Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Simulation of vortex breakdown in swirling jets PRADEEP MOISE, JOSEPH MATHEW, Indian Inst of Science — Numerical simulations of laminar incompressible swirling jets have been carried out to study different types of vortex breakdown, including the commonly reported axisymmetric bubble and the lesser known conical breakdown. Existence of the latter type of breakdown was first discovered in experiments of Billant et al. (1998) who proposed that the bubble and conical breakdown exhibit bistability behaviour. This is confirmed by the present study, where it is shown that the conical breakdown coexists with bubble breakdown over a wide range of swirl strengths. A novel approach employing PDE-constrained optimization techniques (adjoint-based method) is formulated to elucidate the relation between bistable states. This is implemented by means of minimizing strengths of introduced initial velocity perturbations which trigger required transition from one state to another. Features of conical breakdown and their dependence on flow parameters are examined. Solutions of both breakdown types are tested with predictions of the conjugate state theory of Benjamin (1962) by investigating upstream propagation of introduced disturbances in subcritical regions of flow and the theory of Brown and Lopez (1990), by examining development of negative azimuthal vorticity in the flow.

Pradeep Moise
Indian Inst of Science

Date submitted: 27 Jul 2017 Electronic form version 1.4