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Objective detection of Lagrangian vortices in two-dimensional turbulence

Using the recent geodesic theory of transport barriers, we show how all inhibitors of material transport can be uncovered in a direct numerical simulation of forced two-dimensional turbulence. Specifically, we identify hyperbolic barriers (generalized stable and unstable manifolds) and elliptic barriers (generalized KAM tori) as parametrized curves closely shadowed by geodesics of the Cauchy–Green strain tensor. Notably, elliptic barriers provide optimal and frame-independent boundaries for coherent vortices, demarcating regular islands in a chaotic background flow stirred by hyperbolic barriers. By contrast, Eulerian vortical features with no elliptic barriers show intense filamentation and ultimate disintegration.