§23. Dynamical Electron Energy Transport Study Using Modulated ECRH in LHD

Notake, T., Inagaki, S., Kubo, S., Shimozuma, T., Tamura, N., Fukuda, T. (Osaka Univ.)

one of the most important themes in fusion plasma researches and which has been studied mainly based on a global scalar quantity, the energy confinement time. However, the quantity is just volume-averaged value of the transport coefficient χ weighted at plasma peripheral region, so it is not suitable for clarifying the complex anomalous transport caused by turbulence. The essence in this study is a dynamical relationship between energy flux and temperature gradient because fusion plasmas have properties like non-linearity, non-locality and multi-states. Also, experimental results based on this analysis will give us a more natural comparison with sophisticated transport simulations considering microscopic instabilities.

Dynamical transports about electron heat energy using cold or heat pulse perturbations have been investigated in some devices [1-3]. In the 10th experimental campaign of large helical device (LHD), modulated ECRH is used for perturbation source of electron temperature and dynamical behaviors between electron energy fluxes and electron temperature gradients are analyzed. The electron energy flux can be evaluated from the conventional conservation law of electron heat energy as below.

$$Q_e = \frac{1}{r'}\int_0^{r'} rdr\left[P_e - \partial\left(1.5 n_e T_e\right)/\partial t\right]$$

Here, *Pe* should be the power source density including the electron-ion energy equipartition and radiative losses. But a contribution from the ECRH is only considered here. The *Te* is measured with ECE radiometer diagnostic with high spatial and temporal resolutions and electron density perturbation during modulated ECRH is neglected because the perturbation amplitude much less than that of electron temperature. To produce target plasmas with different Te-gradients, ECRH depositions are changed as shown in Fig.1. However, corresponding target plasmas have almost same Te-gradients. A further optimization of off-axis ECRH is desired to investigate dynamical transports in wide Te-gradient ranges. Fig.2 shows the dynamical behaviors in Qe/ne-∇Te space during a cycle of modulated ECRH for two target plasmas; (a) on-axis ECRH, (b) off-axis ECRH. The energy fluxes are normalized by electron density and χ=10 is plotted as an indicator. In the peripheral region, strong stiffness is observed that implies $\chi_{hp} >> \chi_{pb}$. In the intermediate region near the deposition, hysteresis-dependences are observed and the electron energy fluxes are strongly different nevertheless the ∇Te is not so different for the two cases. In order to grasp the details of energy transport mechanism, further experiments in the extended parameter regions will be needed.

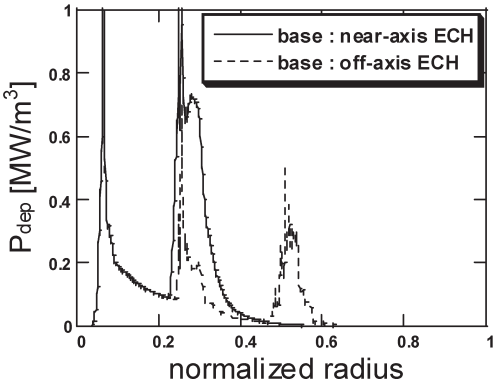

Fig.1. Power deposition profile

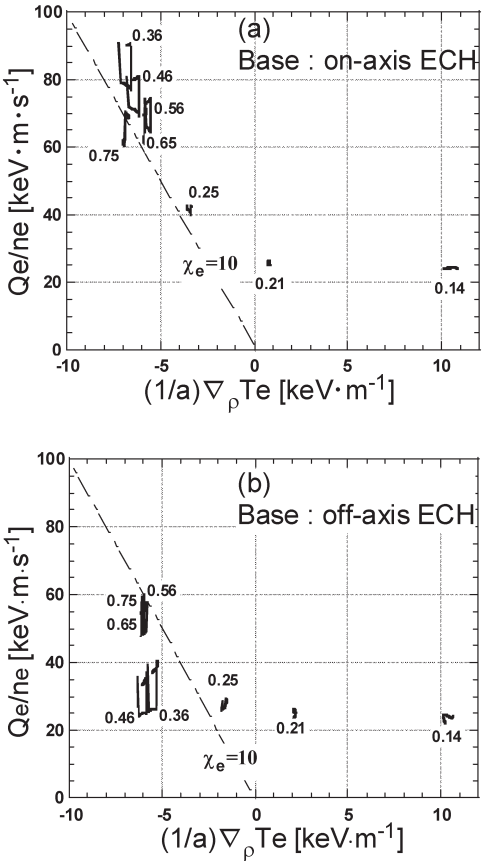

Fig.2. Electron energy dynamics (flux-gradient relation)

References

1) S.Inagaki, N.Tamura, et.al., PPCF **48** (2006) A251-257
2) K.Ida, S.Inagaki, et.al., Phys. Rev. Letters **96,** p.1105 (2006)
3) K.W.Gentle, Physics of Plasmas **13,** 012311 (2006)