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Statistical description of turbulent transport for flux driven toroidal plasmas

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During recent years an overwhelming body of evidence shows that the overall transport of heat and particles is to a large part caused by intermittency (or bursty events) related to coherent structures. One of the main challenges in magnetic fusion research has been to predict the turbulent heat and particle transport originating from various micro-instabilities. The ion-temperature-gradient (ITG) mode is one of the main candidates for causing the anomalous heat transport in core plasmas of tokamaks. Significant heat transport can however be mediated by coherent structures such as streamers and blobs through the formation of avalanche like events of large amplitude, as indicated by recent numerical studies. These events cause a deviation of the probability distribution functions (PDFs) from a Gaussian profile on which the traditional mean field theory (such as transport coefficients) is based.

A crucial question in plasma confinement is thus the prediction of the PDFs of the transport due to these structures and of their formation. This work provides a theoretical interpretation of numerically generated PDFs of intermittent plasma transport events as well as offering an explanation for elevated PDF tails of heat flux. Specifically, in this work we analyze time traces of heat flux generated by global nonlinear gyrokinetic simulations of ion-temperature-gradient turbulence by the GKNET software [1]. The simulation framework is global, flux-driven and considers adiabatic electrons. In these simulations SOC type intermittent bursts are frequently observed and transport is often regulated by non-diffusive processes, thus the PDFs of e.g. heat flux are in general non-Gaussian with enhanced tails.

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