Alignment of inertial fibers in turbulence and two-way coupling effects

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Rigid fibers can be used as a proxy to measure velocity difference statistics of turbulence at the scale of the fiber length[1]. A requirement is that the fibers sample the flow homogeneously, i.e. they do not accumulate within specific flow regions or preferentially align with the flow, which was verified by Brizzolara et al. (2021). Some studies have shown preferential alignments between fibers and vorticity and strain rate[2][3]. These alignments are pronounced for fibers that do not react back to the flow[2][3], while they seem to weaken for fibers with back reaction[1][4].
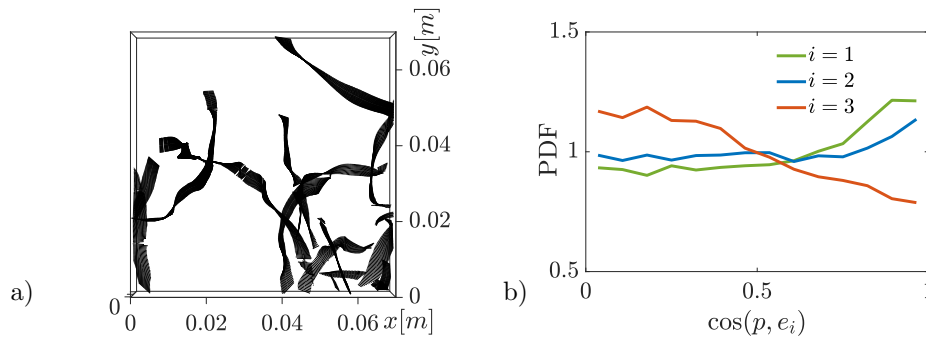

Figure 1: (a) Fibers tumbling in turbulent flow tracked with MyFTV. (b) PDFs of the alignments between fiber orientations $\boldsymbol{p}$ and strain eigenvectors $\boldsymbol{e}_i$.

Leveraging the approach of Brizzolara et al. (2021), in this work we investigate the dynamics of fibers in turbulence by simultaneously tracking the motion of flow tracers and rods using two 3-D particle tracking velocimetry systems (Figure 1). Our results show how the fiber back-reaction actively modifies the surrounding flow and weakens the alignments.

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[1]Brizzolara et al. *Phys. Rev. X.* **11.3**, (2021).

[2]Ni et al, *J. Fluid Mech.* **766**, (2015).

[3]Pujara et al, *J. Fluid Mech.* **860**, (2019).

[4]Olivieri et al, *J. Fluid Mech.* **946**, (2022).