New insights into confinement-induced like-charge colloidal attractions and other colloidal anomalies

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Similarly charged colloidal spheres dispersed in water repel each other with a screened-Coulomb potential. Confining such spheres by charged glass surfaces appears to change this behavior, introducing a long-ranged attractive component into the pair potential that cannot be explained by mean-field theory, and has yet to be seen in simulations. Given the difficulty of explaining this anomalous behavior in terms of macroionic electrodynamics, alternative explanations have been proposed, including the possibility of nonequilibrium hydrodynamic coupling, uncorrected many-body effects, and subtle statistical artifacts. We report new colloidal interaction measurements based on the equilibrium configurations of geometrically confined monolayers that exploit the recently-introduced notion of configurational temperatures to achieve thermodynamically self-consistent results. These measurements confirm that anomalous attractions constitute pair-wise additive contributions to the equilibrium free energy. Using these techniques, we also explore the effects of sphere composition and surface properties on confined spheres' interactions. These measurements reveal that confinement-induced attractions may be more general than previously supposed, and cast new light on their possible origins.