Turbulence intermittence and relation to low order rational surfaces in the TJ-II stellarator

B.Ph. van Milligen[1], B.A. Carreras[2], L. García[2], C. Hidalgo[1] and the TJ-II Team

[1] CIEMAT, Av. Complutense 40, 28040 Madrid, Spain

[2] Universidad Carlos III de Madrid, Av. de la Universidad 30, 28911 Leganés, Madrid, Spain

In recent work [1], we explored the multifractal intermittence parameter as a tool to study turbulence in fusion plasmas. Based on the results from turbulence simulations, we found that the intermittence, *C(1)*, is affected by the (poloidal) zonal flow. Comparing results with preceding work on the analysis of heat transport using the transfer entropy [2], we also found that radial minima of *C(1)* correspond to maxima of the transfer entropy, which were identified with 'trapping zones' for radial heat transport. It seems therefore, that minor radial heat transport barriers ('trapping zones'), often associated with low order rational surfaces, have an effect on the intermittent character of the turbulence via zonal flows. Thus, the intermittence parameter provides valuable indirect information about the interaction of turbulent fluctuations, zonal flows, and the magnetic topology of fusion plasmas.

Following up on these findings, the present work intends to show that the multifractal intermittence parameter can be fruitfully applied to the identification of the radial location of low order rational surfaces inside a magnetically confined plasma. To do so, we make use of Langmuir probe data from a set of experiments in which the rotational transform was scanned dynamically in the TJ-II stellarator. It is shown that up to five rational surfaces can be identified from the data, which is a first in plasma physics, to the best of our knowledge. The effect of the radial electric field on intermittence was also studied using a specific subset of experiments in which the electron density was raised on a shot by shot basis. The observations are contrasted with results from numerical calculations using a resistive Magneto-HydroDynamic model to facilitate interpretation.

[1] B.A. Carreras, L. García, J. Nicolau, B.Ph. van Milligen, U. Höfel, and M. Hirsch. Intermittence and turbulence in fusion devices. Plasma Phys. Control. Fusion, 62:025011, 2020.

[2] B.Ph. van Milligen, B. Carreras, L. García, and J. Nicolau. The radial propagation of heat in strongly driven non-equilibrium fusion plasmas. Entropy, 21(2):148, 2019.