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The dilute rheology of swimming suspensions: A simple kinetic model DAVID SAINTILLAN, MechSE, University of Illinois at Urbana-Champaign — A simple kinetic model is presented for the shear rheology of a dilute suspension of particles swimming at low Reynolds number. If interparticle hydrodynamic interactions are neglected, the configuration of the suspension is characterized by the particle orientation distribution, which satisfies a Fokker-Planck equation including the effects of the external shear flow, rotary diffusion, and particle tumbling. The orientation distribution then determines the leading-order term in the particle extra stress in the suspension, which can be evaluated based on the classic theory of Hinch and Leal [J. Fluid. Mech. 52(4):683-712 (1972)], and involves an additional contribution arising from the permanent force dipole exerted by the particles as they propel themselves through the fluid. Numerical solutions of the steady-state Fokker-Planck equation were obtained using a spectral method, and results are reported for the shear viscosity and normal stress differences in terms of flow strength, rotary diffusivity, and correlation time for tumbling. It is found that the rheology is characterized by much stronger normal stress differences than for passive suspensions, and that tail-actuated swimmers result in a strong decrease in the effective shear viscosity of the fluid.

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