

Comment on “Effects of Particle Shape on Growth Dynamics at Edges of Evaporating Drops of Colloidal Suspensions”

Recently, Yunker *et al.* [1] reported an interesting experimental study on colloidal particle shape effects on edge growth for evaporating water drops, finding that kinetic roughening [2] of one-dimensional fronts of deposits depends on particle shape. In one of three regimes studied, particles with anisotropy $1.5 \leq \varepsilon \leq 3.5$ induce roughness exponent values $\alpha_{\text{loc}} \approx 0.61$, $\beta \approx 0.68$, argued to be compatible with the quenched Kardar-Parisi-Zhang (QKPZ) universality class. This QKPZ conclusion was supported by simulations of a discrete model [1], being found by the authors “unexpected,” as quenched disorder was not the main experimental source of noise. Heterogeneous growth conditions were argued to originate it, via a “colloidal Matthew effect” (ME) by which particles adsorbing in particle-depleted regions are attracted to particle-rich regions, where they deposit preferentially.

We have simulated the large- ε model from Ref. [1], finding that the system does not feature quenched disorder or any related property [2]. Hence, QKPZ behavior is ruled out by our simulations. Instead, intrinsic anomalous roughening occurs [3,4]: The roughness exponent *differs*, if measured at scales close to the system size (α) or at smaller scales (α_{loc}), slopes being nonstationary [3]. Contrasting with Ref. [1], Family-Vicsek scaling does *not* hold, exponents z and $\beta = \alpha/z$ being still defined. Structure factors $S(k, t) = \langle |h_k(t)|^2 \rangle$ [with $h_k(t) = \sum_{j=1}^L h(x, t) e^{ikx}$] shift with time [3], data collapse still ensuing; see Fig. 1. However, the *nonzero* slope of the master curve in the large- $kt^{1/z}$ scaling region implies [3] that (i) $\alpha > 1$; i.e., the interface is super-rough [3] due to frequent jumps in the profiles (Fig. 1); and (ii) $\beta > 1/2$; i.e., in the absence of quenched disorder, a *morphological instability* occurs [2]. This is actually the *correct* interpretation for the ME: peaks grow faster than troughs, dynamics amplifying height differences, and it is built into the rules of the large- ε model, the growth probability of a column being proportional to its height [1].

In the large- ε experiments, $h(x, t)$ also jumps discontinuously; compare Fig. 1(g) in Ref. [1] with Fig. 1 here. High probabilities for large slopes induce intrinsic anomalous roughening [5]. Physically, jumps ensue due to the ME, combined with the single-valued approximation defining $h(x, t)$. Quite similarly, in experiments [4] and discrete models of diffusion-limited (DL) growth [6], the standard DL-aggregation instability also induces *effective* anomalous scaling [2,3] within the single-valued approximation. Actually, many experimental anomalous-roughening systems feature morphological instabilities [4]. Exponent values are nonuniversal, changing with system parameters; typically, [4,6] $\alpha > 1$, $\beta > 1/2$, $\alpha_{\text{loc}} = 0.6\text{--}0.8$, as observed in Ref. [1] for large ε . Here, exponents are quite insensitive to the interparticle interaction. Such a robustness is

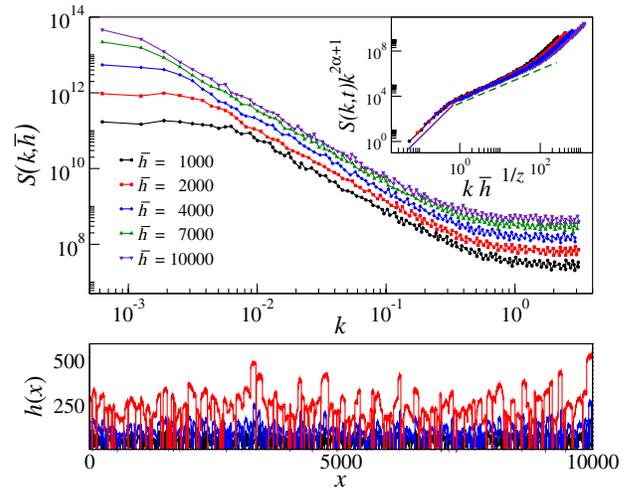


FIG. 1 (color online). Top: Structure factor of the large- ε model [1] for increasing \bar{h} ; see the legend. Inset: Data collapse of the same curves. Slopes of reference lines are 3.5 (solid) and 1.5 (dashed). Bottom: Front profiles for $\bar{h} = 50, 100, 250$, bottom to top.

naturally attributed to a mechanism similar to that in DL systems. Meanwhile, in Ref. [6], asymptotics are of the KPZ type but hard to observe due to the crossovers induced by the instability. We expect similar behavior to be operating in the large- ε experiments [1], although systematic study seems in order.

Summarizing, the ME plausibly explains the large- ε scaling behavior, not because it induces quenched noise as argued in Ref. [1] but, rather, because it implies a morphological instability that induces effective anomalous roughening. More work is necessary to fully elucidate the experiments, based on more refined models. Indeed, sources of quenched randomness do exist, such as unevenness of the contact line and shape of the drop surface, etc. Their dynamical role has not yet been assessed and deserves future investigation.

We acknowledge suggestions by J. Muñoz-García. This work has been partially supported through Grants No. FIS2009-12964-C05-03 (MICINN, Spain) and No. FIS2012-38866-C05-01 (MEC, Spain).

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Received 5 June 2013; published 12 November 2013

DOI: [10.1103/PhysRevLett.111.209601](https://doi.org/10.1103/PhysRevLett.111.209601)

PACS numbers: 61.43.Fs, 64.70.kj, 64.70.pv, 82.70.Dd

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