§15. Dependence of Change of Magnetic Island Structure on Beta and Collisionality in LHD

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Well-defined magnetic surfaces are required for the favorable plasma confinement. 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 shrinks 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. The seed island with $m/n = 1/1$ (where, m and n are poloidal and toroidal mode number, respectively) is used in this study. The behavior of the magnetic island (the enlargement or shrinkage) depends on the beta and collisionality as shown in Fig.1. The width of the magnetic island enlarges at higher collisionality ($\nu_h^* > 0.07$) and lower beta ($\beta < 0.3\%$) region (shown as the closed circles). On the other hand, the magnetic island disappears at lower collisionality ($\nu_h^* < 0.07$) and/or higher beta ($\beta > 0.3\%$) region (open circles). This behavior means that the magnetic island will be suppressed in high beta plasmas regardless of the collisionality. When a magnetic island changes, a perturbed magnetic field appears, which brings some information about the magnetic island such as the width and the position of the X(O)-point [3]. The beta dependence of the perturbed magnetic field $\delta b_1^{n=1}$ normalized by the toroidal magnetic field B_t are shown in Fig.2 (a) with the particular collisionality ($0.1 < \nu_h^* < 1.0$). The normalized perturbed magnetic field $\delta b_1^{n=1}/B_t$ corresponds the square root of the width of the magnetic island and the minus sign means that the width of the magnetic island shrinks. It is clearly divided into two regions, one for island expansion and the other for the island shrinking. 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 β = 0.3%. In above β = 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 behavior of the toroidal position of the X-point $\phi_{n=1}$ is shown in Fig.2 (b). The $\phi_{n=1}$ has two positions depending on the beta. In the lower beta ($\beta < 0.3\%$) region, the $\phi_{n=1} \sim 0.86\pi$ [rad]. When the island shrinks ($\beta > 0.3\%$), the position of the X-point shifts to around $\phi_{n=1} = 0$[rad]. The position of the X-point of the seed island is located at $\phi = \pi$ [rad]. The $\phi_{n=1}$ (~0.86π [rad]) is roughly same as the seed island when the island enlarges. When the island shrinks, on the other hand, the $\phi_{n=1}$ is in the opposite toroidal position to that of the seed island. It is future work to clarify the kind of the current that influences the behavior of a magnetic island. This work was supported by NIFS under Contract No.NIFS06ULHH518.

Reference

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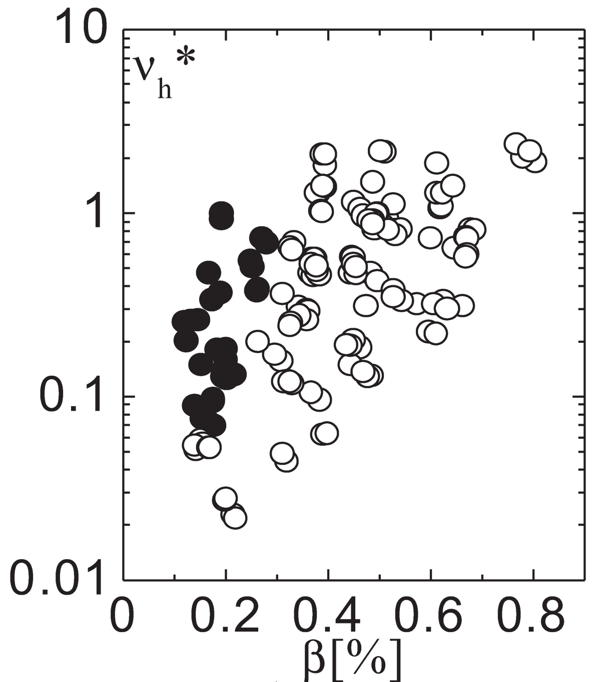

Fig.1. Beta vs. ν_h^* space. Open circles indicate the case where the island is not observed. Filled circles denote that the island enlarges.

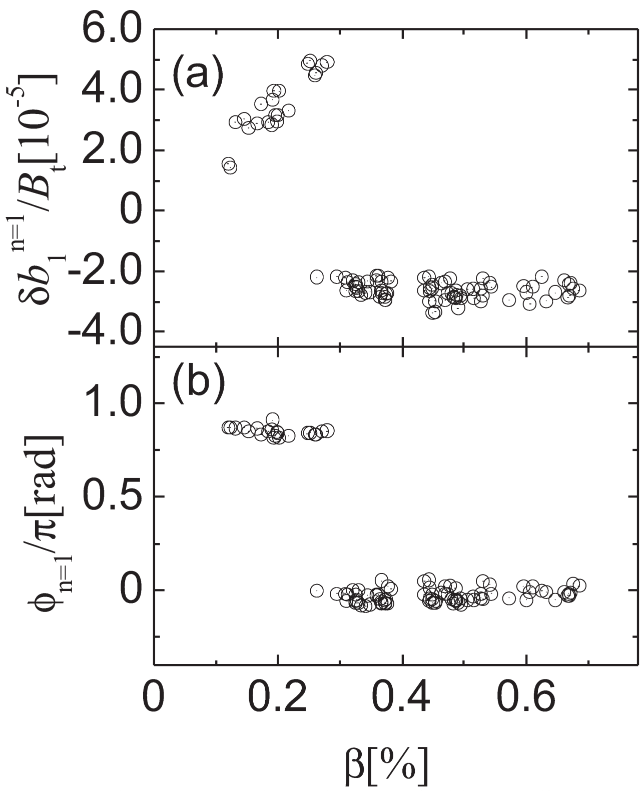

Fig.2. Beta dependency of (a) amplitude of perturbed magnetic field of n = 1 mode $\delta b_1^{n=1}/B_t$ and (b) position of the X-point $\phi_{n=1}$.