Nonequilibrium critical dynamics: upturns from surface kinetic roughening

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The collective properties that characterize dynamical complex systems often emerge via non-equilibrium analogues of phase transitions [1], at which fluctuations play an essential role. A prime example of this is generic scale invariance (GSI) [1], whereby external driving and dissipation act at comparable time scales, in such a way that criticality emerges spontaneously without parameter tuning. Thus, strong correlations pervade the spatiotemporal dynamics, being encoded in scaling behavior of observable quantities, largely irrespective of parameter values [1]. Surface kinetic roughening constitutes an important instance of GSI due to its ubiquity across system nature and physical scales [2]. Moreover, it generalizes equilibrium critical dynamics away from equilibrium, accounting for the behavior of even non-interfacial systems. For instance, in Ref. [3] the Tracy-Widom probability distribution function (PDF) ---which describes interface fluctuations in the celebrated 1D Kardar-Parisi-Zhang (KPZ) universality class [4]--- has been very recently found to also account for the statistics of phase fluctuations in the synchronization of rather generic oscillator lattices, whose evolution is demonstrated as a full-fledged instance of kinetic roughening [3].

In this talk we will address recent works [3,5-8] on kinetic roughening systems which, in spite of featuring a KPZ nonlinearity, may or may not be in the KPZ universality class, as well as systems related with these. Examples range from the stochastic Burgers [5] to Kuramoto-Sivashinsky equations [6], spreading of precursor films [7], or the KPZ equation without surface tension [8] or with columnar disorder [3]. These cases illustrate some limitations of the standard definition of universality classes via scaling exponent values [2] and the role at this of the PDF of interface fluctuations and/or interface covariance [4], and of generalizations of the standard dynamic scaling Ansatz. They also provide interesting examples on ways in which system symmetries and/or the nature of fluctuations reflect into these traits of the universality class, all of which should eventually reflect into a comprehensive understanding of dynamic criticality away from equilibrium.

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