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Long-range quenched disorder in the bidimensional Potts model.

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In collaboration with M. Picco and Raoul Santachiara, we tackled the problem of weak disordered bi-dimensional Potts model at criticality.
The aim of this study is to understand how the critical properties of the pure (P) model are modified by the addition of long-range-correlated disorder on the spin-couplings, i.e. the random-bond Potts model.
For uncorrelated or short range (SR) disorder the answer is given by the Harris criterion, [5].
We, instead, analysed the case where the couplings, $J(x) \geq 0$, are drawn from an isotropic-long-range-correlated-bimodal probability distribution, whose second cumulant, decreases as a power-law for large distances, $g(|x|) \sim |x|^{-a}$. The extended Harris criterion, [6], determine in which region of the parameters (q, a) the disorder is relevant.
When $a > d = 2$, the critical behavior of the system is expected to be the same as the one with SR disorder.
The behavior of the Potts model when the long-range (LR) is dominant over the SR is much less understood.
We studied the SR-LR crossover for $q \in \{1, 2, 3\}$ on the self-dual critical line. These q values are representative for all q, since the SR disorder is respectively irrelevant, marginal and relevant .
By tuning the range of the correlation, the strength of the disorder, and by measuring the fractal dimension of the Fortuin-Kasteleyn (FK) clusters, d_f, we gained information about the fixed-points stability in different phases of the renormalisation group (RG) flow. We established the existence of an LR fixed point for all values of $q > 1$. Also, for $q = 1$, a 1-loop RG computation, done above the upper critical dimension, predicted the existence of a Long Range percolation (LRp) point. This is in agreement with our study in $d = 2$.
Furthermore, we built a unifying phase diagram a vs. q describing the crossover among LR-SR, LR-P and LR-LRp physics.

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