§28. Studies of Plasma Responses on Magnetic Islands in a Heliotron with Low Magnetic Shear

Suzuki, Y., Muto, T., Watanabe, K.Y., Sakakibara, S.,
Yokoyama, M., Nakajima, N.,
Sano, F., Mizuuchi, T., Kondo, K., Okada, H.,
Nagasaki, K.,
Kobayashi, S., Nakamura, Y., Motojima, G.,
Yamamoto, S. (Kyoto Univ.),
Nishino, N. (Hiroshima Univ.),
Kitajima, S. (Tohoku Univ.)

The MHD equilibrium is the basis of both most theoretical considerations and physics interpretation of the experimental results. In recent experiments, net toroidal currents, which are the bootstrap and Ohkawa and so on, were observed. Net toroidal current affects the topology of the magnetic field. In particular, in low magnetic shear configuration like Heliotron J, appearing of magnetic islands and ergodization of the magnetic field are expected. In order to consider the sensitivity of the configuration, the topological study is necessary using the code without the assumption of nested flux surfaces such as the HINT2[2] and PIES[3] codes. In this study, MHD equilibrium including net toroidal currents of Heliotron J device is studied using HINT2 code.

Figure 1 shows puncture maps of magnetic field lines for the vacuum and finite-β equilibria with/without net toroidal currents[4]. The profile of the plasma pressure and net current density are specified to $p = p_0(1-s)^2$ and $\vec{j} = \vec{j}_0(1-s)^2$, where s is the normalized toroidal flux at the edge. Figure 2 shows profiles of the rotational transform as the function the averaged minor radius corresponding to figure 1[4]. For the vacuum field, clear flux surfaces are sustained. However, 4/7 island chain appears in a finite-β equilibrium without net toroidal currents because the iota on the axis increases and comes across 4/7. On the other hand, for flowing net toroidal currents, the topology of the magnetic field is changed. For adductive direction of currents, the island width increases and large resonance appears in the peripheral region. Thus, the topology is significantly changed. Increasing total current, two resonances are overlapped and the last closed flux surface shrinks. However, for subtractive direction of currents, since the rotational transform on the axis decreases, the resonance of 4/7 disappears. Therefore, clear flux surfaces are sustained in finite-β equilibrium. This suggests a possibility to keep clear flux surfaces in finite-β. In Heliotron J, current driven experiments to control MHD equilibrium were done[5]. Detailed comparison and its verification are a future subject.

1) Hirshman, S. P. et al. : Phys. Fluids **26** (1983) 3553
2) Suzuki, Y. et al. : Nucl. Fusion **46**, (2006) L19
3) Reiman, A. et al. : Compt. Phys. Commnun. **43** (1986) 157
4) Mizuuchi, T. et al. : Nucl. Fusion **47** (2007) 395
5) Motojima, G. et al. : Nucl Fusion **47** (2008) 1045

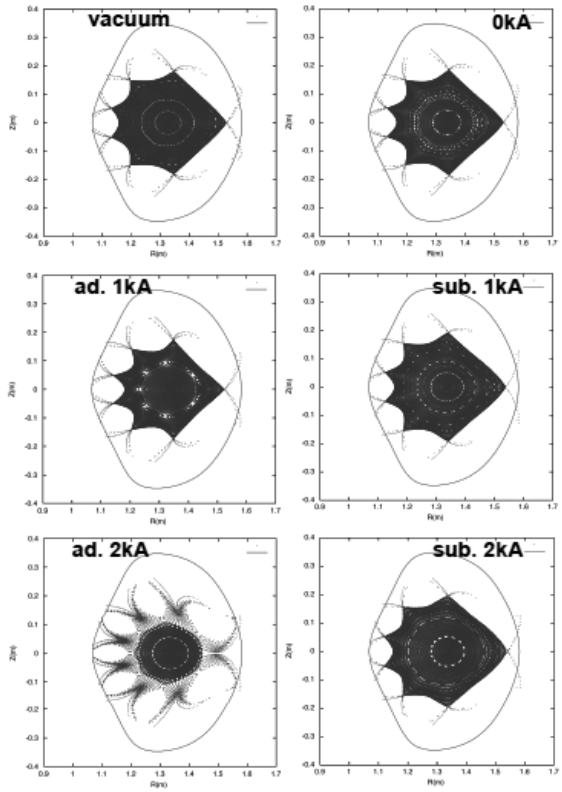

Fig.1. Puncture map of field lines on the standard configuration with net toroidal currents.

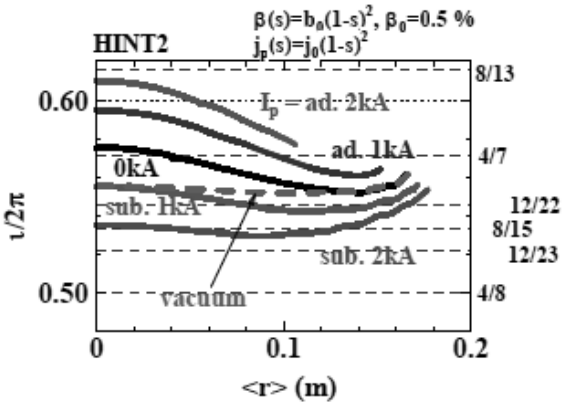

Fig.2. Profiles of the rotational transform of the standard configuration with net toroidal currents.