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Using tangles to quantify topological mixing of fluids[1] QIANTING CHEN, SULIMON SATTARI, KEVIN MITCHELL, Univ of California - Merced — Topological mixing is important in understanding complex fluid problems, ranging from oceanic transport to the design of micro-mixers. Typically, topological entropy (TE), the exponential growth rate of material lines, is used to quantify topological mixing. Computing TE from the direct stretching rate is computationally expensive and sheds little light on the source of the mixing. Previous work has focused on braiding by "ghost rods" (See, e.g. works by Boyland, Aref, Stremler, Tiffeault, and Finn). Following Grover et al. [Chaos 22,043135 (2012)], we study topological mixing in a two-dimensional lid-driven cavity flow. For a certain parameter range, the TE is dominated by a period-3 braid. However, this braid alone cannot explain all the TE within this range, nor the TE outside the range of existence of the braid. By contrast, we explain TE through the topology of intersecting stable and unstable manifolds, i.e. heteroclinic tangles, using homotopic lobe dynamics (HLD). In the HLD approach, stirring originates from "ghost rods" placed on *heteroclinic* orbits. We demonstrate that these heteroclinic orbits generate excess TE not accounted for in Grover et al. Furthermore, in the limit of utilizing arbitrarily long manifolds, the HLD technique converges to the true TE.

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