北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Weekly Seminar

New Opportunities with Atomic Quantum Simulations: from unconventional spin glass orders to the computation advantage

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摘要

With recent experimental progress in quantum technology, unprecedented programmability has been achieved in various atomic quantum systems from cold atoms to Rydberg tweezer arrays, and trapped ions. This gives new opportunities for Hamiltonian quantum simulations. In this talk I will describe our recently developed algorithmic protocols for programmable quantum simulations of long-range coupled Hamiltonians including all-to-all coupled spin glasses [1], “perfect” 2D topological flatbands, and Poincaré crystals [2]. Programmable quantum simulations of spin glasses provide a systematic way to solve such difficult computation problems as binary optimization, Max-Cut and prime factorization. In an anisotropic spin-glass like model, which has a natural realization with Rydberg p-wave atoms, we discover a “peratic” phase transition in the ground state. This unconventional phase transition is described by a bulk-to-surface response, and has a rigorous duality to the dynamical order-to-chaos transition [3]. We establish the peratic phase transition and its quantum generalization by constructing a frustration-free Ising lattice and a qudit model.

References:

[1] Xingze Qiu, Peter Zoller, Xiaopeng Li, Programmable Quantum Annealing Architecture with Ising Quantum Wires, PRX Quantum 1, 020311 (2020) with Editorial Suggestion

[2] Pei Wang, Zhijuan Huang, Xingze Qiu, Xiaopeng Li, Programmable Hamiltonian Engineering with Quadratic Quantum Fourier Transform, arXiv: 2204.04378 (2022)

[3] Xingze Qiu, Hai Wang, Wei Xia, Xiaopeng Li, Peratic Phase Transition by Bulk-to-Surface Response, arXiv: 2109.13254 (2021)

报告人简介

Xiaopeng Li is professor of physics in the Physics Department of Fudan University, China, jointly employed by Shanghai Qi Zhi Institute. He is active in quantum information science and AMO physics, with his primary research interests in exploiting the quantum computation power of various quantum simulation platforms. He received his Ph.D. in physics from the University of Pittsburgh in 2013 and joined Fudan University as a faculty member in 2016 after three years at the University of Maryland, supported by a Joint Quantum Institute theoretical postdoctoral fellowship. He has been a full professor since 2019. He received the Shanghai Rising Star award from Shanghai Municipal of Science and Technology in 2021, and has been awarded “Xie Xide” Junior chair professor at Fudan in 2022.