Random quantum Ising model in 2+1 dimensions

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We present a Monte Carlo study of the random quantum Ising model in 2+1 dimensions. It can be shown that a d-dimensional quantum Ising model in a transverse magnetic field can be mapped to a $(d+1)$-dimensional classical Ising model, where the extra dimension corresponds to imaginary time. Random disorder in the original quantum problem becomes linearly correlated in imaginary time, which leads to interesting "nonclassical" universality classes of the Ising phase transition. We take the distribution of coupling constants to be logarithmic, which means that rare regions of the disorder potential are present. The model has no frustration and is thus well suited for Monte Carlo simulation. We use the Wolff collective update model which is highly effective for studying phase transitions. The system is tuned through the quantum transition by changing a fake classical temperature T, which controls the quantum fluctuations. In 1+1 dimensions remarkable properties have been predicted by D. Fisher [1] and verified in numerous simulations. This solution shows that average and typical correlations scale with different exponents, and activated scaling leads to Griffiths singularities. We investigate the corresponding properties in higher dimensions, like 2+1, where the properties are less well known.

References

[1] D. S. Fisher, Phys. Rev. B. **51**, 6411 (1995).