Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Impact of large-scale flow states on small-scale 3D turbulence[1]
CRISTIAN C LALESCU, MICHAEL WILCZEK, Max Planck Institute for Dynamics and Self-Organization, Goettingen — Turbulent flows often feature an intricate interplay between anisotropic, even quasi-two-dimensional, large-scale features and three-dimensional small-scale fluctuations. To systematically study the relation between large-scale flow structures and small-scale turbulence, we investigate a conceptually simple shear flow – a generalized turbulent Kolmogorov flow. The flow is forced with a single shear mode and is subject to large-scale friction, which effectively allows to control transitions between different large-scale states. We present a detailed investigation of the energetics of the system, and we find that the excitation of three-dimensional small-scale turbulence provides a dissipation channel for the large scales in the sense of classical eddy viscosity. We show that the energy transfer rate depends on the large-scale flow state, which establishes a direct coupling between the large scales and smaller-scale flow features such as small-scale intermittency.

[1]This work was supported by the Max Planck Society

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Date submitted: 01 Aug 2019 Electronic form version 1.4