MONDAY

COLLOQUIUM

Fascinating Dynamics and Mechanics of Active Crystals and Glasses

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26 Aug 2024 (Monday) | 16:00 Hrs (Tea / Coffee 15:45 Hrs) | Venue: TIFRH Auditorium

Active glasses are dense and disordered systems consisting of motile particles, capturing various phenomenology observed in many biological systems. Active glasses are assumed to be qualitatively similar to their equilibrium counterparts at a suitably defined effective temperature. We show that an active glass is qualitatively different from an equilibrium glassy system. Although the relaxation dynamics can be similar to an equilibrium system with an appropriate effective temperature, the effects of activity on the Dynamic Heterogeneity (DH), which has emerged as a cornerstone of glassy dynamics, is quite nontrivial and complex. In particular, active glasses show dramatic growth of DH, and systems with similar relaxation time can have widely varying DH. In particular, we demonstrate a dramatic growth of correlation length in these systems with increasing activity, which is very different compared to the passive glasses. I will touch upon a proposal to measure the strong growth of DH and its associated length scale in these systems using a rod-like probe particle. I will then discuss the effect of these active fluctuations in two-dimensional systems to show that Mermin-Wagner-like long wavelength fluctuations get enhanced due to active particles leading to faster than the logarithmic divergence of Debye-Waller factors with system size. I will also show logarithmic divergence in three-dimensional systems, indicating a possible change in the upper critical dimensions of these systems under active driving. Finally, with time permitting, I will show our recent results on the investigation of motility-driven annealing and fluidisation in these systems, offering new perspectives on cellular aging and maturation. Our study establishes a correspondence between the yielding behaviour of glassy systems under active dynamics and their yielding under oscillatory shear, revealing striking similarities between them. This suggests that some mechanical changes observed in ageing tissues may partially stem from processes analogous to enhanced ageing observed in active glasses. We also demonstrate that in active solids one can either suppress or promote brittle failure via shear band formation by tuning activity.

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