KPZ-class interfaces in turbulent liquid crystal: beyond a "mere" confirmation

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Growing interfaces in turbulent liquid crystal constitute a reliable experimental system for studying the (1+1)-dimensional KPZ class [1]. Indeed, we previously showed that the circular interfaces exhibit the GUE Tracy-Widom distribution and the Airy_2 correlation (the latter as the spatial correlation), whereas the flat interfaces exhibit the GOE Tracy-Widom distribution and the Airy_1 correlation, in full agreement with the rigorous results derived for solvable models. This naturally leads to the conclusion that the universality hypothesis of the KPZ class has been experimentally confirmed, including the split into different subclasses (here the curved and flat subclasses), which is perhaps, from modern viewpoints, not too surprising, given the abundant numerical evidence and a growing number of experiments reaching a similar conclusion [2]. Here, I would like to stress the importance of going beyond, by investigating (presumably) universal but theoretically unsolved properties of the KPZ class, by which experiments can provide substantial information for theory, instead of simply confirming it.

Among others, arguably the most important unsolved property is time correlation. Our experimental results showed that it is also universal, and different between the circular (curved) and flat interfaces [1]. Specifically, while the two-time correlation function for the flat interfaces decays, that for the circular ones remains strictly positive forever: in short, positive fluctuations tend to be positive forever, and vice versa. This is corroborated by the persistence probability $P_\pm(t,t_0) \sim (t/t_0)^{-\theta_\pm}$, i.e., the probability that the local height fluctuations keep the same sign from time t_0 to t, for which we found $\theta_\pm > 1$ for the flat case and $\theta_\pm < 1$ for the circular case, so that the mean duration of a single sign diverges for the latter. This suggests that the so-called "weak ergodicity breaking" [3], which refers to anomalous temporal behavior due to diverging trapping time, may be a key notion to diagnose the different time correlations of the flat and circular interfaces. Indeed, we find that a certain set of properties is in a quantitative agreement with the dichotomous process, a prototypical model for studying weak ergodicity breaking [4].

I also argue that time correlation controls crossover from the flat subclass to the stationary one. I will show, both experimentally and numerically, how crossover from the GOE Tracy-Widom to the Baik-Rains F_0 distributions, and from the Airy_1 to the stationary correlations, takes place in the course of time [5].

References

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