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Fracture and earthquake physics in a non extensive view

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It is well known that the Gutenberg-Richter (G-R) power law distribution has to be modified for large seismic moments because of energy conservation and geometrical reasons. Several models have been proposed, either in terms of a second power law with a larger b value beyond a crossover magnitude, or based on a magnidute cut-off using an exponential taper. In the present work we point out that the non extensivity viewpoint is applicable to seismic processes. In the frame of a non-extensive approach which is based on Tsallis entropy we construct a generalized expression of Gutenberg-Richter (GGR) law. The existence of lower or/and upper bound to magnitude is discussed and the conditions under which GGR lead to classical GR law are analysed. For the lowest earthquake size (i.e., energy level) the correlation between the different parts of elements involved in the evolution of an earthquake are short-ranged and GR can be deduced on the basis of the maximum entropy principle using BG statistics. As the size (i.e., energy) increases, long range correlation becomes much more important, implying the necessity of using Tsallis entropy as an appropriate generalization of BG entropy. The power law behaviour is derived as a special case, leading to b-values being functions of the non-extensivity parameter q.
Furthermore a theoretical analysis of similarities presented in stress stimulated electric and acoustic emissions and earthquakes are discussed not only in the frame of GGR but taking into account a universality in the description of intrevent times distribution. Its particular form can be well expressed in the frame of a non extensive approach. This formulation is very different from an exponential distribution expected for simple random Poisson processes and indicates the existence of a nontrivial universal mechanism in the generation process. All the aforementioned similarities within stress stimulated electrical and acoustic emissions and seismicity suggests a connection with fracture phenomena at much larger scales implying that a basic general mechanism is “actively hidden” behind all this phenomena.

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