

[SU-A4]

(DCMMP/DPMCM)

Single-Molecule Polymer Physics: Fundamental Questions /
Physique des polymères monomoléculaires: questions fondamentales

SUNDAY, JUNE 13
DIMANCHE, 13 JUIN
09h30 - 12h30

[Rooms/Salles : Ballrooms B/C]

Chair: J.L. Bechhoefer, Simon Fraser U.

SU-A4-1

09h30

EDIT M. SEVICK, Australian National University

*The Fluctuation Theorem as a Generalised Second-Law for Nanomachines and Single Biopolymer Manipulations: Optical Tweezers Experiments and Beyond**

The puzzle of how time-reversible microscopic equations of mechanics lead to the time-irreversible macroscopic equations of thermodynamics has been a paradox since the days of Boltzmann. Boltzmann simply side-stepped this enigma by stating “as soon as one looks at bodies of such small dimension that they contain only very few molecules, the validity of this theorem [the Second Law of Thermodynamics and its description of irreversibility] must cease.” Today we can state that the Transient Fluctuation Theorem (TFT) of Evans & Searles is a generalised, Second-Law like theorem that bridges the microscopic and macroscopic domains and links the time-reversible and irreversible descriptions. In this talk we apply this theorem a colloidal particle in an optical trap, and demonstrate that this system can evolve reversibly and “violate” the Second Law over experimentally realisable time and length scales. Moreover, we show how the theoretical Fluctuation Theorem (FT) formalism can be rigorously re-framed in stochastic dynamics. This is important as the dynamical responses of polymer and biophysical systems are often well-described by stochastic dynamics and this suggests new applications of the FT.

* In collaboration with J.C. Reid¹, D.M. Carberry¹, G.M. Wang¹, D.J. Searles² and D.J. Evans¹, ¹ Australian National University and ² Griffith University.

ORAL SESSION ABSTRACTS

SU-A4-2 **10h15**

NANCY FORDE, UC Berkeley

*Using Optical Tweezers to Study Single-Molecule Reactions in Real Time**

The ability to exert force on single molecules offers an experimental means to probe mechanical processes and to see beyond ensemble-averaged behaviours. Optical tweezers, which use a focused laser beam to manipulate micron-sized refractive particles with nanometer precision, allow us to exert and detect forces on the picoNewton scale. By attaching molecules of interest to these particles, we can determine molecular response to applied mechanical force. In this talk, I will discuss our recent experiments that take advantage of previously characterized elastic properties of DNA in order to follow the movement of RNA polymerase along DNA in real time. RNA polymerase is a molecular motor that catalyzes synthesis of an RNA polymer chain, converting chemical energy into mechanical force causing directed movement along the DNA template. By studying this transcription reaction by single molecules of RNA polymerase, and applying a mechanical force to assist or oppose translocation along DNA, we have been able to follow, and in some cases alter, the reaction kinetics in real time.

* In collaboration with C. Bustamante ^{1,2,3}, D. Izhaky ¹, ¹ Howard Hughes Medical Institute, ² Department of Molecular and Cell Biology, and ³ Department of Physics, University of California, Berkeley.

SU-A4-3 **11h00**

BAE-YEUN HA, University of Waterloo

Statics and Dynamics of Biopolymers: Theory and Biological Relevance

In this talk, I will discuss conformational and dynamical properties of biomolecules with an emphasis on their biological implications. I will first present simple theoretical models for describing loop formation of DNA, both double-stranded (ds) and single-stranded (ss) DNA. In the case of dsDNA (or other semiflexible polymers), large loops are entropically disfavored, while small-loop formation costs bending energy. This results in an optimal loop size at which the closing time is shortest. In contrast, the looping kinetics of short ssDNA is mainly controlled by stacking-breakage probability and shows loop-composition sensitivity. Finally, I will discuss polyelectrolyte aspects of DNA, especially the electrostatic mechanism behind DNA packaging by polyvalent counterions.

SU-A4-4 **11h45**

HANS JUERGEN KREUZER, Dalhousie University

Stretching and Confinement of Single Polymer Molecules and the Growth of a Polymer Brush: a First Principles Theory

A first principles theory based on (i) *ab initio* (density functional theory) calculations of the potential energy surfaces of the polymer conformers, and (2) the proper statistical mechanics (including the intricacies of the AFM), allows the parameter-free calculation of the thermodynamic properties of single polymer strands and polymer brushes. For the statistical mechanics we succeeded to formulate and solve a Green's function approach (transfer matrix method) in the presence of an external force field. Applied to poly(ethylene glycol) molecules we achieve quantitative agreement with experimental data, both in hexadecane and in water. Results for the confinement of single polymer molecules in pores and for the constrained adsorption of a polyelectrolyte on a self-assembled monolayer will be presented. A theory of the growth of a polymer brush from solution will be developed.

12h15 **Session Ends / Fin de la sessio-**