Quasi-Discrete Time Crystals in the quasiperiodically driven Lipkin-Meshkov-Glick model

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Abstract

A discrete time crystal (DTC) is a remarkable non-equilibrium phase of matter characterized by the persistent sub-harmonic oscillations of physical observables. Motivated by the question of whether such a temporal periodic order can persist when the drive becomes aperiodic, we investigate the dynamics of a Lipkin-Meshkov-Glick model under quasiperiodic Thue-Morse driving. Intriguingly, this infinite-range-interacting spin system can host "quasi- discrete time crystal" (quasi-DTC) phases characterized by periodic oscillations of the magnetization. We demonstrate that our model can host the quasi-DTC analog of both period-doubling DTCs as well as higher-order DTCs. These quasi-DTCs are robust to various perturbations, and they originate from the interplay of "all-to-all" interactions and the recursive structure of the TMS. Our results suggest that quasi-periodic driving protocols can provide a promising route for realizing novel non-equilibrium phases of matter in long-range interacting systems.