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トロイダルプラズマにおける外部磁場揺動による強制磁気再結合
Forced reconnection by external magnetic perturbation in toroidal plasmas

石井康友、安積正史[1)]
Yasutomo Ishii,　Masafumi Azumi

日本原子力研究開発機構、高度情報科学技術研究機構[1)]
JAEA, RIST[1)]

Magnetic perturbations applied to magnetically confined plasma cause the forced magnetic reconnection and lead to magnetic island formation. Such a change of the magnetic structure affects the plasma performance. The forced magnetic reconnection process has been studied in many theoretical, numerical and also experimental works. However, especially in the theoretical studies and/or numerical simulation ones, many works treated the slab geometry or the cylindrical geometry focusing on fundamental process of the magnetic reconnection. On the other hand, magnetic confined plasma aiming for nuclear fusion reactor is confined in the toroidal geometry. In the toroidal geometry, if an external magnetic perturbation with a single helicity is applied, many modes with different helicities are excited through the side band mode couplings and affect the magnetic configuration. In this study, we will report results obtained by numerical simulation study about effects of the external magnetic perturbation applied to tokamak plasma with toroidal symmetry, especially about feature of externally driven magnetic islands.

Figure 1 shows the time evolution of the magnetic island width excited by applying the external magnetic perturbation with m/n=5/1 at the plasma surface to toroidal plasma, which has the aspect ratio of 4 and has the safety factor at the magnetic axis q_0=2.01 and at the plasma surface q_a=6.11. The initial equilibrium is stable for the tearing mode and the resistivity is10^-6, which is constant in the radial direction in this simulation. In this configuration, there is a possibility that m/n=5/1,4/1 and 3/1 harmonics interacts with each other. The external perturbation evolves as the followings;

psi(5/1)=10^-4 t/250 : 0 < t < 250
=10^-4 (500-t) /250 : 250 < t < 500
=0 :　500 < t.

As shown in fig.1, for the magnetic island with m/n=5/1, while outer magnetic island width evolves according to the time evolution of the external perturbation, inner magnetic island width continues to grow even in the decreasing phase of the external perturbation. After some time, the inner magnetic island width begins to decrease. This feature is caused by the difference between the process of compressing magnetic field in the increasing phase of the external magnetic perturbation and that of relaxation process of the magnetic field in the decreasing phase of the external magnetic field. After disappearance of the external magnetic perturbation, m/n=5/1 magnetic island continues with longer time scale.

In this configuration, magnetic islands with m/n=4/1 and m/n=3/1 are also excited by the toroidal mode coupling with the magnetic perturbation with m/n=5/1. However, these side band modes evolve in more slow time scale as shown in fig.1. In the low resistivity parameter region, the time evolution of magnetic island after disappearance of the external magnetic perturbation becomes slow. Therefore, this shows that, even after the disappearance of the external magnetic perturbation, there is a possibility that externally driven magnetic island affects the plasma performance for a long time.

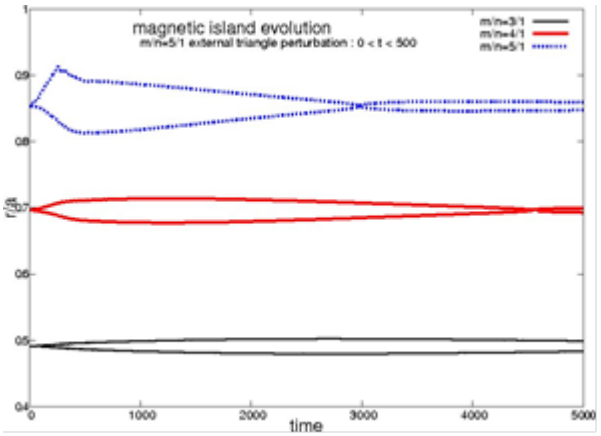

Fig.1 Time evolution of magnetic islands excited by m/n=5/1 external magnetic perturbation.