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Computation of Topological Entropy in Three Dimensions from Fluid Trajectories[1] ERIC ROBERTS, SUZANNE SINDI, University of California, Merced, SPENCER SMITH, Mount Holyoke, KEVIN MITCHELL, University of California, Merced — We introduce and verify an algorithm for estimating a three-dimensional flow's topological entropy, a measure quantifying the complexity of chaotic dynamics. Analogous to the topological entropy calculation from the "braiding" of system trajectories in two dimensions by Thiffeault, we achieve this in three dimensions by exploiting the collective motion of an ensemble of potentially-sparse system trajectories; as the ensemble evolves in time, the points repeatedly stretch and fold two-dimensional rubber sheets. The topological entropy is bounded below by the exponential growth rate of this sheet, thereby quantifying the flow complexity. New to three-dimensional entropy calculations is the introduction of computational geometry tools: we maintain a Delaunay triangulation of points as they move to record the evolution and growth of a sheet. Because this algorithm requires only trajectory data and no knowledge of governing equations, these results aid greatly in a wide variety of natural and industrial fluid systems, including the large-scale dispersion of pollutants in the Earth's atmosphere and oceans and the rapidly developing field of microfluidics, all while remaining generally applicable to theorists and experimentalists alike.

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