Quantum algorithms for the nuclear shell model

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Quantum computers offer a new way to study complex quantum fermionic systems - systems that are extremely hard to handle with today's classical computers. In this talk, I will describe our ongoing work using quantum inspired methods to study atomic nuclei within the nuclear shell model. I will begin with hybrid quantum–classical algorithms and show what kinds of quantum resources future devices would need to tackle different nuclei [1,2]. I will then discuss our recent studies of how quantum entanglement appears inside nuclei [3,4]. Finally, I will present a new adiabatic quantum algorithm we have developed specifically for solving shell model problems [5], along with a compact encoding method that achieves very accurate predictions for nuclear ground states [6].

[1] A. Pérez-Obiol et al., Sci. Rep. 13, 12291 (2023).
[2] M. Carrasco-Codina et al., arXiv:2507.13819.
[3] A. Pérez-Obiol et al., Eur. Phys. J. A 59, 240 (2023).
[4] A. Pérez-Obiol et al., arXiv:2409.04510.
[5] E. Costa et al., SciPost Physics 19, 062 (2025).
[6] E. Costa et al., Phys. Lett. B 809, 140042 (2025).