Ballistic deposition patterns beneath a growing Kardar-Parisi-Zhang interface.

Summary: “We consider a (1 + 1)-dimensional ballistic deposition process with next-nearest-neighbor interactions, which belongs to the Kardar-Parisi-Zhang (KPZ) universality class. The focus of our analysis is on the properties of structures appearing in the bulk of a growing aggregate: a forest of independent clusters separated by ‘crevices.’

Competition for growth (mutual screening) between different clusters results in ‘thinning’ of this forest, i.e., the number density $c(h)$ of clusters decreases with the height $h$ of the pattern. For the discrete stochastic equation describing the process we introduce a variational formulation similar to that used for the randomly forced continuous Burgers equation. This allows us to identify the ‘clusters’ and crevices with minimizers and shocks in the Burgers turbulence. Capitalizing on the ideas developed for the latter process, we find that $c(h) \sim h^{-\alpha}$ with $\alpha = 2/3$. We compute also scaling laws that characterize the ballistic deposition patterns in the bulk: the law of transversal fluctuations of cluster boundaries and the size distribution of clusters. It turns out that the intercluster interface is superdiffusive: the corresponding exponent is twice as large as the KPZ exponent for the surface of the aggregate. Finally we introduce a probabilistic concept of ballistic growth, dubbed the ‘hairy’ Airy process in view of its distinctive geometric features. Its statistical properties are analyzed numerically.”

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