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Theoretical predictions of the orientation distribution of high-aspect-ratio, inertial particles settling in isotropic turbulence[1]
UDAYSHANKAR MENON, Cornell University, ANUBHAB ROY, Indian Institute of Technology, Madras, STEFAN KRAMEL, GREG VOTH, Wesleyan University, DONALD KOCH, Cornell University, VOTH LAB COLLABORATION — When anisotropic particles settle in isotropic turbulence, the inertial torque due to their settling favors broadside alignment while turbulence favors orientational dispersion. This process leads, for example, to the anisotropic scattering of electromagnetic radiation in icy clouds due to the orientation distribution of ice crystals which can have needle-like or disk-like shapes. We study two types of particles amenable to the use of slender-body theory (Batchelor 1970, Khayat and Cox 1989): fibers and planar triads consisting of three connected rods. For particles smaller than the Kolmogorov scale, the effect of turbulence can be described in terms of a temporally fluctuating local linear flow field following the motion of the particle. When the settling velocity is small compared with the Kolmogorov velocity, the particle samples the fluid velocity gradients along a Lagrangian path and our simulations employ the stochastic velocity gradient model of Girimaji and Pope (1990). When the settling velocity is large compared with the Kolmogorov velocity, the large inertial torque causes the particle to achieve a quasi-steady orientation with respect to the local velocity gradient allowing analytical predictions of the small orientational dispersion away from the preferred horizontal alignment. Supported by Army Research Office grant W911NF1510205

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