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Simultaneous measurements of velocity gradients and tumbling motion of rods in 3D turbulence[1] STEFAN KRAMEL, GREG VOTH, Wesleyan University, RUI NI, NICHOLAS OUELLETTE, Yale University — The tumbling motion of anisotropic particles, advected in a fluid flow, is governed by the velocity gradient tensor. We have simultaneously measured the orientation of neutrally buoyant, rod-shaped particles and the velocity gradient tensor surrounding them in a 3D turbulent flow. We have built a scanning particle tracking velocimetry (SPTV) system, in which we illuminate a narrow slab of the detection volume and scan the illuminated slab through the entire detection volume, taking sequential images with four stereoscopic high speed cameras. The advantage of this technique over other PTV systems is that it enables us to increase the tracer particle concentration, because it removes many stereo-matching ambiguities, resulting in a high spatial resolution of the fluid velocity field. A trade-off is the decrease in temporal resolution. Our measurements of the tumbling rate of rods is in good agreement with Jeffery's equation, and this provides a good way to quantify the accuracy of the velocity gradient measurements. Reconstructed individual rod trajectories show the complex way that alignment with the vorticity and eigenvectors of the strain-rate tensor affect the tumbling rate.

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