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Rise Velocity of Bubbles in Turbulence[1] DANIEL RUTH, MARLONE VERNET, LUC DEIKE, Princeton University — Turbulence in the liquid phase impacts the mean rate at which bubbles rise or heavy particles sink through the fluid, with practical relevance in environmental and industrial processes in which bubbles mediate mass transfer between liquid and gaseous phases. With a turbulent water flow generated in the laboratory, we show that air bubbles significantly smaller than the integral length scale of the turbulence experience a reduction in mean rise speed $\langle v_z \rangle$ by an amount approximately equal to the scale of the turbulent fluctuations u' (that is, $\langle v_z \rangle \approx v_{\mathrm{q-u'}}$, where v_{q} is the bubble rise speed in a quiescent environment), when the dimensionless intensity of the turbulence $\beta = u'/v_{\mathrm{q}}$ is less than 1. Our experiment employs planar particle image velocimetry to characterize the turbulence throughout the measurement volume and a two-camera stereo vision system to track bubbles in three dimensions. We then utilize the homogeneous, isotropic turbulence simulation from the Johns Hopkins Turbulence Database to integrate the Maxey-Riley equation for a point-bubble in a carrier flow, revealing the mechanisms responsible for the turbulence's reduction of the bubbles' rise velocity.

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