§9. The Effects of the Resonant Magnetic Perturbation on Particle Transport in LHD

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The effects of the resonant magnetic perturbation (RMP) on particle transport are investigated in the Larger Helical Device (LHD). RMP is used to mitigate edge localized mode in tokmak [1] and helical [2] device. The enhancement of the particle transport is observed in DIII-D tokamak [3]. In order to understand physics mechanism of effect of RMP on particle transport, systematic experiments were performed at inwardly shifted configuration, where the magnetic axis position (R_{ax}) is 3.6m at Bt=2.75T. NBI heating power (PNBI) is scanned from 1.5 to 7.5MW and density is modulated at 2.5Hz to estimate diffusion coefficient (D) and convection velocity (V).

Figure 1 shows comparison of n_e and T_e profile with and without RMP for high power (7.5MW) and low power (1.5MW) heating. As shown in Fig.1, flattening of T_e is clearly observed with RMP at m/n=1/1 island position. Also, density profiles are clearly different. With high power, density profile changes from hollowed one without RMP to flat one with RMP. With low power, density profile changes from flat one without RMP to peaked one with RMP. In order to estimate D and V, the model shown in Fig.2 are used for the analysis [4]. Figure 3 shows the collisionality dependence of D and V. As shown in Fig.3, edge D (ρ=0.7-1.0) is clear enhanced with RMP and core V (ρ=0.4-0.7) changes from outwardly direction without RMP to inwardly direction with RMP. These difference are not clearly observed at outwardly shifted configuration (R_{ax}=3.9m) for ν_h*<1 [5] suggesting RMP effects is also function of magnetic configuration.

Figure 4 (a) shows dependence of edge D (ρ=0.7-1.0) on the applied RMP current for high heating power. As shown in Fig.4 (a), minimum is not 0kA but around -1kA. This offset is likely to be formation of magnetic island by error field at 0kA. Figure 4 (b) shows dependence of edge D (ρ=0.7-1.0) on the normalized magnetic island. The island width is estimated by the following equation.

$$W = \sqrt{\frac{B_r/B_t}{d\iota/d\rho}} \qquad (1)$$

.In eq.(1), toroidal magnetoic field Bt and rotational transform shear dι/dρ are set to be vacuum values, radial components of magnetic field B_r is measured by the saddle loop coil. As shown in Fig. 4(b) edge D is proportional to island width. RMP enhances particle transport with island formation, however RMP will not affect when island is healed.

1) Evans, T. et al. : Nature Physics, 2,(2006), 419
2) Toi, K, et al. :24th FEC 2011, October 8-13 (2012) San Diego, USA
3) Mordijck, S. et al. : Phys. of Plasmas, **19,** (2012), 056503
4) Tanaka, K. : Fusion Sci. and Tech. **58,** 70 (2010)
5) Tanaka, K.: Plasma Fusion Res. to be published

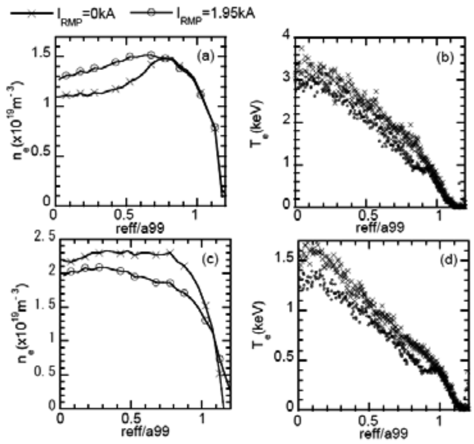

Fig.1 Comparison of n_e and T_e profiles (a),(b) P_{NBI}=7.5MW, (c),(d) P_{NBI}=1.5MW

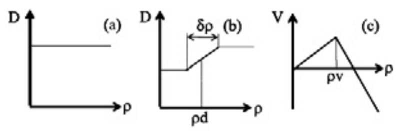

Fig2 Model of D and V. δρ=0.1, ρd=ρv=0.7

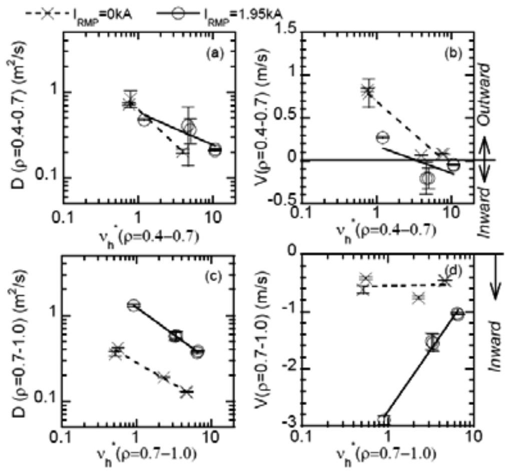

Fig.3 Collisionality dependence of D and V

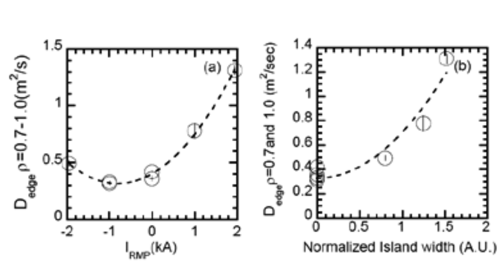

Fig.4 Dependence of D_{edge} on (a) I_{RMP} and (b) normalized island width