Exploring the Phase Diagram of the Quantum One-Dimensional ANNNI Model using Tensor Networks

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In this work, we explore the phase diagram of the quantum one-dimensional ANNNI model [1] using Tensor Networks. Despite its simplicity, the ANNNI model reveals a rich and complex phase diagram, making it an ideal testbed for studying the emergence of various phases and their critical behaviors. Our research aims to investigate the model's phase transitions and uncover the distinct features of each phase.

A key focus of our study is the elusive floating phase, which is challenging to characterize [2]. Situated between gapped phases, this gapless phase exhibits exotic phenomena that demand deep understanding. By employing the well-known Density Matrix Renormalization Group (DMRG) algorithm [3], we unveil the correlations and ordering patterns within the floating phase. Our findings reveal the presence of characteristic oscillations known as Friedel oscillations [4], which combined with the phenomenon of the Devil's staircase [5] highlight the complex interplay of interactions in the system.

Our research contributes to a deeper understanding of the underlying principles governing quantum many-body systems, offering new perspectives on the behavior of systems with competing interactions. It also showcases the power of Tensor Networks as computational techniques for exploring complex phase diagrams. Furthermore, the results of the floating phase will be used to build useful training datasets for a complete classification of the ANNNI model's phases with Quantum Machine Learning (QML) methods [6].

References

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