Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

On the growth of enstrophy in axisymmetric 3D Euler flows with swirl DIEGO AYALA, CHARLES DOERING, University of Michigan — By numerically solving suitable PDE-constrained optimization problems, we study a family of axisymmetric vector fields, having the structure of a pair of vortex rings with swirl, that maximize the instantaneous production of enstrophy in the context of 3-dimensional (3D) incompressible Euler flows. The axisymmetric fields are parametrized by their energy $\mathcal{K}$, enstrophy $\mathcal{E}$ and helicity $\mathcal{H}$. The imposed symmetry is justified by the results from the seminal work of Doering & Lu (2008), recently confirmed independently by Ayala & Protas (2015), where highly localized pairs of colliding vortex rings were found to be instantaneously optimal for enstrophy production in 3D Navier-Stokes flows. The axial symmetry allows for an exhaustive exploration of the parameter space $(\mathcal{K}, \mathcal{E}, \mathcal{H})$, as the 3D problem is effectively reduced to a 2-dimensional system of partial differential equations for the modified azimuthal vorticity and the azimuthal circulation density, with the corresponding reduction in computational complexity. Possible connections between these optimal axisymmetric fields with swirl and the "blow-up" problem are discussed.

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Date submitted: 01 Aug 2015

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