§6. Radial Electric Field and Electron Heat Transport of the Plasma with Electron Internal Transport Barrier

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The transition of radial electric field and formation of internal transport barrier (ITB) are observed near the magnetic axis in the plasma with electron cyclotron heating when the collisionality is low enough to expect the transition from the ion-root to electron-root in neoclassical theory.

The neutral beams with the beam energy of 130 - 145 keV are injected to initiate and sustain the plasma and the ECH in the 2^{nd} harmonic resonance (the magnetic field is 1.52T) with a frequency of 82.4 GHz and 84 GHz and with a power of 0.63 - 0.88 MW is added. The focal point of the ECH is tuned exactly at the magnetic axis of 3.8m (major radius in vacuum of 3.75m), which is measured with a soft X-ray CCD camera. The transition from ion root to electron root is observed near the plasma center, when the plasma is well into the collisionless regime ($n_e(0)$ ~ $0.3 \times 10^{19} m^{-3}$, ν_e =0.08 at ρ = 0.27). Associated with the transition from ion root to electron root, the formation of electron internal transport barrier (significant increase of electron temperature gradient) near the plasma center $\rho < 0.3$ is observed when the ECH power exceeds the threshold value (> 0.7 MW) as shown in Fig.1.

The radial electric field near the plasma center changes its sign from negative to positive when the ECH is applied to the plasma center even when the ECH power is below the threshold. However, the magnitude of the radial electric field and its shear is small when there is no internal transport barrier. The strong radial electric field and large E_r shear appear associated with the formation of the internal transport barrier as seen in Fig.2. This phenomenon shows the positive feedback between the increase of electron temperature gradient and radial electric field, since the radial electric field increases as the electron temperature gradient is increased in the electron root.

Since the electron transport in these plasmas is considered to be governed by the turbulent transport, the electron thermal diffusivity measured is normalized by $T_e^{3/2}$ for the comparison in Fig.3. The thermal diffusivity normalized by gyro-Bohm factor, $T_e^{3/2}$ is considered to be roughly constant in the L-mode plasmas when the temperature gradient is below the threshold of $R/L_{Te} < 10$, where R is the major radius and L_{Te} is a scale length of electron temperature radial profile. The normalized thermal diffusivity in the ECH+NBI heated plasma with ITB is lower than the plasma with NBI heating inside the transport barrier at $\rho < 0.3$. The reduction of thermal diffusivity is considered to be due to the radial electric field and its shear near the plasma center.

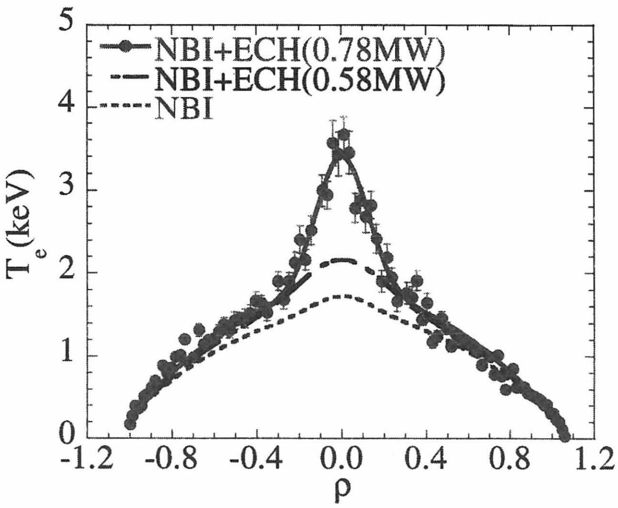

Fig.1 Radial profiles of electron temperature for the plasma with (0.78MW) and without (0.58MW) ITB.

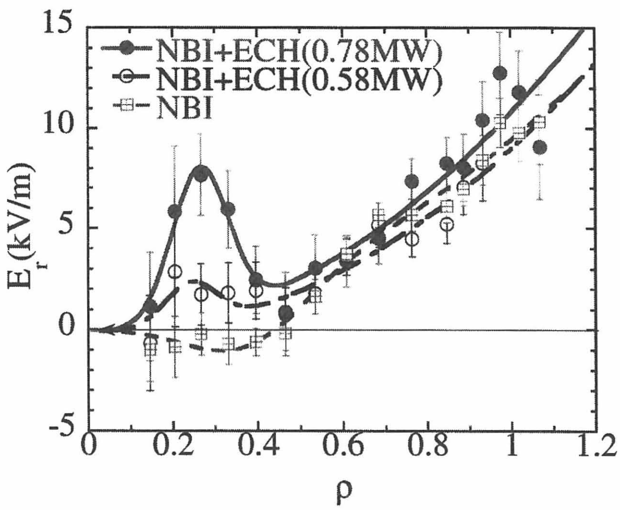

Fig.2 Radial profiles of radial electric field for the plasma with (0.78MW) and without (0.58MW) ITB.

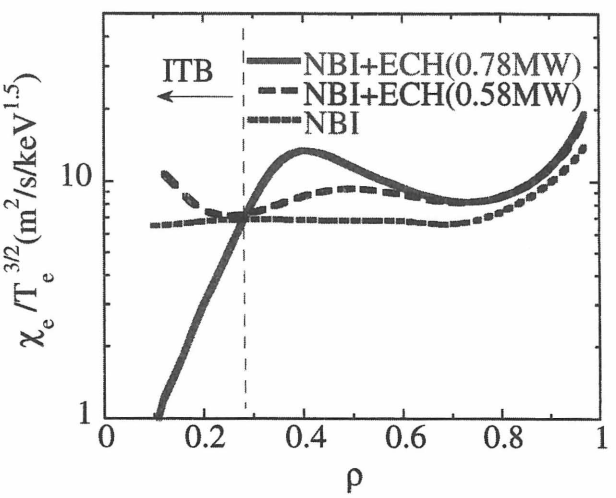

Fig.3 Radial profiles of normalized electron thermal diffusivity for the plasma with (0.78MW) and without (0.58MW) ITB.