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A Quantum Annealing Protocol to Solve the Nuclear Shell Model

Content

The nuclear shell model accurately describes the structure and dynamics of atomic nuclei. However, the exponential scaling of the basis size with the number of degrees of freedom hampers a direct numerical solution for heavy nuclei. In this talk, I present a quantum annealing protocol to obtain nuclear ground states. I propose a tailored driver Hamiltonian that preserves a large gap and validate our approach in a dozen nuclei with basis sizes up to 10^5 using classical simulations of the annealing evolution. I show the relation between the spectral gap and the total time of the annealing protocol, assessing its accuracy by comparing the fidelity and energy relative error to classical benchmarks. While the nuclear Hamiltonian is non-local and thus challenging to implement in current setups, the estimated computational cost of our annealing protocol on quantum circuits is polynomial in the many-body basis size, paving the way to study heavier nuclei.

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