

Large deviations of surface height in the Kardar-Parisi-Zhang equation

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The Kardar-Parisi-Zhang (KPZ) equation describes an important universality class of nonequilibrium stochastic growth. There has been much recent interest in the one-point probability distribution $P(H,t)$ of height H of the evolving interface at time t . I will show how one can use the optimal fluctuation method (also known as the instanton method, the weak-noise theory, the macroscopic fluctuation theory, or simply WKB) to evaluate $P(H,t)$ for different initial conditions in 1+1 dimensions. At short times the body of the height distribution is Gaussian, but its tails are non-Gaussian and highly asymmetric. In a moving frame, one of the tails coincides, at all times, with the proper tail of the Tracy-Widom distribution (for the flat and curved interface), and of the Baik-Rains distribution (for the stationary interface). The other tail displays a behavior that differs from the known long-time asymptotic. At sufficiently large $|H|$ this large-deviation tail also persists at arbitrary long times. The case of stationary interface is especially interesting. Here at short times the large deviation function of the height exhibits a singularity at a critical value of $|H|$. This singularity results from a symmetry-breaking of the “optimal path” of the system, and it has the character of a second-order phase transition.

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