



## Description of pre-seismic MHz electromagnetic in analogy with a thermal second order phase transition : the reproducibility of results

Y. Contoyiannis, J. Kopanas, G. Antonopoulos, L. Contoyianni, and K. Eftaxias

University of Athens, Faculty of Physics, Department of Solid State Physics, Athens, Greece (ceftax@phys.uoa.gr, +30 210 727 6733)

Precursory fracture induced electromagnetic (EM) emissions, rooted in opening cracks and ranging from MHz to kHz, with the MHz appearing earlier, are produced and detected both at laboratory and geophysical scale. Recently, we have proposed the following two epochs / stages model of earthquake (EQ) generation: (i) The final kHz part is triggered by the fracture of high strength and large asperities that are distributed along the activated fault and sustain the system. (ii) The initial MHz part is thought to be due to the fracture of highly heterogeneous system that surrounds the family of asperities. Herein, we focus on the MHz pre-seismic activity. Interestingly, it has been shown that the MHz EM time-series: (i) can be described in analogy with a thermal second order phase transition, and (ii) shows anti-persistent behavior [1, 2]. In this field of research the reproducibility of results is desirable: the results should be verify by a numerous of precursory EM emissions. We refer to ten precursory MHz EM activities associated with ten significant surface EQs that occurred on land or near the coast line in Greece. The analysis suggests that all the MHz EM precursors can be described in terms of a continuous second order phase transitions showing anti-persistency. We introduce a criterion for the existence of an underling strong critical behavior. We show that this criterion is confirmed for all the ten precursors under study, while the associated critical exponents lead to Hurst exponents that indicate that the profiles of the MHZ EM time series follow the anti-persistent fractional Brownian model. These systematically detected critical features are compatible with fracture of a heterogeneous material.

[1] Contoyiannis, Y, Kapiris, P. and Eftaxias, K, A Monitoring of a Pre-Seismic Phase from its Electromagnetic Precursors, *Physical Review E*, 71, 061123-1 – 061123-14, 2005.

[2] Y. Contoyiannis and K. Eftaxias, Tsallis and Levy statistics in the preparation of an earthquake, *Non-linear Processes in Geophysics*, 15, 379–388, 2008.