§4. MHD Simulation on High Density Plasmoid

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Injecting small pellets of frozen hydrogen into torus plasmas is a proven method of fueling [1]. Since a high-density low-temperature plasmoid induced by pellet ablation drifts to the low-field side, pellet fueling to make the plasmoid approach the core plasma in a tokamak is successful when a pellet is injected from the high-field side. However, such good performance has not yet been obtained in experiments in the planar axis heliotron, the Large Helical Device (LHD), even when a pellet was injected from the high-field side [2]. To clarify the difference in plasmoid motions in a tokamak and in the LHD, a three-dimensional (3D) magnetohydrodynamics (MHD) code including ablation processes has been developed by extending the pellet ablation code (CAP) [3].

The distribution of the equilibrium magnetic pressure in the LHD is determined by the toroidicity and helicity. The inboard sides of the midplane in the horizontally and vertically elongated poloidal cross sections are the lower and higher field sides due to the helicity, respectively. In order to investigate the plasmoid motion induced by the helicity, MHD simulations have been carried out in the straight helical plasmas. Figures 1(a) and (b) show the temporal evolutions of the pressure perturbations of the plasmoids 1 and 2, respectively, which are shown by the solid lines. The plasmoids 1 and 2 are located in the horizontally and vertically elongated poloidal cross sections, respectively. Dashed lines show the equilibrium magnetic pressures of the midplanes. The plasmoids 1 and 2 drift to the left hand sides in the figure. This fact means that the plasmoids 1 and 2 drift to the lower and higher field sides, respectively. These drift motions are induced by the magnetic tension. The drift direction by the magnetic tension is determined by two features, which are the direction to the lower field side and the magnetic pressure distribution along the field line. At the location of the plasmoid 1, the direction to the lower field side is the negative direction of the minor radius and the magnetic pressure is a local minimum along the field line as shown in Fig. 1(a). The motion of the plasmoid elongated along the field line due to the ablation pressure is disturbed because the magnetic pressure becomes large along the field line. In result, the plasmoid drifts to the negative direction of the minor radius. On the other hand, at the location of the plasmoid 2, the direction to the lower field side is the minor radius direction and the magnetic pressure is a local maximum along the field line as shown in Fig. 1(b). In other words, the above two features of the magnetic field to dominate the drift direction are exactly opposite to those of the plasmoid 1. If one of the features is opposite, the plasmoid 2 drifts in the opposite direction to the plasmoid 1, namely in the minor radius direction. However, since both features are opposite, the plasmoid 2 drifts in the negative direction of the minor radius. In addition, the fast back and forth induced by the magnetic sound wave and the slow one determined induced by the connection length are created. The frequency of the slow back and forth is determined by the toroidal pitch. We will investigate the condition for the plasmoid to drift to the core in the future work.

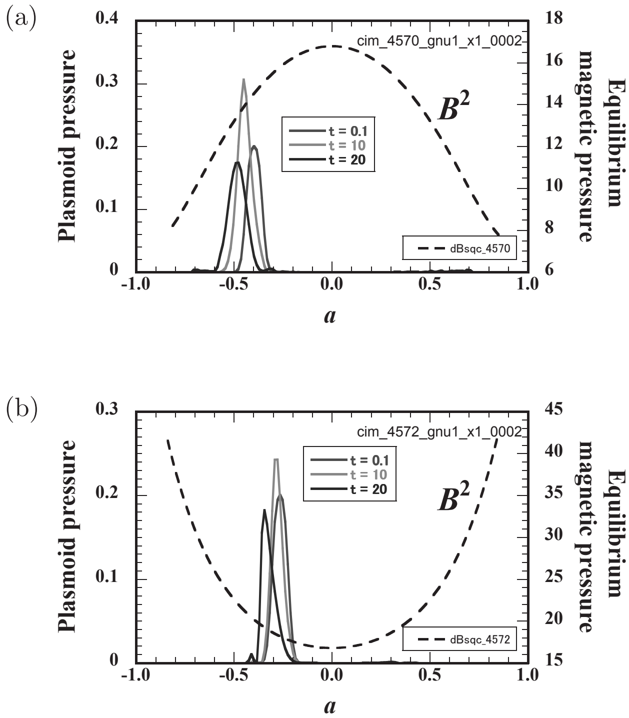

Fig. 1: (a) The pressure perturbation of the plasmoid 1 as functions of the minor radius a at the midplane of the horizontally elongated poloidal cross section in the straight helical plasma. (b) The pressure perturbation of the plasmoid 2 as functions of the minor radius a at the midplane of the vertically elongated poloidal cross section in the straight helical plasama. Those temporal evolutions are shown by the color solid lines. The dashed line shows the equilibrium magnetic pressure.

1) L. R. Baylor et al., Phys. Plasmas, **7**, 1878 (2000).

2) R. Sakamoto et al., Nucl. Fusion, **44**, 624 (2004).

3) R. Ishizaki and N. Nakajima, Plasma Phys. Control. Fusion, **53**, 054009 (2011).