02P44

The influence of heat source profile on turbulent transport statistics in flux-driven gyro-kinetic simulations

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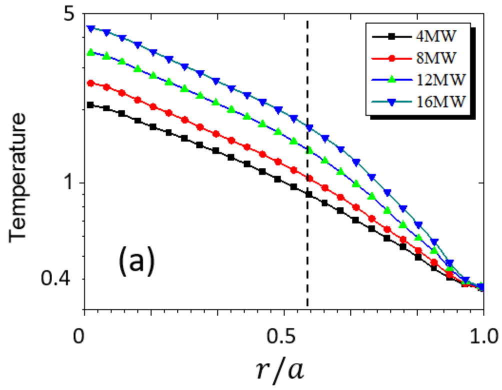
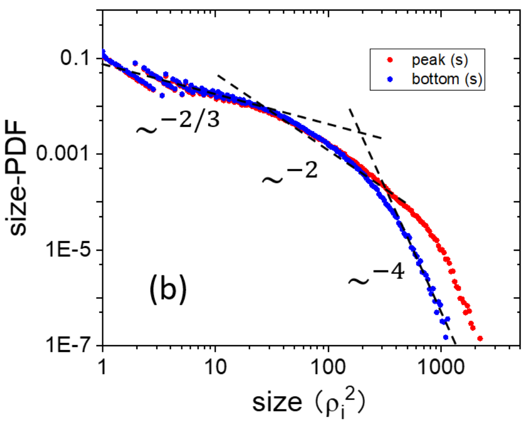
Understanding of turbulent transport in a steady-state burning plasma is a critical issue on improving the confinement performance in Tokamaks. To achieve a global profile with high temperature near the core region, external heating is necessary and the complex nature of turbulence with heating source input becomes an important issue in fusion research. Due to continuous energy input, plasma evolves into a steady state and a global temperature profile is formed. In recent works based on gyro-kinetic simulations, a two-stage profile is observed in the presence of E×B staircase [1,2], and the statistical characteristics of turbulent transport in leading to burst and/or quiescent phase are investigated through a newly developed size-PDF analysis [2].

However, when heating power varies, characteristics of turbulent transport also changes. In this work, non-local non-diffusive transport dynamics and global profile formation have been investigated based on GKNET simulations which is a 5-dimentional global full-f gyro-kinetic code. With input power scan, temperature profile stiffness is observed, which shows a two-slope profile with a turning point near the half radius where staircase located (figure a). Since global profile formation is the direct consequence of transport phenomena, at first we found the dominated frequency of avalanches has positive relationship to the heating power. To get more details of transport phenomena with different heating power, size-PDF analysis is utilized in this work.



Here we extend the size-PDF analysis from single time step to multi steps average, to get a more reliable statistical result. Figure (b) shows the comparison of size-PDF between transport peaks and bottoms using 30 points (for each) in the 16MW case. The 3-step power law and two turning points can be clearly observed. Based on this upgraded method, the influence of heating profile is investigated.



[1] W. Wang, *et al.*, *Nucl. Fusion* **58** 056005 (2018).
[2] W. Wang, *et al.*, *Nucl. Fusion* **60** 066010 (2020).