# Quantum-classical entangled approach using tensor networks for investigating quantum spin liquid

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Abstract:
The fundamental difficulty in treating quantum many-body problems in classical computers is the exponentially large vector space. In contrast, a well-controlled quantum system, such as a quantum computer, offers the potential to solve these problems with a cost that scales polynomially with the number of particles. In recent years, the variational quantum eigensolver (VQE) has attracted much interest in using a noisy quantum computer for quantum many-body problems. However, it is still unclear whether or not the VQE approach can outperform classical computations for practical quantum many-body problems. This talk explores the potential of using tensor network representations to devise an efficient quantum circuit, particularly suited for near-future noisy quantum computers. Specifically, we will examine the spin liquid state in the honeycomb lattice Kitaev model. We demonstrate that a simple tensor network state effectively captures the quantitative properties of the gapless Kitaev spin liquid. We discuss that such a tensor network construction can be applied to the VQE approach by representing tensor network states as quantum circuits. We will also highlight how this methodology enables us to optimize the infinite-size systems effectively by solving an optimization problem in small clusters.