The two-dimensional Ising spin glass at zero temperature

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Junior Research Group "Complex Systems with Frustration"

Introduction

A spin glass is a magnetic system in which spins are coupled by random choices of ferromagnetic and anti-ferromagnetic bonds. The Hamiltonian of an Ising spin glass in the Edwards-Anderson model is given by

$$H = \sum_{\langle i,j \rangle} J_{ij} S_i S_j .$$

To determine the exact ground state energy of such a system, we used an algorithm based on "minimum weight perfect matching". If we change the BCs from Periodic to Anti-periodic, we can define:

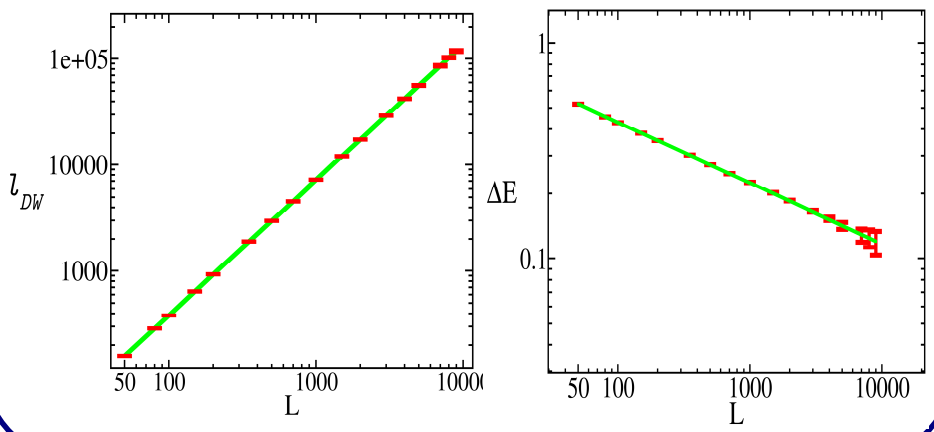
defect energy: $\Delta E = |E_P - E_{AP}| \propto L^{\theta}$ domain wall: $l_{DW} \propto L^{d_f}$

In two dimensions, using conformal field theory the stiffness exponent has been conjectured to be related to the fractal dimension via [4]

$$d_f = 1 + \frac{3}{4(3+\theta)} .$$

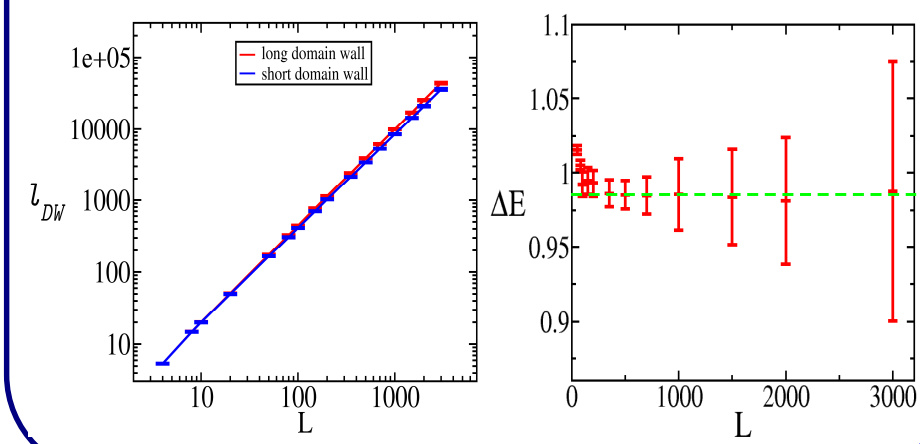
Periodic-Free BCs with Gaussian couplings:

$4 \le L \le 9000$



Periodic-Free BCs with bimodal couplings:

$4 \le L \le 3000$

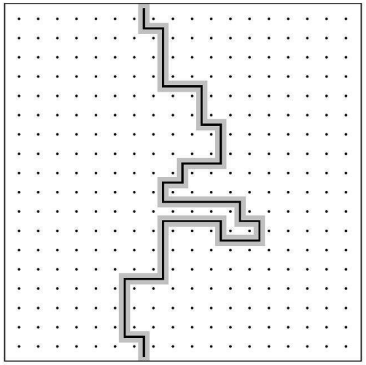


Schramm-Loewner Evolution (SLE):

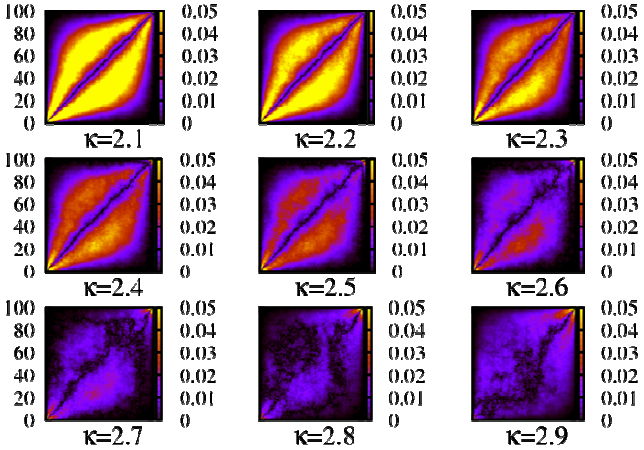
If the domain wall in this system obeys SLE, then we can classify a statistical ensemble of curves in 2D with only one parameter κ which is the diffusion constant in Brownian motion. If such a domain wall obeys SLE, according to conformal field theory the fractal dimension and diffusion constant should be related to each other via

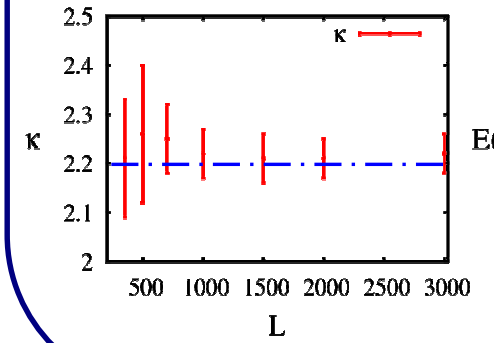
$$d_f = 1 + \kappa/8.$$

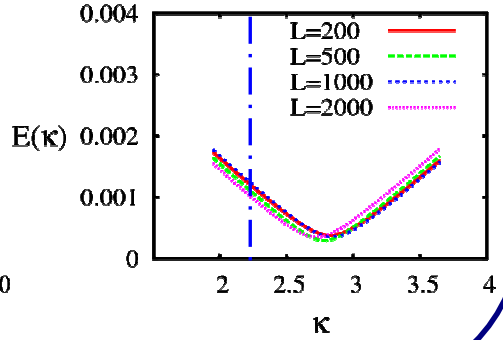
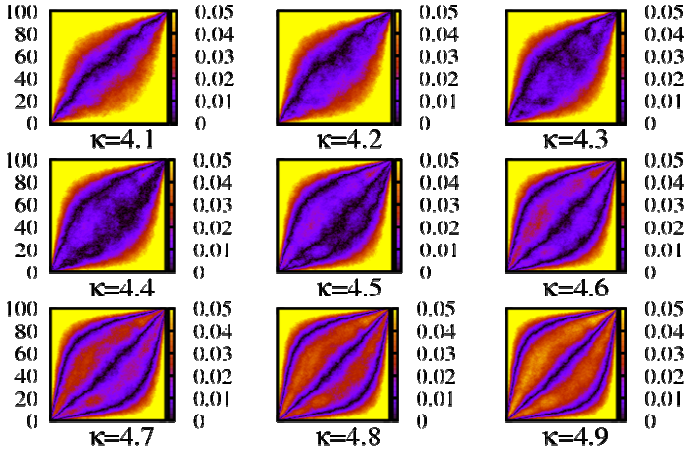
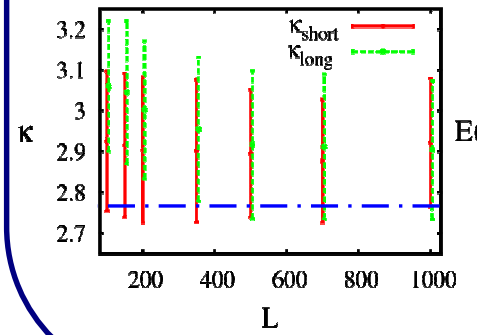
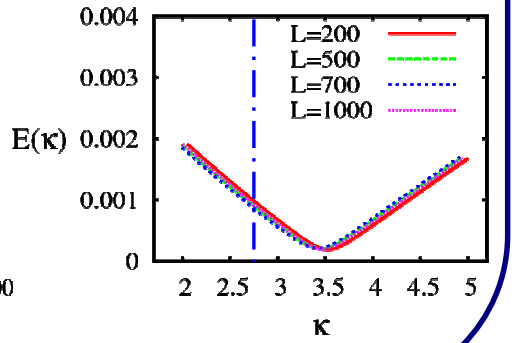
For fixed BCs we compared our results with the exact value of left passage probability (LPP) at each points, and for periodic BCs we used slit map approach.



Gaussian couplings







Bimodal couplings