§41. Study of Dynamics of Magnetic Island in LHD

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Nested flux surfaces are prerequisite for the good confinement of toroidal plasmas. There is, however, a possibility to produce magnetic islands due to misalignment of the coils and the finite beta effect etc. In the Large Helical Device (LHD) experiment, it has been reported that the magnetic island width enlarges or disappears during the plasma discharge [1,2], which is thought to be dew to some kinds of currents flowing in the plasma acting to enlarge or suppress the magnetic island. When a magnetic island changes, a perturbed magnetic field appears, which brings some information about the magnetic island width. The beta dependence of the perturbed magnetic field $\delta b_1^{n=1}/B_t$ in the particular collisionality ($0.1 < \nu_h^* < 1.0$) is shown in Fig.1. It is clearly divided into two regions, one for island expansion and the other for the island shrinking [3,4]. At lower beta ($\beta < 0.3\%$), $\delta b_1^{n=1}/B_t$ linearly increases with the beta, which means that the magnetic island width increases with the beta up to $\beta = 0.3\%$. In above $\beta = 0.3\%$, $\delta b_1^{n=1}/B_t$ is almost constant regardless of the beta. This means that the growth of the perturbed magnetic field is restricted by some mechanisms when the magnetic island disappears. The situation in which a magnetic island is suppressed is considered. It can be thought that the bootstrap current does not flow inside the magnetic island due to zero-pressure gradient, which gives a modified bootstrap current density profile with the same mode structure as that of the magnetic island. The modified bootstrap current yields a perturbed magnetic field with a certain mode structure which should be an $m/n = 1/1$ in this study. The modified bootstrap current contributes to magnetic island suppression because the bootstrap current in typical LHD plasma flows in the co-direction [5]. To investigate the effect of the change of direction of the bootstrap current on the magnetic island, the dependence on the bootstrap current by the finite beta effect via the change of the magnetic configuration is calculated [6]. The solid line indicates the boundary where the bootstrap current reverses. The direction is ctr- in the high-ν_h^* regime and co- in the low-ν_h^* regime. As shown in Fig.2, the dependence of the beta on the direction of the bootstrap current is small whereas the dependency of collisionality is weak in experiment. To ascertain the reason of the weak dependence of collisionality is a future work. Therefore, the cause of the dissipation of the magnetic island cannot be explained by the dependence on the bootstrap current due to the finite beta effect via the change of the magnetic configuration. The studies of the effect on the bootstrap current of the width of the magnetic island and other mechanisms except for the bootstrap current are future subjects.

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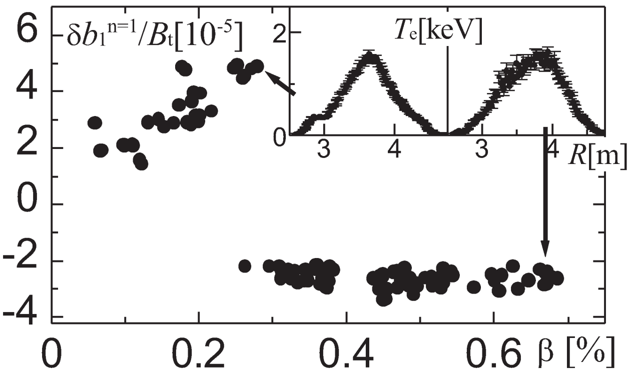

Fig.1. Beta dependency of amplitude of perturbed magnetic field of $n = 1$ mode $\delta b_1^{n=1}/B_t$.

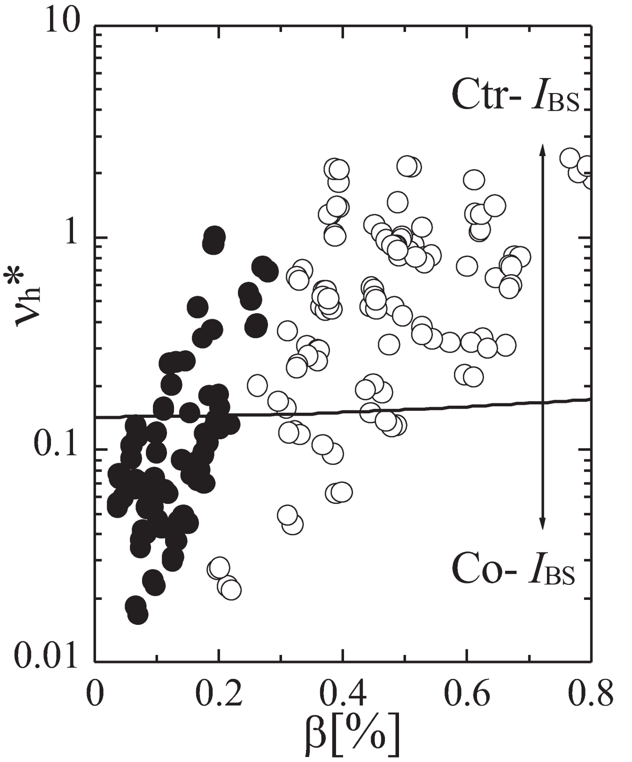

Fig. 2. β - ν_h^* space. Open circles indicate the cases where the island is not observed. Closed circles denote that the island is observed. Solid line shows the boundary where the bootstrap current reverses.

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