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Relative motion between rigid fibers and fluid in turbulent channel flow[1] CRISTIAN MARCHIOLI, ALFREDO SOLDATI, University of Udine
— We examine how rigid fibers with different length and inertia translate and rotate relative to the surrounding fluid in presence of non-linear mean shear and flow anisotropy. Two observables will be investigated: the fiber-to-fluid translational velocity (slip velocity) and angular velocity (slip spin). Slip velocity and slip spin statistics are extracted from DNS of turbulence at $Re_\tau = 150$ coupled with Lagrangian tracking of prolate ellipsoids with Stokes number $1 < St < 100$, and aspect ratio $1 < \lambda < 50$. We find that elongation has quantitative effects on the statistics, particularly for fibers with small St. As St increases, differences due to the aspect ration vanish and the relative motion is controlled by fiber inertia through preferential concentration. Inertial effects show up in the different distribution of slip velocities observed when fibers are trapped in sweeps/ejections or segregated in near-wall fluid streaks. The corresponding conditional PDFs are found to be non-Gaussian, suggesting that relative motions cannot be modeled as a standard diffusion process at steady state. This is evident in the strong shear region, where fiber anisotropy adds to flow anisotropy to induce strong deviations on fiber dynamics with respect to spherical particles.

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