Satyendra Nath Bose National Centre for Basic Sciences

Azadi Ka Amrit Mahotsav

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Statistical Mechanics

30 NOV 2021
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TITLE

Forces from non-equilibrium fluctuations in Active Matter and QED

ABSTRACT

The pressure of a gas, the van der Waals attraction between molecules, and the Casimir force in quantum electrodynamic (QED) are classical examples of forces resulting from equilibrium (thermal or quantum) fluctuations. Current research on ?Active Matter? studies collective behaviors of large groups of self-driven entities (living or artificial), whose random motions superficially resemble thermally fluctuating particles. However, the absence of time reversal symmetry leads to unusual phenomena such as directed (ratchet) forces, and a pressure that depends on the shape and structure of the confining wall.

Some manifestations of QED fluctuations out of thermal equilibrium are well-known, as in the Stefan-Boltzmann laws of radiation pressure and heat transfer. These laws, however, acquire non-trivial twists in the near-field regime of sub-micron separations, and in the proximity of moving surfaces. Symmetry arguments suggest that lateral ratchet forces should emerge out of equilibrium and with broken spatial symmetry. We inquire if such forces can be used to construct a heat engine, and discuss constraints on its operation.

SPEAKER

Professor Mehran Kardar, *Massachusetts Institute of Technology*

Prof. Mehran Kardar is the Francis Friedman Professor in the Physics Department at MIT, USA. He is a renowned theoretical physicist specializing in statistical physics, known worldwide for the Kardar–Parisi–Zhang (KPZ) equation, which has been named after him and collaborators. His research interest spans a wide range of topics including behaviour of disordered systems, nonequilibrium collective phenomena, soft matter and biological physics. His work has been recognized by a number of awards, such as the Bergmann memorial research award, A. P. Sloan Fellowship, Presidential Young Investigator award, Edgerton award for junior faculty achievements (MIT), and the Guggenheim Fellowship. He is Fellow of the American Physical Society, the American Academy of Arts & Sciences, and the National Academy of Sciences. Prof. Kardar is also an eminent teacher, and has authored two textbooks "Statistical Physics of particles" and "Statistical Physics of Fields" which are considered among the best textbooks on the subject.

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