Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Reynolds Number Effects on Mixing Due to Topological Chaos
SANGEETA WARRIER[1], SPENCER SMITH[2], Mount Holyoke College — Topological chaos has emerged as a powerful modeling tool to investigate fluid mixing. While this theory can guarantee a lower bound on the stretching rate of certain material lines, it does not indicate what fraction of the fluid actually participates in this minimally mandated mixing. Indeed, the area in which effective mixing takes place depends on physical parameters such as the Reynolds number. To help clarify this dependency, we numerically simulate the effects of a batch stirring device on a 2D incompressible Newtonian fluid in the laminar regime. In particular, we calculate the finite time Lyapunov exponent (FTLE) field for two different stirring protocols, one topologically complex (pseudo Anosov) and one simple (finite order), over a range of viscosities. After extracting appropriate measures indicative of mixing from the FTLE field, we see a clearly defined range of Reynolds numbers for which the relative efficacy of the pseudo Anosov protocol over the finite order protocol justifies the application of topological chaos. The Reynolds number dependance of these mixing measures also reveals several other intriguing phenomena.

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Date submitted: 01 Aug 2014 Electronic form version 1.4