Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Optimal Mixing, Part I[1] CHARLES R. DOERING, University of Michigan, ZHI LIN, Institute for Mathematics and its Applications, JEAN-LUC THIFFEAULT, University of Wisconsin — We investigate optimal incompressible stirring to mix an initially inhomogeneous distribution of diffusionless passive tracers. The H^{-1} Sobolev norm is adopted as the quantitative mixing measure of the tracer concentration field: its vanishing as $t \to \infty$ is equivalent to the stirring flow's mixing property in the sense of ergodic theory. We derive rigorous bounds on the rate of mixing by flows with fixed energy or energy dissipation rate constraints, and determine the flow field that instantaneously maximizes the decay of the mixing measure – when such a flow exists – by solving a variational problem. When no such 'steepest descent' flow exists (a possible but non-generic situation) we determine the flow that maximizes the growth rate of the scalar's H^{-1} norm's decay rate. This optimal stirring strategy is implemented numerically on a benchmark problem and compared to the rigorous bounds as well as an optimal control approach using a restricted set of flows.

[1]Supported by NSF Awards PHY0555324, PHY0855335, and DMS-0806821.

Charles R. Doering
University of Michigan

Date submitted: 07 Aug 2010 Electronic form version 1.4