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Quantum many-body dynamics in digital quantum computers

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Owning to the recent rapid advancement of quantum technologies, digital quantum computers with more than 100 qubits have emerged as a new platform to explore quantum many-body dynamics that may potentially be out of reach for classical computers. In this talk, I will introduce some of the recent progress in this direction and present our recent studies. In particular, I will discuss our recent investigation of the dynamics of periodically driven systems using an IBM Quantum Heron processor, focusing on the emergence of discrete time crystals (DTCs) and discrete time quasicrystals (DTQCs) in two spatial dimensions [1]. Our study, based on a kicked Ising model with 133 qubits, reveals a prethermal regime characterized by magnetization oscillations. We observe period-doubling DTCs and discover DTQCs induced by the longitudinal field. Our findings, supported by classical simulations based on state vector methods as well as tensor network methods, shed light on out-of-equilibrium dynamics in quantum systems and highlight the potential of digital quantum computers for studying many-body systems.
[1] K. Shinjo, K. Seki, T. Shirakawa, R.-Y. Sun, and S. Yunoki, “Unveiling clean two-dimensional discrete time quasicrystal on a digital quantum computer”, arXiv:2403.16718.

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