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Passive Scalar Dispersion in Uniformly Sheared Turbulence

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The dispersion of a plume of dye from a continuous point source is investigated experimentally in uniformly sheared, nearly homogeneous, turbulent flow generated in a water tunnel. The flow has a turbulence Reynolds number of $Re_\lambda \approx 150$ and a shear rate parameter of $S^* \approx 12$. Neutrally buoyant fluorescent dye (fluorescein and/or rhodamine B/6G) is injected isokinetically from a streamlined injection tube into the developed turbulent flow. Instantaneous concentration and velocity fields of the plume are measured simultaneously using planar laser induced fluorescence (PLIF) and particle image velocimetry (PIV). Joint statistics of the concentration and velocity fields are measured and compared to predictions of theoretical models of both absolute and relative (two-particle) dispersion. The contribution to scalar transport by horseshoe vortices, shown earlier to be the dominant coherent structures of uniformly sheared turbulence, is determined by analysis of coincident instantaneous maps of concentration and velocity.

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