Scalings, saddle points and Gaussian variational method revisited for the 1D interface in random media

Elisabeth Agoritsas*[1] and Vivien Lecomte[2]

[1]Laboratoire de Physique Théorique de l'ENS (LPTENS) – CNRS : UMR8549, Université Pierre et Marie Curie (UPMC) - Paris VI, École normale supérieure [ENS] - Paris – 24 rue Lhomond, 75231 Paris CEDEX 05, France

[2]Laboratoire de Probabilités et Modèles Aléatoires (LPMA) – Université Pierre et Marie Curie (UPMC) - Paris VI, CNRS : UMR7599, Université Paris VII - Paris Diderot – France

Abstract

We discuss as a case study the scaling properties of a one-dimensional interface at equilibrium, at finite temperature and in a disordered environment with a finite disorder correlation length. We focus our approach on the scalings of its geometrical fluctuations, specifically of the variance of its relative displacements at a given length scale. This 'roughness' follows at large length scales a power law whose exponent characterises a superdiffusive behaviour, which in 1+1 dimension is known to be the characteristic 2/3 exponent of the Kardar-Parisi-Zhang (KPZ) universality class. On the other hand, the Flory exponent of this model, obtained by a power counting argument on the interface Hamiltonian, is equal to 3/5 and thus does not yield the correct KPZ roughness exponent. However, a standard Gaussian-Variational-Method (GVM) computation of the roughness is supposedly bound to predict the Flory exponent instead of the physical KPZ one.

In this work, we first review some of the available power-counting options, and examine the distinct exponent values that they predict. Their (in)validity is shown to depend on the existence (or not) of well-defined optimal trajectories in a large-size or low-temperature asymptotics. We identify the crucial role of the 'cut-off' lengths of the model - the disorder correlation length and the system size - which one has to carefully follow throughout the scaling analysis. In particular, we report new results obtained within a GVM computation scheme which includes explicitly a finite system size, allowing to avoid the usual Flory pitfall and thus to predict correctly a 2/3 asymptotic roughness exponent.

Reference: Elisabeth Agoritsas and Vivien Lecomte, arXiv:1610.01629 [cond-mat.stat-mech], " Power countings versus physical scalings in disordered elastic systems - Case study of the one-dimensional interface "

*Speaker