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Rotation of porous ellipsoids in simple shear flows[1] HASSAN MASOUD, Courant Institute of Mathematical Sciences, NYU and Department of Mechanical and Aerospace Engineering, Princeton University, HOWARD A. STONE, Department of Mechanical and Aerospace Engineering, Princeton University, MICHAEL J. SHELLEY, Courant Institute of Mathematical Sciences, NYU
— We study theoretically the dynamics of porous ellipsoids rotating in simple shear flows. We use the Brinkman-Debye-Bueche (BDB) model to simulate flow within and through particles and solve the coupled Stokes-BDB equations to calculate the overall flow field and the rotation rate of porous ellipsoids. Our results show that the permeability has little effect on the rotational behavior of particles, and that the Jeffery's prediction of the angular velocity of impermeable ellipsoids in simple shear flows remains an excellent approximation, if not an exact one, for porous ellipsoids. We also examine the orientational diffusion of permeable ellipses and spheroids in the absence of a background flow. Employing an appropriate scaling, we present approximate expressions for the orientational diffusion of ellipses and spheroids. Our findings can serve as basis for developing a suspension theory for non-spherical porous particles.

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