§10. Features of Non-Local Electron Heat Transport in LHD

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It is presumed that local turbulence led by local microinstability drives local transport. Several recent experiments in LHD, however, point to the importance of non-local effects in the turbulent-induced transport. It has been observed that the non-local response to edge cold pulses often have reversed polarity, with the core T_e increasing in response to edge cooling as well as in tokamaks. The reported features of the non-local T_e rise observed in LHD are, (1) This phenomenon is observed in plasmas sustained by ECH, NBI and NBI+ECH, (2) The non-local response is also observed in the e-ITB plasmas. In this report, the newly obtained features of non-local transport in LHD are described.

The strong non-local effect is usually observed by TESPEL injection in LHD. The similar improvement of confinement induced by pellet or impurity injection (e.g. PEP-mode RI-mode) has been observed in tokamaks. Similarities and differences between these modes and the non-local phenomena will help to make a physical picture of the turbulence. The non-local T_e rises are observed not only by TESPEL injection but also by shallow pellets injection as shown in Fig. 1. The TESPEL contains impurity (e.g. C and Ti) but pellet is consists of pure H, and thus little importance of impurity is suggested. The particle source profile and/or density profile is also considered to be irrelevant to the non-local transport mechanism because the change in density induced by TESPEL or shallow pellet injection is negligible small ($< 10\%$).

The non-local T_e rises are observed in low collisionality (high T_e and low n_e) plasmams in LHD as shown in Fig. 2. This result is qualitatively consistent with TFTR scaling. There are no qualitative differences of non-locality between Co- and Ctr-NBI plasmas in LHD. The similarities of non-locality between tokamaks and LHD and Co- and Ctr-NBI plasmas allow us to conclude that the magnetic shear is not important in the non-local transport. There are some differences of non-locality between tokamaks and LHD and they are important for understanding non-local transport. The non-local effect is unclear in the auxially heated tokamak plasmas, while it tend to be strong in high power density (low collisionality) LHD plasmas. It has been observed that the non-local effect takes place more easily in small rather than large tokamaks. In helical systems, however, no observation has been reported in small devices.

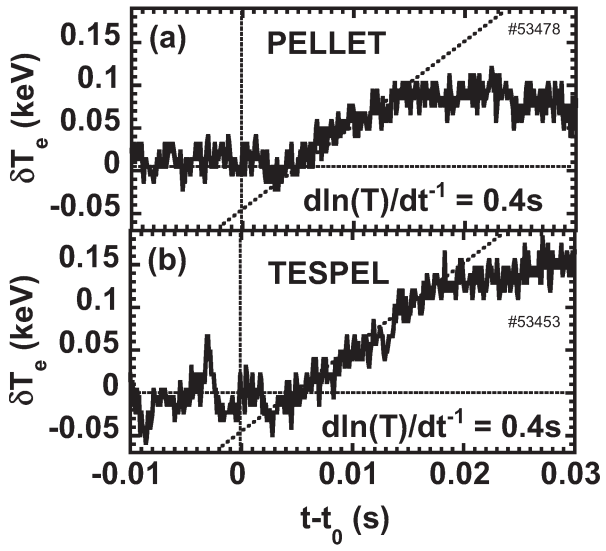

Fig. 1: Time evolution of T_e perturbation in core region ($\rho = 0.3$) induced by (a) a pellet and (b) a TESPEL injection. The pellet and TESPEL are injected to the edge of ECH+NBI plasmas at $t = t_0$. The typical experimental conditions are $R_{ax} = 3.6$m, $B_{ax} = 2.75$T, $\bar{n}_e = 1 \times 10^{19}$m^{-3}.

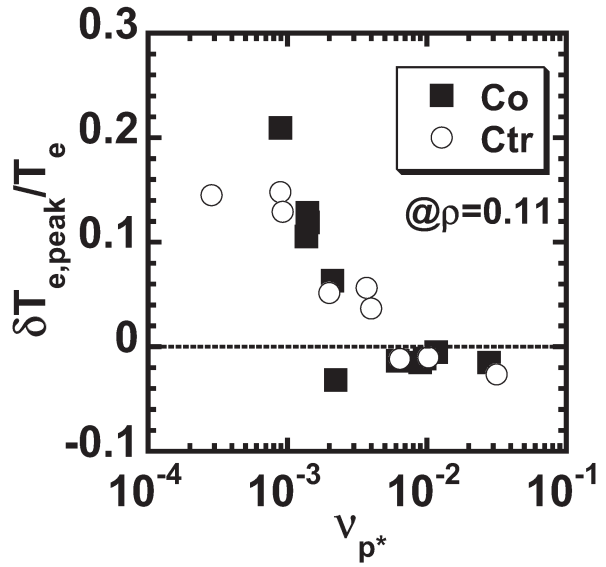

Fig. 2: Collisionality dependence of the normalized T_e perturbation peak. The $\delta T_e/T_e > 0$ indicates the non-local T_e rise. Experiments has been performed in a magnetic configuration of $R_{ax} = 3.5$m, $B_{ax} = 2.829$T.