5Dp02

LHDにおけるRMP磁場印加によって安定化されたデタッチメント運転とコアプラズマ輸送の関係

Core plasma transport during stable divertor detachment with RMP application in LHD

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Compatibility of good core plasma performance with divertor detachment operation is crucial issue for future reactor operation. On the other hand, it has been found that application of (resonant) magnetic perturbation (RMP, MP) field is effective to mitigate or suppress the edge localized mode (ELM) in tokamaks. In LHD, it has been found that the RMP application leads to easier control of detached plasma. However, the effects of RMP on the core plasma performance is still open issue. In this contribution, we focus on the relation between edge and core plasma behaviours during detachment operation with RMP application in LHD.

Temporal evolution of electron pressure profiles obtained by Thomson scattering measurements are plotted for different densities in Fig.1. At the low density of $\bar{n}_e/n_{Sudo}$= 0.45, which corresponds to the attached phase in the RMP application, it is clearly seen that the plasma volume becomes smaller compared to the no RMP case due to the edge island, while the central pressure is almost same. The reduction of volume leads to the reduction of plasma sored energy, W_p, by about 30% at the attached phase. Accordingly, the energy confinement time, τ_E, is also reduced with RMP, as shown below in Fig.2. With increasing density, the pressure profile becomes peaked for both cases, but the peaking is greater with RMP.

In figure 2, the energy confinement time, τ_E is plotted as a function of density normalized with n_{Sudo} . τ_E is divided by $(\bar{n}_e/P)^{0.6}B^{0.8}$ to see deviation from the gyro-Bohm scaling, $\tau_E^{GB} \propto (\bar{n}_e/P)^{0.6}B^{0.8}$. As shown in Fig.2, the scaled τ_E monotonically decreases with increasing density without RMP. The operation domain is bounded hard by the density limit, $\bar{n}_e/n_{Sudo}$ = 1. With RMP application, the energy confinement time is shorter by 30 % than the case without RMP at the attached phase, which is due to the reduced volume as mentioned above. Increasing density leads to continuous reduction of the scaled τ_E in the attached phase. However, at the detachment transition, which occurs at $\bar{n}_e/n_{Sudo}$ ~0.45, it discontinuously increases by about 15%, then starts decreasing with increasing density. At the higher density range, $\bar{n}_e/n_{Sudo}$ > 0.8, however, the scaled τ_E is almost constant against the density increases, indicating appearance of gyro-Bohm nature in τ_E. It is noted that the operation domain with RMP extends beyond the density limit, up to $\bar{n}_e/n_{Sudo}$ ~ 1.1, where the reduction of τ_E from the no RMP case becomes small, ~5 %. Core transport analysis with numerical code is underway.

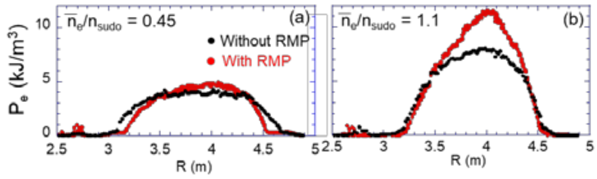

Fig.1 Radial profiles of electron pressure with (red) and without (black) RMP at attached (a) and detached phases (b).

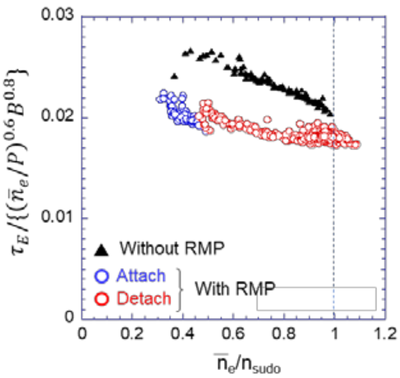

Fig.2 Energy confinement time scaled with gyro-Bohm scaling as a function of density, with (circles) and without (triangles) RMP.