Abstract

$N = 2$ supersymmetry can be used to construct lattice models, which in previous studies [?, ?, ?, ?, ?] are shown to exhibit rich and interesting behavior. After giving a general introduction in how SUSY can be applied in statistical mechanics and an introduction in the subject of quantum criticality, we focus on one of these supersymmetric models: An itinerant fermion model containing two sorts of particles, labeled $+$ and $-$, having nearest neighbor and next nearest neighbor interaction. We study this model on a one-dimensional chain and on a two-dimensional copper-oxide lattice. In both cases the main question of research is whether the system is quantum critical, which we investigate by means of a numerical calculation (1D and 2D) and an analytical investigation of some limits of the phase diagram (1D).

If supersymmetry is broken by introducing an extra parameter, we find, for the chain, a quantum phase transition in the neighborhood of the supersymmetric value of that parameter. We are, however, not able to exactly localize it. For the two-dimensional case, two quantum phase transitions are visible, one at the supersymmetric value, one close to it.

Although we cannot give a rigorous proof, we find strong indications that the system indeed is quantum critical.