

Seminar

From Enhanced Long-Wavelength Fluctuations to Hamiltonian Models of Active Systems

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Active matter exhibits collective behaviour that challenges equilibrium descriptions of fluctuations and order. This talk explores enhanced long-wavelength fluctuations in active solids and develops Hamiltonian approaches connecting equilibrium and active dynamics. Numerical studies of crystals and glasses reveal activity-induced amplification of Mermin-Wagner-Hohenberg fluctuations, with scaling consistent with a shift of the lower critical dimension from two to three. Colloidal experiments establish logarithmic growth of the Debye-Waller factor with system size in passive two-dimensional solids and faster-than-logarithmic growth under activity. An anomalous displacement fluctuation and enhanced long-ranged interaction-stress correlations support enhanced occupation of low-frequency modes. These findings motivate Hamiltonian models as equilibrium references for active systems. We develop symplectic integration schemes and a Nosé-Poincaré thermostat for systems with spin-velocity coupling, enabling canonical sampling of models exhibiting flocking-like collective motion at equilibrium. Next, a Hamiltonian active Brownian particle model connects equilibrium dynamics to activity through translational and rotational heat baths. Comparisons with standard active Brownian particles establish conditions for quantitative agreement, while entropy-production analysis characterises energy dissipation. Finally, active Hamiltonian models also exhibit glassy dynamics and show enhanced long-wavelength fluctuations.

Monday, Oct 5th 2026

14:30 Hrs (Tea / Coffee 14:15 Hrs)

Auditorium, TIFRH