Comment on "Interevent Correlations from Avalanches Hiding Below the Detection Threshold"

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In a recent Letter, Janićević *et al.* [1] proposed a finite detection threshold in the detection of avalanches as a plausible cause of power-law distributed waiting times in a wide range of phenomena exhibiting bursty dynamics: "from deformation of materials to earthquakes"; "from Barkhausen noise in ferromagnets to earthquakes." They based their conclusions on experimental results in interfacial crack propagation and numerical simulations of a one dimensional string propagating in a 2D *random* medium. The main finding is the fact that the detection threshold may break a single event into subavalanches generating artificial correlations in the time series.

This artifact may indeed affect the waiting times *but only up to the value of the duration of the largest event*. This is the case in the data presented in Fig. 3 [1]: duration of largest events $T_{\max} \sim 4$ s and maximum waiting times $T_{W\max} \sim 3$ s. However, it cannot explain the power-law distributions of waiting times of earthquakes: $T_{\max} \sim 10^2$ s, while waiting times following a power law last up to $T^*_{W\max} \sim 10^6$ s [2]. There are no earthquakes with durations larger than a few minutes ($T_{\max} \sim 10^2$ s) to be broken into subavalanches by a given threshold, and therefore the artifact cannot explain the power-law distribution of waiting times of earthquakes.

Furthermore, the power law in the earthquake waiting times is expected (and reported [2]) only for values larger than $T_{\max}$, which corresponds to a time interval not affected by the artifact. Indeed, shortly after a large quake, low-magnitude aftershocks are missing from earthquake catalogs, a phenomenon which is known as short-time aftershock incompleteness (STAI) [3] and resulting from the masking of small earthquakes by the mainshock's coda and the signal of the following large aftershocks. This results in a uniform (rather than a power-law) distribution of waiting times at the beginning of an aftershock sequence, whose duration is incorporated in the modified Omori law as the c value of the $N(t) \propto 1/(c+t)^p$ [3].

A similar situation holds for experiments in subcritical fracture [4]: $T_{\max} \sim 1$ ms, while $T^*_{W\max} \sim 10^2$ s. Notice that the raw signals (inset of Fig. 1 in Ref. [4]) are much simpler than the one presented in Fig. 1 of [1], which allows an easier characterization of the duration of the avalanches. Concerning the waiting times, the exponent of the power-law distribution is robust when passing from direct visualizations to acoustics, with more than a 10^2 gain in resolution (Fig. 3 in Ref. [4]). Avalanches in a sheared granular material are another example of bursty dynamics [5]. Acoustic events follow a power-law distribution of events energies, and a distribution of waiting times behaving qualitatively as in [2], with $T^*_{W\max} \sim 10^2$ s, once again larger than the events' maximal duration $T_{\max} \sim 100$ ms. By monitoring the acoustic emissions of the process it is possible to use the spectral and waveform characteristics of the signal to properly isolate single events, even when masked by the noise or by a larger event. When the acoustics is available, this kind of analysis (common also in Seismology [3]) gives a better indication of the avalanche duration than visualization techniques used in [1]. This discussion shows that the extrapolation of the results obtained in [1] to earthquakes and in general to other phenomena experiencing a bursty dynamics is not appropriate.

In addition, different models of earthquakes (e.g., OFC model; see Fig. 29 in Ref. [6]) and fracture (e.g., fiber bundle models [7]) propose dynamics with power-law distributed waiting times. The existence of temporal correlations between avalanches may be a signature of toughness correlations in the structure that is getting "broken" (or depinned): easy-to-break zones will bring short waiting times, while hard-to-break zones will bring long waiting times. In the case of earthquakes and in the shear experiment the structure, and thus these toughness correlations, evolve in time, particularly after a large event. If the structure of the medium is random and fixed (like in the presented simulations [1]) it seems logical to obtain no temporal correlations between the events. However, in a real situation structural correlations may be relevant.

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