Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Optimal Control of Mixing in Stokes Fluid Flows GEORGE MATHEW, IGOR MEZIC, SYMEON GRIVOPOULOS, UMESH VAIDYA, LINDA PETZOLD, University of California, Santa Barbara — Motivated by the problem of microfluidic mixing, the problem of optimal control of advective mixing in Stokes fluid flows is considered. The velocity field is assumed to be induced by a finite set of spatially distributed force fields that can be modulated arbitrarily with time and a passive material is advected by the flow. To quantify the degree of mixedness of a density field, we use a Sobolev space norm of negative index. We pose a finite-time optimal control problem where we aim to achieve the best mixing for a fixed value of the action (time integral of the kinetic energy of the fluid body) per unit mass. We derive the first order necessary conditions for optimality that can be expressed as a two point boundary value problem and we discuss some elementary properties that the optimal controls need to satisfy. A conjugate gradient descent method is used to solve the optimal control problem and we present numerical results for two problems involving arrays of vortices. A comparison of the mixing performance shows that optimal aperiodic inputs can do better than periodic inputs.

George Mathew
University of California, Santa Barbara

Date submitted: 03 Aug 2006 Electronic form version 1.4