§39. Experimental Study of Ion Tail Production in ECH/ECCD Plasmas of LHD

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In several torus devices, tail ion has been observed even in the electron heated plasmas such as ECH and/or ECCD [1]. These phenomena have been considered to be due to the anomalous electron-ion coupling or acceleration by LH-decay waves, however, the mechanism of the ion tail formation is still an open question. In the Heliotron J experiments, the ion tail have been obtained in the ECH plasmas (lower field side injection) under the condition that the line-averaged electron density was lower than 1×10^{19} m^{-3} [2].

In this experimental campaign, we focused on the measurement of the low energy (< 10 keV) charge exchange (CX) neutral particles with the E//B type neutral particle analyzer (E//B-NPA) and the compact NPA (CNPA) systems in the low density ECH plasmas for the first time. The power modulation experiment was tried by changing the power of the two units of 82.7GHz ECH simultaneously to obtain the higher modulated power.

Figure 1 shows the typical time evolution of the CX flux (#72689) in the energy range of 0-12, 12-30 and 30-60 keV with E//B-NPA in the power modulation experiment with 2 units of 82.7GHz ECH. The modulation frequency was 10 Hz. The initial plasma was produced and sustained by the two units of 84 GHz ECH system and the line-averaged electron density was $0.1\text{-}0.3\times10^{19}$ m^{-3}. As shown in Fig. 1, the CX flux was increased as the modulation ECH was turned on. The change in the fraction of the CX flux of 0-10 keV to 12-30 keV, on the other hand, was not clear because of the low S/N ratio. Figure 2 shows the line-integrated electron density at the core (R=3.669m) and both edge (R=3.309 and 4.119 m) and intensity of the Hα line emission. The edge electron density was kept constant through the discharge. Although the Hα intensity was slightly changed by the power modulation, it was smaller than the change in the CX flux as shown in Fig. 1. The energy spectrum of the CX flux with CNPA from t = 0.3 sec to 0.6 sec in this discharge is shown in Fig. 3. As compared with the effective temperature (T_{eff}) deduced from the slope of the energy spectrum from 0 to 10 keV and from 10 to 20 keV, it was found that T_{eff} in the lower energy side was almost constant about 1.6 keV. However, T_{eff} in the higher energy side was increased as the density was decreased. The ion temperature deduced from ArXVII, on the contrary, was estimated about 0.3 keV. If the Ar temperature was regarded as the bulk ion temperature, the CX flux higher than 2 keV would be considered as the tail component. Further discussion is needed to determine the energy range of the ion tail.

The above results suggest the possibility of the production of ion tail in the ECH plasmas of LHD. However, further analysis and experiments are needed to obtain a clear formation of the ion tail. In the next experimental campaign, the high field side injection of the ECH microwave is being planned aiming at the mode conversion of the EC microwaves to the LH waves at UH resonance layer.

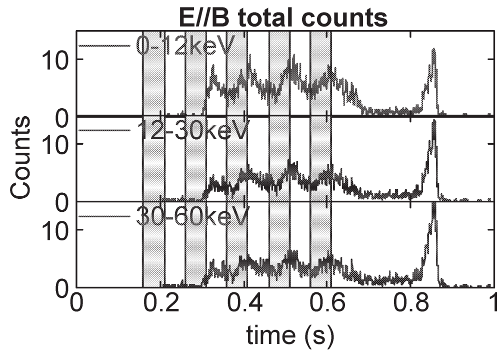

Fig. 1 Time evolution of the CX flux with E//B-NPA in the ECH power modulation experiment (#72689).

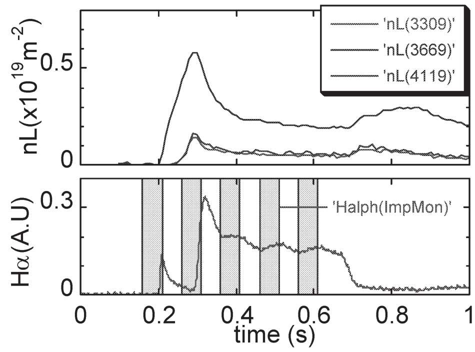

Fig. 2. Time evolution of the line-integrated electron density and the Hα emission intensity.

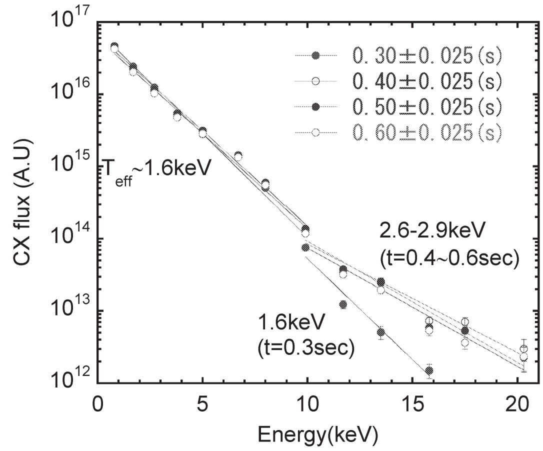

Fig.3 Energy spectrum of CX flux with CNPA obtained in the same discharge shown in Fig. 1.

Reference
1) V.Erckmann and U.Gasparino, Plasma Phys. Control. Fusion **36** (1994) 1896.
2) Kaneko, M., Kobayashi, S. *et al*. 30st EPS Conf. Plasma Phys. St. Petersburg, ECA **Vol.27A**, P-3.28 (2003).