§16. Study of Non-local Ion Transport with Repetitive Pellets

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Non-local transport in the electron transport has been studied using the TESPEL and transient core temperature rise associated with the edge cooling was observed[1)]. It has been a open to question whether a similar behavior can exist in the ion transport and time resolution of charge exchange spectroscopy has been improved to measure the transient change in the ion temperature after the edge cooling . However, the partially ionized carbon ions (C^{5+}) from TESPEL travel along magnetic field and across the line of sight and causes an apparent drop of ion temperature in the charge exchange spectroscopy measurements (plume effect). Therefore the perturbation due to the pellet without carbon is necessary for the accurate measurement of ion temperature. In order to study the non-local characteristics in the ion transport, the repetitive pellets are injected into the plasma with a vacuum magnetic axis of 3.55m, magnetic field of 2.79T and a minor radius, a_{99}, of 0.62m.

Figure 1 shows the time evolution of electron temperature in the core ($r_{\rm eff}/a_{99}$=0.36, R=3.79m) and edge ($r_{\rm eff}/a_{99}$=0.95, R=4.38m) and ion temperature in the core ($r_{\rm eff}/a_{99}$=0.25, R=3.708m) and edge ($r_{\rm eff}/a_{99}$=0.95, R=4.389m) in the discharge with repetitive pellet injection. After the pellet injection at t = 4.0103s, the edge electron temperature drops by 20%, while the core electron temperature is almost unchanged. The electron density is 1.13 $\times 10^{19}$ m^{-3} which is slightly above the critical value for electron temperature rise. The core ion temperature increases by 30% (0.4-0.5 keV) in the time scale of $\sim$ 10 ms and decays in $\sim$ 20 ms. This time scale of the transient change in the core ion temperature is similar to that observed in the electron non-local transport. As the electron density is increased, the magnitude of ion temperature rise becomes smaller, which is similar to that in the electron temperature rise.

Figure 2 shows radial profiles of ion temperature 2.8ms before (t=4.0075s) and 12.2ms after (t = 4.0225s) the repetitive pellet injection. The transient ion temperature rise is observed in the core region of $r_{\rm eff}/a_{99} < 0.6$, which is wider than that observed in the electron temperature rise ($r_{\rm eff}/a_{99} < 0.5$). The region of transport reduction as indicated by the transient increase of ion temperature gradient located at the mid-radius of $r_{\rm eff}/a_{99} = 0.4 - 0.6$, which is in contrast to that the reduction of transport is observed near the plasma center at $r_{\rm eff}/a_{99} = 0.3$ in the electron temperature rise. This experiment clearly shows that core ion temperature rise takes place even in the higher collisionality region, where the core electron temperature rise disappears.

1) N.Tamura. et al. Nucl. Fusion 47 (2007) 449.

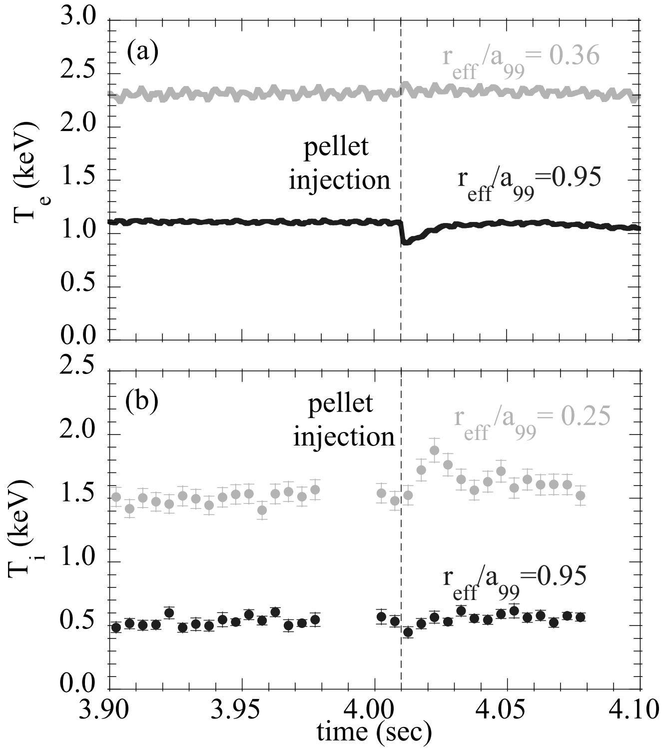

Fig. 1: Time evolution of electron temperature in the core ($r_{\rm eff}/a_{99}$=0.36) and edge ($r_{\rm eff}/a_{99}$=0.95) and ion temperature in the core ($r_{\rm eff}/a_{99}$=0.25) and edge ($r_{\rm eff}/a_{99}$=0.95) in the discharge with repetitive pellet injection.

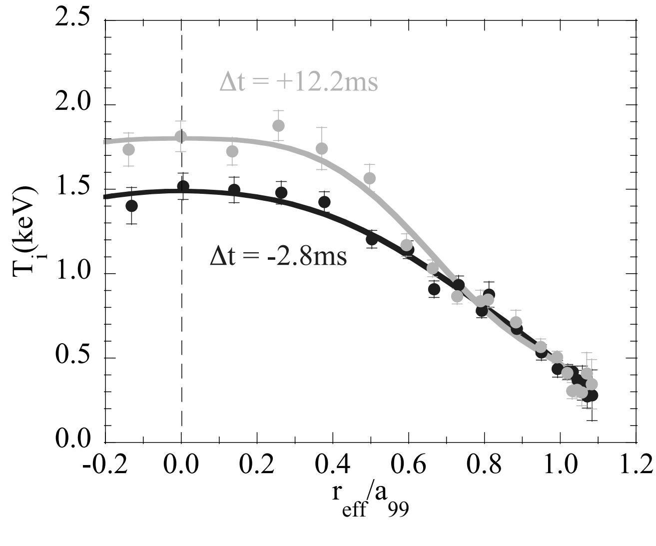

Fig. 2: Radial profiles of ion temperature before and after the repetitive pellet injection. (Δt = -2.8ms and Δt = +12.2ms).