Formation and Control of Nonuniform Vortex States in Nonneutral Plasmas

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Uniform, m-fold symmetric, rotating vortex patches (*V*-states) in *2D* ideal fluids were discovered by Deem and Zabusky two decades ago [1]. Analogous structures can be formed in pure electron plasmas trapped in Penning-Malmberg traps [2], where plasma density plays the role of vorticity. Here we consider excitation and control of nonuniform *V*-states in nonneutral plasmas, the problem related to recent studies of inviscid vorticity symmetrization of *2D* vortices [3]. It will be shown that a family of stable, nonuniform, m-fold symmetric, nonneutral plasma structures in two dimensions (nonuniform *V*-states) can emerge by subjecting an axisymmetric plasma with a sharp density edge profile to a weak oscillating external potential of appropriate symmetry. The phenomenon is due to nonlinear synchronization (autoresonance) in the system, as the plasma density distribution self-adjusts to equate the rotation frequency of the plasma structure with slowly varying oscillation frequency of the external perturbation. The synchronization is induced by passage through resonance with the isolated eigenfrequency of the linearized problem, provided the driving potential amplitude exceeds a threshold. We shall present a quasilinear theory of excitation of nonuniform *V*-States by synchronization and compare the predictions of this theory with contour dynamics simulations.

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