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Aftershock Statistics explained from Geometric Reductionism

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The decay of aftershocks has recently been shown to follow a stretched exponential function instead of the Omori law (Mignan, Geophys. Res. Lett., 2015). This triggers a complete re-investigation of aftershock statistics in Southern California and a new physical interpretation of these results: (1) After verifying the stretched exponential behavior of aftershocks in time, I show that aftershocks follow a pure exponential in space. I then (re)demonstrate that K(M) = exp(α(M-mmin-ΔmB)) with K the aftershock production by mainshock magnitude M, α the Gutenberg-Richter distribution slope and ΔmB Båth's parameter. Based on these observations, I propose the Recursive Aftershock Stretched Exponential (RASE) model. (2) I investigate the origin of aftershocks using geometric reductionism made possible by the Non-Critical Precursory Accelerating Seismicity Theory postulate, which states that spatial density switches from δb0 for background seismicity to δbp for activated events (such as foreshocks, induced seismicity and here aftershocks) when the static stress field σ(r) exceeds the threshold σ(rA*) $\propto$ $\Delta\sigma$* with r the distance to source. The postulate explains the exponential spatial distribution (assuming that aftershocks fill a noisy fractal network within rA*) and aftershock production (assuming a constant stress drop) with K(M) = δbp.V(M), V being the volume of a rounded cuboid centred on the fault of length l $\propto$ exp(αM), and with radius rA*. Finally the observed stretching factor $\beta \approx$ 0.4 is explained topologically from the fractal dimension D $\approx$ 1.5.