Intermittency in space and laboratory plasmas: comparative study of multifractal statistics

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Anomalous transport at the boundaries between moving plasma and fixed magnetic field is a common problem for space, laboratory and astrophysical plasmas. Intermittent fluctuations represent one of the most promising candidate for the means of the turbulent transport. In their presence the plasma flow is concentrating into jets with anomalously high ram pressure and flow density. The jets, looking to appear randomly, are able to carry substantial part of the flow momentum and mass flux. We relay this transport property with a multifractality of the turbulence in the boundary layer between a moving media and a standing obstacle. In space plasma, analysis of the Interball-1 data revealed the scale-invariance and intermittency of magnetic field fluctuations at frequencies below 10 Hz in the Earth's magnetopause boundary layer over polar cusps. Namely in this singular high-latitude regions of the geomagnetic trap with a turbulent boundary layer, where the incoming solar plasma flow interacts with an indented obstacle, there is a zone of intermittent plasma jets appeared to provide both populating of the boundary layer inside the eroded magnetic obstacle, and transient plasma transport downstream the external flow along the boundary. Statistical analysis of plasma turbulence in tokamaks, stellarators and linear plasma machines (tokamak T-10, tokamak HYBTOK-II and linear plasma device NAGDIS-II) have shown a spiky rather than random behavior of turbulent fluctuations and transport in the edge magnetized plasma. The data in fusion devices and space plasma in the turbulent boundary layer have been analyzed in terms of the multifractal formalism revisited with wavelets. The turbulent fluctuations demonstrate similar multifractal statistics, i.e. scaling behavior of absolute moments is described by convex function with non-trivial self-similarity properties. Multifractality exponent defined in multiplicative cascade model is estimated as relevant parameter to characterize boundary plasma turbulence. Self-invariance parameters have been observed to depend on the edge plasma condition in fusion devices. Properties of the multifractal cascades in the edge plasma turbulence of fusion devices and turbulent boundary layer in space plasma are discussed.