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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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