Webinar

Role of Static and Dynamic Length Scales in Glass Transition

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One of the most sought after problems in condensed matter physics is that of the formation of glass from it's parental liquid state. Lots of effort have been made to understand whether the glass transition is a thermodynamical transition (controlled by structure) or a dynamical one. Even after very diligent work,it still remains a matter of debate. Recently growth of locally favoured structural (LFS) motifs or medium range crystalline order (MRCO) has been observed in various glass forming liquid with increasing supercooling. This raises the question of whether molecular mechanisms for the glass transition in liquids with and without LFS or MRCO are the same. To vaidate some of these ideas we have investigated the existence and growth of LFS ordering and its connection with rapid dynamical slow down in glass forming liquids, as well as the growth of static length scales. We show that the static and dynamic properties of glasses with MRCO are different from other glass forming liquids with no predominant local order. Along with this we also resolve an important issue regarding the so-called Point-to-set method for determining static length scales. We have also introduced a new statistical mechanics analysis method, termed as block analysis, an efficient method to obtain the static and dynamic length scales using finite-size scaling in generic glass-forming liquids. This method is experimentally viable and can be used to study glass transition in colloidal systems. Equipped with some of these new techniques, we studied the structure of dynamical heterogeneity from the spatial correlation between displacement fields of particles at the short time scale (β time scale) and the survival of these dynamical heterogeneities at timescales that are much larger than typically studied long timescales (the α-relaxation time) in the problem for various generic glass-forming systems. We have found that the temperature dependence of the heterogeneity length scale remains same through out these timescales ranging from β-relaxation time to few times larger than α-relaxation time, but the region of heterogeneity or spatial extent of heterogeneity changes with time in a non-monotonic way with its maximum at or near the α timescale.

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