

# Non-locality effects in the Eden growth model

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The Eden growth model [1], originally designed to study the growth of cell colonies, is a paradigmatic example of stochastic radial growth, in which the fluctuations in the interface are described by the celebrated Kardar-Parisi-Zhang (KPZ) universality class [2].

Recently, some experiments investigating the scaling behavior of the growth of colonies of different types of cells in agreement with the KPZ class have been reported [3, 4]. However, the evolution of cell aggregates is a nutrient-limited growth process that involves non-local fields while the KPZ equation, which introduced the KPZ universality class, is a strictly local model. In this work we propose a simple extension of the Eden model in order to take into account effects related to access to nutrients introducing non-locality in the growth rules in an Eden off-lattice model. This effect is included by adding an additional probability

$$P = 1 - \exp\left(-A_s \frac{\theta_s}{2\pi}\right) \quad (1)$$

to accept the replication of a cell in the original Eden model rules. Here  $\theta_s$  is the opening angle sought by the replicating cell and  $A_s$  the parameter controlling the intensity of this shadowing effect. The probability of creating a new particle should be related to the amount of space free from cells. A high/low value of  $A_s$  mimics a high/low density of nutrients. If  $A_s$  and, thus nutrient resources, is large the aggregate grows even if the angle  $\theta_s$  is small. On the other hand, the aggregate needs very large  $\theta_s$  to grow if  $A_s$  is small.

Figure 1 shows two aggregates for different values of this parameter. When the  $A_s$  increases, the aggregate resembles the original Eden clusters with a rough surface of circular shape. For high nutrient competition the non-locality effects brings forth and a finger-like shape is observed. We analyzed the scaling properties of the interfaces produced by the aggregates and characterized the regimes where KPZ scaling is observed.

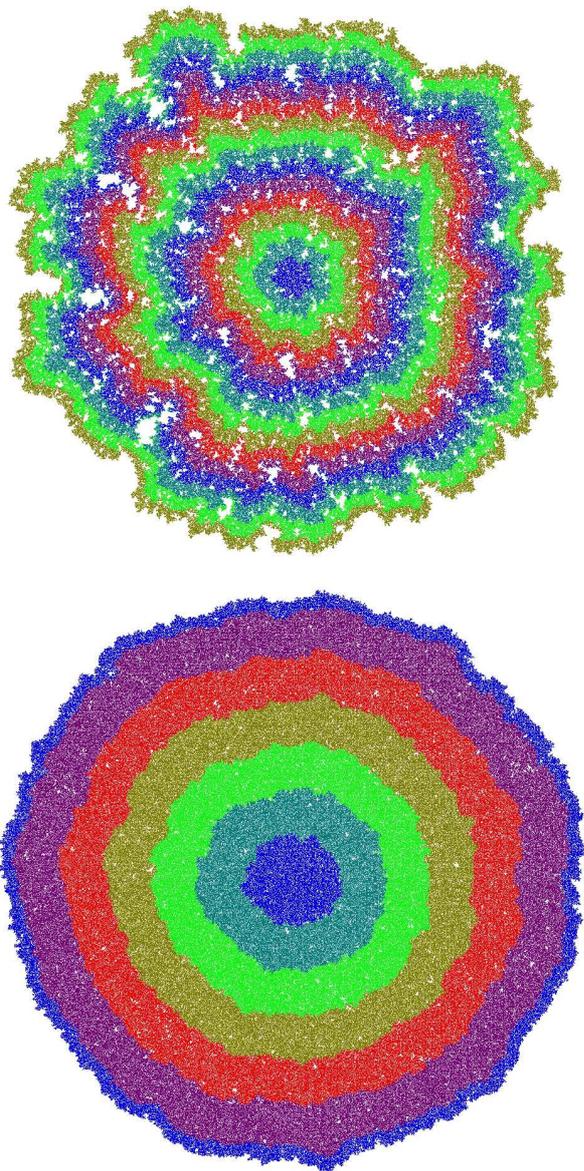


Figure 1: Aggregates for two different values of the parameter  $A_s$  according to equation (1). Top  $A_s = 1$  and bottom  $A_s = 9$ . Colors changes every 150 steps.

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