Experimental Study of Formation of Vortex Crystal Configuration in Pure Electron Plasma

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Abstract

The experimental study of two-dimensional (2D) vortex dynamics with magnetized pure electron plasma is based on the equivalence of the macroscopic dynamics of guiding centers of particles in the non-neutral plasma to the ideal neutral fluid. In the 2D dynamics of strongly magnetized pure electron plasmas, which trapped axially by an electrostatic potential and radially by a strong homogeneous magnetic field, the density and the potential distribution is equivalent to the vorticity and stream function of 2D Euler fluid, respectively. A vortex crystal is a quasi-stationary, symmetric array of intense vortices (clumps). The dynamics of mutually interacting point vortices has been the subject of theoretical and simulational studies of 2D turbulence. In a non-neutral plasma, the experiment by Fine[1] and a subsequent simulational study by Schecter[2] were the first to reveal the important role of the interaction between the clumps and the low level vorticity filling the space around the clumps in the vortical relaxation processes toward the crystal structures. We experimentally examine the contribution of a low-level of background vorticity (BGV) to the relaxation of the clumps ’ dynamics toward the formation of a crystal structure[3]. To simplify the problem and quantify the degree of order, we focus on the dynamics of three clumps which are the minimum to form a unit cell in 2D crystal structures. Quantitative analyses about formation of traiangle configuration will be reported, together with some discussion on time evolution of hydrodynamic integral quantities.

References

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