Test of the Universal Scaling Law of Diffusion in Colloidal Monolayers

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Using the techniques of optical microscopy and particle tracking, we measure the pair correlation function and Brownian diffusion in monolayers of strongly interacting colloidal particles suspended at or near three different interfaces and test the universal scaling law of the normalized diffusion coefficient, $\widetilde{D} \cong e^{a\Delta S}$, as a function of the excess entropy ΔS for a wide range of particle concentrations. It is found that the universal scaling law with $\alpha=1$ holds well for highly charged polystyrene spheres suspended at an air-water interface, where the strong electrostatic interactions play a dominant role. For monolayer suspensions of hard-sphere-like particles, where hydrodynamic interactions become important, deviations from the universal scaling law are observed. The experiment indicates that the hydrodynamic corrections could be incorporated into the universal scaling law of diffusion with an exponent $\alpha<1$.

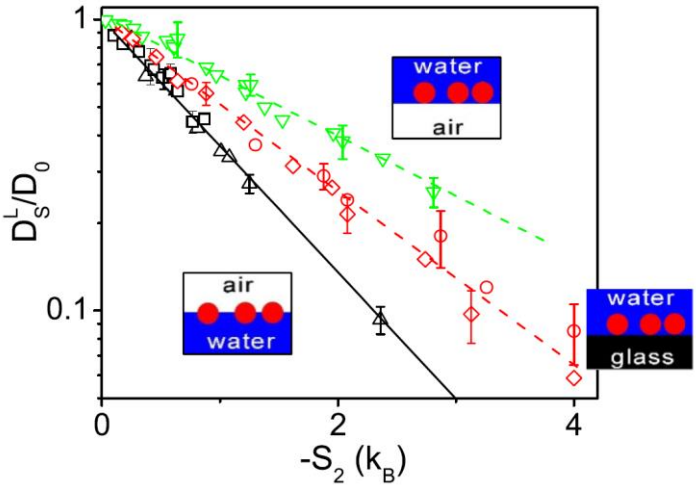

Figure 1. Scaled diffusivity as a function of the excess entropy at/near different interfaces: (black triangles) at air-water interface; (red circle/diamond) near water-glass interface, (green inverted triangle) near water-air interface.