§14. ECRH Effect on Fast Ion Pitch Angle Scattering Process

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In Heliotron-E, the pitch angle scattering is investigated by using off-perpendicular ($v_{\|} \neq 0$) beam injection and NPA with perpendicular ($v_{\|} = 0$) viewing chords.

The shape of the energy spectrum is determined by the ratio of Spitzter's slowing-down time, τ_s, and the 90° scattering time, τ_{sc}. We can evaluate the effective "τ_s^{eff}" experimentally from the rise time of a perpendicular injected NBI. The τ_{sc}^{fit} is obtained from the comparison between measured energy spectra during the off-perpendicular NBI and the Fokker-Planck calculation using τ_s^{eff}. In these calculations $Z_{eff} = 2.0$ is assumed. Results show that τ_{sc}^{fit} is much shorter than the theoretical value, τ_{sc}^{th}. The anomalous factor, $\alpha(\equiv \tau_{sc}^{th}/\tau_{sc}^{fit})$, has an inverse dependence on $n_e(0)$(Fig.1).

ECRH effects on a low $n_e(\sim 2 \times 10^{13} cm^{-3})$ beam heated plasma is analyzed. ECRH is superposed for 30ms. $\Psi_{CX}(E_{inj}/2 < E < E_{inj})$ becomes larger by a factor of $3 \sim 4$. n_e is not changed, but $T_e(0)$ is increased from 400eV to 600eV. In Fig.2, dots are measured energy spectra (initial NBI, before and during the ECRH superposed phase), and lines are calculations using bulk parameters in each timings. In these calculations, $Z_{eff} = 2.0$, and $\alpha = 3.0$ are assumed. Though the calculated energy spectra become large because of the slower deceleration due to the increase of T_e, the measured spectra is much larger than that of calculation during ECRH. There are two possibilities to explain this too much increase of Ψ_{CX}. One is an enhanced anomaly due to ECRH, and the other is due to the reduced loss cone between the detected pitch angle and the injected one. In fact, ECRH makes the plasma potential more positive in the whole radius.[1] Especially, this can reduce the loss cone[2]. Ψ_{CX} should be enhanced by the reduction of the loss cone.

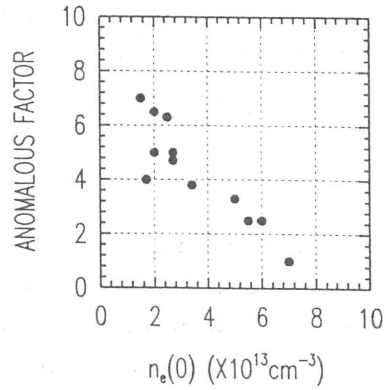

Fig.1: Density dependence of $\alpha(\equiv \tau_{sc}^{th}/\tau_{sc}^{fit})$.

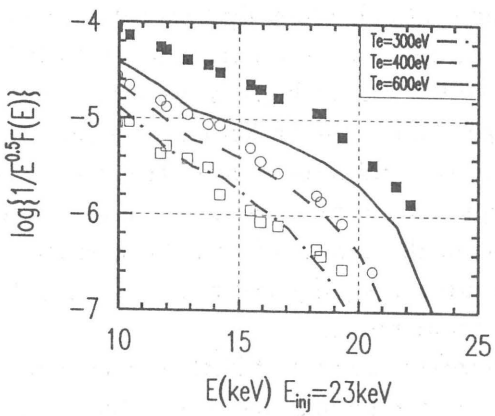

Fig.2: Change in energy spectrum by ECRH superposition.
□: initial NBI, ○: just before ECRH, ■: during ECRH
Lines are calculations using parameters at each timings.

References

[1] H.Zushi,et.al ;*Proc. 15th Int. Conf. on Plasma Phys. and Controlled Nucl. Fusion Research 1994*, IAEA-CN-60/A6/C-P-1, (1995)

[2] H.Sanuki,et.al ;Phys.Fluids B 2, (1990) 2155.