Probing the non-Debye low-frequency excitations in glasses through fast quenching and random pinning

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It has been recently observed in numerical simulations that although they dominate the low-frequency spectrum, phonons are not the only low-energy excitations in glassy systems.

We show that, as temperature T decreases towards the dynamical crossover T_d, the low-energy spectrum is progressively populated by quasi-localized soft-modes whose density of states $D(\omega)$ follows a power law $\sim \omega^{s(T)}$ with $2 \leq s(T) \leq 4$. Considering the growing of s from Debye, i. e., $s = 2$, to non-Debye obtained by frozen randomly a fraction p of particles, we suggest that non-Debye sector results to be magnified by approaching the dynamical transition because of the presence of dynamical heterogeneous regions of linear size ξ.

Finally, we make an estimate of ξ s a function of T comparing the spectrum as temperature decreases with the spectrum as a function of p. Our result is compatible with a power law $\xi \sim (T - T_d)^{-\alpha}$ approaching T_d.