Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Extreme Vortex States and the Growth of Palinstrophy in Two Dimensions DIEGO AYALA, BARTOSZ PROTAS, McMaster University — We probe the sharpness of analytic estimates for the instantaneous rate of growth and the finite-time growth of palinstrophy in 2D viscous incompressible flows on periodic domains. This effort is part of a broader research program concerning a systematic search for extreme vortex states which is intrinsically related to the finite-time "blow-up" problem in 3D incompressible flows. Evidence is presented for the existence of a family of 2D vorticity fields parametrized by their energy and palinstrophy which saturate an estimate characterizing the finite-time growth of palinstrophy. The family of such "optimal" vortex states is obtained by solving suitable optimization problems in which the rate of growth of palinstrophy is maximized under constraints. Although found as a solution of an instantaneous problem, vortex states from this family also saturate the finite-time estimates. This intriguing finding leads to some open questions about the 3D case, namely, whether extreme vortex states with prescribed energy and enstrophy may exhibit a larger growth of enstrophy than the previously found fields in which only enstrophy was fixed and whose growth of enstrophy was too weak to produce a singularity in finite time.

Diego Ayala
McMaster University

Date submitted: 31 Jul 2013 Electronic form version 1.4