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Webinar

Understanding the dynamics of glass-forming liquids with externally imposed disorders

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Existence and growth of amorphous order in supercooled liquids approaching glass transition is a subject of intense research. Even after decades of work, there is still no clear consensus on the molecular mechanisms that lead to rapid slowing down of dynamics while approaching this putative transition. Recently the Random pinning method is being used extensively to probe various aspects of Random First Order transition theory (RFOT) and growth of the static length scale. In this method, a fraction of particles are chosen randomly from their equilibrium positions and then pinned at these positions allowing the rest of the particles to evolve via natural dynamics. Using random pinning ideas in generic glass-forming liquids, we show the existence of another static length scale: the pinning length scale apart from the well studied ”point-to-set” static length scale. We estimated various exponents of RFOT using a relation between these two length scales. We also show that fragility of a liquid can be tuned using random pinning and is intimately related to the static length scale. By extending these ideas, we propose a new susceptibility, the pinning susceptibility, which directly captures the static length scale of the system unambiguously. This method is easy to implement in experimental glass-forming liquids, and one can estimate the length scale associated with the system. We have also studied relaxation processes in supercooled liquids and showed that short time β-relaxation is universally connected to the long time α-relaxation. Moreover, the β-relaxation process was found to be controlled by the dynamic heterogeneity length scale. We also proposed and estimated various other time-scales in supercooled liquids such as the onset of Fickian diffusion, the lifetime of dynamic heterogeneity apart from the well studied α and β timescales. We show that fragility of the liquids, as well as the nature of the Stokes-Einstein violation, will change if one uses these different timescales.

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