Sandpile under rotational constraint

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Abstract

The phenomenon that a class of systems, driven externally, naturally evolves into a state of no single characteristic size or time is known as self organized criticality (SOC). Sandpile model is a prototypical model for studying SOC. The non-equilibrium steady state of sandpile model is characterised by the power law distribution of the avalanche properties. Here a new two state sandpile model is developed by imposing a rotational constraint on the flow of sand grains. In this rotational sandpile model (RSM) the toppling rules are deterministic. A site topples if the dynamical variable associated with it exceeds a critical height. After toppling the sand grains flow in a forward and a rotational direction. The toppling rules as defined make the model nonabelian. The model is simulated on a square lattice in two dimension. At the critical steady state, the avalanche properties of RSM show power law behavior. The corresponding critical exponents are found close to that of BTW model. However, the moment analysis of the probability distribution functions reveals that they follow finite size scaling like Manna's stochastic model. Also it is confirmed that the avalanche dynamics are uncorrelated by measuring their time autocorrelation. Hence RSM has a mixed characteristics of both the BTW and Manna's stochastic model. Consequently RSM belongs to a new universality class.