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Title: Crossover phenomena in deterministic and stochastic sandpile models

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Sandpile models are used to study Self Organized Criticality (SOC) that describes non-equilibrium systems evolving spontaneously into a critical state. Three different sandpile models: Bak Tang Wiesenfeld (BTW) sandpile model, stochastic sandpile model (SSM) and rotational sandpile model (RSM) are considered here. The dynamical toppling rules in BTW is deterministic, in SSM it is stochastic and in RSM it is deterministic with certain rotational constraint and has some internal stochasticity. The scaling behaviour of BTW, SSM and RSM are found different in their respective steady states and they belong to different universality classes. Two different crossover phenomena are studied here. First, a crossover from a dissipative BTW model on a regular $2d$ square lattice to a dissipative model on random network by studying the model on a continuously growing network. The growing networks are generated over a square lattice throwing bond of arbitrary bond length. Second, a crossover from RSM to SSM is studied by varying the concentration of quenched random rotational field in the model. A quenched-randomness is introduced by adding anti-clockwise rotational field to certain randomly chosen sites in a clockwise rotational model. In the first case, the crossover is from multiscaling to finite size scaling (FSS) whereas in the second case both the models follow FSS and the crossover is from one universality class to another one. Thus, different universality classes corresponding to different sandpile models at out of equilibrium situation are not completely independent. They are found to be connected to each other in a suitable parameter space and a crossover from one to another can be achieved by tuning a suitable parameter. Financial support from the Department of Science and Technology, Government of India is gratefully acknowledged.