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EVIDENCE OF SELF-ORGANIZED CRITICALITY BEHAVIOR IN TCABR PLASMA EDGE

G. Z. dos Santos Lima[1], *A. M. Batista*[2], *Z. O. Guimarães-Filho*[3], *K. C. Iarosz*[4], *I. L. Caldas*[5], *R. L. Viana*[6], *S. R. Lopes*[7], *Yu. K. Kuznetsov*[8], *I. C. Nascimento*[9]

[1]Universidade Federal do Rio Grande do Norte, Natal-RN, Brazil, gzampier@ect.ufrn.br
[2,4]Universidade Estadual de Ponta Grossa, Ponta Grossa-PR, Brazil
[3]Equipe DSC/PIIM, Université de Provence, Marseille, France
[5]Universidade de São Paulo, São Paulo, Brazil, ibere@if.usp.br
[6,7]Universidade Federal do Paraná, Curitiba, Brazil
[8,9]Universidade de São Paulo, São Paulo, Brazil

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1. INTRODUCTION

Electrostatic turbulence is the main cause of anomalous particle transport at the plasma edge in tokamaks [1]. Despite the recent theoretical and experimental progress on the understanding of this turbulence a complete description of the observations has not yet been achieved. Thus, understanding this turbulence behavior is still necessary to complete the plasma edge description and to improve plasma confinement in tokamaks. In some recent studies [2], analyzes of the electrostatic fluctuations from confined magnetically plasmas have been described by their space and time self-organized similarity behavior (SOC) [2]. The concept of SOC [3] brings together the ideas of self-organization of nonlinear dynamics systems with the often observed near-critical behavior. The several distinct parading are available for transport of mass or other quantities across plasma confined by a magnetic field. Avalanches events in plasma confined [4] are a key ingredient in the theory of self-organized criticality (SOC) and an intuitive analyses of avalanche is based on modeling of sandpile [2, 3].

2. RESULTS

In this work we investigate the plasma edge turbulence in the tokamak TCABR [5] and identify evidence of self-organized criticality (SOC) behavior of the experimental fluctuating floating electrostatic [4] potential measured by Langmuir probes in the plasma edge and scrape-off layer [Fig.1]. The self-organized criticality (SOC) behavior of the plasma edge is studied using fluctuations data from TCABR measured by Langmuir probe. We looke for possible evidence of SOC in the plasma transport. The expectation is that the frequency spectrum analysis should show scaling behavior, f^{α} , with $\alpha = -1$ [Fig.2].

The autocorrelation function shows an extended tail at large delay times [Fig.3] and high Hurst parameters [Fig.4] indicating the existence of self-organized criticality (SOC) found in TCABR fluctuations.

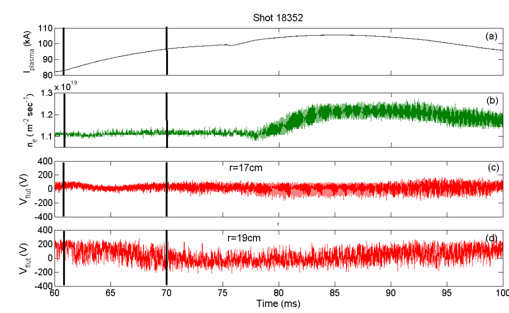

Figure 1 – Time evolution of plasma discharge in TCABR tokamak. (a) Plasma current, (b) central chord plasma mean density, (c) floating electrostatic potential for a typical discharge inside the limiter (r=17 cm), (d) Floating electrostatic potential outside the limiter (r=19 cm). The vertical black lines indicate the analyzed time interval.

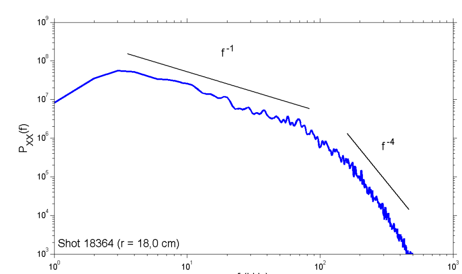

Figure 2 – Power spectra S(f) of the floating potential fluctuation at radial position r/a=1 (border of plasma column).

The experimental flux profile [Fig.5] is compared with the simulated one, obtained from a cellular automata sand-

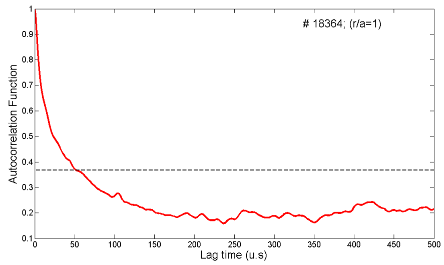

Figure 3 – Aucorrelation Function (ACF) of the floating potential fluctuations measured at radial position r/a=1 (border of plasma column).

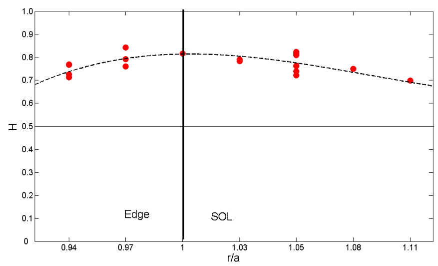

Figure 4 – Radial dependence of the Hurst parameter (small solid triangles up). The black dashed line is a fitting of the Hurst parameter profile for the experimental floating potential fluctuation. The vertical black line marks the position of the plasma column (r/a=1)

pile model, showed in Fig.6. The usual sandpile model [6] is modified by the addition of a specific diffusive function required to qualitatively reproduce the experimental particle flux and density at the TCABR plasma edge.

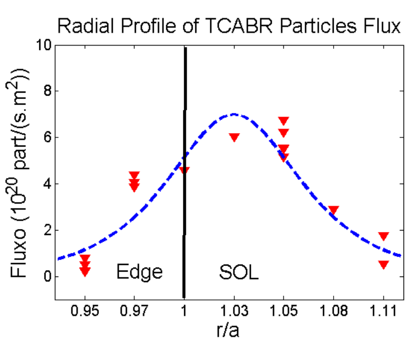

Figure 5 – Radial profile of plasma flux from experimental data (TCABR). The blue dashed line is a secant hyborblic fitting of TCABR data.

3. CONCLUSION

In conclusion, the floating potencial fluctuation data from TCABR tokamak shows SOC behavior evidence. The introduced model reproduces the radial profiles of density, particle transport, and zonal flow observed in TCABR plasma edge.

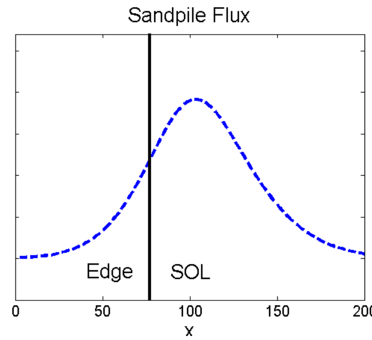

Figure 6 – Radial profile of flux obtained from the modified sandpile model.

4. ACKNOWLEDGMENTS

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