIQUE INDUSTRIELLE ET APPLIQUÉE* — Monday / *Lundi*

MO-POS-60

The Mechanics and Acoustics of Harps. **Christopher Waltham**, G. Chan, *University of British Columbia* — The harp is an instrument with a set of plucked strings that excite the sound board through direct connection at an acute angle, without the medium of a bridge. The combined requirements that the sound board be very light for efficient radiation, and that the strings be tight enough to maintain harmonicity, provide an engineering challenge for the builder. Even the smallest of folk harps have total tensions measured in kilonewtons. The material of choice, wood, is pushed to the limits of its strength, and even professionally built concert harps tend not to last more than a few decades. The quality of the sound produced depends on the motion of the string and its interaction with the resonances of the sound board. The string and sound board motions of small and large harps have been studied using small, fast sensors, and the results are compared with a simple model of non-linear coupled oscillators. We attempt to use the insights thus gained to consider how best to balance sound quality with practical construction issues.

[MO-POS] MEDICAL AND BIOLOGICAL PHYSICS / *PHYSIQUE MÉDICALE ET BIOLOGIQUE* — Monday / *Lundi*

MO-POS-61

NMR Structural Studies of Lung Surfactant Peptides*. **Muzaddid Sarker**, V. Booth, K.M.W. Keough, M.R. Morrow, *Memorial University of Newfoundland* — Lung surfactant is a material composed of proteins and lipids that lines the air/fluid interface in lungs. It is essential for normal breathing through its ability to dramatically lower surface tension, thus preventing alveolar collapse and reducing the work of breathing. We are studying SP-B, an essential protein component of lung surfactant. SP-B is thought to function by facilitating large-scale rearrangements of lipid material, however the structural basis for this ability is not yet understood. SP-B is an exceptionally hydrophobic protein, making it difficult to address with X-ray or conventional solution NMR structural techniques. We have used high-resolution two- and three-dimensional NMR to study the structure of a sub-fragment of SP-B that retains much of the activity of the full-length protein. This fragment, termed "mini-B", consists of only the N- and C-terminal helices of SP-B and is about half the size of the full length protein. We have determined the structure of mini-B in organic solvent, as well as in detergent micelles which mimic the lipid environment in which SP-B is found in the lungs.

* This work is being supported by CIHR

MO-POS-62

The Effect of Pressure on Fast Motions in Ordered Phase Phospholipid Bilayers*, **Michael R. Morrow**, H. Singh, *Memorial University of Newfoundland* — Application of hydrostatic pressure to phospholipid bilayers increases acyl chain order and raises the liquid crystal to gel transition temperature. ^{2}H-NMR spectra and quadrupole echo decay times were obtained at ambient and elevated pressure for ordered-phase bilayers of a zwitterionic phospholipids, 16:0-16:0 PC-d_{62} (DPPC-d_{62}), and an anionic phospholipids, 16:0-16:0 PG-d_{62} (DPPG-d_{62}). The extent to which deuteron magnetization following an initial RF pulse is refocused in the echo after a second pulse is limited by motions that modulate the orientation-dependent quadrupole interaction. In the liquid crystalline phase, echo decay reflects motions that are fast on the NMR timescale as well as slower diffusive and collective motions. The temperature dependences of the echo decay times at ambient pressure are similar for the two lipids. On cooling, the echo decay time passes through a minimum at the main transition where correlation times for some motions go from short to intermediate on the NMR timescale. In the gel phase, the echo decay time displays a maximum before falling to a second minimum. This indicates the persistence of some fast motions into the ordered phase. At ~195 MPa, both lipids undergo transitions to more ordered crystalline phases near 0ºC. This is reflected in the temperature dependence of the quadrupole echo decay time at high pressure. Relative to ambient pressure, application of 85 MPa shifts the main transition of DPPC-d_{62} but not the lower temperature minimum in the echo decay time. The behaviour of DPPG-d_{62} at 85 MPa is qualitatively similar to that at higher pressure. This work provides insight into how chain packing affects local motions.

* This work is being supported by NSERC

MO-POS-63

The Breakup of Multilamellar Vesicles in Cylindrical Pores Under an External Pressure*, **Philipus Patty**, B.J. Frisken, *Simon Fraser University* — We investigate the rupture of the multilamellar vesicles when extruded through pores in polycarbonate track-etched membranes. The size and polydispersity of the vesicles is investigated by dynamic light scattering. The size and polydispersity of the pore size in the track-etched membranes is determined through use of SEM. The rupture of vesicles is monitored by studying the release of a fluorescent dye. Multilamellarity is monitored thorugh the use of a quenching assay. We find that the extruded vesicles are larger than the pore size when membranes with small pore sizes (nominal radii of 25 and 50 nm) are used but smaller than the pore size when large pore size membranes (nominal radii of 100 and 200 nm) are used. The polydispersity of the vesicles increases with the size of the pore while the polydispersity of the pore size decreases. Smaller pores are more effective than larger ones in decreasing the multilamellarity of the vesicles. We will use these properties of extruded vesicles to discuss the mechanisms of vesicle rupture in a cylindrical pore.

* This work is being supported by NSERC

MO-POS-64

Penetration of Deuterium Oxide into Spider Dragline Silk using Solid State NMR*, **Xiang Li**, C.M. Michal, *University of British Columbia* — The remarkable mechanical properties of spider dragline silk can be radically altered by the addition of water. Unconstrained silk fibers contract to about half of their original length when immersed in water-a phenomenon named supercontraction. Supercontraction is accompanied by a large increase in fiber elasticity and a corresponding decrease in stiffness. In recent years, a great deal has been learned about the molecular origins of supercontraction in wet silk, but much more work remains. One prime example is the permeability of water into dragline silk's different structural domains. Previous studies of dragline silk indicated that water permeates the amorphous, glycine-rich regions and not the crystalline, polyalanine β-sheet regions. We use Solid State NMR to study the penetration of deuterium oxide into the dragline silk of golden orb-weaving spider, *Nephila clavipes*. Quadrupolar Echo NMR experiments are performed to investigate how the deuterium content inside silk changes with soaking time and with the time of exposure in the air. ^{13}C-^{2}H Rotational Echo Double Resonance (REDOR) NMR experiments are used to quantify deuterium content in different amino acid segments. In contrast to the indication of previous studies by X-ray diffraction and NMR, our study reveals that the alanine-rich regions of the dragline silk are nearly as permeable to water as the glycine-rich regions. DECODER (direction exchange with correlation for orientation distribution evaluation and reconstruction) NMR experiments are carried out to probe the mobility of alanine methyl group in wet silk.

* This work is being supported by NSERC

MO-POS-65

A Simulation Model of Biofilms with Autonomous Cells: Analysis of a Two-Dimensional Version. **Yergou Tatek**, G.W.S. Slater, *University of Ottawa* — We have developed a biofilm model using a novel individual-cell approach which represents cells as thermodynamic and mechanical autonomous systems. In the two-dimensional version presented here, a cell is represented by a closed chain of self-avoiding beads linked together using the bond fluctuation algorithm. The cell is thus controlled both by the rigidity of its membrane and its internal pressure. The model is complemented by key features such as: the explicit inclusion of the so-called extra polymeric substance (EPS); the explicit presence of nutrient diffusion and flow; the processes of cell division and death; and the attractive interactions between the cell (and / or the EPS) and the surface on which the colony grows. Furthermore, to better mimic real living cells, other characteristics such as cell maintenance, cell motility and mutation have been added. Tuning the parameters of the model can lead to the growth and maturation of various types of biofilms. In addition, the versatility of the present model allows us to simulate the growth of different species of microbial cells in order to understand the underlying mechanisms of group competition and cooperation.

MO-POS-66

Molecular Dynamics Simulation of Lung Surfactant Peptide SP-B 63-78 in a Lipid Monolayer*, **Jennifer Rendell**, V.K. Booth, K.M.W. Keough, D.G.Y. Lee, K. Nag, *Memorial University of Newfoundland* — Lung surfactant is a mixture of lipids and proteins essential to life. It enables breathing by lowering surface tension, thus preventing lung collapse and reducing the work of breathing. We are studying the interactions between model protein fragments and lipids of lung surfactant using experimental and simulation methods. The system consists of dipalmitoyl phosphatidylcholine (DPPC) lipid monolayer, water and protein fragment. MD simulations are performed with GROMACS. DPPC monolayers are simulated at low and high packing density, to address their behaviour at different points during respiration. Our findings will underlie developments of therapeutic molecules for treatment of patients with lung surfactant deficiency, such as those with Respiratory Distress Syndrome.

* This work is being supported by CIHR

MO-POS-67

Fractal Analysis and RBC Aggregation. **Alina Rapa** [1], S. Oancea [2], D. Creanga [3], [1] *N/A*, [2] UAMV / IASI, Romania, [3] IASI, Romania — Cell aggregation phenomenon is the result of promoting and inhibiting factors that can be grouped as biochemical and biophysical ones. This phenomenon plays a very important role in various processes related to the physiological functions. To understand the aggregation process many models has been proposed in the literature. Since aggregates formed by aggregation have fractal structure, mathematical description of their irregular structure can be made using fractal geometry. The phenomenon of reversible red blood cells aggregation has been observed for decades. Red blood cell aggregation is an important component of whole blood viscosity and is the major cause of non-Newtonian flow properties of blood. We studied the erythrocyte agreggability for different animals using fractal analysis. Blood samples were prepared by diluting 1:200 and mixing for 3 minutes in adequate reactive. Turk room microscope system and computer acquisition system (frame-grabber or video blaster) were used to register and analyze images of cell-aggregates. In the case of the blood from caw, sheep, rabbit and birds that we studied no aggregation phenomenon was noticed in the microscope slides. But in the case of horse and human, erythrocyte aggregates were identified and fractal analysis was carried out by means of box counting method (BCM). Higher values of the fractal dimension were for horse in comparison to human samples. The results obtained suggest that higher fractal dimension is corresponding to higher aggregability, meaning higher complexity of cells properties of interaction with each other. These results are concordant with literature data.

[MO-POS] NUCLEAR PHYSICS / PHYSIQUE NUCLÉAIRE — Monday / Lundi

MO-POS-68

TITAN Precision Penning Trap*. **Maxime Brodeur** [1], J. Dilling [1], V. Ryjkov [2], [1] *University of British Columbia / TRIUMF*, [2] TRIUMF and the TITAN collaboration — The TITAN facility at the TRIUMF National Laboratory in Vancouver, Canada will use a Penning trap apparatus for high precision mass measurements. The TITAN experiment will be coupled to ISAC, the TRIUMF on-line facility, and provide highly charge ions to achieve mass measurement precision in the order of 1 ppb. Design and status of the TITAN Penning trap apparatus will be outlined. Computer simulation of the singly and highly charged ions will be presented as well as the motivations for mass measurement experiments.

* This work is being supported by NSERCC & NRCC

[MO-POS] OPTICS AND PHOTONICS / OPTIQUES ET PHOTONIQUES — Monday / Lundi

MO-POS-69

Post-Annealing Green Luminescence of Sulfate Crystals. **Vadim I. Sheludko** [1], S.G. Nedilko [2], [1] *Glukhiv Pedagogical University, Glukhiv, Ukraine* and [2] Taras Shevchenko National University, Kyiv, Ukrai — Alkali sulfate crystals M_2SO_4 (M = K, Rb, or Cs) have been shown to exhibit ail intense luminescence after annealing in vacuum at temperatures near structure phase transition points. The luminescence is similar to that of donor-acceptor pairs in AII BIV semiconductors in its behavior depends on temperature, the exciting radiation power, *etc*. Consideration of data obtained has shown that the luminescence mentioned is similar in characteristics to that of donor-acceptor pairs in CdS crystal. It is supposed that M_2S are formed in the sulfate crystals due to heat treatment microcrystalline inclusions of metal sulfides. The gap width is estimated for those crystallites as well as the energy characteristics of donor-acceptor pairs formed therein.

MO-POS-70

Optical Spectroscopy of an InP Photonic Crystal Microcavity Containing InAs Quantum Dots. **Murray W. McCutcheon** [1], G.W. Rieger [1], J.F. Young [1], D. Dalacu [2], S. Frederick [2], A. Bogdanov [2], P.J. Poole [2], G.C. Aers [2], R.L. Williams [2], [1] *University of British Columbia*, [2] Institute for Microstructural Sciences, NRC — Cavity quantum electrodynamics (CQED) concerns the coherent interaction of a coupled electron/photon system. Single atom transits and single photon sources have been observed in high finesse (>400,000) Fabry-Perot resonators [1], but the fundamental interaction suffers from large mode volumes and small interaction times. Photonic crystal (PC) microcavities with embedded quantum dots (QDs) present a promising new platform for CQED, as they afford mode volumes close to the fundamental limit, Q-factors of up to 40,000 [2], and there is no transit time issue. They are therefore good candidate systems for demonstrating conditional quantum control. Here we will report photoluminescence, resonant scattering, and second harmonic generation spectra from several PC microcavities weakly coupled to a distribution of embedded QDs. The microcavities are formed from a single missing hole defect in a hexagonal lattice of air-holes permeating a free-standing slab of InP with an embedded layer of InAs QDs. Each probe technique produces distinct signatures of the "doped" microcavities. All of this information is currently being used to identify the intrinsic and extrinsic (artifacts due to fabrication imperfections) properties of this novel engineered quantum optical system.

1. J. McKeever, A. Boca., A. D. Boozer, J. R. Buck and H. J. Kimble, *Nature,* **425**, 268 (2003).
2. Y. Akahane, T. Asano, B-S. Song, and S. Noda, *Nature,* **425**, 944 (2003).

[MO-POS] PARTICLE PHYSICS / PHYSIQUE DES PARTICULES — Monday / Lundi

MO-POS-71

A Search for Rare Decays in the TWIST Muon Decay Spectrum*. **Ryan Bayes**, *University of Victoria* — The main objective of TWIST is to measure the muon decay parameters, with a greater precision than previous measurements, using the shape of the muon decay spectrum. However, it is possible to extract additional physics from the experimental data, for example, the search for rare or forbidden muon decay channels. This presentation will focus on a search for isotropic structures within the muon decay spectrum which may reveal the presence of the lepton number violating decay $\mu^+ \to e^+ X^0$ employing greater statistics than any previous experiment. The method described uses the Feldman-Cousins approach to define an acceptance region for a mass dependent branching ratio.

* This work is being supported by NSERC

MO-POS-72

Design and Prototyping of the Preradiator for the KOPIO Experiment. **J. Ives** (for the KOPIO collaboration), *University of British Columbia / TRIUMF* – The KOPIO experiment is designed to measure the branching ratio of the rare decay, $K_L \to \pi^0 \nu \bar{\nu}$ and is a direct measurement of CP violation in the context of the SM. Since the theoretical uncertainties for this measurement are quite small (1-2%) even a small deviation from the prediction or from expectations derived from other measurements of CP violating parameters would signal the presence of new physics beyond the SM. A two-stage endcap detector which consists of the preradiator and an EM calorimeter are used to detect these decay photons from π^0s. The preradiator will determine the times, positions and angles of the photons by tracking the first electron/positron pair created by photon conversion. The preradiator has a depth of 2.7 X_0 and consists of 64 layers of plastic scintillator, and dual-coordinate drift chambers. The design and expected performance of the preradiator will be described.

* This work is being supported by UBC/TRIUMF

MO-POS-73

Looking for SNO Cones. **Tyron Tsui**, C. Waltham, *University of British Columbia* — At a depth of 2092 meters, the Sudbury Neutrino Observatory (SNO) is the deepest water Cerenkov light detector currently operating. The depth both reduces the number of cosmic ray muons seen by the detector and restricts their angular distribution to be more than 24 degrees above the horizon. This allows SNO to uniquely identify muons induced by neutrino interactions in the surrounding rock above and below the horizon and to test atmospheric neutrino oscillations in a nearly model-independent manner. Preliminary work on a new muon track fitter for SNO will be presented. The fitter is based on the Hough transform, which detects parameterized curves (*e.g.* circles) in digitized images by searching for the curves in parameter space. In the case of SNO, the roughly 9500 photomultiplier tubes act as sampling points or pixels. The aim is to create a muon track fitter that is equally effective across the entire detector and to use the common characteristic of all events; they are produced from Cerenkov light emitted as a cone. The Hough transform will be extended to search for the Cerenkov cones produced by a muon, where the sampling information available is restricted to the surface of the sphere that defines the edge of the detector. I will present the progress made in constructing this fitter with a focus on the tube selection methods, edge finding routines and methods to reduce the computational complexity of the scheme.

[MO-POS] PHYSICS EDUCATION / *ENSEIGNEMENT DE LA PHYSIQUE* — Monday / *Lundi*

MO-POS-74

Follow-Up Physics Courses for Life Sciences. **Tetyana Antimirova**, *Ryerson University* — Considerable efforts have been recently aimed at the development and revitalization of large undergraduate introductory physics courses for Life Science and pre-medical students. However, much less attention has been paid to the follow-up courses for the students in Life Sciences who desire (or are required) to continue to take physics courses beyond the first year. The need for such courses constantly increases with more and more students considering to pursue interdisciplinary studies that lead to combined degrees that require more physics background than ever before. Moreover, with the emergence of the new undergraduate programs in health sciences (*e.g.*, Radiation Technology, Medical Physics, Health Physics), the creation of new physics courses geared to the needs of these programs becomes especially important. These courses, as electives, attract students from different programs, in different years or terms, which may require certain flexibility in terms of what material is covered in the particular term or academic year. The modular approach where the course is composed of several large and fairly independent topics that can be delivered in any order is most efficient. A subset of available modules can be used in a particular term based on the current needs. This presentation discusses a prototype of a modular second year physics course for Life Sciences that has been successfully delivered over the past several years. Each module in this course is centred around a major fundamental physics topic and richly illustrated by application examples in Physiology (*e.g.*, fluid mechanics as applied to circulatory system).

MO-POS-75

A Novel Look at the One Dimensional Delta Schrodinger Equation. **Patrick Bruskiewich**, *University of British Columbia* — Both integral transforms and an algebraic reformulation of the second order differential equation are used to derive the solution to the one dimensional attractive delta Schrödinger equation. This is a novel approach not found in any standard textbook. Both the transform and the reformulation methods provide additional insight into the nature of the one dimensional attractive delta potential.

MO-POS-76

Electromagnetism in Doorbells. **Gary Chan**, *University of British* Columbia — The doorbell is an invention from the 19th century that serves as a classic example of electromagnetic theory in application. The poster steps through the electromagnetic mechanisms which drive the modern doorbell. Details are presented in a hundred lines of rhyming poetic prose, both pedagogical and entertaining, complete with circuit diagrams, mechanical designs and a pinch of humour.

MO-POS-77

The Michael Smith Science Challenge: A Snapshot of Canadian Grade 10 Students.*, **Christopher Waltham**, G. Bates, A. Griffiths, A. Kotlicki, S. Sutherland, *University of British Columbia* — The Michael Smith Science Challenge is a contest open to all Canadian high school students studying science in Grade 10/Niveau 4. It aims to test general science knowledge according to common elements in all provincial syllabi at that level. It was initiated in 2002 by members of the UBC Faculty of Science and was piloted in British Columbia schools that year. In April 2003 the contest was run nationally, and has continued to do so in 2004 and 2005. Approximately 800 students have taken part each year, from all regions of the nation. We will present results from the physical sciences component of the contest.

* This work is being supported by NSERC PromoScience

[MO-POS] PLASMA PHYSICS / *PHYSIQUE DES PLASMAS* — Monday / *Lundi*

MO-POS-78

Measurements of the anomalous diffusion coefficient in Tore Supra*, **Martin Dionne** [1], C Boucher [1], J-P Gunn [2], T Loarer [2], J-Y Pascal [2], J Adámek [3], [1] *INRS Énergie, Matériaux et Télécommunications,* [2] Association Euratom-CEA, [3] Association Euratom-IPP.CZ — Improving the understanding of the edge plasma physics is one of the key steps in progress toward ITER. Past studies gave a set of empirical values for the effective radial diffusion coefficient but it is difficult to discern which plasma parameters define its value. Turbulent phenomena are frequently invoked and they allow us to predict that the coefficient's value should increase with the connection length. Due to a novel experimental context, we have been able to characterize the effects of cross-field poloidal plasma transport into a vacuum region under Tore Supra's pumped toroidal limiter by deducing an effective diffusion coefficient. Although this system is only one meter long, the values we obtained are similar to the radial diffusion coefficients deduced for cases in which the connection length is at least of a few tens of meters.

* This work is being supported by CRSNG

[MO-POS] SURFACE SCIENCE / *SCIENCE DES SURFACES* — Monday / *Lundi*

MO-POS-79

Zirconium Adsorption on the Gold (111) Surface*, **Taylor J. Stock** [1], A.J. Slavin [1,2], [1] *Queen's University, & Trent University*, [2] *Trent University* — We have investigated the growth of thin zirconium films (to about 5 atomic layers) on the gold (111) surface in ultra high vacuum using Auger electron spectroscopy, low energy electron diffraction, work function measurements, and scanning tunneling microscopy. This work is part of a larger study of the growth of thin zirconium oxide films on the gold (111) surface. These films, with their relatively large dielectric constants, are of particular interest since they could possibly replace SiO_2 in metal-oxide-semiconductor field-effect-transistors (MOSFETs) and provide a solution to the miniaturization problems imposed on MOSFETs by SiO_2's relatively small dielectric constant. Thus far, we have determined that on gold (111) zirconium films grow in the Frank-van der Merwe (layer-by-layer) mode.

* This work is being supported by NSERC

MO-POS-80

Spectroscopic STM Study of Benzene on Si(111)7x7*, **Steven A. Horn**, W. Liu, T. Dyck, B. Knight, S.N. Patitsas, *University of Lethbridge* — We have obtained, for the first time, STM spectroscopic dI/dV images of individual benzene molecules bound to the Si(111)7x7 surface. Standard topographic constant bias imaging indicates the general location of bonding sites in the 7x7 unit cell but fails to provide detailed information about the precise bonding structure. Calculations by various groups suggest that a 1,4-cyclohexadiene like structure is the most favorable structure for adsorption, but other structures such as a 1,2-cyclohexadiene, an "on-top" structure, or a phenyl and hydrogen structure have not been ruled out. Silicon adatoms tend to saturate the topographic images, but it has been known for some time that spectroscopic dI/dV imaging can be used to filter out the adatoms. We have observed that in spectroscopic imaging, benzene molecules appear bright near +1.5 V sample bias, in fact, they are brighter than any silicon related features such as adatoms, rest atoms, corner holes, *etc*. We attribute this to DOS features associated with the C=C anti-bonding Π^* states on the bound benzene. We believe that this is

a promising result and that future studies will reveal the precise location and orientation of double bonds on adsorbed organics. We will also discuss the experimental techniques used to produce our spectroscopic images, including optimization of signal to noise.

* This work is being supported by NSERC

MO-POS-81

Effect of Bi Surfactant on Atomic Ordering in GaAsSb*. **Weiyang Jiang**, X. Zhang, J.Q. Liu, K.L. Kavanagh, S.P. Watkins, *Simon Fraser University* — The application of Bi as a surfactant is shown to cause dramatic microscopic structure changes in near-lattice-matched GaAsSb. Bi/Ga mole ratios of 0%, 0.5%, 1.0%, 2.0%, and 5.0% were applied during growth of ~60 nm near lattice matched GaAsSb, with and without carbon doping, on InP (001) substrates at 550C. All samples exhibited the same underlying weak $3d_{110}$ orderings and anti-phase boundaries which have been previously reported and likely originate from a 3-fold or 6 fold surface reconstruction. At a critical surfactant application of 1% Bi/Ga, strong CuAu {100} and chalcopyrite {210} orderings, with their c axes perpendicular to the growth direction of [001], were reproducibly observed. This effect was seen in GaAsSb samples grown with and without carbon doping. The carbon doping level was about 5×10^{19} cm^{-3}. The ordered domain sizes are around 10~20 nm, and account for ~40%~50% of the total area in TEM plan view images. Transmission electron microscopy (001) plan view diffraction patterns and high resolution lattice images clearly show the differences in their microscopic structure. No significant changes were observed in the surface morphologies with Bi surfactant. No band gap changes were measured for samples with or without {100} and {210} orderings for samples with Sb concentrations from 0.46 to 0.51. This is probably due to the small ordering domain size. The 1% Bi/Ga application was also investigated at lower growth temperature of 520C and higher growth temperature of 580C for without carbon doped samples. There was no {100} and {210} orderings observed for both growth conditions. Because the evaporation temperature for Bi is higher than 520C but lower than 550C, 1.0% Bi application at 520C means much higher than 1% Bi application, while 1.0% Bi application at 580C means much lower than 1.0% Bi application due to its evaporation, respectively, comparing with the same Bi growth at 550C. These results also verified that the 1% Bi is a critical amount. Extra diffraction spots were observed running in both [110] and [1-10] directions for the lattice mismatched samples with Sb concentration of less than 0.4 grown at 580C. These spots probably are due to the large strains/defects caused by the lattice mismatch. Bright field images show large area of defects on [1-10] direction and small area of defects on [110] direction.

* This work is being supported by Simon Fraser University

[MO-POS] THEORETICAL PHYSICS / PHYSIQUE THÉORIQUE — Monday / Lundi

MO-POS-82

How Much Entanglement Does Adiabatic Quantum Search Need?*, **Daria Ahrensmeier**, G. Kunstatter, R. Kobes, *University of Winnipeg* — Adiabatic Quantum Computation is a special approach to quantum computation that is based on the adiabatic theorem and uses a time-dependent Hamiltonian to evolve the system, instead of the quantum analog of bits, gates and algorithms that is used by traditional circuit quantum computation. Considering search problems, I will discuss the differences (or lack thereof) between the two approaches with regard to physical resources, particularly entanglement, possible implementations, and new insights into foundational problems of quantum theory.

* This work is being supported by University of Winnipeg

MO-POS-83

Dimensional Dependence of Scaling Phenomenon in Massless Scalar Field Collapse*, **Jason Bryan Bland** [1], G. Kunstatter [2], [1] *University of Manitoba*, [2] University of Winnipeg — Since early last decade, the fact that gravitational collapse exhibits phase transition-like critical behaviour, analogous to effects seen in statistical mechanics, has attracted a growing community of researchers to the phenomenon. I will present the results of a numerical scheme used to analyze critical behaviour associated with the collapse of a spherically symmetric massless scalar field in arbitrary spacetime dimension. A map of the parameter space is generated by plotting black hole horizon radius against initial mass parameters as criticality is approached. After some initial success, the code implemented in the four, five, and six dimensional cases was unable to remain stable in higher dimensional spacetimes and considerable work was undertaken in order to optimize the code and reduce sources of numerical instability. A new approach to the coding of the algorithm is presented which effectively changed the order of the calculation of one of the key field variables. Currently, there exist reliable solutions in a number of spacetime dimensions which were, until recently, not accessible. Nevertheless, there remains in progress further analysis before a conclusion can be reached regarding the relationship between the scaling constant and spacetime dimension for the minimally coupled spherically symmetric case.

* This work is being supported by NSERC

MO-POS-84

Rotating Black Holes with First Order String Corrections, **M.H. Dehghani**, *Shiraz University* — In this paper I present a class of rotating solutions in (n+1) dimensions in gravity with first order string corrections. I find that these solutions can present black branes, naked singularities or spacetimes with cosmological horizon if one chooses the parameters of the solutions correctly. I also use the counterterm method and compute the conserved quantities of the spacetime. I find that these conserved and thermodynamic quantities satisfy the first law of thermodynamics.

MO-POS-85

Diachronic Modification of Einstein's View of the Dimensionality of Spacetime*, **Michel A. Duguay**, *Université Laval* —Diachronic time, first considered by Einstein [1], is Greenwich time for a central observer in Greenwich recording astronomical events by means of incoming electromagnetic waves. The diachronic representation of spacetime is obtained by choosing the speed of incoming light to be infinite [2]. In a gedanken experiment we position large mirrors at 1 l-h, 2 l-h, *etc*… normal to the Earth-Sun axis and by means of a telescope we look at the Sun in reflection off these mirrors. We see the Sun shining at minus 2 hours, minus 4 hours, *etc*… with respect to our Greenwich time. The present tense "shining" agrees broadly with Einstein's statement about the dimensionality of spacetime[3], quoting: "It appears therefore more natural to think of physical reality as a four-dimensional existence, instead of, as hitherto, the *evolution* of a three-dimensional existence." One difference brought about by the diachronic representation is that the world, as seen directly and in reflection off mirrors, is four-dimensional *now*. As we observe the world day after day, we observe directly and off mirrors (or equivalently through remote television retransmitters) the "*evolution* of a four-dimensional existence".

1. A. Einstein, *Annalen der Physik*, 1905.
2. M.A. Duguay, paper "Diachronic representation of spacetime….." submitted for publication 27 February 2003.
3. Albert Einstein, p. 150 in "Relativity, the Special and the General Theory", Crown Publishers, Inc., 1961.

* This work is being supported by NSERC

MO-POS-86

New Exact Spherical Interior Solutions of the Einstein-Maxwell Equations*, **David Hobill**, J. Burke, *University of Calgary* — A new family of exact solutions of the Einstein-Maxwell equations are found that match to the exterior Reissner-Nordstrom solution. Some of these solutions avoid pathologies associated with negative pressures, acausal sound speeds and other non-physical conditions. The methods used to discover these solutions will be discussed in addition to their possible physical signifcance.

* This work is being supported by NSERC

MO-POS-87

Probing Decisive Answers to Dark Energy Questions Using Cosmological Probes and Weak Lensing Tomography*. **Mustapha Ishak-Boushaki**, *Princeton University* — The observed cosmic acceleration and the implied existence of dark energy is one of the most important and challenging problems in physics. I will start by reviewing the recent progress in cosmology and the evidence for dark energy. I will then discuss the questions raised by dark energy. Interestingly, cosmological probes are good tools to constrain the dark energy parameters. I will present new results on constraining dark energy parameters from currently available data and from simulations of future experiments. These include results from several ongoing and future Cosmic Microwave Background experiments (WMAP, ACT, PLANCK), Supernovae type Ia surveys, and Weak Lensing surveys. Several parameterizations of dark energy are explored. I will discuss in particular how the weak lensing technique called tomography can add key improvements to the constraints. Finally, I will discuss some of the future approaches to probe the nature of dark energy beyond the ongoing work.

* This work is being supported by NSERC/NASA

MO-POS-88

Generally Covariant Description of Multiple D-Brane Dynamics. **Henry Ling**, M. Van Raamsdonk, D. Brecher, K. Furuuchi, *University of British Columbia* — An interesting property of D-branes is that a collection of N D-branes which are brought closely together lose their individual identities in the sense that we are no longer able to describe the locations of these N branes using separate embedding coordinates for each brane. Instead, we must use a set of N x N matrix coordinates to collectively describe the N branes. However this raises an interesting conceptual question. How can this matrix description of a collection of D-branes be reconciled with the principle of general covariance? In particular, what is the meaning of a coordinate transformation, when the object in question has coordinates which are matrix-valued, and how does one ensure that the dynamical laws governing the behaviour of such objects are coordinate-independent? We analyze the problem of finding a consistent coordinate transformation law for the matrix coordinates of a collection of D-branes, and present a strategy for constructing manifestly generally covariant D-brane actions.

MO-POS-89

Violation of Energy Conditions in Asymptotically Flat Dimensional Reductions*. **Sergei Slobodov**, J. Brannlund, K. Schleich, D.M. Witt, *University of British Columbia* — Studying spacetimes with continuous symmetries through the use of dimensional reduction to a lower dimensional spacetime is common in both classical gravity and string theory. Surprisingly, when dimensional reduction of a higher dimensional spacetime leads to a 3-dimensional asymptotically flat or asymptotically anti-de Sitter spacetime, either the reduced spacetime has one of two possible topologies or else must exhibit pathological geometry. In this talk I will illustrate this result by discussing the properties of the effective stress-energy tensor obtained by one common reduction of 4 dimensional asymptotically flat spacetimes with axial symmetry. In the reduced spacetime, one finds that there are timelike and null observers that see negative energy density and/or superluminal matter flows.

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MO-POS-90

Spindown of a Periodic Gravitational Wave Pulsar Signal*. **Sreeram Valluri** [1], F.A. Chistie [2], A. Vajda [3], D.J. Sikorski [4], T. Williams [4], K.M. Rao [2], [1] *University of Western Ontario (UWO)*, [2] Applied Mathematics (UWO), [3] Computer Science/ Physics and Astronomy (UWO), [4] Physics and Astronomy (UWO) — Detailed analytical and numerical studies of the Fourier transform (FT) of the gravitational wave (GW) signal from a pulsar, taking also into account the spindown of a pulsar in addition to the rotation and orbital motion of the Earth will be presented. This study emphasizes possible usage of parallelization techniques to increase the efficiency and speed of the ensuing calculations. The numerical analysis will employ these techniques to process the data of the multi-parameter GW form that includes the spindown of a pulsar. This is an important computational problem for GW detection analysis. An investigation based on the analytic results has been under way using the Beowulf clusters present at our location (SHARCNet) and numerous parallel programming techniques. A useful side effect of this research has been the development of high-speed special function evaluators (mainly for the Bessel function and the ${}_1F_3$ hypergeometric function). Currently, efforts are concentrated on applications such as the Fast Chirp Transform.

* This work is being supported by SHARCNet

MO-POS-91

Density Matrix Formulism and Its Application in Quantum Non-Clone Theorem and Hidden Variable Theory. **Jinshan Wu** [1], S. Pei [2], [1] *University of British Columbia*, [2] Beijing Normal University — Density Matrix is used to unify the description of classical and quantum objects. The idea is all of state of classical object, state of quantum object and state of quantum operator can be regarded as vector in Hilbert space, so that all the states can be represented by density matrices. After constructing the general framework, we will apply this to discuss Quantum Non-clone Theorem and Hidden Variable Theory of Quantum Mechanics. As results, a generalized version of Quantum Non-clone Theorem is presented, Hidden Variable Theory is ruled out. Under our unified description, the only difference between a quantum full-structure density matrix and a classical PDF density matrix is the existence of the off-diagonal elements. Therefore, both of our above two conclusions can be rephrased in a new way, that a density matrix with off-diagonal elements could not be cloned and could not be equivalently described by a PDF density matrix even with infinite lager dimension. Of course, the ultimate reason is that, for a quantum system, a density matrix with off-diagonal elements has to be used, because of the noncommutative relation between quantum operators.

MO-POS-92

Perturbative Effects due to the Moon and Jupiter on a Periodic Gravitational Wave Pulsar Signal. **Sreeram Valluri**, P. Wiegert, F. Chishtie, D. Sikorski, *University of Western Ontario* — Detailed analytical and some numerical studies of the Fourier Transform (FT) of the gravitational wave (GW) signal from a pulsar, taking also into account the Perturbations due to the Moon and Jupiter, spindown of a pulsar in addition to the rotation and orbital motion of the Earth are presented. This study emphasizes analytical and possible usage of parallelization techniques to increase the efficiency and speed of the necessary calculations. The numerical analysis will also employ parallelization techniques to implement processing of data of the multi-parameter GW waveform that also considers the spindown of a pulsar. This is an important computational problem for GW detection analysis. An investigation based on the analytic results has been under way using the Beowulf clusters present at our location (SHARCNet) and numerous parallel programming techniques. A useful side effect of this research has been the development of high-speed special function evaluators (mainly the Bessel and the ${}_1F_3$ Hypergeometric functions). Analytical methods to assist parallelization will be indicated to call attention to the capabilities of such techniques in multidisciplinary fields.

MO-POS-93

Game Theory on Quantum Objects. **Jinshan Wu,** *University of British Columbia* — Effect of replacing the classical game object with a quantum object is analyzed. We find this replacement requires a throughout reformation of the framework of Game Theory. If we use density matrix to represent strategy state of players, they are full-structured density matrices with off-diagonal elements for the new games, while reduced diagonal density matrix will be enough for the traditional games on classical objects. In such formulism, the payoff function of every player becomes Hermitian Operator acting on the density matrix. Therefore, the new game looks really like Quantum Mechanics while the traditional game becomes Classical Mechanics. The object of Game Theory is a game, a multi-player decision making situation, usually with confliction between players. For example, in a Penny Flipping Game (PFG), two players play with a coin, say initially with *head* state. The strategies can be used by players are *Non — Flip* and *Flip*, which, in the language of Physics, are operators acting on the coin. The payoff is defined such as player 1 wins one dollar for *head* state after both players applied their strategies, and lose one dollar for *down* state. For such static strategy games, Nash Theorem of Game Theory has given a closed conclusion that at least one mixture-strategy Nash Equilibria (NE) exists for any games. Here the NE is defined that under such state no more players will like to change its own strategy state, and mixture strategy is defined as a probability distribution function (PDF) over the strategy space of every player. Our question is how about we replace the two-side coin here with a ½ -quantum spin? What's the effect of this on Game Theory? It's still a game-theory question. Players can still choose strategies to act on the spin, although they have much more the choices. Compared with *Non — Flip* and *Flip* and, in Quantum Mechanics, any unitary 2 x 2 matrices can be used as operators, and $\{I, X, Y, Z\}$ (unity matrix plus Pauli Matrices) are the four typical matrices of them. Now the Game Theory must answer how to define the strategy state for this game, how to define NE, and the existence of NE. At last, we have to ask whether such game can be studied within the framework of Traditional Game Theory (TGT), or should we develop a new framework but still with the same spirit of Game Theory? In this work, we will construct a new framework, which can be used both TGT and the game on quantum objects, which later we will call Quantum Game Theory (QGT).

Author Index / Index des auteurs

The Editorial Board welcomes articles from readers suitable for, and understandable to, any practising or student physicist. Review papers and contributions of general interest are particularly welcome.

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