ICAMS Seminar

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Slowing down of transport in densely packed systems

Transport in a dense liquid slows down drastically as the packing becomes larger or the temperature is lowered. Then the structural relaxation is prolonged to longer and longer times scales until eventually a complete structural arrest sets in, known as the glass transition. Yet, smaller tracer particles may remain mobile and explore the frozen environment which often leads to anomalous transport.

In this presentation I will give a brief introduction to the most striking phenomena accompanying the glass transition and how some of them can be rationalized in terms of the mode-coupling theory of the glass transition (MCT). The quest for a hidden di vergent length scale connected to collectively rearanging entities has stimulated many groups to confine the liquid to micro- and nanoscale compartments and infer from the induced changes the magnitude of a characteristic length scale. We show that peculiar effects arise due to the structural changes and layering in the vicinity of the container which are predicted in the framework of an extended mode-coupling theory. In particu lar, we anticipate non-monotonic behavior of the phase boundary between liquid and glass states as the distance of the confining walls is varied.

In the second part of the presentation, I discuss that transport may persist even in the glass state if the constituent particles display a strong size disparity. Then the small particles can meander through a quasi-arrested matrix. The minimal theoretical model for such a phenemon is the Lorentz model, where a tracer explores an array of independently distributed hard obstacles. As the density of scatterers increases, the regions of excluded volume start to overlap until eventually long-range transport ceases to exist entirely. This localization transition is of purely geometric origin and coincides with the percolation of the void space. A series of power laws accompanies the transition which we study in detail by extensive computer simulations and rationalize by a dynamic scaling hypothesis.