Simulations on a fractal growth model

Julia Marchis

Fractals are everywhere in nature. To understand why nature gives rise to fractal structures implies the formulation of models of fractal growth based on physical phenomena.

In the random deposition model from a randomly chosen site over the surface, a particle falls vertically until it reaches the top of the column under it. In the ballistic deposition model the particle sticks to the first particle, which it meets, so it is not necessary to reach the top of the column under it (see Barabasi, Stanley, Fractal concepts in surface growth, Cambridge University Press). There are situation, when in the system different type of particles has different behavior. We use a model, where a particle follows the rules of the first model with probability p, and the rules of the second model with probability $1-p$. We see the obtained cluster for $p = \frac{1}{2}$ in Figure 1, and for $p = \frac{3}{4}$ in Figure 2. This model can have applications in Chemistry, where different type of particles has different behavior in the reactions.

We study this model mainly numerically. For this we study the interface width, given by the formula

$$w(L,t) = \sqrt{\frac{1}{L}\sum_{i=1}^{L}[h(i,t) - \bar{h}(t)]^2},$$

where L is the system size, t is the time, $h(i,t)$ is the height of column i at time t and $\bar{h}$ is the mean height of the surface defined by

$$\bar{h}(t) = \frac{1}{L}\sum_{i=1}^{L} h(i,t).$$

w increases until a time t_{sat}, then reaches a saturation value w_{sat}. For $t \leq t_{sat}$ $w(L,t) \sim t^{\beta}$ and for the saturation regime $w_{sat}(L) \sim L^{\alpha}$. We determine the value of the parameter α and β numerically for different value of p.

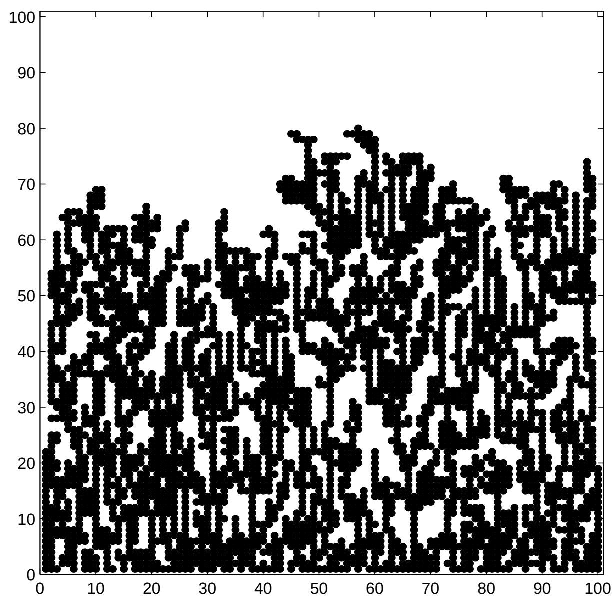

Figure 1: A cluster obtained by depositing 4000 particles on a substrate of horizontal size $L = 100$, for $p = \frac{1}{2}$.

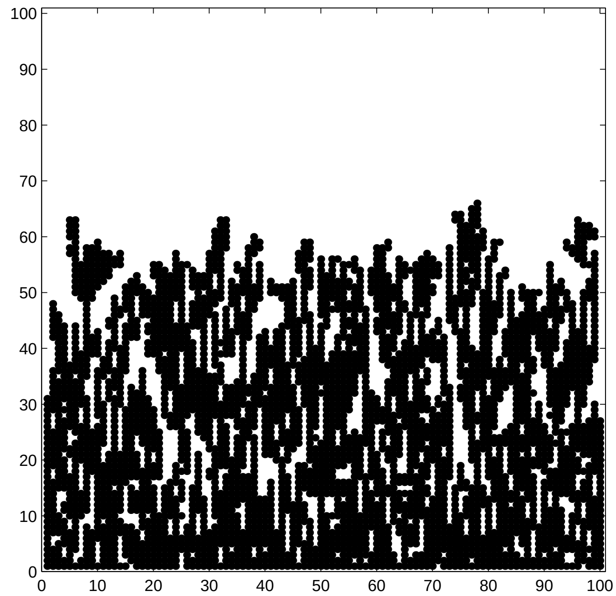

Figure 2: A cluster obtained by depositing 4000 particles on a substrate of horizontal size $L = 100$ for $p = \frac{3}{4}$