§10. Core Electron Temperature Rise Due to Ar Gas-puff in EC-heated LHD Plasmas

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In order to investigate the electron heat transport in LHD plasmas closely, several temperature perturbation techniques, such as a TESPEL injection and a hydrogen ice pellet injection, have been applied. Under some conditions, an abrupt increase in core electron temperature T_e has been observed just after those perturbations. The response time of the core T_e rise to the edge perturbation is beyond the standard transport paradigm (local and diffusive). One of the candidates for explaining this phenomenon is non-locality in turbulence, such as turbulence spreading. In this regard, however, further experimental and theoretical investigations are necessary.

In 10th LHD campaign, after a slight Ar gas-puff, the similar core T_e rise has been observed as shown in Fig. 1(a). In this discharge, the plasma was sustained only by ECH (total injected power ~ 1.6 MW around the timing of the Ar gas-puff). The maximum increment of the core T_e is about 1.3 keV, which is comparable to the case with the TESPEL injection under the same plasma conditions. The line-averaged electron density n_{e_bar} is increased slightly about 30 ms after the Ar gas-puff. This increase in n_{e_bar} is attributed mainly to the increase in edge n_e, as indicated in Fig. 1(d). And there is almost no change in the total radiated power before and after the Ar gas-puff. Thus the core T_e rise cannot be caused by the RI mode, which has characteristically a density peaking and a significant enhancement of radiated power.

A transient response analysis reveals a similarity of the core T_e rise between with the Ar gas-puff and with the TESPEL injection. In both cases, as shown in Fig. 2(a) and (c), the relation of the perturbed electron heat flux normalized by n_e to the gradient of perturbed T_e shows a similar hysteresis loop. And the maximum of normalized perturbed electron heat flux appears around ρ ~ 0.5 (see Fig. 2(b) and (d)). Thus the non-locality in the electron heat transport would be essential for the core T_e rise after the Ar gas-puff as well as for that due to the TESPEL injection.

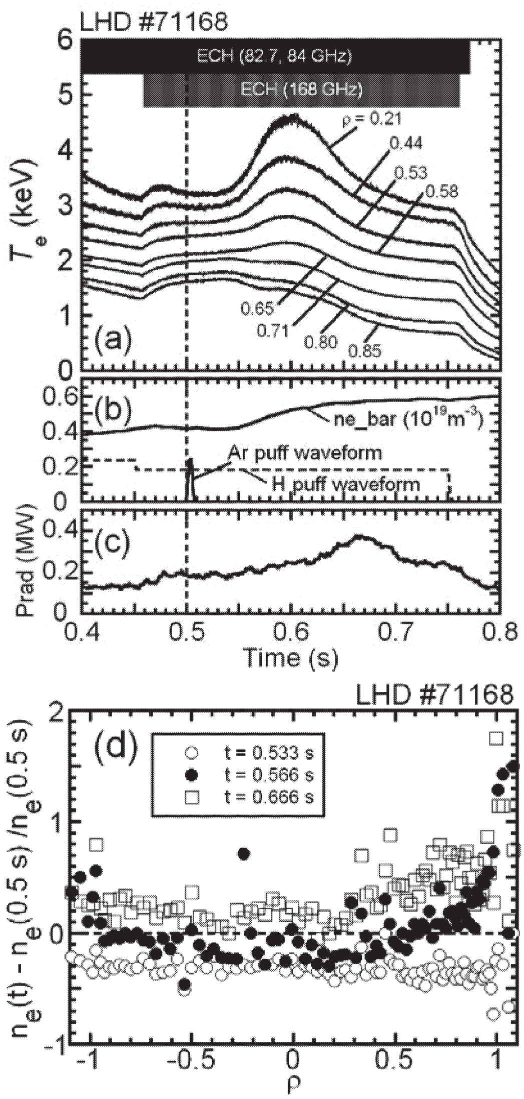

Fig. 1. Time evolution of (a) the T_e measured with the ECE radiometer at different normalized minor radii, (b) the line-averaged n_e and (c) the total radiated power. (d) Normalized radial profiles of the incremental n_e normalized by the base n_e (t = 0.5 s) measured with the Thomson scattering diagnostics. In (b), the waveforms of gas-puffs (H and Ar) are also plotted.

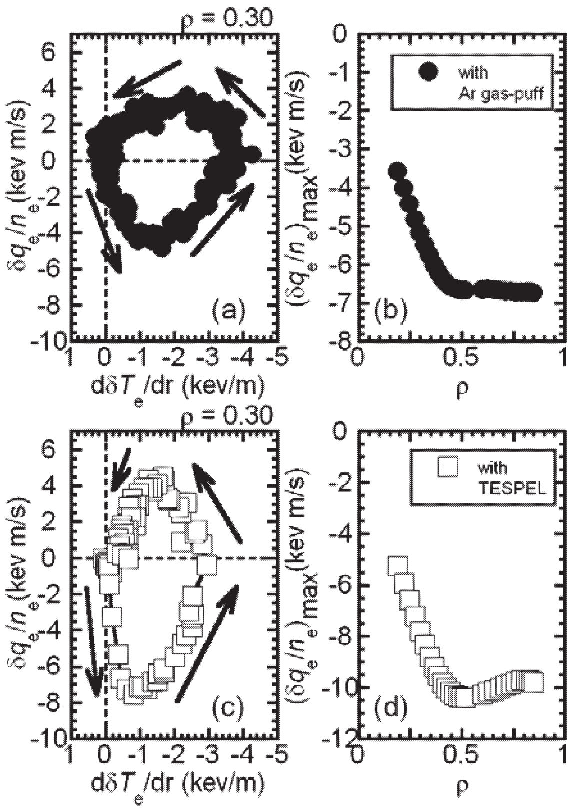

Fig. 2. The relation of the perturbed electron heat flux normalized by n_e to the gradient of perturbed T_e (left) and normalized radial profile of the maximum of normalized perturbed electron heat flux (right). The data with the Ar gas-puff is depicted in (a, b) and that with the TESPEL injection in (c, d).