DPP16-2016-000890

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Evolution of an electron plasma vortex in a strain flow.

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Coherent vortex structures are ubiquitous in fluids and plasmas and are examples of self-organized structures in nonlinear dynamical systems. The fate of these structures in strain and shear flows is an important issue in many physical systems, including geophysical fluids[2] and shear suppression of turbulence in plasmas.[3] In two-dimensions, an inviscid, incompressible, ideal fluid can be modeled with the Euler equations, which is perhaps the simplest system that supports vortices. The Drift-Poisson equations for pure electron plasmas in a strong, uniform magnetic field are isomorphic to the Euler equations, and so electron plasmas are an excellent test bed for the study of 2D vortex dynamics.[4] This talk will describe results from a new experiment using pure electron plasmas in a specially designed Penning-Malmberg (PM) trap to study the evolution of an initially axisymmetric 2D vortex subject to externally imposed strains. Complementary vortex-in-cell simulations are conducted to validate the 2D nature of the experimental results and to extend the parameter range of these studies. Data for vortex destruction using both instantaneously applied and time dependent strains with flat (constant vorticity) and extended radial profiles will be presented. The role of vortex self-organization will be discussed. A simple 2D model[5] works well for flat vorticity profiles. However, extended profiles exhibit more complicated behavior, such as filamentation and stripping; and these effects and their consequences will be discussed.

[1]Work done in collaboration with N. C. Hurst, D. H. E. Dubin, and C. M. Surko.
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