



Contribution ID: 72

Type: Talk

Tensor renormalization group study of (1+1)-dimensional U(1) gauge-Higgs model at $\theta=\pi$ with Lüscher's admissibility condition

Friday, 2 August 2024 14:55 (20 minutes)

We use the tensor renormalization group to investigate the phase structure of the (1+1)-dimensional U(1) gauge-Higgs model with a θ term. The U(1) gauge action is constructed with Lüscher's admissibility condition. Using the tensor renormalization group, both the complex action problem and topological freezing problem in the standard Monte Carlo simulation are avoided. We find a first-order phase transition for a large positive Higgs mass-squared regime at $\theta = \pi$, where the \mathbb{Z}_2 charge conjugation symmetry is spontaneously broken. On the other hand, the symmetry is restored for sufficiently small Higgs mass-squared. We determine the critical endpoint as a function of the Higgs mass parameter and show the critical behavior is in the two-dimensional Ising universality class.

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Session Classification: Theoretical developments

Track Classification: Theoretical Developments