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Quantum simulation for quantum many-body systems: variational quantum algorithms and beyond

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Abstract

As R. Feynman was originally suggested in 1982, quantum many-body systems are the most promising application for quantum computing. Considering noisy near-term quantum devices with a relatively small number of qubits, one of the main focuses in the current quantum simulation research is to identify what one can do with such noisy quantum devices that is not too trivial but still interesting. In this talk, I would like to present some of our recent attempts to simulate quantum many-body systems based on a quantum variational approach and beyond [1-5].

[1] “Symmetry-adapted variational quantum eigensolver”, K. Seki, T. Shirakawa, and S. Yunoki, Phys. Rev. A 101, 052340/1-15 (2020).

[2] “Discretized quantum adiabatic process for free fermions and comparison with the imaginary-time evolution”, T. Shirakawa, K. Seki, and S. Yunoki, Phys. Rev. Research 3, 013004/1-32 (2021).

[3] “Quantum power method by a superposition of time-evolved states”, K. Seki and S. Yunoki, PRX Quantum 2, 010333/1-45 (2021).

[4] “Spatial, spin, and charge symmetry projections for a Fermi-Hubbard model on a quantum computer”, K. Seki, and S. Yunoki, Phys. Rev. A 105, 032419/1-34 (2022).

[5] “Parametrized quantum circuit for weight-adjustable quantum loop gas”, R.-Y. Sun, T. Shirakawa, and S. Yunoki, arXiv:2210.14662.