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Duality in three-dimensional topological dynamics[1] KEVIN MITCHELL, SPENCER SMITH, JOSHUA ARENSON, University of California, Merced — Topological dynamics is a well developed approach for analyzing two-dimensional systems, such as the chaotic mixing of 2D fluids. However, extending such topological techniques into higher dimensions has been met with considerable difficulty. Recently, we have developed a technique to extract symbolic dynamics from the complex topology of intersecting stable and unstable manifolds for systems described by 3D volume-preserving maps. Such maps are physically relevant to particle transport by incompressible fluid flows or by magnetic field lines. Quite unexpectedly, the symbolic dynamics extracted from a variety of examples exhibits a remarkable duality: the symbolic description of the forward evolution of 2D surfaces is equivalent to the symbolic description of the backward evolution of 1D curves. One specific consequence of this is that the exponential growth rate in the area of a surface evolving forward is the same as the exponential growth rate in the length of a curve evolving backward in time. We illustrate this phenomenon with chaotic vortex dynamics in a 3D fluid flow.

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