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Extending the reach of nuclear ab initio calculations via dimensionality reduction techniques

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The so-called ab initio approach to nuclear structure allows to describe atomic nuclei with controlled and systematically improvable approximations.
Such nuclear structure calculations employing interactions derived from chiral effective field theory are nowadays routinely performed in heavy or open-shell systems.
But describing nuclei that are at the same time both heavy and open-shell is still limited by the computational cost of handling very large tensors, especially when breaking rotational symmetry in the calculations.
We apply dimensionality reduction techniques based on a randomized singular value decomposition to Bogoliubov many-body perturbation theory, one of the nuclear ab initio methods.
This requires reformulation of the computational method used to solve the many-body Schrödinger equation.
By employing modern linear algebra algorithms and avoiding the construction of large many-body tensors in the first place, we are able to extend the reach of the method to nuclei where standard approaches would be too expensive to run.

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