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Noncontinuum Effects in Dynamics of Nanoparticles in Polymer Matrices GANESAN VENKATRAGHAVAN, VICTOR PRYAMITSYN, The University of Texas at Austin — The dynamics and rheology of particulate suspensions have long been well-understood in a continuum fluid-mechanical framework dating back to Stokes and Einstein. These theories predict that the mobility of the particles decreases with an increase in the viscosity of the fluid and that the addition of particles increases the overall viscosity of the suspension. However, in many recent applications such as polymer-nanoparticle composites, the particle size is comparable to or smaller than the structural scale of the solvent and the dynamics exhibits many "non-continuum" effects, such as the mobility becoming independent of the molecular weight (and viscosity) of the polymer, a decrease in the suspension viscosity due to the addition of nanoparticles etc. Here we propose a new theoretical formulation for the dynamics of particulate suspensions, which within a single framework encompasses for the first time both the "macroparticle" limit of particles larger than the structural scale of solvent and the "nanoparticle" limit where the particles are smaller than such scales. We present theoretical predictions for the case of polymer-nanoparticle suspensions which quantitatively explain the preceding observations and also delineates the size scales at which the particles cross-over from behaving dynamically as a "particle suspension in polymers" to a "solvent for the polymers."

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