Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Driven Lid Flow in a Hemisphere: Steady-State Stokes Flow and 3-Dimensional Chaotic Advection Under Small and Large Perturbation MICHAEL COFFEY, ANDREW OOI, University of Melbourne, DANIEL LESTER, GUY METCALFE, CSIRO Australia — We investigate flow and transport in a hemisphere filled with viscous fluid whose equitorial plane is a sliding lid. For steady-state Stokes flow the hemisphere has a single vortex line, nearly wall-attached, perpendicular to the sliding direction. Passive particle transport in the hemisphere is confined to cigar shaped shells that are continuously deformed from the vortex line to the boundary. We perturb the steady flow in two ways. (1) A small amplitude azimuthal oscillation in the sliding direction of the lid creates a fully three-dimensional dynamical system for particle transport in the hemisphere. Orbits between shells are connected through close approach manifolds at the parabolic points on the wall. (2) A periodically reoriented flow (PRF) occurs when the lid slides in one direction for a finite time τ then slides (without twisting) in a new direction reoriented from the first by a finite angle Θ. The PRF introduces symmetry, and we search for a mixing optimum in this stirred PRF.

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Date submitted: 30 Jun 2009 Electronic form version 1.4