Statistical Modeling of Extreme Values and Evidence of Presence of Dragon King (DK) in Solar Wind

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The solar wind constitutes a nonlinear dynamical system, presenting intermittent turbulence, multifractality and chaotic dynamics. One characteristic shared by many such complex systems is the presence of extreme events, that play an important role in several Geophysical phenomena and their statistical characterization is a problem of great practical relevance. This work investigates the presence of extreme events in time series of the modulus of the interplanetary magnetic field measured by Cluster spacecraft on February 2, 2002. One of the main results is that the solar wind near the Earth's bow shock can be modeled by the Generalized Pareto (GP) and Generalized Extreme Values (GEV) distributions. Both models present a statistically significant positive shape parameter which implyies a heavy tail in the probability distribution functions and an unbounded growth in return values as return periods become too long. There is evidence that current sheets are the main responsible for positive values of the shape parameter. It is also shown that magnetic reconnection at the interface between two interplanetary magnetic flux ropes in the solar wind can be considered as Dragon Kings (DK), a class of extreme events whose formation mechanisms are fundamentally different from others. As long as magnetic reconnection can be classified as a Dragon King, there is the possibility of its identification and even its prediction. Dragon kings had previously been identified in time series of financial crashes, nuclear power generation accidents, stock market and so on. It is believed that they are associated with the occurrence of extreme events in dynamical systems at phase transition, bifurcation, crises or tipping points.

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