§9. Contribution of Turbulences to the ECH Effect on Tracer Impurity Transport in L-mode Plasmas of the LHD

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In the 18th experimental campaign of the LHD, we have demonstrated a drastic mitigation of the accumulation of tracer vanadium impurity injected by using the TESPEL method (t_{inj} = 3.95 s) by applying an additional electron cyclotron heating (ECH) in the LHD[1]. The demonstration experiment has been done in high-density L-mode discharges (no ion internal transport barrier, that is, no impurity hole is established), where the impurity accumulation has been usually observed. Here, preliminary results on the study of the contribution of turbulences to the ECH effect on the tracer impurity transport in the LHD are reported. It is well known that the turbulent transport could be sensitive to inverse gradient scale lengths of electron density, electron temperature, and ion temperature. Thus it is important to study the changes of those in response to the additional ECH. Figure 1 shows comparison results of inverse gradient scale lengths of electron density, electron temperature, and ion temperature in this study. As shown in Fig. 1, the electron density scale length for the case with 1.5MW ECH around r_{eff}/a_{99} = 0.6 shows the most change due to the additional ECH, although the variation of the electron density scale length for the case with 1.5MW ECH differ little from that for the case with 0.7MW ECH. Concerning the inverse electron temperature gradient scale lengths, the biggest change of that is observed for the case with 0.7MW ECH around r_{eff}/a_{99} = 0.5. In regard to the inverse ion temperature gradient scale lengths, that for the case with 1.5MW ECH inside r_{eff}/a_{99} = 0.6 is slightly larger than those for the case without the ECH and with 0.7MW ECH. Figure 2 shows normalized radial profiles of an electron density fluctuation amplitude measured with a CO_2 laser phase contrast imaging diagnostics for the discharges with 0.7MW ECH and 1.5 MW ECH. As shown in Fig. 2, electron density fluctuations are largely existed outside r_{eff}/a_{99} = 0.7 and the electron density fluctuation amplitude for the case with 0.7MW ECH is larger than that for the case with 1.5MW ECH. Since the mitigation of the tracer impurity accumulation was done only for the case with 1.5MW ECH, these comparison results suggest that the change in electron density fluctuation due to the additional 1.5MW ECH would be unlikely to contribute the mitigation of the accumulation of the tracer impurity. Further investigations on the study of the contribution of turbulences to the ECH effect on the tracer impurity transport will be performed with gyrokinetic calculation by GKV-X and/or GS2.

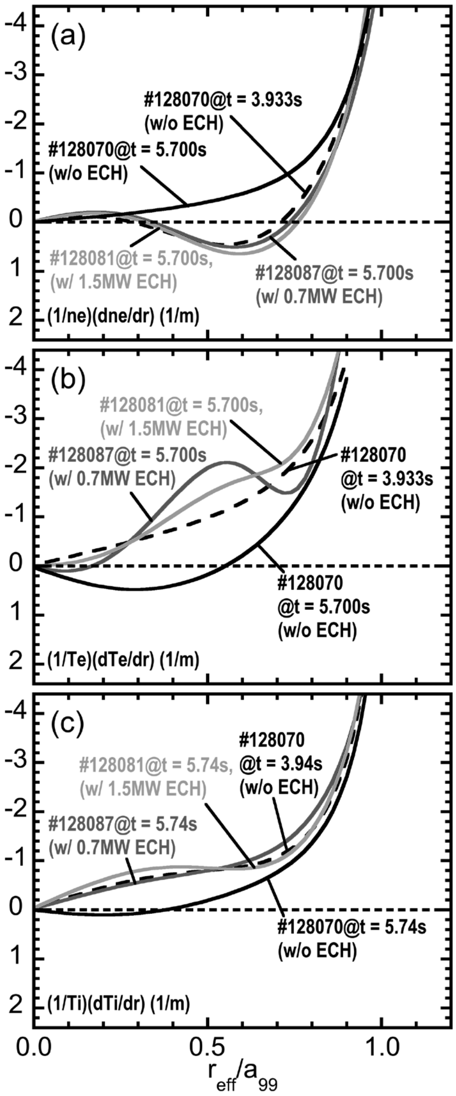

Fig. 1 Comparison of inverse gradient scale lengths of electron density, electron temperature, and ion temperature in this study.

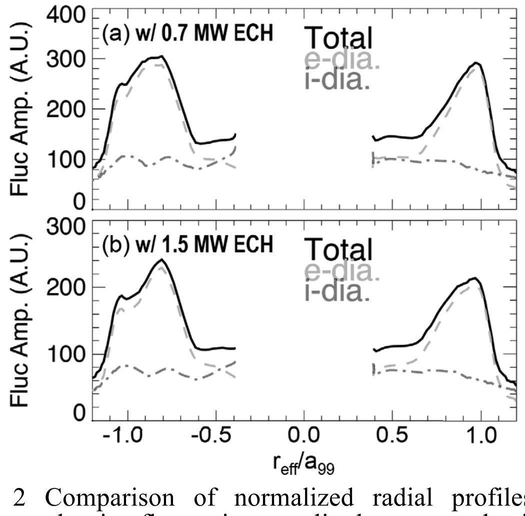

Fig. 2 Comparison of normalized radial profiles of electron density fluctuation amplitude measured with a CO_2 laser phase contrast imaging diagnostics in this study. Here, the dashed line, long dashed dotted line, and solid line denote the electron density fluctuation propagating in the electron diamagnetic direction, that propagating in the ion diamagnetic direction, the total of that, respectively.

1) Tamura, N et al: Ann. Rep. NIFS (2014-2015) 96.