Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Active yielding and the connection to nuclear spatial organisation and cell state transitions

Yagyik Goswami

PSI, Switzerland

The collective behaviour and spatial organisation of out-of-equilibrium systems play a crucial role in a wide range of biological processes, including dynamical transitions in subcellular assemblies. Specifically, nuclear spatial organisation undergoes significant changes during cell-state transitions, which are key events underlying development, tissue maintenance and the onset of disease. Of particular interest in this regard, mechanically induced cellular de-differentiation is characterised by a change in dynamics from arrested states to randomised or fluidised states in nuclear spatial organisation. Here, altered confinement geometry appears to play a key role. These observed structural reorganisations may underpin changes in biological behaviour, motivating an investigation of dynamical states in dense assemblies of self-propelled active particles. We show that a fluidisation transition occurs in these actively driven assemblies and that it resembles the yielding transition in amorphous solids subjected to cyclic shear deformation. In particular, a detailed analogy holds at large but finite persistence times, in terms of a dependence on the initial state, the presence of driving induced annealing, a diverging timescale at the transition, and a discontinuous onset of the flowing state, consistent with recent suggestions. The geometry of confinement has a striking influence on the critical deformation at which the transition occurs, with evidence suggesting that differences in boundary curvature are key. I conclude with a brief discussion of ongoing efforts to better integrate experimental and bioinformatic data characterising cell populations, by considering more detailed model definitions, and by investigating signatures of state transitions in high-dimensional data.

Friday, Jun 27th 2025

14:00 Hrs (Tea / Coffee 13:45 Hrs)

Auditorium, TIFRH