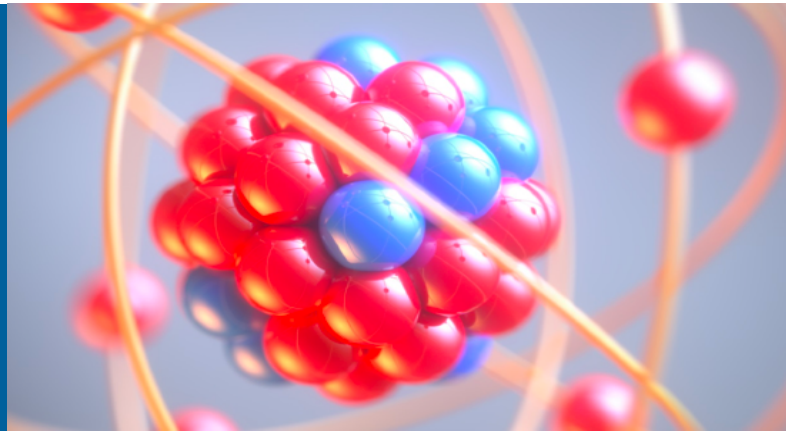
NEURAL NETWORK QUANTUM STATES FOR NUCLEAR PHYSICS



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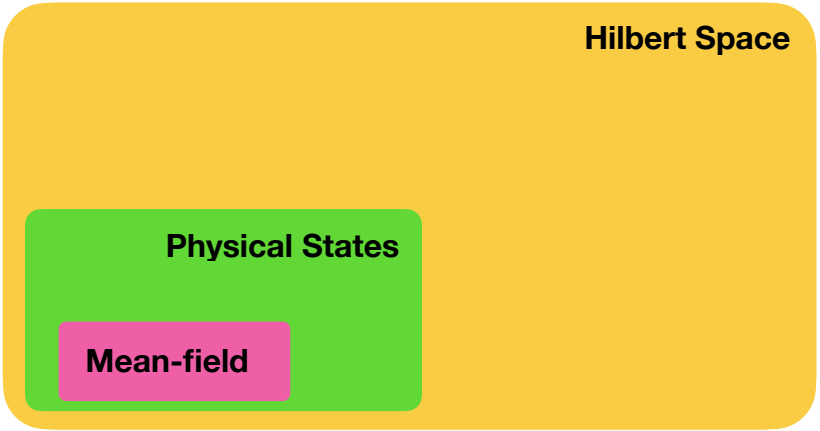
NEURAL-NETWORK QUANTUM STATES

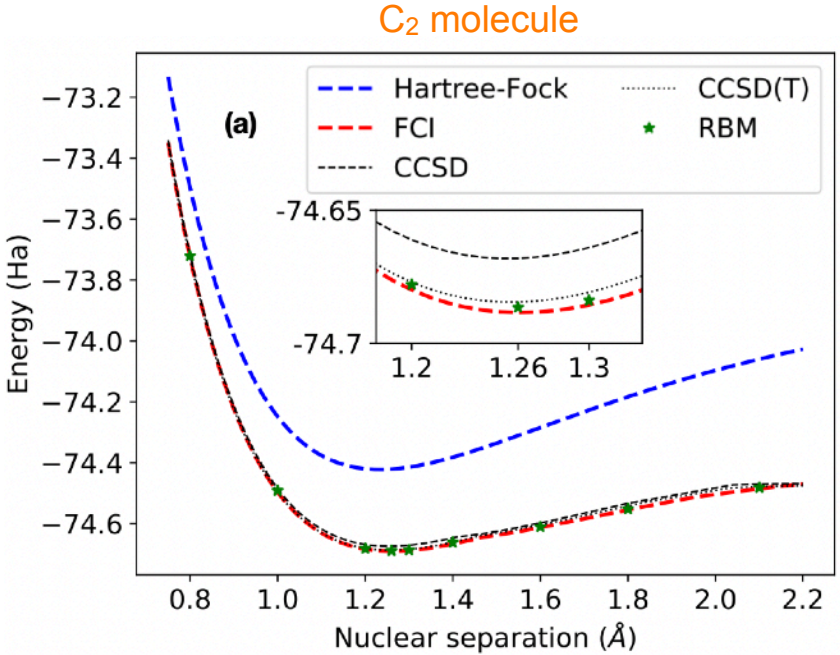
NQS can represent highly accurate solutions of the Schrödinger equation

$$H\hat{\Psi}_0(X,\boldsymbol{\theta}) = E_0\hat{\Psi}_0(X,\boldsymbol{\theta})$$



QMC methods that use NQS outperforms competing many-body methods at relatively modest computational cost

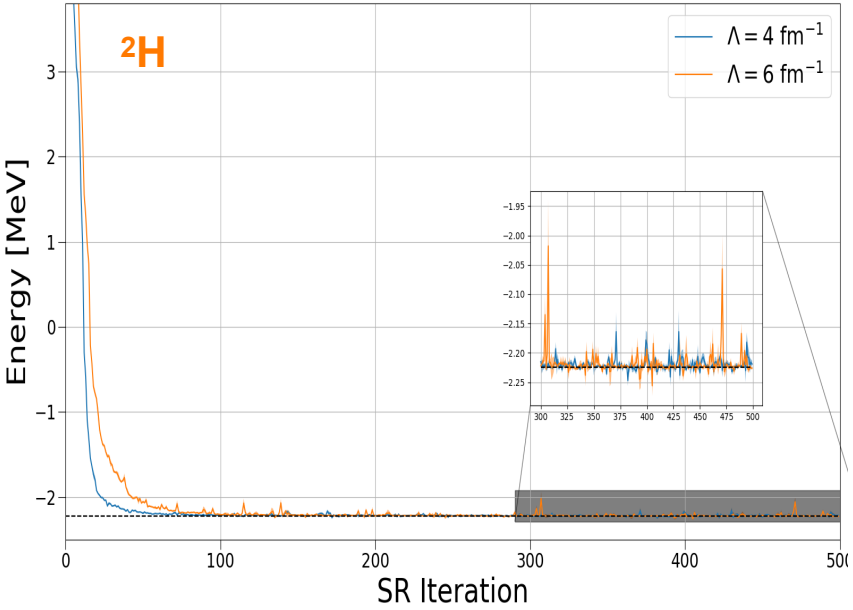
NQS have been successfully applied to quantum chemistry in first and second quantization



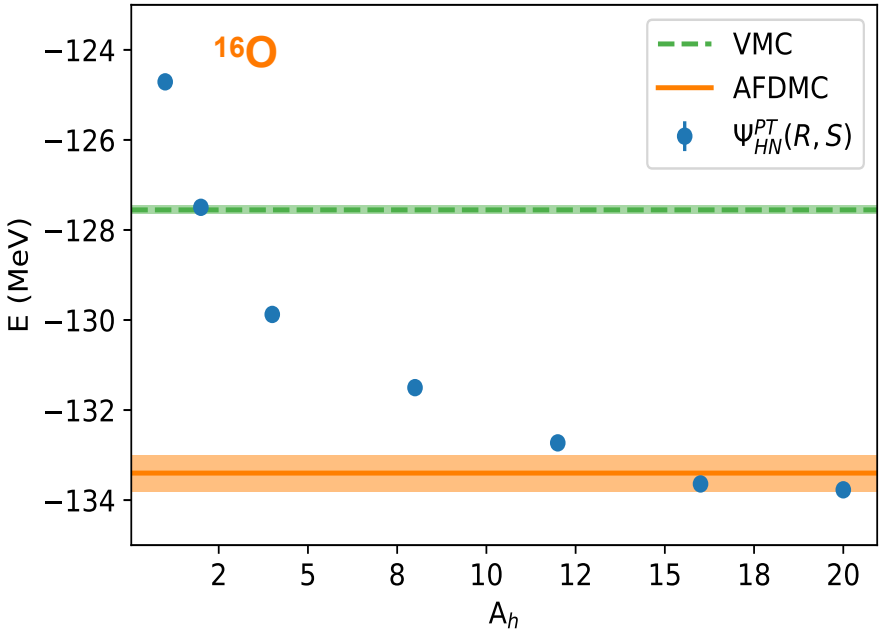
*Choo et al., Nat. Commun **11**, 2368 (2020)*

APPLICATIONS TO ATOMIC NUCLEI

We devised NQS that accurately solves the nuclear many-body problem and exhibits a polynomial scaling with the number of nucleons.



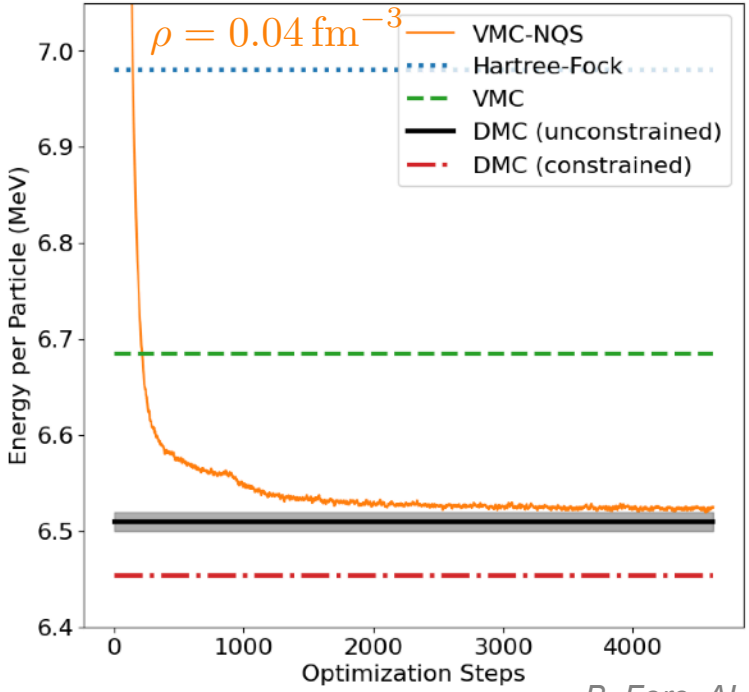
*C. Adams, AL, et al, PRL **127**, 022502 (2021)*

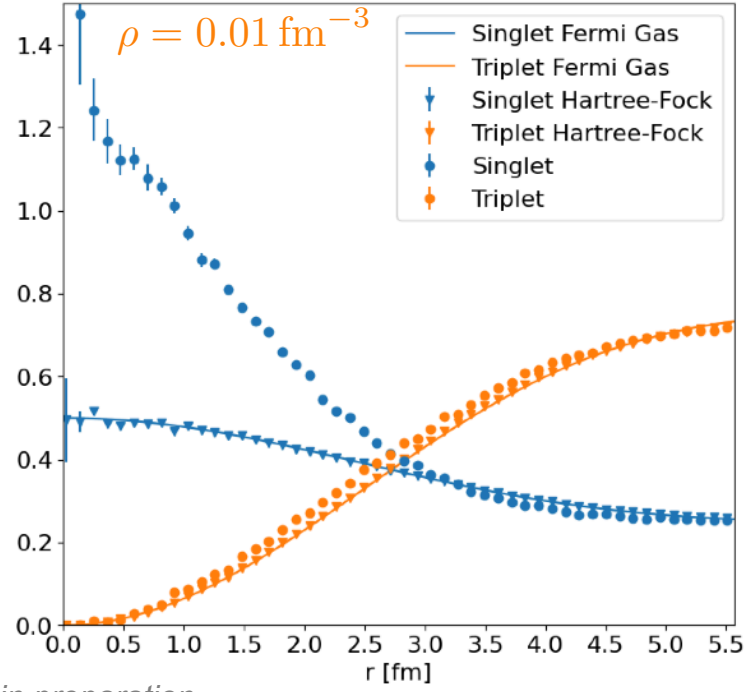


AL, et al, PRR in press (2022)

APPLICATIONS TO NEUTRON MATTER

We can treat infinite neutron matter improving on the constrained-path approximation with a fraction of the computational cost (**~400 GPU/hours** vs **~1.6M CPU/hours**)





B. Fore, AL, et al, in preparation

VISION FOR THE FUTURE

NQS are ideally suited to capitalize on heterogeneous CPU/GPUs super-computers

- Long- and short-range dynamics of **medium-mass and heavy nuclei** (including exotic systems relevant to FRIB)
- Equation of state and transport properties of **infinite nuclear matter** (including clustering and superfluidity)
- Access **real-time dynamics**:

$$(1 - iHdt)|\Psi(\theta)\rangle \simeq |\hat{\Psi}(\theta + d\theta)\rangle$$

  - Successfully applied to spin systems
  - Ab-initio description of **lepton-nucleus scattering**
  - Microscopic modeling of **fission**, and **fusion** (interplay with TDFH)