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Long Range Interactions in Synthetic Dimensions

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In recent cold atom experiments, the utilization of internal degrees of freedom as synthetic dimensions has enabled the simulation of higher-dimensional systems. Specifically, magnetic quantum numbers have been employed to transform a 1D chain of atoms into a synthetic 2D lattice, resulting in the realization of an integer quantum Hall state. However, this configuration introduces highly anisotropic and long-range particle interactions. To facilitate theoretical analysis, we develop a 1D effective model in the limit of infinite interaction anisotropy. This model serves as a simplified representation, allowing us to explore the impact of long-range interactions on the phases realized in the system. Our investigation delves into the emergence of new phases, the study of phase transitions, and the stability of configurations under the influence of extreme long-range interactions. This research contributes to a deeper understanding of the intricate interplay between synthetic dimensions and particle interactions in cold atom systems.

Abstract category

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