§2. Extended Study of RMP Effect on Particle Transport in LHD

Tanaka, K., Fujii, K. (Kyoto Univ.), Goto, M.,
Dinklage, A., Jakubowski, M. (IPP-Greifswald, Germany)

The resonant magnetic perturbation (RMP) are used for the mitigation of Edge Localized Mode (ELM) in tokamak [1] and helical device [2]. Recently, an application of RMP was found to improve density controllability and prevent radiation collapse, resulting in a steady state operation of LHD [3]. In addition to the initial study of the RMP effects on particle transport [4], extended studies were carried out. The RMP currents were scanned over a wider region (from the previous values of +-2kA, to +-3kA in this experiment). Also, the experiment was performed at higher collisionality. These extensions made formed islands larger, thus enabling the island effects to be studies more clearly.

Figure 1 shows comparison of various profiles in modulation experiments. Each profile was obtained by accumulating for two seconds. Fitted data of n_e and T_e were obtained using Thomson scattering, while those of T_i using charge exchange spectroscopy. The spatial profile of ionization rate was determined from the cross section of ionization and the Doppler broadening of an H_α intensity [5]. These profiles were averaged ones at the inner and outer halves of magnetic axis of the horizontally elongated cross section. The O point of m/n=1/1 island were located at around ρ = 0.9. As shown in Fig. 1(b), flattenings of the T_e profiles are progressively observed at ρ =0.9 with an increase in currents. Weaker flattenings are seen in the T_i profiles as shown in Fig. 1 (d). Peakings of densities inside the island are seen in Fig.1 (a). Similar observations were made in pellet injection experiments [6]. Beside such differences in profiles, ionization rates are almost the same in profiles.

Diffusion coefficients (D) and convection velocities (V) were estimated from the 2.5Hz density modulation experiment using data from a far infrared laser interferometer. For the analysis of density modulation, the poloidal symmetry was assumed, although the existence of the m/n=1/1 island breaks this assumption. Also, transports at O and X point must be different at the same minor radius. Improvements of analysis are required to take into account this problem. Present values of D and V are poloidaly averaged value at radial location. Figure 2 shows comparison of D and V profiles and Fig. 3 shows dependence of core (ρ=0.4-0.7) and edge (ρ =0.7-1.0) values of D and V on RMP currents. As shown in Fig.3, dependence on RMP currents has as off set values at -1kA. This is likely due to the effects of the error field. Apart from -1kA, both D_{core} and D_{edge} increased and V_{core} changed from the outward to the inward direction. On the other hand, V_{edge} did not show any clear dependence. As shown in Fig. 2(a), change of D, V with different RMP current can be seen non only in edge region, but also core region. These indicate RMP changes particle transport not only island region but also the whole region of the plasma. Density peaking inside the island suggests good confinement at the island O point. However, Fig. 3(a) suggests that an averaged particle diffusion at the radius of the island location enhanced particle transport. Such change of the averaged diffusion can influence density controllability [3].

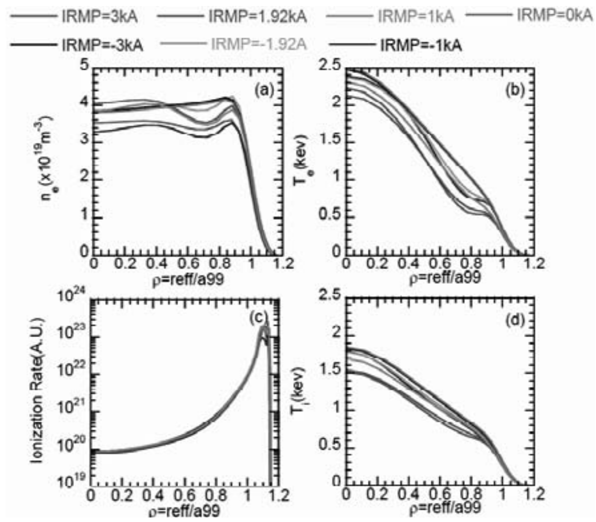

Fig. 1 Comparison of profiles with different RMP currents. (a) n_e, (b) T_e, (c) ionization rate and (d) T_i.

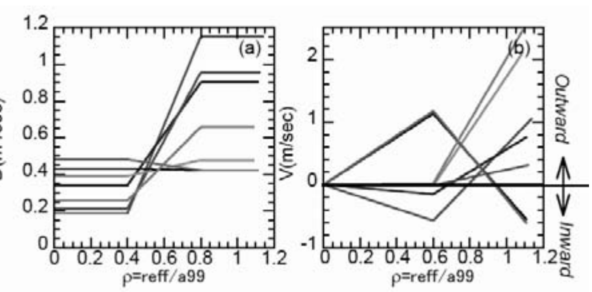

Fig. 2 Comparison of (a) D and (b) V profiles. Legends are the same as in Fig. 1.

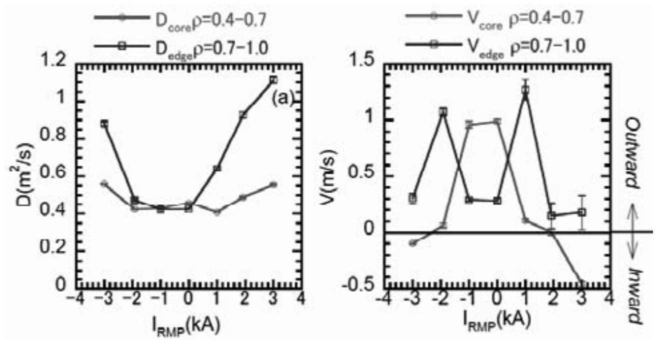

Fig. 3 Dependence of (a) D and (b) V on applied RMP currents.

1) T. Evans et al., Nature Physics, 2,(2006), 419
2) K. Toi et al., Nucl. Fusion **54** (2014) 033001
3) K. Tanaka et al., this annual report
4) K. Tanaka et al., NIFS annual report 2012-2013
5) M. Goto et al., Nucl. Fusion, **51**, (2011), 023005
6) T. Evans et al., this annual report