Entropic Wetting, Many-Body Induced Layering, and Capillary Condensation and Freezing of Colloid-Polymer Mixtures

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We develop an efficient simulation scheme to study a model suspension of colloidal hard spheres and nonadsorbing polymer coils, both in bulk and in external fields. The many-body character of the polymer-mediated effective interactions between the colloids yields a bulk phase diagram and adsorption phenomena that differ substantially from those found for pairwise simple fluids; e.g. we find an anomalously large bulk liquid regime and, far from the bulk triple point, three layering transitions in the partial wetting regime prior to a transition to complete wetting by colloidal liquid. We also investigate the fluid-fluid and fluid-solid demixing transition of a colloid-polymer mixture confined between two smooth planar hard walls using density functional theory and computer simulations. Our results predict capillary condensation and freezing of the colloid liquid phase, which should be experimentally observable. Finally, we also study colloid-polymer mixtures in a gravity field.