Geophysical Research Abstracts
Vol. 20, EGU2018-11552, 2018
EGU General Assembly 2018
© Author(s) 2018. CC Attribution 4.0 license.

# Have Mainshocks and Aftershocks Different Physical Origins? Evidence from Earthquake Magnitude Correlations.

Shyam Nandan (1), Guy Ouillon (2), and Didier Sornette (3)

(1) ETH, SED, Earth Science, Zurich, Switzerland (shyam4iiser@gmail.com), (2) Lithophyse, 4 rue de l'Ancien Sénat, 06300 Nice, France, (3) ETH Zürich, Department of Management, Technology and Economics, Scheuchzerstrasse 7, 8092 Zürich, Switzerland

Earthquakes have long been described as either foreshocks, mainshocks or aftershocks. Foreshocks precede mainshocks, which themselves trigger aftershocks obeying the Omori law. This conception has become obsolete, and the present dominant view is that undistinguishable earthquakes trigger other undistinguishable earthquakes: a mainshock is just an "aftershock" of a previous earthquake that happens to be larger. This paradigm has been the driving concept behind the most successful statistical forecasting models of the general class of ETAS models, in which relatively rare background events, powered by plate tectonics, cascade into multitudes of triggered events sharing the same physical properties and the same space-time-magnitude distribution laws.

Using a powerful EM algorithm applied to the Californian earthquake catalog, we find that the distribution of earthquake magnitudes in empirical catalogs exhibits three distinct $\beta$-values, $\beta_b$ for background events, $\beta_a + \delta$ and $\beta_a - \delta$ for triggered events; the two last values express a correlation between the magnitudes of triggered events with that of the triggering earthquake, a feature so far absent in all proposed generalizations of the ETAS model. This novel kinked structure in the GR law is still compatible with statistical self-similarity. The generalized Vere-Jones ETAS (gV-ETAS) model then provides by far the best description of seismic catalogs, and thus the best forecasting potential. The kinked GR law results from the system tending to restore the symmetry of the regional displacement gradient tensor that has been broken by the initiating event. The general emerging concept is that triggered earthquakes are quasi-Goldstone fluctuations of a self-organized critical deformation state.