



Statistical similarities of pre-earthquake electromagnetic emissions to biological and economic extreme events

Stelios M. Potirakis (1), Yiannis Contoyiannis (2), John Kopanas (2), Anastasios Kalimeris (3), George Antonopoulos (3), Athanasios Peratzakis (2), Konstantinos Eftaxias (2), and Costantinos Nomicos (4)

(1) Department of Electronics Engineering, Technological Education Institute (TEI) of Piraeus, 250 Thivon & P. Ralli, GR-12244, Aigaleo, Athens, Greece, spoti@teipir.gr, (2) Department of Physics, Section of Solid State Physics, University of Athens, Panepistimiopolis, GR-15784, Zografos, Athens, Greece, yconto@yahoo.gr, jkopian@otenet.gr, thperatz@gmail.com, ceftax@phys.uoa.gr, (3) Department of Environmental Technologists, Technological Education Institute (TEI) of the Ionian Islands, GR-29100, Zakynthos, Greece, {taskal, sv8rx }@teiio.gr, (4) TEI of Athens, Department of Electronics, Electronics, Athens, Greece (cnomicos@teiath.gr, +30 210 5385304)

When one considers a phenomenon that is "complex" refers to a system whose phenomenological laws that describe the global behavior of the system, are not necessarily directly related to the "microscopic" laws that regulate the evolution of its elementary parts. 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 disparate problems ranging from particle physics to economies of societies. Several authors have suggested that earthquake (EQ) dynamics can be analyzed within similar mathematical frameworks with economy dynamics, and neurodynamics.

A central property of the EQ preparation process is the occurrence of coherent large-scale collective behavior with a very rich structure, resulting from repeated nonlinear interactions among the constituents of the system. As a result, nonextensive statistics is an appropriate, physically meaningful, tool for the study of EQ dynamics. Since the fracture induced electromagnetic (EM) precursors are observable manifestations of the underlying EQ preparation process, the analysis of a fracture induced EM precursor observed prior to the occurrence of a large EQ can also be conducted within the nonextensive statistics framework.

Within the frame of the investigation for universal principles that may hold for different dynamical systems that are related to the genesis of extreme events, we present here statistical similarities of the pre-earthquake EM emissions related to an EQ, with the pre-ictal electrical brain activity related to an epileptic seizure, and with the pre-crisis economic observables related to the collapse of a share. It is demonstrated the all three dynamical systems' observables can be analyzed in the frame of nonextensive statistical mechanics, while the frequency-size relations of appropriately defined "events" that precede the extreme event related to each one of these different systems present striking quantitative similarities. It is also demonstrated that, for the considered systems, the nonextensive parameter q increases as the extreme event approaches, which indicates that the strength of the long-memory / long-range interactions between the constituents of the system increases characterizing the dynamics of the system.