Effects of Static Magnetic Islands on Interchange Mode in Straight Heliotron Configuration

K. Saito[a], K. Ichiguchi[a,b], N. Ohyabu[a,b]

[a] *The Graduate University for Advanced Studies, 322-6 Oroshi-cho, Toki 509-5292, Japan*
[b] *National Institute for Fusion Science, 322-6 Oroshi-cho, Toki 509-5292, Japan*

saito.kinya@nifs.ac.jp

In the magnetic confinement of the fusion plasma, a configuration with nested surfaces is the most favorable. However, error magnetic field originated from such as misalignment of the field coils and the terrestrial magnetism induces static magnetic islands. The static islands have a possibility to affect the plasma confinement substantially. Particularly, the heliotron configuration is easily affected by the static islands because all of the confinement magnetic field is generated by the outer coils. In the Large Helical Device (LHD), which is a typical heliotron device, the Local Island Diverter coils are installed in the system to control the static islands with $(m, n) = (1, 1)$ actively and investigate the effects on the global confinement[1].
On the other hand, the interchange mode is a crucial MHD mode in the heliotron configurations. Therefore, a lot of theoretical analyses have been done for the behavior in the nested surface configuration. However, only a few works treated the behavior of the interchange mode in the existence of the static islands. Therefore, comprehensive study about the direct interaction between the interchange mode and the static islands has not been carried out.
Thus, we analyze the effects of the static island on the interchange mode systematically. The present work is the first step of the analysis. Here we employ a straight heliotron configuration corresponding to an LHD configuration because we investigate the basic mechanism of the island effects. Since the nonlinear treatment is inevitable for the study of the magnetic islands, we utilize the NORM code[2] in the study, which is based on the reduced MHD equations. Here we choose the $(m, n) = (1, 1)$ magnetic islands. The effect of the islands is incorporated by assuming the existence of a finite static poloidal magnetic flux at the plasma boundary. By controlling the boundary value of the poloidal flux, we can change the island size. We also assume that the perturbations have a single helicity resonant with the magnetic islands. In this case, it is obtained that the interchange mode linearly grows and saturates nonlinearly as in the case without the islands. However, the linear growth rates of the modes with higher harmonics are different. Furthermore, in high resistivity case, the imposed islands can disappear when the mode saturates. We will discuss the property of the interchange mode in the linear phase and the island behavior in the saturation phase.
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