[MO-P10] **Quantum Information Theory / *Théorie de l'information quantique*** **MONDAY, JUNE 14**
LUNDI, 14 JUIN

(DTP/*DPT*) **14h15 -17h00**

[Room/Salle : Kildonan] ***Chair: R. Mann, U.Waterloo***

MO-P10-1 **14h15**

RAYMOND LAFLAMME, Institute for Quantum Computing, University of Waterloo

NMR And Quantum Information Processing

Advances in computing are revolutionizing our world. Present day computers advance at a rapid pace toward the barrier defined by the laws of quantum physics. The quantum computation program short-circuits that constraint by exploiting the quantum laws to advantage rather than regarding them as obstacles. Quantum computer accepts any superposition of its inputs as an input, and processes the components simultaneously, performing a sophisticated interference experiment of classical inputs. This "quantum parallelism"

allows one to explore exponentially many trial solutions with relatively modest means, and to select the correct one. This has a particularly dramatic effect on factoring of large integers, which is at the core of the present day encryption strategies (public key) used in diplomatic communication, and (increasingly) in business. As demonstrated approximately five years ago, quantum computers could yield the most commonly used encryption protocol obsolete. Since then, it was also realized that quantum computation can lead to breakthroughs elsewhere, including simulations of quantum systems, implementation of novel encryption strategies (quantum cryptography), as well as more mundane applications such as sorting. I will describe recent work done in quantum computation, in particular I will give a critical review of the NMR implementation, its achievements and future prospect.

MO-P10-2 14h45

BARRY C. SANDERS, University of Calgary

Quantum Information Processing with Continuous Variables

Quantum information theory is built on creating, manipulating and reading qubits yet some of the dramatic experimental successes, such as unconditional quantum teleportation, quantum cryptography with coherent states, and threshold quantum secret sharing, have been achieved for continuous variables. I will explain continuous variable quantum information processing, discuss its realizations as quantum optics experiments, expose the weaknesses, extol the strengths, and consider its future. The field of continuous variable quantum information processing is exciting on several levels. The mathematics is elegant, and the quantum optics experiments can be understood in terms of Hamiltonians that obey the symplectic algebra. The experiments make use of sophisticated, yet well-developed, technology such as the ability to squeeze the vacuum fluctuations of light, perform balanced homodyne detection, and prepare highly coherent states of light. Decoherence is often negligible in these settings. These advantages make continuous variable quantum information processing the best avenue for first proofs-of-concept. The field faces formidable challenges, including encoding quantum information into continuous variables allowing for robust error correction, achieving nonlinear transformations outside the symplectic transformations that allow universal unitary transformations of the field without significant decoherence, and security proofs for quantum cryptography. These challenges are not insurmountable; rather they add to the excitement of the field, which I will discuss.

15h15 Coffee Break / Pause café

MO-P10-3 15h30

RANDY KOBES, University of Winnipeg

Exploring Paths in Adiabatic Quantum Computing

Many systems, such as quantum computers, can be formulated in terms of networks of a large number of coupled two-level quantum systems. Due to the complex interactions, however, it is difficult to infer general properties about the evolution of the system. In such cases it is often useful to consider the behaviour of the system when a degree of randomness is introduced in the interactions, the hope being that, when averaged over large classes of randomness, some qualitative information about the evolution of the system can be deduced. Here we describe one such study, with particular emphasis on seeing the difference between short and long range interactions.

MO-P10-4 16h00

PHILIP STAMP, University of British Columbia

Decoherence Mechanisms And The Dynamics Of Decoherence In Qubit Networks

The major problem confronting the construction of quantum information processing networks of any kid is decoherence, caused either by the interactions of the network with the surrounding environment, or from the time-dependent changes in the network parameters as computations or processing are carried out. To quantify decoherence we need (i) realistic physical models of what causes it, and (ii) means of calculating network dynamics. The main decoherence in solid-state qubit networks at low T comes from localized excitations in the environment (the ‘spin bath’). How this works is discussed quantitatively for superconducting and magnetic qubit networks, and compared with experiment. In optical systems the decoherence comes from unwanted photon modes. The problem of network dynamics raises a second fundamental question- how do decoherence rates increase with the number of entangled qubits? This question can be answered in detail with models incorporating spin and oscillator baths acting on ‘quantum memory’ networks. If there is time I will also discuss decoherence for topological quantum computer designs.

MO-P10-5 16h30

ACHIM KEMPF, University of Waterloo

Towards a Notion of Qubit Density for Quantum Fields in Curved Spacetime

In the literature, there is much discussion as to whether spacetime is discrete or continuous. In information theory, the link between continuous information and discrete information is established through well-known sampling theorems. Sampling theory explains, for example, how frequency-bounded music signals are reconstructible perfectly from discrete samples. I will present a generalization of sampling theory to pseudo-Riemannian manifolds. The aim is to provide a new set of mathematical tools for the study of spacetime at the Planck scale: theories formulated on a differentiable space-time manifold can be completely equivalent to lattice theories. There is a close connection to generalized uncertainty relations which have appeared in string theory and other studies of quantum gravity.

17h00 Session Ends / Fin de la session