Glass transition in dense systems of self-propelled particles

Chandan Dasgupta

Department of Physics Indian Institute of Science

In several biological systems, such as bacterial cytoplasm, cytoskeleton-motor complexes and cell nuclei, self-propulsion or "activity" is found to fluidize a glass-like state that exhibits characteristic glassy features in the absence of activity. To develop a theoretical understanding of this activity-induced non-equilibrium glass transition, we have studied, using molecular dynamics and Brownian dynamics simulations, the effects of activity in two model glass forming liquids: the Kob-Andersen binary mixture in three dimensions and a two-dimensional system of two kinds of dumbbells. Activity is introduced by assuming that some of the particles in the system experience a random active force characterized by its magnitude and persistence time.

We find that the introduction of activity dramatically reduces the glass transition temperature and the glass transition disappears beyond a threshold value of the activity. Some of the effects of activity on the dynamics in the liquid state are determined by an "active temperature" that adds to the bath temperature. However, several properties of the "active" super cooled liquid, obtained as the
glass transition is approached by reducing the activity at a low temperature, are found to be qualitatively different from those of the "thermal" super cooled liquid obtained as the glass transition is approached by lowering the temperature at low activity. We present simple analytic arguments and a hydrodynamic theory which provide explanations of some of the features of the dynamics observed in our simulations.

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