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Joint Statistics of Finite Time Lyapunov Exponents in Isotropic Turbulence[1] PERRY JOHNSON, CHARLES MENEVEAU, Johns Hopkins University — Recently, the notion of Lagrangian Coherent Structures (LCS) has gained attention as a tool for qualitative visualization of flow features. LCS visualize repelling and attracting manifolds marked by local ridges in the field of maximal and minimal finite-time Lyapunov exponents (FTLE), respectively. To provide a quantitative characterization of FTLEs, the statistical theory of large deviations can be used based on the so-called Cramér function. To obtain the Cramér function from data, we use both the method based on measuring moments and measuring histograms (with finite-size correction). We generalize the formalism to characterize the joint distributions of the two independent FTLEs in 3D. The "joint Cramér function of turbulence" is measured from the Johns Hopkins Turbulence Databases (JHTDB) isotropic simulation at $Re_\lambda = 433$ and results are compared with those computed using only the symmetric part of the velocity gradient tensor, as well as with those of instantaneous strain-rate eigenvalues. We also extend the large-deviation theory to study the statistics of the ratio of FTLEs. When using only the strain contribution of the velocity gradient, the maximal FTLE nearly doubles in magnitude and the most likely ratio of FTLEs changes from 4:1:-5 to 8:3:-11, highlighting the role of rotation in de-correlating the fluid deformations along particle paths.

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