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On the role of topological chaos and ghost rods in fluid mixing
MOHSEN GHEISARIEHA, MARK STREMLER, Virginia Tech — We consider stirring and mixing of two-dimensional Stokes flow in a circular domain due to the motion of three rods. Two similar protocols are discussed that are expected to give significantly different results based on the predictions of the Thurston-Nielsen (TN) theorem. Somewhat surprisingly, under many conditions the topologically "trivial" finite order protocol produces a larger stretch rate than does the pseudo-Anosov protocol, which is guaranteed to be chaotic by the TN theorem. We show that, in these cases, periodic points in the flow act as "ghost rods" that can be considered responsible for the large stretch rates produced by the finite order protocol. However, the existence and importance of these ghost rods is dependent on the specific system geometry, and perturbations can lead to very low stretch rates when using the finite order protocol. In contrast, selection of a pseudo-Anosov protocol leads to a robust minimum for the stretch rates as predicted by the TN theorem. In order to associate the stretch rate results to fluid mixing, we also discuss the homogenization of a passive scalar advected by the flow.

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