§58. Polarization of ECE in LHD

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In LHD configuration, the sheared field yields a coupled propagation of X and O-mode. The coupled propagation might lead to mode conversion and result in polarization effect on the emitted wave. The propagation of ECE waves have been calculated by solving the coupled wave equations numerically over the path towards the diagnostic antenna. The calculation for $n_e >$ 1.0×10^{19} m^{-3} shows that polarization rotates almost up to the edge of the plasma, and hence all frequencies exit the plasma under approximately the same angle.

Long LHD discharges of more than 10 s with constant density and temperature make it possible to change the polarization rotator during the discharge, and subsequently measure the complete ECE polarization. The ECE intensities measured with two radiometers are plotted versus the polarization rotator angle, as shown in Fig. 1. Here, the rotator angle is defined so that the radiometer for the 1st harmonic detects the polarization parallel to the magnetic field line at $\rho = 1$, i.e. the O-mode when the angle is zero. It is found that the ECE is elliptically polarized and is independent from the frequency. Similar experiments have been performed with the outside antenna and the grating polychromator as diagnostic, and identical results have been found for other densities (1.0-4.9$\times 10^{19}$ m^{-3}). Striking is the fact that the O-mode level is always approximately 70 % of the X-mode level in the 2nd harmonic of ECE (In contrast, the X-mode level is always approximately 70 % of the O-mode level in the 1st harmonic of ECE). However, the 1st harmonics of X-mode and the 2nd harmonics of O-mode are expected to be small because of the low optical depth. A simple calculation shows that, with a zero O-mode

emission in LHD, a reflection coefficient of 0.85 and a mode conversion fraction of 0.1 is enough to generate an O-mode intensity, 70% of the X-mode level. Hence, it is expected that large parts of the X-mode or the O-mode emission are due to mode converted reflections. Thus these polarization components will also be proportional to the electron temperature.
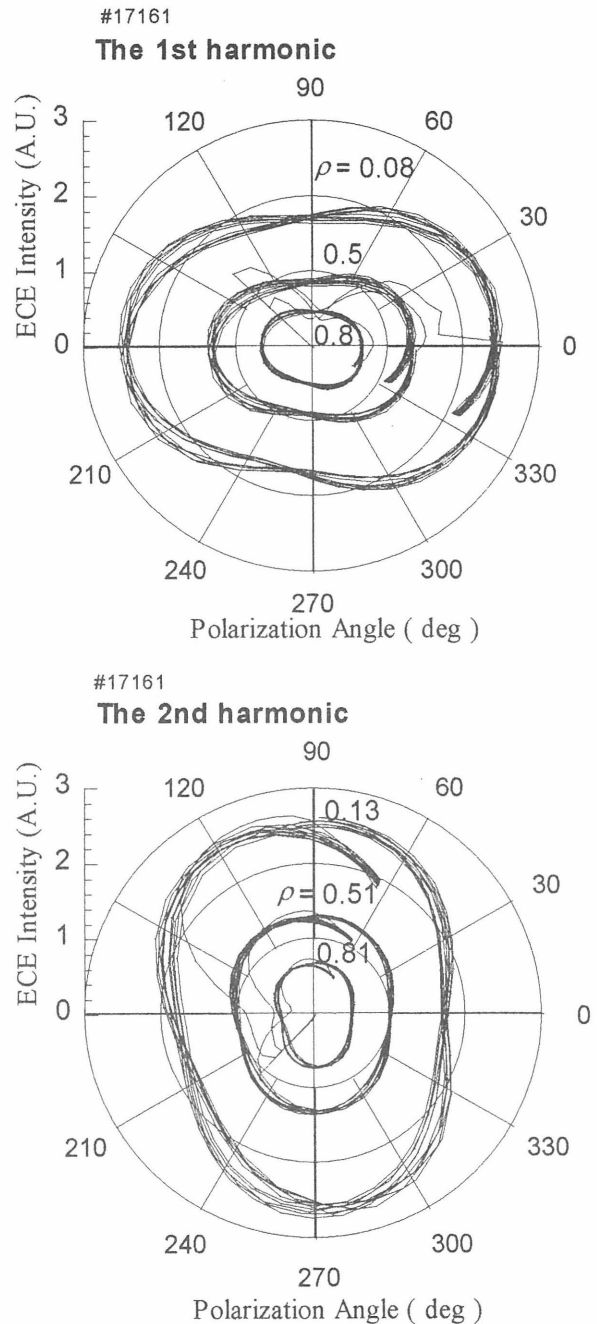

Fig. 1. The polarization plots of the 1st and the 2nd harmonics of ECE. The average density is 1.0×10^{19} m^{-3}. Three different positions are shown.