The role of topology on the Kardar-Parisi-Zhang universality class

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The kinetic roughening properties of growth models in the 1D Kardar-Parisi-Zhang (KPZ) universality class are quite remarkable. Beyond critical exponent values, the full probability distribution of interface fluctuations is shared by systems in this class [2, 3]. Moreover, topological constraints on the interface are relevant: On a cylinder (band geometry), the Tracy-Widom distribution (TW) from random matrix theory ensues for the Gaussian Orthogonal ensemble. On a plane (circular geometry), the TW variant for the Gaussian Unitary ensemble occurs.

In [4, 5] we considered a covariant version of the KPZ equation; it allows extension to arbitrary Riemannian manifolds and is devoid of small-slopes and no-overhangs approximations:

$$\partial_t \vec{r} = (A_0 + A_1 K(\vec{r}) + A_n \eta(\vec{r}, t))\vec{u}_n. \tag{1}$$

Here, $\vec{r}$ is the position of an interface point, $A_j > 0$ are constants, $K(\vec{r})$ is the local extrinsic curvature, η is white noise, and $\vec{u}_n$ is the outwards pointing normal. Our numerical simulations of (1) indicate topological effects also at *short-times*: e.g., for the plane and large noise the universality class is that of *self-avoiding walks* [5] rather than Edwards-Wilkinson. In this contribution, we consider the role of topology in the KPZ class, by investigating Eq. (1) on a family of manifolds which interpolates smoothly between the cylinder and the plane, namely, cones of increasing aperture, see Fig. 1. The Gauss-Bonnet theorem provides a conserved quantity with a topological origin, which helps explain the different behaviors. Moreover, we study the KPZ class in homogeneous spherical and hyperbolic geometries.

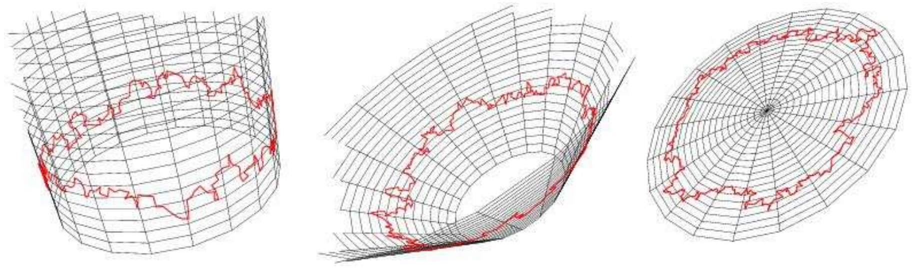

Figure 1: KPZ growth on several manifolds: cylinder (left), cone (middle), and plane (right).

References

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