Geophysical Research Abstracts
Vol. 19, EGU2017-14011-1, 2017
EGU General Assembly 2017

Non-Extensive Statistical Analysis of Magnetic Field and SEPs during the March 2012 ICME event, using a multi-spacecraft approach

George Pavlos (1), Olga Malandraki (2), Evgenios Pavlos (2), Aggelos Iliopoulos (1), and Leonidas Karakatsanis (1)

(1) Democritus University of Thrace, Department of Electrical and Computer Engineering, Xanthi, Greece (gpavlos@ee.duth.gr), (2) IAASARS, National Observatory of Athens, Athens, Greece (omaland@astro.noa.gr)

As the solar plasma lives far from equilibrium it is an excellent laboratory for testing non-equilibrium statistical mechanics. In this study, we present the highlights of Tsallis non-extensive statistical mechanics as concerns their applications at solar plasma dynamics, especially at solar wind phenomena and magnetosphere. In this study we present some new and significant results concerning the dynamics of interplanetary coronal mass ejections (ICMEs) observed in the near Earth at L1 solar wind environment, as well as its effect in Earth's magnetosphere. The results are referred to Tsallis non-extensive statistics and in particular to the estimation of Tsallis q-triplet, (qstat, qsen, qrel) of SEPs time series observed at the interplanetary space and magnetic field time series of the ICME observed at the Earth resulting from the solar eruptive activity on March 7, 2012 at the Sun. For the magnetic field, we used a multi-spacecraft approach based on data experiments from ACE, CLUSTER 4, THEMIS-E and THEMIS-C spacecraft. For the data analysis different time periods were considered, sorted as "quiet", "shock" and "aftershock", while different space domains such as the Interplanetary space (near Earth at L1 and upstream of the Earth's bowshock), the Earth's magnetosheath and magnetotail, were also taken into account. Our results reveal significant differences in statistical and dynamical features, indicating important variations of the SEPs profile in time, and magnetic field dynamics both in time and space domains during the shock event, in terms of rate of entropy production, relaxation dynamics and non-equilibrium meta-stable stationary states.
So far, Tsallis non-extensive statistical theory and Tsallis extension of the Boltzmann-Gibbs entropy principle to the q-entropy entropy principle (Tsallis, 1988, 2009) reveal strong universality character concerning non-equilibrium dynamics (Pavlos et al. 2012a,b, 2014, 2015, 2016; Karakatsanis et al. 2013). Tsallis q-entropy principle can explain the emergence of a series of new and significant physical characteristics in distributed systems as well as in space plasmas. Such characteristics are: non-Gaussian statistics and anomalous diffusion processes, strange and fractional dynamics, multifractal, percolating and intermittent turbulence structures, multiscale and long spatio-temporal correlations, fractional acceleration and Non-Equilibrium Stationary States (NESS) or non-equilibrium self-organization process and non-equilibrium phase transition and topological phase transition processes according to Zelenyi and Milovanov (2004). In this direction, our results reveal clearly strong self-organization and development of macroscopic ordering of plasma system related to strengthen of non-extensivity, multifractality and intermittency everywhere in the space plasmas region during the CME event.

Acknowledgements: This project has received funding form the European Union's Horizon 2020 research and innovation program under grant agreement No 637324.