Physical Behaviors of Biopolymers: Applications & Implications for Life Sciences

By
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Date: 2 February 2015, Monday
Time: 4pm to 5pm
Venue: Perseverance Room, Enterprise Level 5

Abstract

DNA is one of the most important polymers in existence due to its role in biology and biochemistry. In this talk, I will present the physical behaviors of DNA under various conditions, including (1) DNA in nanofluidic channels, (2) knotted DNA, (3) the coil-globule phase transition of DNA, and (4) DNA conformation change in a macromolecular crowding environment. Computer simulations and theoretical analysis are applied to elucidate the general physical mechanism behind the behavior of DNA under these conditions. All of these scenarios play a role in emerging biotechnologies, and close parallels are found in biological systems. Confining DNA in nanofluidic channels has been applied to genome mapping. Knotted DNA molecules present interesting phenomena in the process of sequencing genomes during nanopore translocation. The coil-globule phase transition mirrors protein folding and DNA packaging. Macromolecular crowding is also experienced by DNA in vivo due to the presence of a large amount of proteins. These results of can also be generalized to other biopolymers, including proteins and cell cytoskeletons.

Short Biography

Dr. Dai Liang is currently a senior postdoctoral associate in BioSystems and Micromechanics Inter-Disciplinary Research Group of Singapore-MIT Alliance for Research and Technology (SMART). Dr. Dai pursued the undergraduate study from 2000 to 2004 in the physics department of University of Science and Technology of China (USTC), followed by a PhD study from 2004 to 2008 in the physics department of National University of Singapore (NUS). Before joining SMART in 2010, Dr. Dai was a postdoc in the Center for Computational Biology and Bioinformatics of Indiana University. Dr. Dai applies multi-scale modeling, from atomistic to coarse-grained, and statistical mechanics to perform research in soft matter physics and biophysics, with tight collaboration with experimental groups in MIT and NUS. Dr. Dai published 13 first-author papers in reputable peer-reviewed journals, including 3 in Physical Review Letters. Dr. Dai also co-authored 4 other papers. A number of awards have been granted to Dr. Dai, including the 2009 Chinese Government Award for Outstanding Self-Financed Students Abroad, and the 2004 USTC award for the outstanding undergraduate thesis.