Superconcentration for minimal surfaces in first passage percolation and disordered Ising ferromagnets

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In this talk, we investigate the standard first passage percolation model on $\mathbb{Z}^d$ with a distribution G that takes two values $0 < a < b$. Our focus lies on analyzing the maximal flow through the cylinder $[0, n]^{d-1} \times [0, hn]$ between its top and bottom faces, as well as the associated minimal surface(s). We establish that the variance of the maximal flow exhibits superconcentration, specifically in $O\left(\frac{n^{d-1}}{\log n}\right)$, for $h \geq h_0$ (with $h_0 = h_0(a, b)$ being a sufficiently large constant). Furthermore, we deduce chaoticity of the minimal surface.

We will also present the connection between first passage percolation model on $\mathbb{Z}^d$ and the ground state energy of a disordered Ising ferromagnet confined within a cylinder $[0, n]^{d-1} \times [0, hn]$.

Our proof draws inspiration from the work of Benjamini, Kalai, and Schramm (BKS) (Annals of Probability 2003). However, a major challenge in this context lies in effectively controlling the influence of edges since the averaging technique employed in the BKS proof is not applicable to surfaces.

Joint work with Christophe Garban.