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Capturing velocity gradients and particle rotation rates in turbulence LEONHARD LEPPIN, MICHAEL WILCZEK, Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — Turbulent fluid flows exhibit a complex small-scale structure with frequently occurring extreme velocity gradients. Particles probing such swirling and straining regions respond with an intricate, shape-dependent orientational dynamics, which sensitively depends on the particle history. In this contribution, we systematically develop a reduced-order model for the small-scale dynamics of turbulence, which captures the velocity gradient statistics along particle paths. The analysis of the resulting stochastic dynamical system allows us to identify the emergence of non-Gaussian statistics and non-trivial temporal correlations of vorticity and strain, as previously reported from experiments and simulations. Based on these insights, we use our model to compute the orientational statistics of anisotropic particles in turbulence, enabling modeling applications for complex particulate flows.

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