# Exploring geometry dependence of universal laws for growing interfaces

**Kazumasa A. Takeuchi**

*Department of Physics, Tokyo Institute of Technology, Tokyo 152-8551, Japan*

The Kardar-Parisi-Zhang (KPZ) universality class plays a central role in the studies of universal scaling laws for systems driven out of equilibrium [1]. First, the KPZ class is known to describe a wide variety of systems ranging from growing interfaces to driven lattice gas, directed polymer problems, fluctuating hydrodynamics, etc. More importantly, the (1+1)-dimensional KPZ class is now an exactly tractable problem, allowing us to compare nontrivial exact results for solvable toy models and experimental data from far more complex real systems. An important outcome of such developments is that the KPZ class actually splits into a few "subclasses", according to the initial condition and/or the global geometry of interfaces. Indeed, we showed experimentally that growing interfaces in liquid-crystal turbulence exhibit the largest-eigenvalue distribution (aka Tracy-Widom distribution) for random matrices in Gaussian unitary ensemble (GUE) when circular interfaces grow from a point nucleus (FIG. 1 left images), while flat interfaces from a line (right images) show the equivalent for Gaussian orthogonal ensemble (GOE) [2].

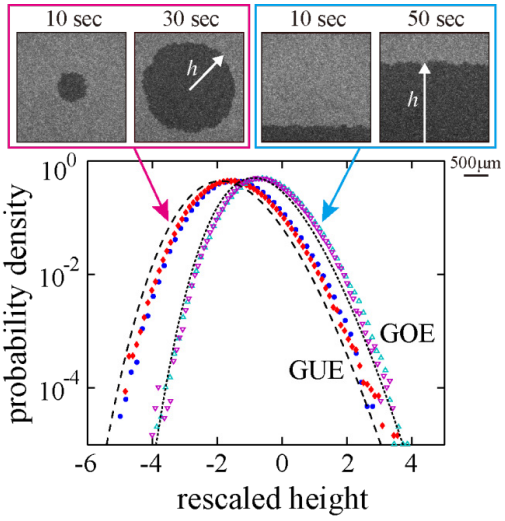


FIG. 1: Circular and flat interfaces in liquid-crystal turbulence [2].

This result arouses a number of new questions. For example, what happens when the initial condition is neither a point nor a straight line, but a slightly curved line? (FIG. 2a) What happens when interfaces grow inward from a circle? (FIG. 2b) These natural questions actually remained unanswered by theoretical approaches, but we realize such interfaces both experimentally and numerically and study their fluctuation properties [3]. Moreover, we prepare a system composed of two regions with different growth speeds (FIG. 2c). Such a situation can be compared with the "half-space" problem studied in the theoretical literature, for which the Tracy-Widom distribution for Gaussian symplectic ensemble (GSE) was identified in some case. This is joint work with Yohsuke T. Fukai and Yasufumi Ito.

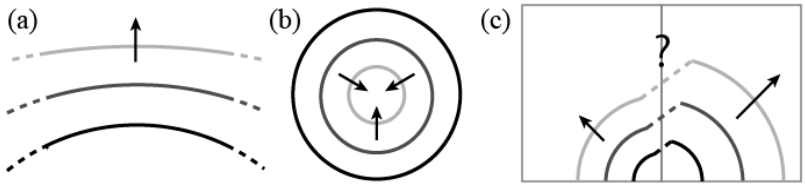


FIG. 2: Various geometries. These schematics illustrate the mean profile of interfaces, while we are interested in fluctuations on top of this.

**REFERENCES**

1. For a review, see, K. A. Takeuchi, arXiv:1708.06060.
2. K.A. Takeuchi *et al.*, *Sci. Rep.* **1**, 34 (2011); K.A. Takeuchi and M. Sano, *J. Stat. Phys.* **147,** 853 (2012).
3. Y. T. Fukai and K. A. Takeuchi, *Phys. Rev. Lett.* **119**, 030602 (2017).