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Space-time phase transitions in models of glasses

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Glass forming systems have a much richer dynamical phase structure than their thermodynamics would suggest. I will show how to explore this by means of large-deviation methods. In particular, I will demonstrate the existence of space-time phase transitions in kinetically constrained models of glasses. Similar space-time transitions seem to be present in atomistic models of supercooled liquids. In contrast to equilibrium phase transitions, which occur in configuration space, these transitions occurs in trajectory space, and are controlled by variables that drive the system out of equilibrium. Glass formers appear to live at, or close to, first-order coexistence between two distinct dynamical phases: an active and equilibrium phase, and an inactive and non-equilibrium one. This space-time coexistence helps explain observed fluctuation effects such as dynamic heterogeneity and transport decoupling. The connection of the glass transition to a true order-disorder dynamical transition offers the possibility of a unified picture of glassy phenomena.