§3. Locality and Nonlocality in Turbulent Heat Transport in LHD

Tamura, N., Ida, K., Inagaki, S. (Kyushu Univ.),
Itoh, K., Sudo, S.

A better understanding of electron and ion heat transport in magnetically-confined toroidal plasmas is highly necessary to have good control over burning fusion plasmas, since the burning plasmas is highly autonomous. In the electron and ion heat transport of LHD plasmas, an incomprehensible phenomenon, so-called "nonlocal transport phenomenon" has been observed[1]. Core electron temperature T_e and ion temperature T_i is abruptly changed in response to an edge cooling induced by a TESPEL (it can be considered as a very tiny plastic [polystyrene, $-CH(C_6H_5)CH_2-$] pellet) injection, as shown in Fig. (a, b). In Fig. (a), some T_i data in the core region is omitted because it is obviously affected by the C^{5+} ion plume, which is originated from the TESPEL. Experimental conditions of the discharge (LHD pulse #81131) are as follows; magnetic axis position of 3.55 m, toroidal magnetic field strength of 2.789 T, port-through power of negative-ion based tangential NBI of 7.4 MW, port-through power of positive-ion based perpendicular NBI of 3.0 MW, injected ECH power of 1.0 MW. The line-averaged electron density just before the TESPEL injection is 0.69×10^{19} m^{-3} and the TESPEL deposition zone is estimated to be outside ρ = 0.87. One can imagine from Fig. (a, b) that an overall improvement of heat transport for any reason, such as the formation of an internal transport barrier, may result in the abrupt rise of both T_e and T_i in the core region. Indeed, the time scale of the rise and fall of the core T_i seems to be similar to that of the core T_e. However, as shown in Fig. (c, d), it has been observed that the core T_i (some data is omitted for the same reason as in Fig. (a)) does not respond to the edge cooling invoked by the TESPEL injection while the core T_e is abruptly increased in response to that. Experimental conditions of the discharge (LHD pulse #85586) are as follows; port-through power of negative-ion based tangential NBI of 14.3 MW, port-through power of positive-ion perpendicular based NBI of 4.7 MW. No ECH is applied for the LHD pulse #85586. The line-averaged electron density just before the TESPEL injection is at 1.28×10^{19} m^{-3} and the TESPEL is deposited outside $\rho \sim 0.86$ at most. The magnetic axis position and the toroidal magnetic field strength are the same as LHD pulse #81131. These experimental observations suggest that the change in the T_e and T_i in the core region will be surely a consequence of changing in micro-turbulence there, not depend solely on the nonlocality of the heat transport. In order to examine this idea, further experimental investigations on the coupling of the turbulences of various sizes will be necessary.

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

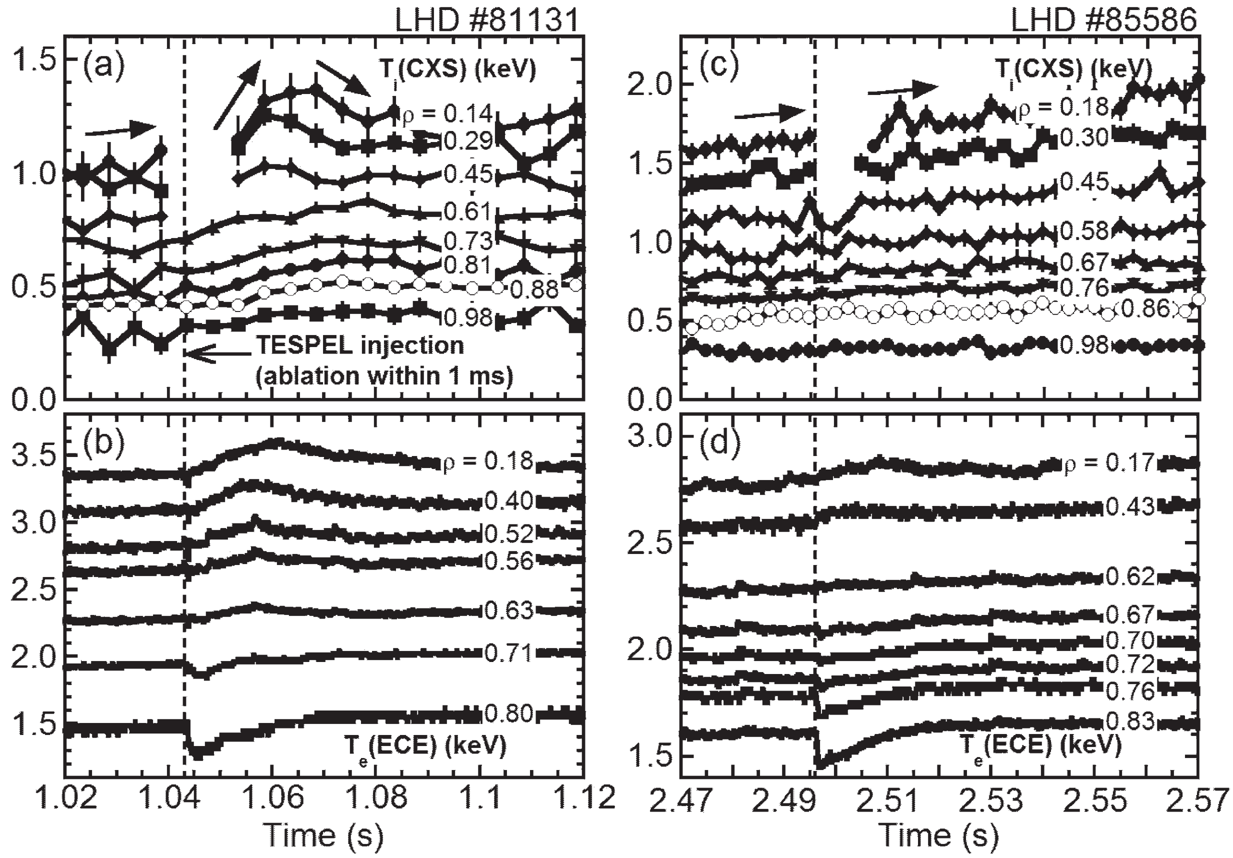

Fig. Temporal evolution of (a, c) the ion temperature measured using the charge exchange spectroscopy and (b, d) the electron temperature measured with the ECE radiometer at different normalized minor radii. The vertical dashed lines represent the time of the TESPEL injection.