§2. MHD Simulation of Pellet Plasmoid in LHD

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It is well known that an ablation cloud; a high density and low temperature plasmoid, drifts to the lower field side in tokamak plasmas, which leads to a good performance on fueling in tokamak [1]. Such a good performance, however, has not been obtained yet in Large Helical Device (LHD) experiments [2]. In order to clarify the difference on the plasmoid motions between tokamak and LHD, MHD simulations have been carried out [3].

Figures 1(a) and (b) show the horizontal and vertical elongated cross sections, respectively. Initial plasmoids in cases 2 and 3 are shown in Fig. 1(a) and one in case 4 is shown in Fig. 1(b). The helical plasma has a saddle point of the magnetic pressure. Since the plasmoid in case 2 is located inside the torus and at the lower field side than the saddle point, the curvature vector is positive in the major radius direction. On the other hand, the curvature vectors in cases 3 and 4 are negative. The simulation results in cases 2, 3 and 4 are shown in Figs. 2(a), (b) and (c), respectively. In case 2, the plasmoid drifts slightly back and forth in the direction of the major radius. In case 3, it drifts in the direction of the major radius. In case 4, it slightly drifts but dose not reach the magnetic axis. It is found that the results in LHD are not corresponding to ones in the tokamak in which the plasmoid drifts in the opposite direction to the curvature vector. The major radius component of the leading force acting on the plasmoid is approximately expressed by $F_R = B^{eq}B_R^{pl}/L_c - B_\phi^{eq}B_\phi^{pl}/R$, where the cylindrical coordinate (R, ϕ,Z) is used. L_c is the connection length depending on the configuration, and B^{eq} and B^{pl} is the equilibrium magnetic field and perturbed one induced by the plasmoid, respectively. In the tokamak, the connection length becomes $L_c \sim \pi qR$. The second term in F_R becomes relatively larger than the first term when $q \sim 1$. Since the second term is always positive due to the diamagnetic effect, the plasmoid has a positive acceleration. In LHD, the connection length depends on the location of the plasmoid. The connection length around the plasmoid in case 3 becomes longer than ones in cases 2 and 4. As a result, the second term is the leading one in the tokamak, and the first terms are the leading ones in case 2 and 4. That causes the essential difference on the plasmoid motion between tokamak and LHD.

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

2) R. Sakamoto et al., *in proceedings of 29th EPS conference on Plasma Phys. and Contr. Fusion*, **26B**, P-1.074 (2002).

3) R. Ishizaki and N. Nakajima, J. Plasma and Fusion Res. SERIES, **8**, 995 (2009).

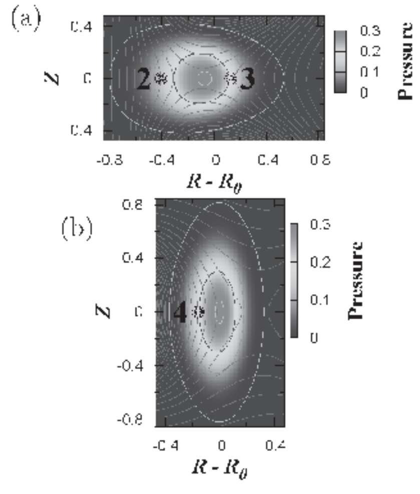

Fig. 1: Poloidal cross sections in (a) cases 2 and 3 and (b) case 4. Contours and colors show the magnetic and plasma pressures. Circles are initial plasmoids.

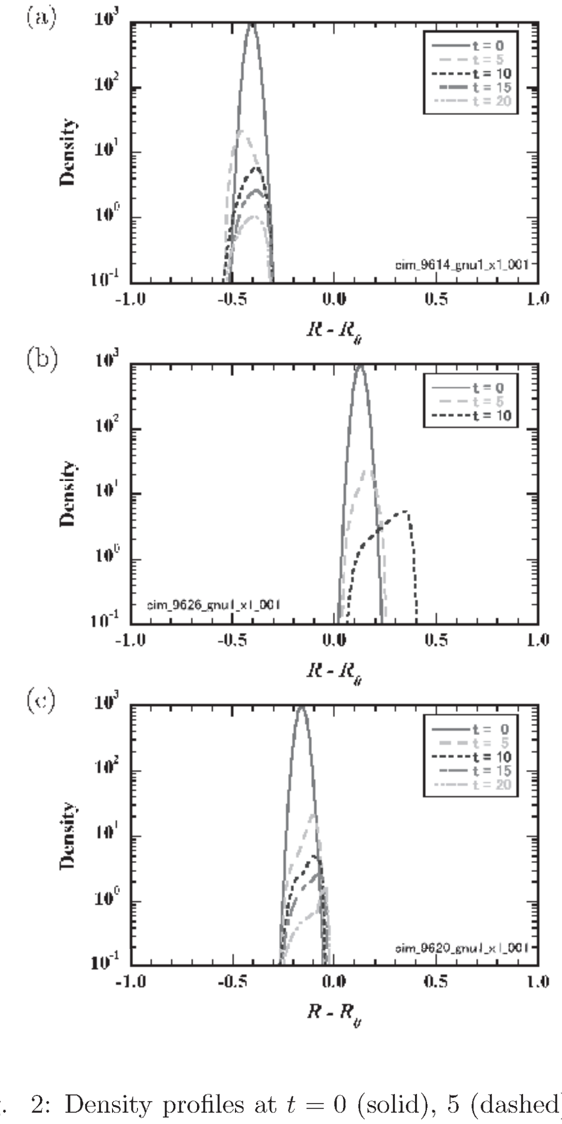

Fig. 2: Density profiles at $t = 0$ (solid), 5 (dashed), 10 (dotted), 15 (dash-dotted) and 20 (dash-dot-dotted) in (a) case 2, (b) case 3 and (c) case 4.