

Scale-free distributions in nature: an overview of self-organized criticality

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Power-law distributions in nature pose a challenge for statistical physics. The paradigm of self-organized criticality (SOC), introduced by Per Bak and coworkers [1], might resolve this puzzle. SOC shows how scale-free event-size and duration distributions can arise in the apparent absence of tuning parameters, in a system of many interacting entities, each having a threshold for relaxation, under a slow external drive. This paradigm may underly phenomena such as power-law distributions in meteorology [2,3] and neuronal activity [4]. SOC in its most familiar context, the “sandpile” models, is related to a continuous phase transition to an absorbing state [5]. Together, relaxation and slow drive restrict the system to the neighborhood of the critical point, yielding power-law scaling without parameter tuning [5,6].

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3. J. D. Neelin et al., J. Atmos. Sci. 66, 2367 (2009).
4. J. M. Beggs and D. Plenz, J. Neurosci. 23, 11167 (2003).
5. R. Dickman et al, Braz. J. Phys. 30, (2000) 27.
6. G. Pruessner, Self-Organised Criticality (CUP, Cambridge, 2012).

Author: DICKMAN, Ronald (UFMG)

Presenter: DICKMAN, Ronald (UFMG)

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