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Non-continuum tangential resistivity functions for two spheres suspended in a gas[1] MELANIE LI SING HOW, DONALD L. KOCH, LANCE R. COLLINS, Cornell University — In the limit of absence of gas-phase inertia, the motion of two spheres is described by the Stokes equation for large separations and by the linearized Boltzmann equation for separations comparable with the mean-free path of the gas. The forces and torques the gas exerts on each sphere are described by five resistivity functions (Jeffrey & Onishi, J. Fluid Mech. 139: 261-290 1984). The resistivity functions undergo a transition as the separation distance between the spheres approaches the mean free path of the gas. In particular, the divergences of the Stokes resistivity functions as the spheres approach contact are reduced by non-continuum effects. We present modified tangential resistivity functions that are uniformly valid through this transition (i.e., from the continuum limit at distant separations to separations where the lubrication flow near contact is a free molecular flow). We apply the modified resistivity functions to two illuminating cases: (i) a sphere falling in close proximity to a vertical wall; and (ii) two spheres settling under gravity. The results show qualitative differences from the classical Stokes flow solution and are applied to the study of coalescing cloud droplets settling under gravity.

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