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Length scale of dynamic heterogeneity and its relation to time scales in a glass-forming liquid[1]

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The role of the length scale of dynamic heterogeneity in the enormous increase in the relaxation times of glass-forming liquids upon supercooling has received much attention recently. Using molecular dynamics simulations and finite-size scaling for a realistic glass-forming liquid, we establish that the growth of dynamic heterogeneity with decreasing temperature is governed by a growing dynamic length scale. We also perform a computational study of a four-point structure factor, defined from spatial correlations of mobility, for the same liquid and show that estimates of the dynamic correlation length and susceptibility obtained from this study are consistent with the results of the finite-size scaling analysis. However, the observed dependence of the simultaneously growing time scale of the long-time α-relaxation on system size does not exhibit the same scaling behavior as the dynamic heterogeneity: this time scale is instead determined, for all studied system sizes and temperatures, by the configurational entropy, in accordance with the Adam-Gibbs relation. We also investigate the dependence of the time scale of the short-time β-relaxation on temperature and system size. A finite-size scaling analysis of this dependence reveals the existence of a length scale that grows as the temperature is reduced. Surprisingly, the temperature dependence of this length scale is found to be identical to that of the length scale that governs the growth of dynamic heterogeneity at the α-relaxation time scale. This result suggests a close connection between short-time dynamics and dynamic heterogeneity at time scales of the order of the α-relaxation time.

[1]This talk is based on work done in collaboration with S. Karmakar, S. Sastry and S. Sengupta.