Universalities in Fixed Energy Sandpiles

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SOURISH BONDYOPADHYAY
Department of Physics
University of Calcutta
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List of Publications (included in thesis)

(1) "Conserved mass models with stickiness and chipping", Sourish Bondyopadhyay and P. K. Mohanty, J. Stat. Mech. P07019 (2012).

(2) "Fixed-Energy Sandpiles Belong Generically to Directed Percolation", Mahashweta Basu, Urna Basu, Sourish Bondyopadhyay, P. K. Mohanty , and Haye Hinrichsen, Phys. Rev. Lett. 109, 015702 (2012).

(3) "Dependence of asymptotic decay exponents on initial condition and the resulting scaling violation", Sourish Bondyopadhyay, Phys. Rev. E. 88, 062125 (2013).

Abstract

Stochastic fixed-energy sandpiles (FES) like conserved Manna model, CTTP and similar models like CLG *etc.* were believed to be representative of an independent universality class, namely Manna class. Observations like anomalous decay behavior (undershooting; $\alpha \neq \delta$ though $\beta \approx \beta'$), scaling violation ($\alpha \neq \beta/\nu_{\parallel}$), same upper critical dimension and same mean field exponents as that DP class, *etc.*, raise a doubt on existing claims. Using natural initial condition instead of random initial condition, we have clearly shown [38] that generic FES in 1D belong to DP class.

Then, using the simple example of CLG in 1D, we have shown [41] how the initial condition (i.c.) may crucially affect the critical behavior of a system. In this model the decay exponent is $\alpha_{in} = 1/4$ for random i.c. whereas $\alpha_{in} = 1/2$ for natural i.c. and the later is in agreement with that obtained from the temporal decay of stationary state autocorrelation. The decay exponent α obtained from natural i.c. and stationary state autocorrelation are consistent with the scaling relations whereas α obtained from random i.c. shows scaling violation. Thus, natural i.c. and stationary state autocorrelation capture the universal features whereas random i.c. do not. We have shown that this kind of feature has nothing to do with the non-ergodicity and the origin of such feature is the existence of two competing time scales-(i) $\tau_{in} \sim l_{is}^2$ which is a measure of duration of persistence of the initial memory effect and (ii) $\tau \sim L^2$ which arise from the finite size effect. Different features may arise depending on how the two time scales compete.

Next, we study continuous models of absorbing phase transition (APT) and show that FES models are closely related to mass chipping models (MCM). These models undergo DP-like transitions in presence of threshold w which allows only those sites having $E_i \geq w$, to transfer mass or energy to the neighboring sites. In presence of a threshold, these models show discontinuity in the probability density for energy (or mass). We propose a method of obtaining the critical point and other critical behavior analytically. We have introduced a novel perturbation approach [57] and obtained the stationary state mass distributions for a set of general mass chipping models.

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