内部崩壊現象における径電場の自己生成シミュレーション

松本太郎、徳田伸二、岸本泰明、内藤裕志 [1)]
日本原子力研究所 炉心プラズマ研究部、[1)]山口大学 工学部 電気電子工学科
E-mail: tmatsumo@naka.jaeri.go.jp

In tokamaks with high current density where the safety factor at the magnetic axis (q_0) is less than unity, the m/n=1/1 mode evolves and causes the internal collapse, where m and n are the poloidal and the toroidal mode numbers, respectively. Because of this inherent properties of the m=1 mode, the nonlinear development of the mode are still far from fully understanding. Naitou et. al. performed a nonlinear gyro-kinetic particle simulation of the 1/1 mode in a cylindrical geometry with an uniform plasma pressure[1]. They showed the collisionless magnetic reconnection caused by the electron inertia and that the magnetic configuration where q_0 is less than unity can be reconstructed after the full reconnection. A particle-fluid hybrid model based on nonlinear gyrokinetics is also an example for such an advanced simulation model.

In this research, the density gradient effect on the collisionless m = 1 mode has been studied by extending the nonlinear gyrokinetic simulation model to the nonuniform plasma with a density gradient [2]. Even when the density gradient is not so large enough to change the process of the full reconnection, the later process is changed considerably due to the self-generated radial electric field, i.e. the m/n = 0/0 mode, induced by the nonlinear interaction. The radial electric field is found to exponentially grow in two stages, i.e. before and after the saturation of the dominant 1/1 mode, and to reach to the same level as the 1/1 mode. The radial electric field drives a **E**x**B** plasma rotation in the ion diamagnetic direction which violates the symmetry of the plasma flow associated with the full reconnection. As a result, the current reconcentration which induces the secondary reconnection is prevented. Therefore, it is a delicate problem whether the configuration with q<1 is reconstructed. Furthermore, the **E**x**B** rotation rolls in the plasma so that the coherent vortex structure of the density profile is formed. This shows that the flattening process of the pressure is triggered by this kind of the fine scale structure. As a summary, the generation of radial electric field which is not included in the conventional MHD model leads to the complex behavior in the process of the internal collapse. It should be noted that the radial electric field is observed after the full reconnection in JIPP-TII tokamak[3].

[1] H.Naitou, T.Sonoda, S.Tokuda and V.K.Decyk, J. Plasma and Fusion Research, **72** 259 (1996).

[2] T.Matsumoto, S,Tokuda, Y.Kishimoto and H.Naitou, Phys. Plasmas, **10** 195 (2003).

[3] Y. Hamada, A. Nishizawa, Y. Kawasumi, et.al., Nucl. Fusion, **36** 515 (1996).