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Non-equilibrium Stokes-Einstein relation via active microrheology of hydrodynamically interacting suspensions HENRY CHU, ROSEANNA ZIA, Cornell University — In our recently developed non-equilibrium Stokes-Einstein relation, we showed that, in the absence of hydrodynamic interactions, the stress in a suspension is given by a balance between fluctuation and dissipation. Here, we generalize our theory for systems of hydrodynamically interacting colloids, via active microrheology, where motion of a Brownian probe through the medium reveals rheological properties. The strength of probe forcing compared to the entropic restoring force defines a Peclet number, Pe. In the absence of hydrodynamics, the first normal stress difference and the osmotic pressure scale as Pe^4 and Pe^2 respectively when probe forcing is weak, and uniformly as Pe for strong probe forcing. As hydrodynamics become important, interparticle forces give way to lubrication interactions. Hydrodynamic coupling leads to a new low-Pe scaling of the first normal stress difference and the osmotic pressure as Pe^2, and high-Pe scaling as Pe^δ, where $0.799 \leq \delta \leq 1$ as hydrodynamics vary from strong to weak. For the entire range of the strength of hydrodynamic interactions and probe forcing, the new phenomenological theory is shown to agree with standard micromechanical definitions of the stress. We further draw a connection between the stress and the energy storage in a suspension, and the entropic nature of such storage is identified.

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