Geophysical Research Abstracts
Vol. 12, EGU2010-1334, 2010
EGU General Assembly 2010

Multifractal Turbulence in the Heliosphere

Wieslaw M. Macek (1,2) and Anna Wawrzaszek (2)

(1) Faculty of Mathematics and Natural Sciences, Cardinal Stefan Wyszynski University, Warsaw, Poland , (2) Space Research Centre, Warsaw, Poland (macek@cbk.waw.pl, +48 22 8403131)

We consider a solar wind plasma with frozen-in interplanetary magnetic fields, which is a complex nonlinear system that may exhibit chaos and intermittency, resulting in a multifractal scaling of plasma characteristics. We analyze time series of plasma velocity and interplanetary magnetic field strengths measured during space missions onboard various spacecraft, such as Helios, Advanced Composition Explorer, Ulysses, and Voyager, exploring different regions of the heliosphere during solar minimum and maximum. To quantify the multifractality of solar wind turbulence, we use a generalized two-scale weighted Cantor set with two different rescaling parameters [1]. We investigate the resulting spectrum of generalized dimensions and the corresponding multifractal singularity spectrum depending on the parameters of this new cascade model [2]. We show that using the model with two different scaling parameters one can explain the multifractal singularity spectrum, which is often asymmetric. In particular, the multifractal scaling of magnetic fields is asymmetric in the outer heliosphere, in contrast to the symmetric spectrum observed in the heliosheath as described by the standard one-scale model [3]. We hope that the generalized multifractal model will be a useful tool for analysis of intermittent turbulence in the heliospheric plasma. We thus believe that multifractal analysis of various complex environments can shed light on the nature of turbulence.

[1] W. M. Macek and A. Szczepaniak, Generalized two-scale weighted Cantor set model for solar wind turbulence, Geophys. Res. Lett., 35, L02108 (2008), doi:10.1029/2007GL032263.

[2] W. M. Macek and A. Wawrzaszek, Evolution of asymmetric multifractal scaling of solar wind turbulence in the outer heliosphere, J. Geophys. Res., A013795 (2009), doi:10.1029/2008JA013795.

[3] W. M. Macek and A. Wawrzaszek, Multifractal turbulence at the termination shock, in Solar Wind Twelve, edited by M. Maximovic et al., American Institute of Physics, 2010.