Singular diffusion in a confined sandpile

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We investigate the behavior of a two-state sandpile model subjected to a confining potential in one and two dimensions. From the microdynamical description of this simple model with its intrinsic exclusion mechanism, it is possible to derive a continuum nonlinear diffusion equation that displays singularities in both the diffusion and drift terms. The stationary-state solutions of this equation, which maximizes the Fermi-Dirac entropy, are in perfect agreement with the spatial profiles of time-averaged occupancy obtained from model numerical simulations in one as well as in two dimensions. Surprisingly, our results also show that, regardless of dimensionality, the presence of a confining potential can lead to the emergence of a power-law tail in the distribution of avalanche sizes.