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Fluctuation signatures of rotation reversals and non-local transport events in KSTAR L-mode plasmas

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In KSTAR experiments, we found that non-local transport (NLT) is closely connected to the rotation reversal and impurity transport. We demonstrated that NLT can be controlled by ECH, and the intrinsic rotation and impurity dynamics follow the change in NLT. Supersonic molecular beam injection (SMBI) was used to induce the cooling of edge electrons. The cut-off density for NLT can be significantly extended by ECH. Without ECH, NLT disappears as the line averaged density ne increases above 1.5×10ˆ19mˆ(-3). By applying ECH, NLT reappears with the ne =2.4×10ˆ19 mˆ(-3). The ion temperature profiles show little changes. But the electron temperature profiles are significantly changed by ECH, and core toroidal rotation also changes from counter-current in OH plasma to co-current direction in ECH plasma. The carbon impurity profile becomes hollow by ECH. We investigated the fluctuation characters of these ECH and OH plasmas by 2D diagnostics in KSTAR. Although sawtooth exists during NLT in the ECH plasma, 2D ECEI images show that NLT pattern is not rotating in time. Poloidal flow of core plasma estimated from ECEI is in electron diamagnetic direction in ECH plasma. The ECEI results indicate that the correlation between NLT and conventional MHD activity is weak. The MIR and BES results show that the auto-power spectra of density fluctuation are almost the same in outer region for ECH and OH plasma. In the core region, the power spectra of the density fluctuation of ECH plasma are broader than those of OH plasma. The discrepancy in the density power spectra of ECH and OH plasma increases with frequency. All these observations in macroscopic parameters and micro fluctuations suggest a possible link between the macro phenomena and the structural changes in micro-fluctuations. One theoretical hypothesis to explain the cutoff density for NLT is the transition of dominant fluctuation mode from ion temperature gradient (ITG) mode to trapped electron mode (TEM). The rotation reversal can be also explained by the transition of fluctuation mode. The increase of the cut-off density for NLT by ECH supports this theoretical hypothesis. A preliminary gyrokinetic analysis indicates that the ECH drives strong TEM instabilities in the core region. These efforts will build a concrete physical picture to unify NLT and intrinsic rotation with the dynamics of microscopic turbulence.

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