§25. Intermittent Transport of Particle and Heat in Scrape-Off Layer of Limiter and Divertor Configurations of CHS

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Recently, there are many observation of intermittent transport of particle and heat fluxes in the scrape-off layer (SOL) even in L-mode plasmas and advanced H-mode plasmas with few ELMs in tokamaks. 2D measurement of SOL in DIII-D and MAST by using fast camera clearly showed intermittent convective plasma transport, so-called "density blobs", which is thought to play a key role for cross-field plasma transport in SOL. However, there are few studies on intermittent convective plasma transport in helical devices.

In this article, we will report a statistical analysis of the intermittent edge plasma fluctuation of plasma density $n(t)$ measured with a multi-pin probe in the CHS device.

Plasma with low density and temperature was generated by electron cyclotron resonance heating (ECR). Fig. 1 shows the typical power spectrum $S(f)=|n(f)|^2$ of the density fluctuation measured at normalized minor radius r of unity. There are no apparent peaks observed in the signal. The shapes of $S(f)$ allow one to conclude whether the scaling behavior of the fluctuation can be described by power-law dependences of the type $S(f)\sim f^{\gamma}$ with the single exponent γ. Kolmogorov theory (K41) predicts the inertial sub-range with self-similar properties leading to a power law dependence $S(f)\sim f^{\gamma}, \gamma=-1$. The typical value of the scaling exponent of the power spectra in the high frequency range of Fig. 1 is $\gamma=-3.0$, which is nontrivial one. Fig. 2 shows that dependence of the γ on the normalized minor radius. In the whole radial positions, the scaling exponent γ is found to be close to -3.0. This results means there would be intermittent coherent events in the density signal.

The density fluctuation property was analyzed with probability distribution function (p.d.f.). The p.d.f. gives important statistical quantities for turbulence research. The skewness is defined as $S=\langle x^3\rangle/\langle x^2\rangle^{3/2}$ to describe the asymmetry of the p.d.f., and the flatness $F=\langle x^4\rangle/\langle x^2\rangle^2$ measures the tail's weight with respect to the core of the distribution, where x is the deviation from averaged value. In the Gaussian distribution function, the skewness and flatness are 0 and 3, respectively.

Fig. 3 shows radial distribution of the skewness and the flatness. The skewness increases toward the edge to be S = 1 at r = 1, which means the positive density bursts is dominating at the edge plasma region, which could be related to the density blobs observed in tokamak devices.

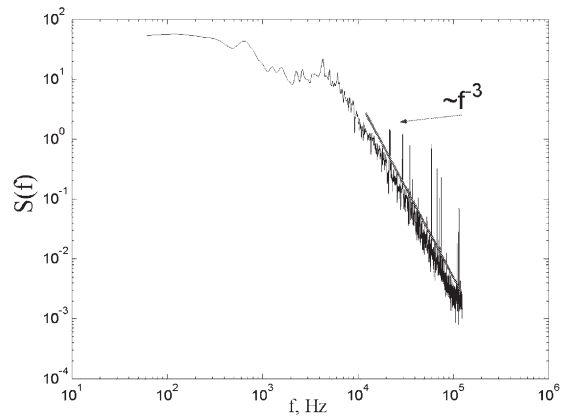

Fig 1. Power spectrum of plasma density fluctuation measured at the normalized minor radius *r* of unity.

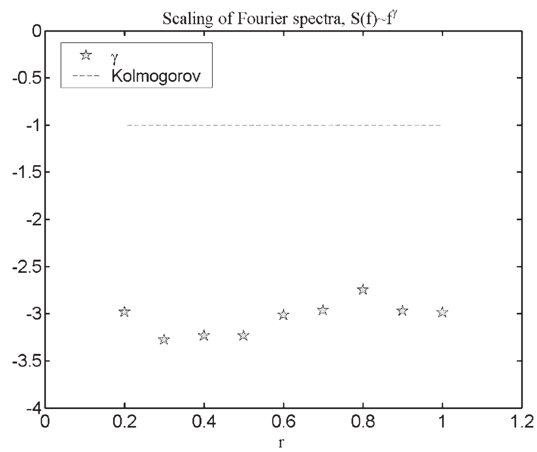

Fig 2. Dependence of the scaling exponent γ of the power spectra of density fluctuation on the normalized minor radius *r*.

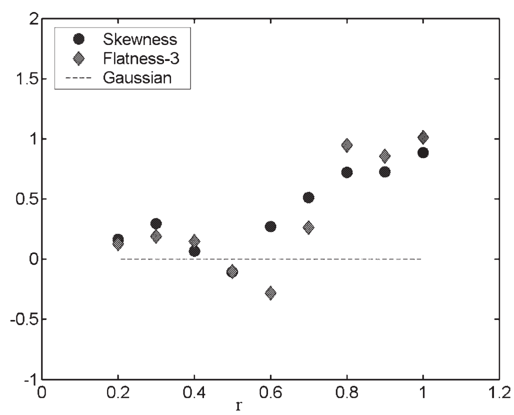

Fig 3. Skewness and flatness as a function of the normalized minor radius *r*.