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Measurements of inertial range scaling in rotations of rigid particles in turbulence[1] GREG VOTH, BRENDAN COLE, STEFAN KRAMEL, Wesleyan University — We measure the rotation rate of 3D-printed particles with sizes spanning the inertial range in a turbulent flow between oscillating grids. Tetrads, composed of four slender rods in tetrahedral symmetry, and triads, three slender rods in triangular planar symmetry, are tracked in a flow with $R_\lambda = 156$ and $R_\lambda = 214$ using four high-speed cameras. Tetrads rotate like spheres and triads rotate like disks. Measurements of tetrads' solid body rotation rates as a function of particle size are direct measurements of the coarse-grained vorticity and provide a new way to measure inertial range scaling in turbulent flows. We observe Kolmogorov scaling for the mean square solid body rotation rate of tetrads, $\langle \Omega^2 \rangle \propto r^{-4/3}$, extending earlier work on rods by Parsa and Voth (PRL 2014) to particles that do not experience preferential orientation. The theory is extended to higher moments and intermittent scaling, but experiments do not yet resolve intermittency corrections. For triads, the solid-body rotation rate is preferentially aligned with the particle orientation, and we find that the preferential alignment of these large planar particles is quite different than was previously observed for small tracer disks.

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Greg Voth
Wesleyan Univ

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