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Criticality in Dynamic Arrest: Correspondence between Glasses and Traffic

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Dynamic arrest is a general phenomenon across a wide range of dynamic systems including glasses, traffic flow, and dynamics in cells, but the universality of dynamic arrest phenomena remains unclear. We connect the emergence of traffic jams in a simple traffic flow model directly to the dynamic slowing down in kinetically constrained models for glasses. In kinetically constrained models, the formation of glass becomes a true (singular) phase transition in the limit $T \rightarrow 0$. Similarly, using the Nagel-Schreckenberg model to simulate traffic flow, we show that the emergence of jammed traffic acquires the signature of a sharp transition in the deterministic limit $p \rightarrow 1$, corresponding to overcautious driving. We identify a true dynamic critical point marking the onset of coexistence between free flowing and jammed traffic, and demonstrate its analogy to the kinetically constrained glass models. We find diverging correlations analogous to those at a critical point of thermodynamic phase transitions.

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