§33. Investigation of Hydrogen Isotope Effects on Particle Transport in Heliotron-J

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The understanding of the hydrogen isotope effects are one of the most important issues for the future fusion reactor. In Heliotron-J, a particle transport study was done for hydrogen (H) rich and deuterium (D) rich plasma to understand hydrogen isotope effects. For this study, far-infrared interferometer using 337μm wavelength HCN laser was newly installed in Helioton-J[1]. Figure 1 shows HCN laser heterodyne interferometer. For the frequency shifting super rotating grating[2] is used to get 1 MHz intermediate frequency for the heterodyne detection. The fast time response of electron density up to 1MHz can be measured. Using microwave interferometer together, quantitative study of particle transport became possible. The microwave interferometer passes plasma center using horizontal view chord. The far-infrared laser interferometer passes at normalized position (ρ) =0.3 using vertical viewing chord. Contamination of H and D are controlled by the changing external fueling species.

Figure 2 shows comparison of density decay after turning off of gas fueling. Both in NB and EC heating plasma, decay time of density is longer in D rich plasma than in H rich plasma. Also, in NB heated plasma, the difference of decay time is larger than in EC heated plasma. However, the decay time is determined by particle confinement and also by the wall fueling recycling. Thus, it is difficult to judge the observed difference is due to the difference of the particle transport or recycling. Therefore, for the quantitative understanding, density modulation experiments are performed to estimate diffusion coefficient (D) and convection velocity (V) separately. The D,V model fitting technique was tried[3]. For the analysis using only two channels, modulation frequency was scanned at 20, 50 and 100Hz. Similar experiments are done in JT-60U[4]. The different modulation amplitude and phase profiles are obtained at different frequency for same D and V. This increases the fitting constrain. Figure 3 and 4 show comparison of measured modulation amplitude and phase. The different amplitude and phase profile suggests that particle transports are different in H and D rich plasma both with NB and EC heating. The model calculation for spatially constant D=0.3, 0.6 and 1.2m^2/sec are also shown this figure. The particle balance equation of modulation components are solved for each D values, them integrated along microwave and far infrared interferometer. The value of the modulation ratio and phase is close to these calculation, however, profile does not agree. This indicates modeled D does not account the observation. Also, other possibility is V is necessary to fit experimental values. Detail analysis to determine D and V will be done.

1) Ohtani, Y., et al, Plasma Fusion Res. to be published.
2) Maekawa, T., et al, Rev. Sci. Instrum. 62,304, (1991)
3) Tanaka. K. et al, Fusion Sci, Tech. **58**, 70 (2010)
4) Nagashima, K., et al, Nucl. Fusion, 33 (1993) 1677

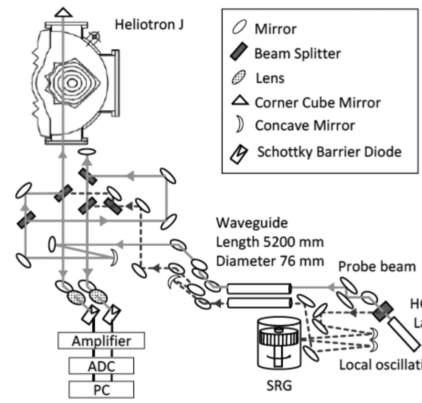

Fig.1 Schematic view of HCN laser interferometer

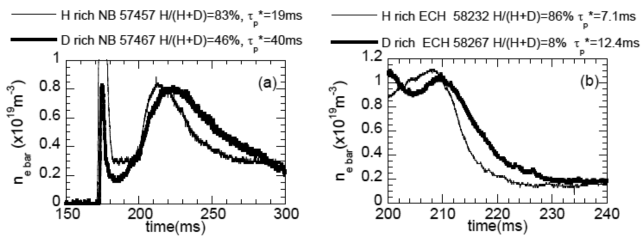

Fig.2 Comparison of density decay after turning off of gas puffing (a) NB heated plasma and (b) EC heated plasma

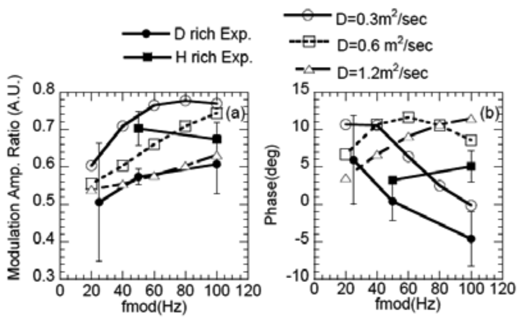

Fig.3 Comparison of modulation (a) amplitude and (b) phase between experiment and model calculation in NB heated plasma

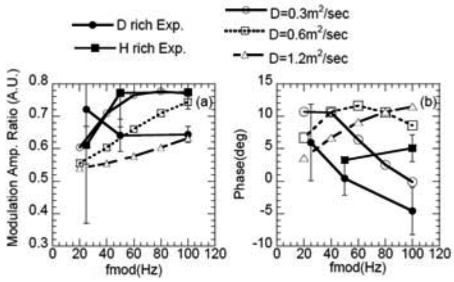

Fig.4 Comparison of modulation (a) amplitude and (b) phase between experiment and model calculation in EC heated plasma