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Stress modeling in colloidal dispersions undergoing non-viscometric flows BENJAMIN DOLATA, Cornell University, ROSEANNA ZIA, Stanford University — We present a theoretical study of the stress tensor for a colloidal dispersion undergoing non-viscometric flow. In such flows, the non-homogeneous suspension stress depends on not only the local average total stresslet—the sum of symmetric first moments of both the hydrodynamic traction and the interparticle force—but also on the average quadrupole, octupole, and higher-order moments. To compute the average moments, we formulate a six dimensional Smoluchowski equation governing the microstructural evolution of a suspension in an arbitrary fluid velocity field. Under the conditions of rheologically slow flow, where the Brownian relaxation of the particles is much faster than the spatiotemporal evolution of the flow, the Smoluchowski equation permits asymptotic solution, revealing a suspension stress that follows a second-order fluid constitutive model. We obtain a reciprocal theorem and utilize it to show that all constitutive parameters of the second-order fluid model may be obtained from two simpler linear-response problems: a suspension undergoing simple shear and a suspension undergoing isotropic expansion. The consequences of relaxing the assumption of rheologically slow flow, including the appearance of memory and microcontinuum behaviors, are discussed.

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