Accessibility to Equilibrium with Shallow/Deep Penetration in Rotating Magnetic Field Current Drive

M. Ohnishi, H. Osawa, M. Mizuno
Kansai University
and
A. Ishida
Niigata University

The stability of the rotation rate of the electron fluids was recently studied in regards to the balance of the forces exerted on the electrons by the resistive friction and the rotating magnetic field (RMF). The linear stability analysis including the effects of ion rotation and separatrix radius change due to the flux conservation within the flux conserver gave analytically the stability conditions in the equilibrium of the shallow penetration. The stability conditions derived from the present experimental parameters indicate that the equilibrium may be marginally stable. The accessibility to the equilibrium with the shallow/deep penetration of the RMF into an FRC is studied by numerically integrating the rate equations for the ion and electron rotations with the perturbed initial equilibrium values. When the initial angular frequency of the electron fluid is less than the equilibrium value which satisfies the stability conditions, the electron angular frequency stays near the initial value to achieve the equilibrium of the shallow penetration. The initial electron angular frequency barely larger than the equilibrium brings rapidly the angular frequency close to the RMF frequency and results in the full penetration of the RMF. On the other hand, when the equilibrium is unstable, the smaller initial value than the equilibrium electron rotation leads to the continuous current decay and does not sustain the configuration. The larger initial value results in the rapid full penetration of the RMF similarly to the case of the unstable equilibrium. Both of the perturbed initial values do not keep the electron angular frequency near the initial equilibrium value. When the equilibrium, therefore, is unstable, the full penetration may be observed in the experiments. However, when the equilibrium is stable, the full penetration cannot be accessed, as is observed in the present experiments, from the electron rotating state non-synchronous with the RMF. The study on the dynamic behaviors of the electron angular frequency clarifies the accessibility to the equilibrium of the shallow/deep penetration and the means to control the degree of the penetration of RMF.