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(G*) Bundled matrix product states represent low-energy excitations faithfully

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Finding the ground-state energy of many-body lattice systems is exponentially costly due to the size of the Hilbert space, making exact diagonalization impractical. Ground-state wave functions satisfying the area law of entanglement entropy can be efficiently expressed as a matrix product states (MPS) for local, gapped Hamiltonians. The extension to a bundled matrix product state describes excitations, but a formal proof is lacking despite excellent performance in practical computation. We provide a formal proof for the claim. We define a bundled density matrix as a set of independent density matrices which are all written in a common (truncated) basis. We demonstrate that the truncation error is a practical metric that determines how well an excitation is described in a given basis common to all density matrices. We go on to demonstrate that states with volume law entanglement are not necessarily more costly to include in the bundle. The same is true for gapless systems if sufficient lower energy solutions are already present. This result implies that bundled MPSs can describe low-energy excitations without significantly increasing the bond dimension over the cost for ground state calculation with the proviso of some conditions that we explain.

Keyword-1

Bundled MPS

Keyword-2

Entanglement

Keyword-3

low-energy excitations

Primary authors: SEIF, Negar (PhD student); BAKER, Thomas (Department of Physics & Astronomy and also of Chemistry, University of Victoria)

Presenter: SEIF, Negar (PhD student)

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