Edge Plasma Electrostatic Fluctuation and Anomalous Transport Characteristics in the Sino-United Spherical Tokamak (SUNIST)

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Abstract

In this paper, the edge plasma parameters, including electron temperature T_e, density n_e, plasma potential f_p, radial electric field E_r and the corresponding fluctuations in the Sino-United Spherical Tokamk have been systematically measured with Langmuir probe arrays. Characteristics of the edge electrostatic fluctuations and the turbulence-induced transport are experimentally investigated. Results show that a naturally formed $E_r \times B_f$ poloidal velocity shear layer (VSL) exits near the radial location of the limiter. Wavenumber spectrum analyses show that edge fluctuations have a radial propagation character of the drift wave turbulence, with a characteristic radial phase velocity v_{phr} ~ 0.7 km s^{-1} in SOL and v_{phr} ~ 0.9-1.4 km s^{-1} in plasma edge, suggesting that the edge turbulence may originate from the core and propagate to the edge via intermittent pattern.

Temporal intermittency of the fluctuation-driven particle transport fluxes is analyzed. The conditional statistics analysis indicates that the intermittent structures have an about 30 μs character time width, which is the typical fluctuation time scaling. It is also found that the transport fluxes have a multifractal character over the fluctuation time scales, and exhibit a long-time-range correlation character with self-similar parameter $H > 0.5$ in the plasma confinement time scales. Furthermore, the analyses show that the level of the intermittency and long-range correlation of the fluxes vary with the plasma density being raised. These observations are consistent

with the prediction of the avalanche-like model.

Generally, the results measured in conditions of ohmically-heated discharges in SUNIST are similar to the observations in other conventional tokamaks. This similarity reflects the common qualities of the edge plasma parameters and the electrostatic fluctuations in magnetically confined devices.