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Effect of input power on non-local transport event in flux-driven ITG turbulence

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In tokamak plasmas, transport events show non-local and non-diffusive intermittent transport processes such as turbulent spreading and avalanches. Both in experiments and simulations, mesoscopic transport events often dominate the turbulent transport levels.[1] However, their proper quantitative estimation requires new statistical methods. Recently, size probability distribution function (size-PDF) method to study bursty heat transport events in flux-driven gyrokinetic simulations has been developed and was tested at 16 MW input power tokamak plasma.[2] In the size-PDF method, heat flux eddies are segmented by thresholding at 10% cutoff level. We employ this method to study non-local and non-diffusive transport events in flux-driven GKNET[3] global gyrokinetic simulations of ion temperature gradient (ITG) turbulence with different input power at low levels. We find that at both 0.5 MW and 2 MW input power, the radial heat flux burst appear infrequently and irregularly, unlike in 16 MW input power case where heat flux bursts appear quasi-periodically.[2] Also, heat transport level is mostly higher at 2 MW input power than at 0.5 MW input power (Fig. 1). At 2 MW input power, in the quiescent phase, the size PDF P(S) for heat eddy size S in squared ion gyro-radius ρ_i^2, is fitted by two piecewise power laws $P(S) \propto S^{-0.5}$ and $P(S) \propto S^{-2.5}$ (Fig. 2), and in the burst phase P(S) is fitted by three piecewise power laws $P(S) \propto S^{-0.5}$, $P(S) \propto S^{-1.5}$ and $P(S) \propto S^{-6}$ (Fig. 3). The total radial heat flux in the burst phase is mostly due to the radially elongated heat flux eddies in size region $500 < S < 800$, corresponding to the region of the third power law fit, which do not appear in the quiescent phase. The separation between the quiescent phase and the burst phase observed in our work is qualitatively similar to the previous work.[2] Improvement of size-PDF analyses using different heat flux cutoff levels and different heat flux eddy segmentation methods are in progress and will be reported.

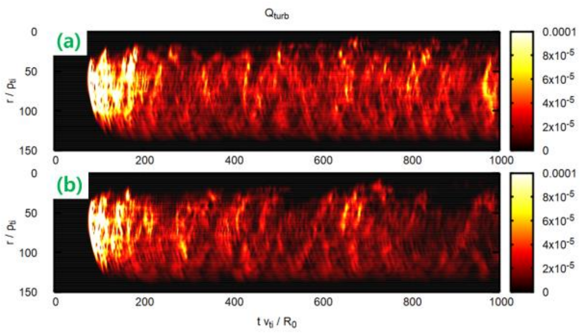

Fig. 1. Time evolution of the radial turbulent heat flux (a) at 2 MW input power and (b) at 0.5 MW input power.

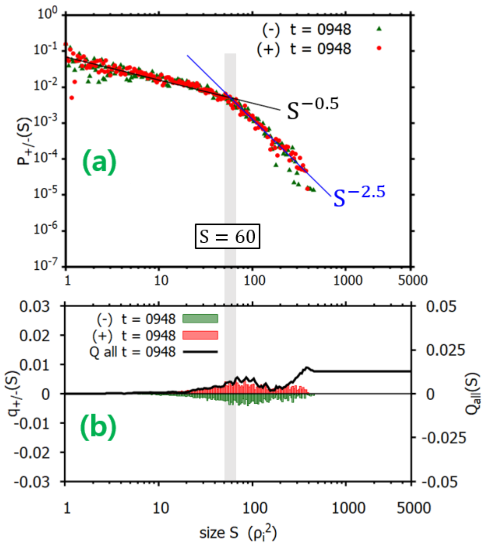

Fig. 2. Size PDF of heat flux eddies (a) and total heat flux contribution by eddy size (b) at quiescent phase.

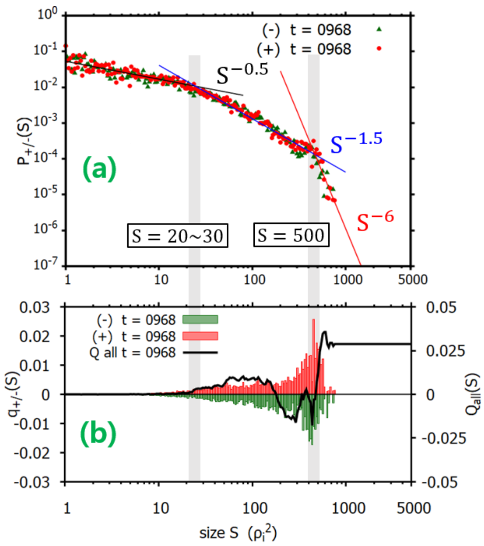

Fig. 3. Size PDF of heat flux eddies (a) and total heat flux contribution by eddy size (b) at burst phase.

References
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