The static behaviour of tectonic aftershocks: From geometric to subdiffusion analysis

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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; Mignan, Seismol. Res. Lett., 2016). 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 behaviour of aftershocks in time, I show that aftershocks follow a pure exponential in space and that there is no observed spatial diffusion with time.
2. I investigate the origin of aftershocks using geometric reductionism made possible by the Non-Critical Precursory Accelerating Seismicity Theory (N-C PAST) postulate, which states that spatial density switches from $\delta b_0$ for background seismicity to $\delta b_p$ for activated events (such as foreshocks, induced seismicity and here aftershocks) when the static stress field $\sigma(r)$ exceeds the threshold $\sigma(r) > \sigma^* + \Delta \sigma^*$ 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 $K(M) = \delta b_p V(M)$, $V$ being the volume of a rounded cuboid centred on the fault of length $l = \exp(\alpha M)$, and with radius $rA^*$. Finally the observed stretching factor $\beta \approx 0.4$, characteristic of aftershock subdiffusion, is explained topologically from the fractal dimension $D \approx 1.5$. 