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Excitations are localized and relaxation is hierarchical in glass-forming liquids AARON KEYS, LESTER HEDGES, Lawrence Berkeley National Laboratory, JUAN GARRAHAN, University of Nottingham, SHARON GLOTZER, University of Michigan, DAVID CHANDLER, University of California, Berkeley
— For several atomistic models of glass formers, at conditions below their glassy dynamics onset temperatures, $T_{\rm o}$, we use importance sampling of trajectory space to study the structure, statistics and dynamics of excitations responsible for structural relaxation. Excitations are detected in terms of persistent particle displacements of length a. At supercooled conditions, for a of the order of or smaller than a particle diameter, we find that excitations are associated with correlated particle motions that are sparse and localized, occupying a volume with an average radius that is temperature independent and no larger than a few particle diameters. We show that the statistics and dynamics of these excitations are facilitated and hierarchical. Excitation energy scales grow logarithmically with a. Excitations at one point in space facilitate the birth and death of excitations at neighboring locations, and space-time excitation structures are microcosms of heterogeneous dynamics at larger scales. This nature of dynamics becomes increasingly dominant as temperature T is lowered. We show that slowing of dynamics upon decreasing temperature below $T_{\rm o}$ is the result of a decreasing concentration of excitations and concomitant growing hierarchical leng

Aaron Keys
Lawrence Berkeley National Laboratory

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