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Linking Equilibrium and Nonequilibrium Dynamics in Glass-Forming Systems

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Understanding nonequilibrium glassy dynamics is of great scientific and technological importance. However, prediction of the temperature, thermal history, and composition dependence of nonequilibrium viscosity is challenging due to the noncrystalline and nonergodic nature of the glassy state. Here, we show that the nonequilibrium glassy dynamics are intimately connected with the equilibrium liquid dynamics. This is accomplished by deriving a new functional form for the thermal history dependence of nonequilibrium viscosity, which is validated against experimental measurements of industrial silicate glasses and computed viscosities for selenium over a wide range of conditions. Since the temperature and composition dependence of liquid viscosity can be predicted using temperature-dependent constraint theory, our work also opens the possibility to improve understanding of the physics of nonequilibrium viscosity.