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Material barriers to the transport of momentum and vorticity[1]

GEORGE HALLER, ETH Zurich — Recent work has identified objective (frame-indifferent) material barriers that are the least impermeable to the diffusion of passive scalars in turbulent flows. Here we discuss the extension of these results to identify material barriers to the transport of active quantities, such as vorticity and momentum, in three-dimensional unsteady flows. Challenges in such an extension include the vectorial nature of these active quantities, as well as their dependence on the frame of reference. With these challenges addressed, we obtain a general algorithm for locating objective material barriers to active transport, which form a dynamical skeleton around possible pathways in the flow. We illustrate the results on closed-form solutions of the Navier-Stokes equations, and well as on three-dimensional numerical simulations.

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