PROMIT GHOSAL, Columbia University

Coulomb gas electrostatics control large fluctuation of the KPZ equation

We establish a large deviation principle for the Kardar-Parisi-Zhang (KPZ) equation, providing precise control over the left tail of the height distribution for narrow wedge initial condition. Our analysis exploits an exact connection between the KPZ one-point distribution and the Airy point process – an infinite particle Coulomb-gas which arises at the spectral edge in random matrix theory. We develop the large deviation principle for the Airy point process and use it to compute, in a straight-forward and assumption-free manner, the KPZ large deviation rate function in terms of an electrostatic problem (whose solution we evaluate). In addition to these long-time estimates, we provide rigorous proof of finite-time tail bounds on the KPZ distribution which demonstrate a crossover between exponential decay with exponent 3 (in the shallow left tail) to exponent 5/2 (in the deep left tail). The full-space KPZ rate function agrees with the one computed in Sasorov et al. [J. Stat. Mech, 063203 (2017)] via a WKB approximation analysis of a non-local, non-linear integro-differential equation generalizing Painleve' II which Amir et al. [Comm. Pure Appl. Math. 64, 466 (2011)] related to the KPZ one-point distribution.