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Directed polymers in a random environment with a defect line

The directed polymer in a random environment (DPRE) models a one-dimensional object interacting with disorder. The $1+1$ dimensional version of the model first was studied in the physics literature by Huse and Henley as a model for the interface in two-dimensional Ising models with random exchange interaction. We show that the difference between quenched and annealed free energies is of order β^4 as $\beta \to 0$, assuming only finiteness of exponential moments of the disorder values, improving existing results which required stronger assumptions.

A related problem is the competition between extended and point defects as reflected in pinning phenomena, arising for example in the context of high-temperature superconductors. On a lattice this can be described by a random potential, typically i.i.d. at each lattice site, representing the point defects, with an additional fixed potential u added for sites along some line, representing the extended defect. The polymer must choose between roughly following the extended defect, or finding the best path(s) through the point defects. As u is decreased, one expects a depinning transition at some critical u_c where the polymer ceases to follow the extended defect.

We show that for small inverse temperature β the quenched and annealed free energies differ significantly at most in a small neighborhood (of size of order β) of the annealed critical point $u_c^a = 0$.

This is a joint work with Kenneth S. Alexander.