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Geometry and Scaling Laws of Excursion and Iso-sets of Enstrophy and Dissipation in Isotropic Turbulence[1] JOSE HUGO ELSAS, Department of Mechanical Engineering, Johns Hopkins University; Instituto de Fisica, Universidade Federal do Rio de Janeiro, ALEXANDER SZALAY, Department of Physics and Astronomy and Department of Computer Science, Johns Hopkins University, CHARLES MENEVEAU, Department of Mechanical Engineering, Johns Hopkins University — We examine the spatial structure of sets with varying small-scale activity levels. These sets are defined using indicator functions on excursion and iso-value sets, and their geometric scaling properties are analyzed by examining possible power-law decay of their radial correlation function. We apply the analysis to enstrophy, dissipation, and velocity gradient invariants Q and R and their joint spatial distibutions, using data from a DNS of isotropic turbulence at $\mathrm{Re}_\lambda \approx 430$. Such power-law scaling in the inertial range is found in the radial correlation functions. Thus a geometric characterization in terms of these sets' correlation dimension is possible. Strong dependence on the threshold is found, consistent with multifractal behavior. Nevertheless the lack of scaling of the box-counting analysis precludes direct quantitative comparisons with earlier work based on the multifractal formalism. Surprising trends, such as a lower correlation dimension for strong dissipation events compared to strong enstrophy events, are observed and interpreted in terms of spatial coherence of vortices in the flow. We show that sets defined by joint conditions on strain and enstrophy, and on Q and R, also display power law scaling behavior.

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