Effect of isotope mass on bulk ion particle transport in isotope mixture plasma

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Effect of isotope mass on particle transport in isotope mixture plasma, where ion particle transport is decoupled from electron particle transport, is investigated in Large Helical Device (LHD). The LHD is a heliotron-type device for magnetic confinement of high-temperature plasma. In order to investigate effect of isotope mass on particle transport, the hydrogen (H) or deuterium (D) pellet is injected into the D-H mixture plasma and the radial profiles of ion density of hydrogen (H) and deuterium (D) are measured after the pellet injection using bulk charge exchange spectroscopy. It should be noted that the transport study in the D-H mixture plasma is essential in order to resolve a degenerate between ion particle transport and electron particle transport due to the quasi-neutralization condition.

Bulk charge exchange spectroscopy system has been installed in LHD to measure the radial profiles of hydrogen and deuterium ion density in the plasma from H_α and D_α lines emitted by the charge exchange reaction between the bulk ions and the neutral beam injected. The hot component due to the active charge exchange reaction with the neutral beam is smaller than the cold component emitted in the edge by one order of magnitude. In order to subtract the cold component of the H_α and D_α charge exchange lines, beam modulation technique is applied. Although most of the cold components of the charge exchange lines are subtracted by the beam modulation, there still remain cold components comparable to the hot components. Therefore, the charge exchange lines are fitted by 4 Gaussian of H and D cold components and H and D hot components. H and D densities are calculated from the H and D hot components and beam density.

Figure 1 shows three time slices of radial profiles of hydrogen and deuterium ion density 5 ms before and 15 ms and 55 ms after the H pellet injection. The hydrogen ion density decreases during the density decay phase after the H pellet injection as is expected. It is very interesting finding that the hydrogen ion density even increases during the density decay phase after H pellet injection. This measurement clearly shows the evidence of the exchange of isotope ions in the isotope mixture plasma after the pellet injection.

This paper reports important findings on difference in the ion particle transport between hydrogen and deuterium plasma in the H-D mixture plasma, which implies the importance of the difference in D and T ion particle transport in the fusion plasma in future.

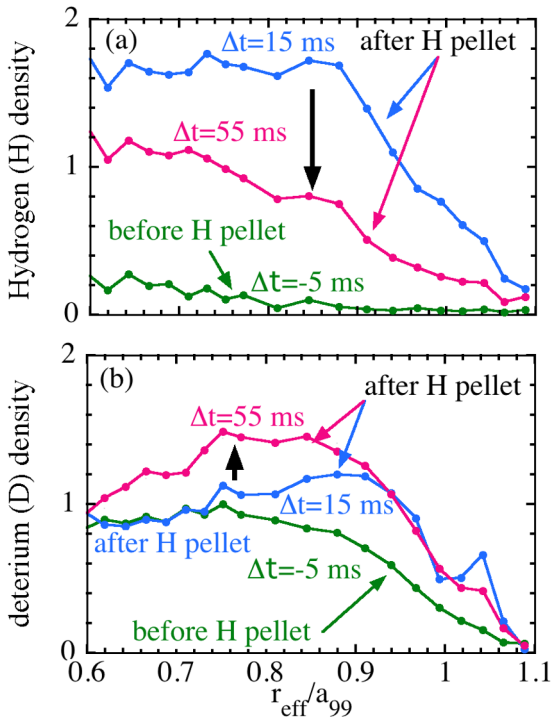

Figure 1. *Radial profiles of hydrogen and deuterium ion density after the hydrogen (H) pellet injection into the deuterium (D) plasmas.*