Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Nonlinear optimisation of scalar mixing in plane Poiseuille flow with finite diffusivity C.P. CAULFIELD, BP Institute & DAMTP, University of Cambridge, DIMITRY FOURES, DAMTP, University of Cambridge, P.J. SCHMID, LadHyX, CNRS-Ecole Polytechnique — We consider the nonlinear optimisation of the mixing of a passive scalar, initially arranged in two layers, in 2D plane Poiseuille flow at finite Reynolds number and Péclet number, $Re \sim Pe \sim O(10^3)$. We use a nonlinear-adjoint-looping approach to minimise the variance of the scalar concentration θ at various target times T, subject either to a finite kinetic energy initial disturbance, or wall velocity perturbation. We show that both optimal initial perturbations and optimal wall excitation strategies which minimise the variance of θ are distinct from the equivalent perturbations which maximise the time-averaged energy gain of disturbance at $t = T$, and that these "gain" perturbations can often be poor at scalar mixing. We also identify perturbations and excitation strategies which minimise the distribution of θ at the target time relative to a particular Sobolev norm of negative index, a "mix-norm" as used in flows with no diffusion to measure "mixing" in the sense of ergodic theory (G. Mathew, I. Mezic, & L. Petzold 2005 *Physica D*, **211**, 23-46). We show the close connection between these mix-norm perturbations and the optimal variance perturbations, all of which initially increase gradients to ensure good mixing at later times.

Colm-cille Caulfield
BP Institute & DAMTP, University of Cambridge

Date submitted: 26 Jul 2013 Electronic form version 1.4