§44. Development of Suppression Methods of Global Interchange Instability by External Resonant Perturbed Field in LHD

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In LHD high beta experiments, the disruptive phenomena driven by MHD instabilities have never been observed. However, the decrease of the pressure gradients around the low order resonant rational surfaces and the degradation of the global energy confinement performance by about 10% are observed when the global MHD instabilities appear [1]. It should be noted that the amplitude of the confinement degradation strongly depends on that of the magnetic fluctuation. In the tokamak's and the RFP's previous researches, it is known that the resonant perturbed field externally induced is effective to suppress the low order MHD instabilities. Here the effects of the statically induced low order resonant perturbed field with the external coil sets, so-called LID coils, on the interchange instabilities in LHD.

The experiments are done in the following conditions where the m/n=1/1 modes (m and n are the poloidal and toroidal mode numbers) are often observed, R_{ax}=3.75m, B_q=10%, γ=1.254, B_0=1.2T, $<\beta>\sim1\%$. It should be noted that the resonant surface is located at $\rho\sim0.9$ (ρ; the normalized minor radius). Figure 1 shows the radial amplitude of the m/n=1/1 mode fluctuation measured by Soft X-ray (SX) measurement (a) and the amplitude of the magnetic fluctuation as the function of the induced resonant perturbed fields. The amplitude of the induced perturbed field are expressed by the coil current in the LID coils normalized by the operation field, and the dashed line corresponds to the coil current to compensate the intrinsic error field due to the miss-alignment of the device, the size of the magnetic island due to which is about 10% of the plasma minor radius. From Fig.1, the radial amplitude of the SX signal and that of the magnetic fluctuation decrease as the resonant perturbed field increases. In Fig.1, the maximum of the perturbed field corresponds to the 10 times larger field than that of the intrinsic error field, which corresponds to the island formation with the size of the 30% of the minor radius, where the radial amplitude of the SX fluctuation signal is reduced to one-tenth, and the amplitude of the magnetic field is to a half. Here the SX signal corresponds to the line-integral measurement. The more detail study, for example the study of the relationship between the magnetic field fluctuation and the radial displacement vector, needs the additional analysis like the Abel inversion of the fluctuation, which is one of the most important future subjects. Figure 2 shows that temperature profiles for the discharges with/without the externally resonant perturbed field, which correspond to the experimental conditions marked with the circles in Fig.1. In the both cases, the temperature gradients are almost same, which suggests that the reduction of the fluctuation amplitude is not due to the reduction of the driving term of the instability (pressure gradient) and is due to the interaction of the MHD instability and the static resonant field. Here we should note that, in the discharges with/without the externally resonant perturbed field, though the magnetic island size with the 10% and the 30% of the minor radius ate expected, the flattened pressure profiles are not observed. In order to resolve the mechanism of the suppression, the development of the new models and/or the simulation code is necessary.

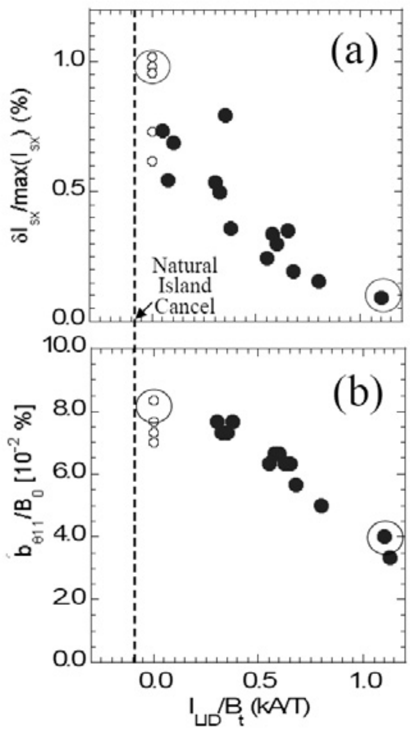

Fig. 1. (a) Radial amplitude of the m/n=1/1 mode fluctuation measured by Soft X-ray measurement and (b)amplitude of the magnetic fluctuation as the function of the induced resonant perturbed fields.

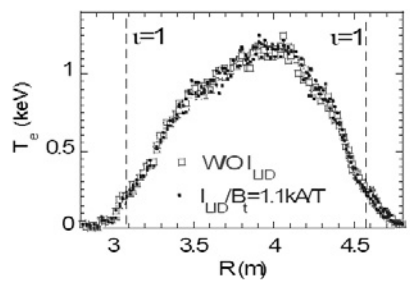

Fig. 2. temperature profiles for the discharges with/ without the externally resonant perturbed field.

1) Watanabe, K.Y. et al, Phy. Plasma 18 (2011) 056119.