Identification of magnetic islands in Heliotron J experiments

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Generating and keeping clear flux surfaces are an aim of magnetic confinement researches, because magnetic islands and stochasticity of magnetic field leads the degradation of the confinement connecting and overlapping filed lines. In tokamaks, the degradation of the confinement due to generating islands like the locked mode and neoclassical tearing mode (NTM) were observed and studied [1,2]. In addition, same degradation is also observed in helical system [3]. Thus, understanding and controlling of island dynamics are urgent and critical issues to aim the fusion reactor. A method to identify magnetic islands is measuring electron temperature and density. However, if islands are rotating or healing, the profile measurement cannot identify island structure. Another method is the magnetic diagnostics. Since the magnetic diagnostics detects the change of magnetic flux directly, above problems are resolved but the diagnostics must be installed appropriately to detect perturbed field of islands.

In this study, we study island dynamics using the magnetic diagnostics in Heliotron J plasmas. Heliotron J is an L=1/M=4 helical axis heliotron configuration. A characteristic is the rotational transform profile with low magnetic shear (ι~0.5) to improve the particle confinement. This means there is a possibility of generating of large magnetic islands with coupling the perturbation. If low n resonances are superposed, low n/m islands appear. This is an advantage to study the island dynamics using those islands. Thus, in order to generate low order magnetic islands and the impact of the equilibrium response, external perturbation coils are designed and installed in Heliotron J device.

Since the profile of the plasma pressure becomes flat, the equilibrium response is driven by flattering pressure. The magnetic diagnostic identifies the response localized along the toroidal direction. In the experiment, n/m=2/4 islands are generated. The islands width is about 50% of the effective minor radius. The interpretation of signals from the diagnostics is done by combining a 3D MHD equilibrium calculation code without the assumption of nested flux surfaces [4] and a loop signal analysis code [5]. Detailed comparison between experimental results and numerical analysis will be presented.

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