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Decoupling inequalities for the random walk loop soup

Based on a joint work with Caio Alves

The random walk loop soup on $\mathbb{Z}^d$ (in dimensions $d \geq 3$) is a Poisson ensemble of nearest neighbor closed paths (loops) on $\mathbb{Z}^d$ with intensity measure $\alpha \frac{1}{\text{length}}(\frac{1}{2d})^{\text{length}}$. The model was introduced by Lawler and Trujillo Ferreras in 2007 as a discretisation of the Brownian loop soup of Lawler and Werner and has been since then broadly studied partly due to its connections to a number of other models such as, e.g., the Gaussian free field and the loop erased random walk. This model has polynomially decaying spatial correlations, which makes the analysis of its geometric properties particularly challenging.

In this talk we prove certain decoupling inequalities for the random walk loop soup, which allow us to obtain detailed information about effective large-scale connectivity of the loop soup and its vacant set. The principal idea behind decoupling inequalities is that the effect of correlations can be well dominated by a slight variation (sprinkling) of the intensity parameter. Introduced by Szntiman in the study of random interlacements, it has been an impetus for the recent progress in understanding percolative properties of strongly correlated random spatial processes with additive structure such as, e.g., Poisson ensembles or Gaussian fields.