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Quantum computation approach to nuclear ground and excited state calculation

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Quantum computers offer the promise of efficiently solving problems which suffer exponential scaling with problem size on classical computers. In application to the simulation of physical systems, quantum computers may be able to overcome the explosion of Hilbert space size with particle number, and to deal efficiently with entangled states.

In this contribution, we show some applications of quantum algorithms to solving sample problems in nuclear structure: The preparation of ground states in a shell-model [1,2] and density functional picture [3], and the generation of excited states using a novel variational quantum algorithm [4].
We finish by giving prospects for future work as quantum computing technology moves towards the era of fault-tolerant machines.

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[2] Joe Gibbs, Paul Stevenson, and Zoë Holmes, Quantum Mach. Intell. 7, 14 (2025)
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[4] I. Hobday, P. Stevenson, and J. Benstead, *accepted for publication in Phys. Rev. C*, arxiv: 2403.08625

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