Relaxation dynamics in classical and quantum supercooled liquids

Gopika Krishnan, Upendra Harbola
Indian Institute Of Science, Bangalore, Bangalore, India

Supercooled state of a liquid is characterized by extremely slow and spatially heterogeneous dynamics. Being a low temperature phenomenon, the properties of supercooled liquids are expected to be affected significantly by quantum fluctuations, atleast for light molecules [1,2,3]. Quantum liquids show high degree of dynamic heterogeneity at short times, which is weakly dependent on the degree of quantumness as quantified in terms of the thermal de-Broglie wavelength associated with a particle. This is in contrast to the classical case, where the dynamic heterogeneity is zero for short times. These non-classical features arise due to the initial uncertainty in the quantum particle's position [4,5]. The dynamic heterogeneity in the intermediate time scales arises from the caging of particles by the neighbors, and the subsequent slowdown of dynamics. We compare the static and dynamic properties of cages in the classical [6] and the quantum supercooled liquids. The cage size fluctuations decrease with decreasing temperature in the classical case. A similar effect is seen in the quantum case with increasing quantumness in the moderate quantum regime.

References

[1] V.N. Novikov, A.P. Sokolov, Phys. Rev. Lett. 110, 065701 (2013).
[2] V.N. Novikov, A.P. Sokolov, Eur. Phys. J. E, 40, 1 (2017).
[3] T.E. Markland, J.A. Morrone, B.J. Berne, K. Miyazaki, E. Rabani, D.R. Reichman, Nature Phys., 7, 1 (2011).
[4] A. Das, G. Krishnan, E. Rabani, U. Harbola, Phys. Rev. E,105, 054136 (2022).
[5] G. Krishnan, U. Harbola, Phys. Rev. E 106, 064604 (2022).
[6] G. Krishnan, U. Harbola, Int. J. Mod. Phys. B, 2250065 (2022).