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Study of pre-seismic kHz EM emissions by means of complex systems

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The field of study of complex systems holds that the dynamics of complex systems are founded on universal principles that may used to describe disparate problems ranging from particle physics to economies of societies. A corollary is that transferring ideas and results from investigators in hitherto disparate areas will cross-fertilize and lead to important new results.

It is well-known that the Boltzmann-Gibbs statistical mechanics works best in dealing with systems composed of either independent subsystems or interacting via short-range forces, and whose subsystems can access all the available phase space. For systems exhibiting long-range correlations, memory, or fractal properties, non-extensive Tsallis statistical mechanics becomes the most appropriate mathematical framework. As it was mentioned a central property of the magnetic storm, solar flare, and earthquake preparation process is the possible occurrence of coherent large-scale collective with a very rich structure, resulting from the repeated nonlinear interactions among collective with a very rich structure, resulting from the repeated nonlinear interactions among its constituents. Consequently, the non-extensive statistical mechanics is an appropriate regime to investigate universality, if any, in magnetic storm, solar flare, earthquake and pre-failure EM emission occurrence.

A model for earthquake dynamics coming from a non-extensive Tsallis formulation, starting from first principles, has been recently introduced. This approach leads to a Gutenberg-Richter type law for the magnitude distribution of earthquakes which provides an excellent fit to seismicities generated in various large geographic areas usually identified as "seismic regions".

We examine whether the Gutenberg-Richter law corresponding to a non-extensive Tsallis statistics is able to describe the distribution of amplitude of earthquakes, pre-seismic kHz EM emissions (electromagnetic earthquakes), solar flares, and magnetic storms. The analysis shows that the introduced non-extensive model provides an excellent fit to the experimental data, incorporating the characteristics of universality by means of non-extensive statistics into the extreme events under study.