Quantum flow algorithms for simulating many-body systems on quantum computers

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We conducted quantum simulations of strongly correlated systems using the quantum flow (QFlow) approach [1], which enables sampling large sub-spaces of the Hilbert space through coupled eigenvalue problems in reduced dimensionality active spaces. Our QFlow algorithms significantly reduce circuit complexity and pave the way for scalable and constant-circuit-depth quantum computing. The discussed simulations show that QFlow can optimize the collective number of wave function parameters without increasing the number of required qubits using active spaces having an order of magnitude fewer number of parameters. Moreover, preliminary tests suggest that modifying the QFlow by optimizing all active space problems simultaneously, rather than using a serial-type algorithm, produces equivalent optimized energy and comparable convergence patterns, enabling the development of efficient parallel/distributed QFlow algorithms.

[1] K. Kowalski, N.P. Bauman, *Phys. Rev. Lett.* **131**, 200601 (2023).