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Magnetic storms and solar flares: can be analysed within similar mathematical framework with other extreme events?

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The field of study of complex systems considers that the dynamics of complex systems are founded on universal principles that may be used to describe a great variety of scientific and technological approaches of different types of natural, artificial, and social systems. We apply concepts of the nonextensive statistical physics, on time-series data of observable manifestations of the underlying complex processes ending up to different extreme events, in order to support the suggestion that a dynamical analogy characterizes the generation of a single magnetic storm, solar flare, earthquake (in terms of pre-seismic electromagnetic signals) , epileptic seizure, and economic crisis. The analysis reveals that all the above mentioned different extreme events can be analyzed within similar mathematical framework. More precisely, we show that the populations of magnitudes of fluctuations included in all the above mentioned pulse-like-type time series follow the traditional Gutenberg–Richter law as well as a nonextensive model for earthquake dynamics, with similar nonextensive q-parameter values. Moreover, based on a multidisciplinary statistical analysis we show that the extreme events are characterized by crucial common symptoms, namely: (i) high organization, high compressibility, low complexity, high information content; (ii) strong persistency; and (iii) existence of clear preferred direction of emerged activities. These symptoms clearly discriminate the appearance of the extreme events under study from the corresponding background noise.