THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

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SEMINAR

How May a Protein Unknot a Knotted DNA? Statistical Physics of Local Inference of Global Topology by Topoisomerases

by

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(http://biochemistry.utoronto.ca/chan/bch.html)

Abstract

Closed DNA circles can be unknotted, knotted or linked (catenated). Such topological entanglements of DNA molecules have important impact on biological processes. Topoisomerases are a ubiquitous class of enzymes that pass one DNA segment through another, serving critical biological functions in cellular replication and maintenance of genome stability.

Experimentally, type-2 topoisomerases (topo II) can reduce knot population by as much as 90 times and catenane population by ~16 times. These observations raise a fundamental question of physical principle: How does a relatively small enzyme discern the global topology of a much larger DNA molecule that it acts upon? Because it seems that topo II can work magic, it has even been likened to Maxwell's demon. This talk addresses the statistical mechanical basis of topo II actions. Using coarse-grained lattice and continuum wormlike chain models, we have elucidated the mathematical basis of the hypothesis that topo II recognize and act at specific DNA juxtapositions. We found that selective segment passage at hooked geometries can reduce knot populations as dramatically as seen in experiments.

Selective segment passage also provided theoretical underpinning for an intriguing empirical scaling relation between unknotting and decatenating potentials. Such selective segment passage also accounts for supercoil simplification (narrowing linking number distribution) by topo II.

The consistent agreement between theory and experiment argues for topo II actions at hooked or twisted-hooked DNA juxtapositions. Our investigation highlights how a biological phenomenon can lead to the discovery of a general connection between local geometry and global topology in polymer configurations and how the information can be harnessed to resolve entanglements.

Date: **August 23, 2010 (Monday)**
Time: **4:00pm – 5:00pm**
Venue: **Room 4472, Academic Building, HKUST (Lifts 25-26)**