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Microscopic Approach for the Friction on a Spherical Particle in Dense Liquids: Hydrodynamics and Beyond UMI YAMAMOTO, KENNETH SCHWEIZER, University of Illinois, Urbana-Champaign — We propose a new microscopic, non-mode-coupling, statistical dynamical approach to deriving the Stokes-Einstein (SE) friction coefficient of a large spherical particle dissolved in a dense fluid. The real space method is based on including as a slow variable the force exerted on a particle by the surrounding fluid. By exploiting the appropriate separation of time and length scales, and the Kirkwood superposition approximation for multi-point correlations, the SE result is obtained including the slip and stick limits plus the crossover function. This advance provides the foundation for developing a unified theory of friction for nanoparticles that includes both hydrodynamics and the non-hydrodynamic contribution associated with material-specific particle-fluid and particle-particle forces. Applications to nanoparticles in unentangled and entangled polymer solutions and melts, under various interfacial polymer-particle structure conditions, will be reported. Questions of particular interest include how the non-hydrodynamic friction contribution scales with particle radius, the role of length-scale-dependent viscosity in polymer liquids, and the conditions required for crossover to the hydrodynamics-dominated regime.

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