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Optical characterization of fibers suspensions in turbulent pipe flow

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Suspensions of elongated rigid fibers in turbulent flows are commonly encountered in applications of engineering interest, and may exhibit complicated rheological properties depending on the spatial distribution and orientation of the fibers. Despite the practical importance of fiber suspensions there is insufficient experimental data to validate numerical simulations and provide benchmarks. This paper presents an image analysis algorithm used to calculate orientation and distribution of fibers suspended in turbulent pipe flow. The algorithm is validated using artificial images. These images represent three-dimensional randomly orientated ellipsoids illuminated by a laser sheet and projected onto a two-dimensional plane. The error magnitude on the orientation distribution and number density is found by means of Monte Carlo simulations. Experiments are carried out considering small control volume near the pipewall. Results indicate that fibers exhibit preferred spatial orientation close to the pipewall and more randomized orientation close to the centerline, in qualitative agreement with the available numerical simulations.

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