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Characterizing the dynamics of unsteady planar flows through the topology of coherent-structure-based trajectories MARK STREMLER, PRADEEP RAO, SHANE ROSS, Virginia Tech — There has been significant development in the identification of coherent structures associated with Lagrangian transport. Methods include Lagrangian Coherent Structures (LCS), which identifies transport barriers with minimal flux between regions, and Almost Invariant Sets (AIS) or the related Finite-Time Coherent Sets (FTCS), which identify the coherent regions that are separated by transport barriers. These methods are valuable tools for identifying key features of complex spatio-temporal transport at given instants in time. Understanding how the time-dependent interaction of these structures relates to the global characteristics of transport in the system has proven a more difficult task. We present evidence that space-time trajectories embedded in coherent structures, which we identify via AIS or FTCS, can be used to describe the global structure of transport in the flow. For sufficiently complex flows, these trajectories 'braid' about one another, and the topology of this braid can be directly correlated with chaos in the system. We investigate the connection between the occurrence of braiding AIS/FTCS trajectories and the exponential stretching of material lines associated with chaos in several example flows, including lid-driven cavity flow and the double gyre flow.

Mark Stremler
Virginia Tech

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