§9. Characterization of Turbulence and Transport in Magnetic Confinement Devices

Rajković, M. (Institut for Nuclear Sciences Vinča, Belgrade, Serbia), Watanabe, T.-H., Škorić, M.M.

Two aspects of plasma turbulence are considered: multifractal (MF) properties and the zero-crossings of the turbulent signal related to the stochastic catastrophe theory (SCT). The zero-crossing function is a consistent approximation to the invariant probability density function and as such replaces transformation invariant pdf detecting stochastic bifurcations between equilibrium states. Each device and each turbulence regime may be distingusihed based on either local or global ME properties[1].

i) Applications of Stochastic Catastrophe Yheory to Plasma Turbulence We consider three signals: L-mode, dithering H mode and H-mode plasma edge turbulence recorded in the MAST device. In Fig. 1 the pdf obtained using kernel density estimate (left) and the level-crossing function (right) are presented for the 6861 L-mode. Both are unimodal and no new information is provided by the level-crossing function. Analogous results are presented in Fig. 2 for the case of dithering H-mode. Level-crossing function suggests two stable states while unimodal kernel density estimate shows one.

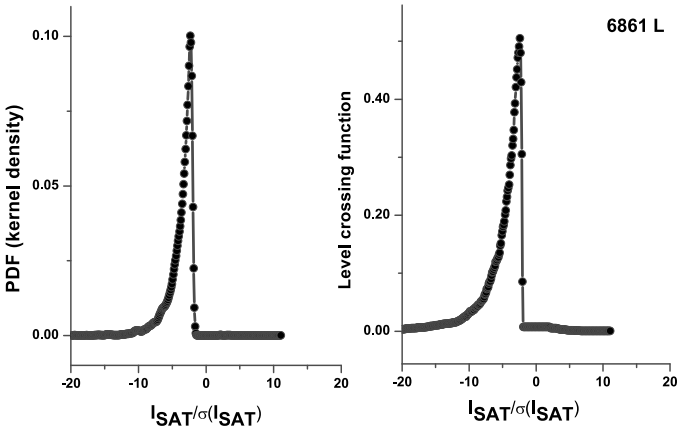

Fig. 1: Kernel density estimation of pdf of 6861 L-mode (left) and the corresponding invariant level-crossing function (right).

There is a small elevated part of the kernel density pdf albeit too small to be declared a mode. Dithering H mode has a heating power close to the threshold of the L-H transition with high ELM activity and its unstable character is likely due to the transition between two stable low and high confinement modes. However the stable 5738 H mode (Fig. 3) also has two stable equilibria so that strong ELM bursts, which dominate this signal, may be explained in terms of bifurcations

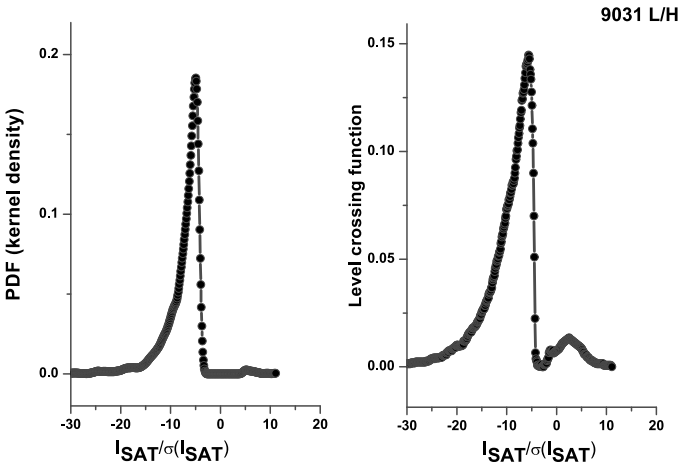

Fig. 2: Kernel density estimation of pdf of 9031 dithering H -mode (left) and the corresponding invariant level-crossing function (right).

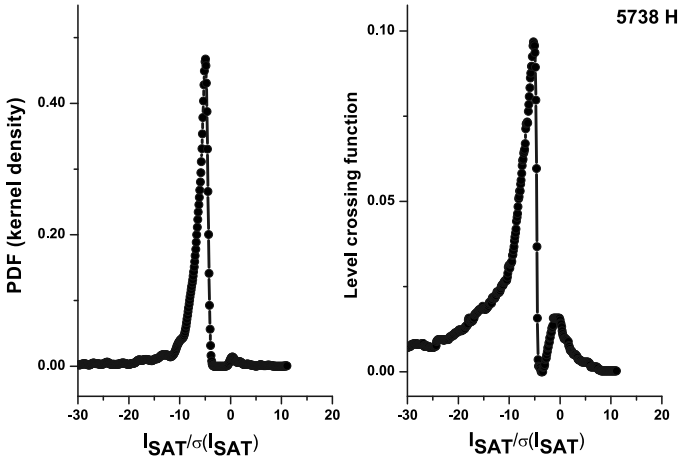

Fig. 3: Kernel density estimation of pdf of 5738 H -mode (left) and the corresponding invariant level-crossing function (right).

between two equilibrium states implying that their occurrence and dynamics depends on control parameters.

The results presented here[2] support the bifurcation scenario according to which the ELMs may be regarded as transition between different confinement modes.Such a scenario rules out the self-organized criticality (SOC) [3] which does not require control parameters. Hence, level-crossing function may be also useful in determining and testing the proper strategy for controlling ELM dynamics.

1) M. Rajković, T. -H. Watanabe and M. M. Skoric, it Nucl. Fusion **49**2009 095016.

2) M. Rajković, T. -H. Watanabe and M. M. Skoric, AIP Conf. Proc. **1445** 2012 15-33.

3) P. Bak, C. Tang and K. Wiesenfeld, *Phys. Rev. Lett.* **59**(1987) 381.