Density dependence of heat pulse transport property in LHD

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Understanding of cross-field thermal transport in magnetically confined plasmas is regarded as a key issue for realization of thermonuclear fusion reactor. It is well-known that electron thermal transport in axially heated plasmas cannot be modeled by the classical diffusion transport model with a single scalar diffusive coefficient. Recently, emergence of hystereses in the flux-gradient relation was discovered [1, 2], involving rapid responses of turbulence intensity and turbulent transport to heating. A model that can describe the transport hysteresis was developed [3]. Empirically the transport hysteresis is known to emerge in low density plasmas. However, systematic density scans have not yet been performed.

In this study, we performed the modulation electron cyclotron resonance heating (MECH) experiment in order to analyze the transport hysteresis in the electron thermal transport in LHD. The MECH frequency and the peak-to-peak amplitude were set to 23 Hz and ~ 700 kW, respectively. The target plasmas were sustained with two nearly balanced neutral beam heating systems. Electron density was scanned from 0.6×10^{19} m^{-3} to 2.3×10^{19} m^{-3} with a small step $\sim 0.3 \times 10^{19}$ m^{-3}, in order to discuss the density dependence of the transport hysteresis. Response in the electron temperature was measured with a multi-channel electron cyclotron emission radiometer system. At low density plasmas, the transport hysteresis appeared. The hysteresis width became smaller as the density is increased. Above a threshold density, 1.5×10^{19} m^{-3}, the hysteresis width became less than the noise level.

References

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