Experimental study on nonlocal electron heat transport in LHD

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The full understanding of electron heat transport in magnetically confined plasmas is still an important issue for achieving a good predictive capability for burning plasmas, where the electron heating is dominant as a result of the interaction between electrons and alpha particles as a fusion reaction product. The electron heat transport is anomalous in the whole plasma region in tokamaks of various sizes and large helical system, in fact, Large Helical Device (LHD). In the study of the electron heat transport in toroidal plasmas, where turbulence dominates as a cause of anomalous transport, various interesting phenomena, including the fast non-diffusive propagation of a temperature perturbation, have been observed. The highlight of this phenomenon is the inversion of polarity of a cold pulse from the edge to the core, which has been observed in many tokamaks so far and more recently in helical device [1, 2]. Comparison of the characteristics of this phenomenon in between helical device and tokamaks will give new insight into the causal mechanisms affecting the core T_e rise, since helical systems have a quite different magnetic configuration (normally negative magnetic shear), which can affect the characteristics of turbulence.

The core T_e rise in response to the edge cooling is observed in the low density and high temperature plasmas of LHD as well as tokamaks. The time response of the core T_e rise observed in LHD plasmas can take on a variety of forms, all of which are different from the observations in tokamaks. The delay of the onset of the core T_e rise is increased with the increase both in the collisionality ν_b^* of the core plasma and in the T_e gradient scale length in the outer region of the plasma. The transient response analysis reveals that (i) just after the edge cooling, the electron heat flux in the core region is decreased without change in local electron temperature and its gradient, thus, the core T_e rise invoked by the edge cooling is attributed to the nonlocality in the electron heat transport and (ii) the electron heat transport transits between the nonlocal state and the local state.

[1] N. Tamura *et al*., Phys. Plasmas **12** (2006) 110705.

[2] N. Tamura *et al*., Proc. 21st IAEA Fusion Energy Conf. (2006) EX/5-6.