

Quantum simulation of the tricritical Ising model in tunable Josephson junction ladders

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L. Maffi, N. Tausendpfund, M. Rizzi, M. Burrello

Modern hybrid superconductor-semiconductor Josephson junction arrays are a promising platform for analog quantum simulations. Their controllable and non-sinusoidal energy/phase relation opens the path to implement nontrivial interactions and study the emergence of exotic quantum phase transitions. Here, we propose the analysis of an array of hybrid Josephson junctions defining a 2-leg ladder geometry for the quantum simulation of the tricritical Ising phase transition.

This transition provides the paradigmatic example of minimal conformal models beyond Ising criticality and its excitations are intimately related with Fibonacci non-Abelian anyons and topological order in two dimensions. We study this superconducting system and its thermodynamic phases based on bosonization and matrix-product-states techniques. Its effective continuous description in terms of a three-frequency sine-Gordon quantum field theory suggests the presence of the targeted tricritical point and the numerical simulations confirm this picture.

Our results indicate which experimental observables can be adopted in realistic devices to probe the physics and the phase transitions of the model. Additionally, our proposal provides a useful one-dimensional building block to design exotic topological order in two-dimensional scalable Josephson junction arrays.

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Orateur: RIZZI, Matteo (Universität zu Köln)