Intermittency in non-diffusive regimes of fast ion transport in turbulent toroidal plasmas

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In many plasmas, a fraction of the ion-population has much higher velocities than the thermal average. In a fusion device, fast ions originate e.g. from fusion reactions or neutral beam injection and their turbulent transport can impact energy deposition and plasma heating [1].

Fast ion physics is a central research topic on the TORoidal Plasma EXperiment [2]. A beam of Li-6 ions is injected into a low-temperature hydrogen plasma with a helical open magnetic field-line geometry. Both the time-averaged profile [2, 3] and local time-series [4] of the ion-beam have been measured with a dedicated set of Gridded Energy Analyzers. Using simulations from the Global Braginskii Solver (GBS) code, non-diffusive transport regimes of the fast ions have been identified, ranging from sub- to super-diffusion depending on fast ion energy [2, 3].

Here we present first time-resolved measurements performed in all non-diffusive transport regimes, which exhibit significant intermittency (skewness) associated to the propagation of plasma filaments ('blobs'). Detailed analysis indicates an increasing importance of intermittency from sub- to super-diffusion and for longer times-of-flight of the ions. The quantification of these observations was furthered by analysis-methods accounting for the often significant noise in this turbulent environment.

A dedicated particle tracer utilising floating potential measurements in TORPEX is developed to give insight into the instantaneous behaviour of the fast ion beam and to allow comparisons with synthetic time-series. Supported by first findings on the generation of intermittency, models for predicting the skewness in certain scenarios are introduced to outline possibilities and limitations in linking local fast ion time-series properties to global transport properties.

References

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