§19. Rotation and Oscillation of Nonlinear Dipole Vortex in the Drift-Unstable Plasma

Orito, K. (Dept. Phys. Nagoya Univ.)
Hatori, T.

The behaviors of the nonlinear dipole vortex in the drift unstable plasma are studied by numerical approaches[1]. Model equations used in numerical simulation are derived from two-fluid model and are composed of two equations with respect to the electrostatic potential ϕ and the density perturbation n_1. In our model the potential vorticity $q = \nabla^2\phi - n_1 - \nu_0 x$ is conserved along the trajectory, where $\nu_0 = d\ln n_0(x)/dx$. When the initial dipole vortex is inclined at some angle with respect to the direction of the drift velocity, the dipole vortex oscillates or rotates. Oscillation of the dipole vortex in stable system is reported Makino et al[2].

Most interesting result is that the dipole vortex rotates and becomes a monopole vortex. Figure 1 is a time series of the electrostatic potentials ϕ in the frame moving with the phase velocity u of the dipole vortex. At $t = 10$, the dipole vortex moves toward positive x direction, which is the low unperturbed density side. Since the potential vorticity is conserved, potential increases and due to the induced flow from the enlarged positive vortex, the shrunk negative vortex rotates clockwise around the positive vortex. In stable system, the negative vortex enlarge while the positive vortex decreases and finally the recovered dipole vortex propagates to the high density side. In the unstable system the positive vortex continues to grow further by the destabilization effect so that the small negative vortex does not recover and continues to rotate around a large positive vortex.

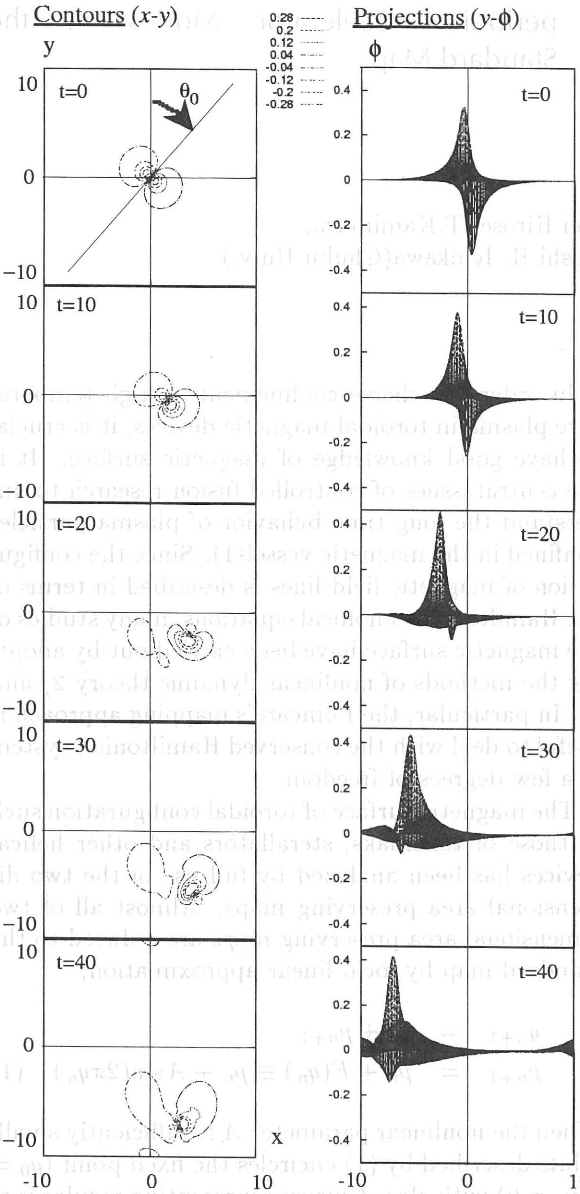

Fig. 1. A time series of contour plots of the electrostatic potential ϕ(left hand side) and profiles as a function of y in the frame moving with $u = -0.24$. Parameters are $r_0 = 1.0$, $\nu_0 = -0.2$, $\mu = 0.1$ and $\theta_0 = -40°$.

References

1) K. Orito and T. Hatori, J. Phys. Soc. Jpn. **67**, 487 (1998).
2) M. Makino and T. Kamimura and T. Taniuti, J. Phys. Soc. Jpn. **50**, 980 (1981).