§4. Nonlocal Transport in Cold Pulse Experiments

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Transient response of a plasma against various types of perturbations may provide a powerful knob to understand anomalous transport in a tokamak plasma. In JIPP T-IIU the perturbative transport experiments are carried out by using a cold pulse produced at the plasma edge. The cold pulse is produced with a positively biased electrode inserted just inside the last closed flux surface and by ice pellet injection. The front of the cold pulse observed in ECE signals propagates inward from the plasma edge. It is interesting to study the nature of radial propagation of the cold pulse, that is, diffusive nature governed by local plasma parameters or non-diffusive(or nonlocal) one.

Figure 1 shows the time evolution of electron temperature T_e at various minor radii when a positive bias voltage is applied to an electrode inserted just inside the last closed plasma surface (r/a~0.8). Electron temperature near the peripheral region (r/a>0.5) is decreased and that in the region of r/a=0.30-0.35 remains almost unchanged. But, T_e near the center(r/a<0.2) rises with only a shot time-delay for the drop of T_e at the edge. Note that the ohmic input is hardly increased due to the edge cooling(Fig.1). Ion saturation current I_{is} in the scrape-off layer is considerably increased during the biasing. This shows the enhanced particle loss across the last closed flux surface. Magnetic fluctuations are also enhanced during the biasing. The similar Te-rise induced by edge cooling is observed also in ice pellet injection, as shown in Fig.2. In this discharge the pellet is mostly ablated in the peripheral region of r/a>0.5. In contrast to the biasing case, I_{is} and magnetic fluctuations are decreased just after the pellet injection.

The Te-rise in the center observed in both cold pulse experiments suggests non-local electron heat transport. This phenomenon is observed only in ohmically plasmas. As seen from Fig.2 the loop voltage is obviously increased just after the pellet injection, of which voltage increase is caused by edge cooling and also by increase in the internal inductance. The Te-rise in the plasma center induced by the edge cooling may be interpreted by the reduction of the electron heat transport in the plasma central region, as discussed in TEXT[1], or by anomalously fast change of the ohmic heating power density near the center. Although the former cause seems to be plausible, but so far the latter is not completely ruled out.

[1] K.W. Gentle et al., Phys. Rev. Lett. **74** (1995) 3620.

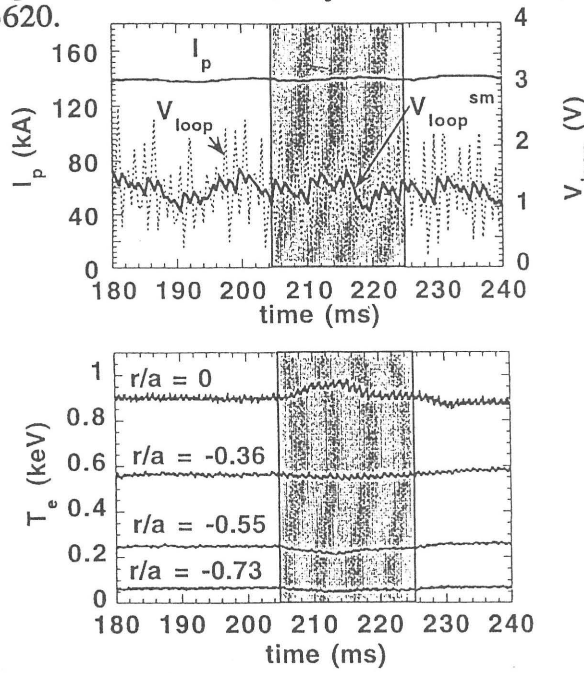

Fig.1 Time behavior of the ohmic discharge when the positive bias is applied to the electrode inserted just inside the last closed flux surface.

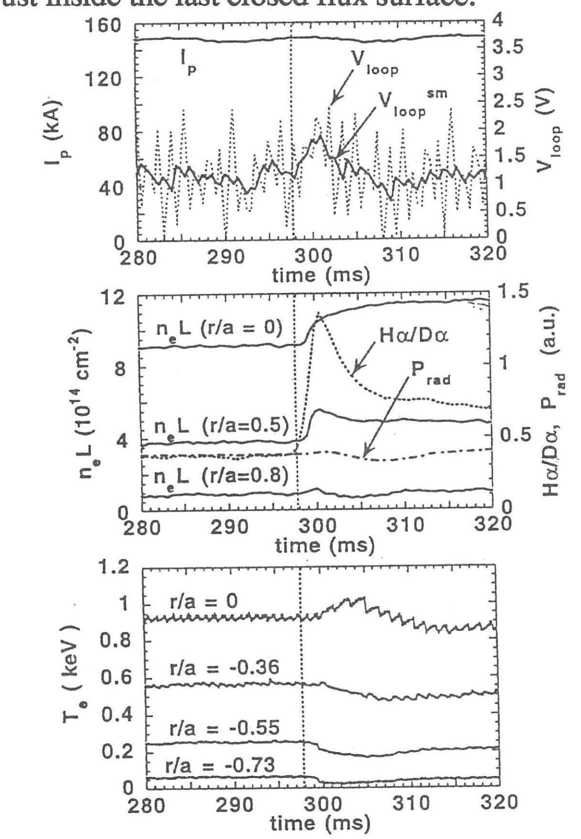

Fig.2 Time evolution of the ohmic plasma when a small ice pellet is injected. (Upper figure) plasma current, loop voltage and smoothed one, (Middle figure) line integrated electron density, Hα/Dα light and total radiation power, and (Lower figure) electron temperature obtained by ECE .