27pA10 LHD における外部共鳴磁場印加による粒子輸送への影響

Effects of resonance magnetic perturbation field on particle transport in LHD

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Resonant magnetic perturbation (RMP) coils are one of the most effective controlling tools to mitigate edge localized mode (ELM) activity in tokamaks [1]. In addition to ELM mitigation, RMP changes transport as well. For example, in DIII-D, enhancement of particle transport, the so-called particle pump-out, is reported [1]. Understanding the effect of RMPs on transport is essential for the ELM mitigated operation in tokamaks. In contrast to tokamaks, 3D devices allow for detailed assessments of the effect of stochastic fields on transport. In LHD, ELM-like events are observed in H -modes at relatively high plasma beta [2]. ELMs are, however, not regarded as a critical issue for LHD, since ELMs are not observed in most of the L mode discharges and in other improved modes such as high ion temperature discharges [3]. But the effect of RMPs on transport can also be used as a tool to control transport. The advantage of LHD is that the magnetic field structure in ergodic region is well determined and agrees with field calculations confirmed by saddle loop coil measurements. The experiments are done at the outwardly shifted configuration with a magnetic axis position at 3.9m and the width of ergodic layer becomes order of 30% of plasma minor radius. Figure 1 shows comparison of time trace with RMP and without RMP. The RMP forms an m/n=1/1 magnetic island close to the last closed flux surface. The power of the NBI has been reduced from 5.5 to 2.2 MW at t=5.3sec. The density is modulated at 5Hz by external gas fueling to estimate diffusion coefficient (D) and convection velocity (V). In low density, high power phase (t=3.1-5.3), edge D at ρ>0.7 is 0.67+-0.015m^2/s and 0.55+-0.014m^2/sec with and without RMP respectively, while V is almost identical. This indicates RMP causes enhanced edge diffusion. In high density, low power phase after t=5.3s, a higher increase of density is observed with lower external fueling without RMP. As shown in Fig.1(a), after t=5.3 sec, the density perturbation becomes very small in the case without RMP. Moreover, the figure indicates the density to be much better controlled with RMPs. This is sought to be due to the enhanced particle transport with RMPs. Figure 2 shows comparison of profiles of T_e, n_e, and density fluctuation amplitude with and without RMP at low power (high density). With RMPs, a flattening of T_e and n_e is seen at ρ=0.95-1.1 at the position of the m/n=1/1 island (cf. Fig. 2(a) and (b)). It is noted that this flattening does not occur in preceding phases of the discharge at low density, high power phase (t=3.1-5.3s). Fluctuation amplitudes measured by two dimensional phase contrast imaging (2D-PCI) [4] indicate the peak of fluctuation at ρ=0.8 without RMPs in inner regions with flat density profile. With RMPs, the fluctuation peaks around m/n=1/1 island. Concluding, these observations indicate that RMPs affect the turbulence character and enhance the particle transport in the discharges investigated.

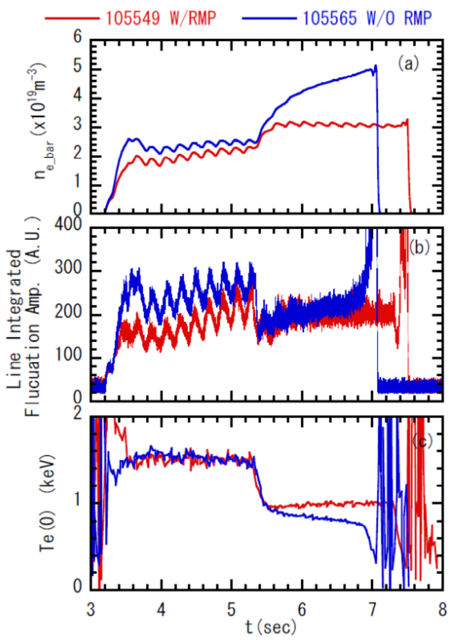

Fig.1 Comparison of (a) line averaged density, (b) line integrated fluctuation and (c) central electron temperature with and without RMP

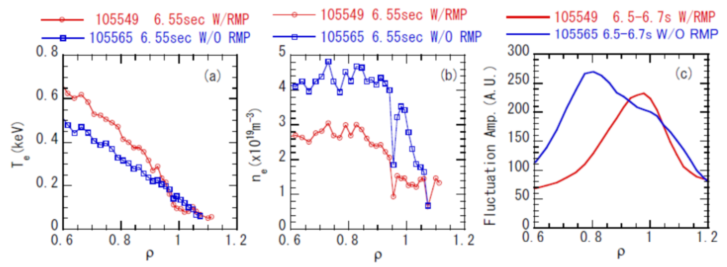

Fig.2 (a) T_e, (2) n_e and (c) fluctuation amplitude profile in the high density phase

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