§55. ECE Measurement in the High Density Plasmas on LHD

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In high-density plasmas, the ECE is refracted and the direction of the ECE propagation changes depending on the density profile and magnetic field. The ECE intensity can hence decrease regardless of the change in temperature when the density approaches the cut-off value. This density dependence is quite important to measure the electron temperature by ECE measurements.

We compare the ECE intensity T_{ece}, which is measured with the heterodyne radiometer, with the electron temperature T_e measured by Thomson scattering. T_{ece} is calibrated by using low-density plasmas, which are optically thick enough. The density dependence of T_{ece}/T_e obtained from 80.5GHz ($\rho = 0.24$) and 65.5GHz ($\rho = 0.75$) ECE signals are shown in Fig.1. In this figure, the circle (triangle) shows the case that the optical depth is larger (smaller) than 5. The thick solid lines show T_{ece}/T_e of the X-mode calculated by using the theoritical model represented by

$$T_{ece}/T_e \propto 1 - e^{-\tau}, \quad (1)$$

where τ is optical depth and is estimated from the relationship between temperature and density, $T_e^{\rho=0.24} = 1.7 n_e^{-0.49}$. The relationship, $T_e^{\rho=0.24} = 1.7 n_e^{-0.49}$, is consistent with the International Stellarator Scaling 95. And the coefficient of this equation was obtained from several discharges, where the NBI power was about 1.3MW. The thin solid lines show T_{ece}/T_e of the X-mode estimated from the relation ship, $T_e^{\rho=0.24} = n_e^{-0.49}$, whose coefficient was calculated from 1MW NBI shots. The experimentally obtained T_{ece}/T_e does not agree with the theoretical prediction. The reduction of the ECE intensity is observed when the density exceeds 50 % of the cut-off density at both radial positions. The reduction observed at the periphery is lager than that at the core region.

The reduction of the ECE intensity may come from two main reasons. One is the decrease in the emission. The decrease in the ECE intensity due to change of τ is taken into account in Eq. (1) as a finite density effect of τ. Another is the running away of the ECE from the sight line, that is, the bending of the ECE. Equation (1) does not include the bending effect of the ECE. Thus, the simulation with the ray tracing is necessary as a future work in order to explain the radial dependence of ECE intensity and the disagreement between experimental results and theoretical prediction.

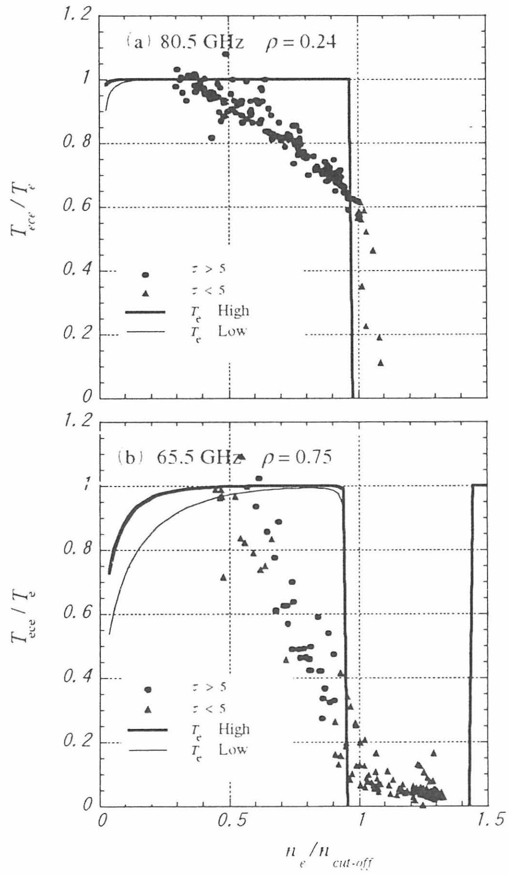

Fig. 1. The density dependence of T_{ece} / T_e with the ECE frequency (a) f = 80.5GHz (ρ = 0.24) and (b) f = 65.5GHz (ρ = 0.75). The circle (triangle) is the case that the optical depth is larger (smaller) than 5. The thick (thin) solid lines are T_{ece} / T_e of the X-mode with high (low) temperature assumption.