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Title: Molecular Motors: Force and Fluctuations, Information and Infidelity

Abstract

In living cells molecular motors transduce energy to generate forces required for motility, contractility and intracellular self-organization. The sizes of the motors typically range from tens to hundreds of nano-meters. We model the stochastic kinetics of the motors and motor-driven processes to explore the mechanisms of energy transduction and information processing by these machines. Unlike their macroscopic man-made counterparts, their dynamics is dominated by viscous drag and random Brownian forces. Some of these motors are physical realizations of Feynman's ratchet. Like Maxwell's demon, these escape the constraints of the second law of thermodynamics by operating far from thermodynamic equilibrium. More sophisticated motors that use their filamentous tracks as templates to synthesize 'macromolecules of life' (namely, DNA, RNA and proteins) are essentially 'tape-copying Turing machines'. We model the fidelity of decoding and recoding of genetic information by these machines to understand the competing demands of speed and fidelity in the tape-copying processes. We also investigate the traffic congestion and jamming of molecular motors using the concepts and techniques of non-equilibrium statistical physics for self-driven interacting particles. Does the interior of a living cell resemble an urban transportation network? Or is it a smart, but noisy, micro-factory where the nano-machines as well as their connections self-organize in an aqueous medium and where the supply chain is highly dynamic? In this lecture, I'll give an overview of the recent exciting developments and briefly mention a few of our own works in the appropriate context.

About the Donor

Prof. Chintamani Nagesa Ramachandra Rao was born on June 30, 1934 in Bangalore. In 1958, he completed his Ph.D. from Purdue University and became a research chemist at the University of California at Berkeley. Returning to India in 1959, he worked as a lecturer at the Indian Institute of Science in Bangalore. He was a Professor of Chemistry at IITK from 1963-76 and also the Dean of R&D from 1968-1971. During 1984 -89, he was the Director of IISC Bangalore. He was the founder president of Jawaharlal Nehru Center for Advanced Scientific Research Bangalore.

He received Bharat Ratna, the highest civilian award in India in the year 2014. He is the recipient of most of the major scientific awards, and is a member of all major scientific organizations. He is a foreign member of the US National Academy of Sciences, American Academy of Arts and Sciences and also a Fellow of the Royal Society (London).

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About the Speaker

Prof. Debashish Chowdhury received his M.Sc. from IIT Kharagpur in 1980 and Ph.D. from IIT Kanpur in 1984. After postdoctoral research in Germany and USA, he served as a faculty member for five years in JNU before joining IIT Kanpur in December, 1992. He was promoted to full Professor in May, 1997. He was Dr. Jag Mohan Garg Chair Professor at IIT Kanpur (2011-14). At present, he is Prof. S. Sampath Chair Professor (2015-18) and head of the department of Physics.

Prof. Chowdhury is an elected fellow of the Indian National Science Academy (New Delhi), Indian Academy of Sciences (Bangalore) and National Academy of Sciences, India (Allahabad). He is a recipient of the Alexander von Humboldt Fellowship (1984-85), INSA Young Scientist medal (1989) and J.C. Bose National Fellowship (2013-2018). He has served as visiting scientist / visiting professor at Ohio State University (USA), University of Toronto (Canada), McGill University (Canada), University of Cologne (Germany), Forschungszentrum Juelich (Germany), Max-Planck Institute for Physics of Complex Systems, Dresden (Germany). He was an invited speaker in special symposia organized by the Indian Academy of Sciences to celebrate both its Diamond Jubilee (1994) and Platinum Jubilee (2009) of the academy. He has delivered invited talks at many other prestigious conferences including the IUPAP international conference STATPHYS23 in Genova, Italy.

Prof. Chowdhury has authored 3 books and more than 150 research papers in international refereed journals. One of his single-author papers has been selected in "Best of 2013" in Biophysical Journal published by Biophysical Society, USA. He is one of the authors of the special issue of the FEBS J. published by the Federation of European Biochemical Societies to celebrate the centenary of the classic paper by Michaelis and Menten. Prof. Chowdhury has served as a member of the Editorial Board of European Physical Journal B. He also serves as one of the moderators of arXiv, the e-print archive of scholarly papers, owned and operated by Cornell University, USA.

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2011	Amalendu Chandra	Molecular simulations of liquids and interfaces: An HPC activity at IITK

Contact: Dean of Research & Development