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P4.4011 Self-organized criticality uncorrelated pulses and intermittency

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Self-organized criticality (SOC) is a well-known paradigm for explaining power law probability distributions and frequency spectra in astrophysical, space and laboratory plasmas [1, 2]. By contrast, in the scrape-off layer of magnetically confined fusion plasmas and other turbulent systems, probability distributions with exponential tails and Lorentzian frequency spectra are observed [3, 4]. These observations are well explained by a stochastic model consisting of a superposition of exponential pulses, arriving according to a stationary Poisson process, called the filtered Poisson process (FPP) [3, 4].
Connections between SOC and the FPP were made as early as one of the original SOC publications [5], where power-law distributed event durations and power-law frequency spectra were explained based on viewing a SOC time series as a sequence of uncorrelated pulses. However, this result relies on an erroneous, yet often repeated conclusion [6]. As exponential waiting times are often observed in SOC models, Poisson distributions (stationary and otherwise) have been invoked as well [1, 7], although a careful definition of 'waiting time' is required [7].
In this contribution, the connection between the FPP and SOC is discussed. As both event duration times and waiting times are explicit parts of the FPP formulation, the difference between these and time spent above a threshold are discussed and compared to the SOC notion of event duration. It is argued that without power-law inputs, pink-noise spectra are not found in the FPP and it is only in the limit of infinite pulse overlap that power law distributed times above a threshold appear. In this limit, the FPP is identical to an Ornstein-Uhlenbeck process [8], which leads naturally to fractional brownian motion, an often studied process in the context of SOC [1, 2]. Unfortunately, in this limit any advantage of using the FPP formulation disappears. The FPP is thus argued to be incompatible with the SOC paradigm.

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