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P4.4001 Relaxation of strongly magnetized non-neutral electron plasmas

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The dynamics of a pure electron plasma confined by strong magnetic fields in a Malmberg-Penning trap is analogous to the vortex flow in an inviscid two-dimensional fluid. In fact, in the guiding-center approximation the transverse electron evolution is dictated by the drift-Poisson equations which are isomorphic to the Euler equations that describe the vorticity field in an ideal fluid. As a consequence, the effects of the collisions between electrons are negligible in such devices and the plasma never reaches the thermodynamic equilibrium. Instead, it relaxes through Landau damping to a complex nonequilibrium stationary state. A theory is presented which allows us to quantitatively predict the final stationary state achieved by the plasma [1]. Nonequilibrium phase transitions are observed as the initial conditions are varied. Theoretical estimates of the location in the parameter space of these transitions are also discussed. All the theoretical results are compared with explicit molecular dynamics simulations.

References

[1] R. Pakter and Y. Levin, Phys. Rev. Lett., 121, 020602 (2018).

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