Research Highlight: Polynomial chaos and scaling limits of disordered systems

Work of Associate Professor SUN Rongfeng

Many disordered systems arise as a result of perturbing an underlying pure model with disorder. When small disorder perturbation changes the qualitative behavior of the model on large space-time scales, the model is said to be disorder relevant; if only large enough disorder perturbation induces such qualitative change, the model is said to be disorder irrelevant.

In recent joint work with F. Caravenna and N. Zygouras [CSZ17], A/Prof. Rongfeng Sun gave novel criteria to determine whether a given disordered system is disorder relevant. Their key insight is that for many disordered systems defined on a lattice, disorder is relevant if and only if one can tune the strength of disorder down to zero as the lattice spacing is decreased to zero, such that one obtains a disordered model in the continuum. This significantly generalizes earlier work by Alberts, Khanin and Quastel [AKQ14], where such disordered continuum limit was constructed for the directed polymer model in dimension 1+1. New models that have been incorporated into this framework include the disordered pinning model, the long-range directed polymer model in dimension 1+1, and random field perturbation of the critical Ising model in dimension 2.

References:

- [AKQ14] T. Alberts, K. Khanin, and J. Quastel. The intermediate disorder regime for directed polymers in dimension 1+1. Ann. Probab. 42 (2014), 1212–1256.
- [CSZ17] F. Caravenna, R. Sun, and N. Zygouras. Polynomial chaos and scaling limits of disordered systems. Journal of the European Mathematical Society, 19, No. 1 (2017): 1-65.