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Structure and Stability of Colloid-Nanoparticle Mixtures[1]
BRADEN M. WEIGHT, ALAN R. DENTON, Department of Physics, North Dakota State University — Colloidal particles can acquire charge through dissociation of counterions in a polar solvent. The resulting electrostatic interactions between particles stabilize the suspension against aggregation due to van der Waals forces and can affect physical properties. We explore the influence of added nanoparticles on structure and phase behavior of charge-stabilized colloidal suspensions. To reduce complexity, we model electrostatic interparticle interactions via effective Yukawa (screened-Coulomb) pair potentials, which implicitly include counterions and salt ions in the Debye screening constant. Within this coarse-grained model, we perform molecular dynamics simulations of mixtures of charged colloids and nanoparticles. Over ranges of parameters (charges, sizes, and concentrations of the two species), we analyze particle configurations to compute radial distribution functions and static structure factors. These structural properties reveal that nanoparticles tend to weaken correlations between colloids, thus destabilizing colloidal crystals. We further show that nanoparticles may be implicitly incorporated into an effective colloid-colloid pair potential to facilitate modeling of complex multicomponent systems and to guide experiments and applications to nanocomposite materials.

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