

Probing chiral interactions to N³LO in medium-mass nuclei

J. Hoppe, C. Drischler, K. Hebeler, A. Schwenk, and J. Simonis

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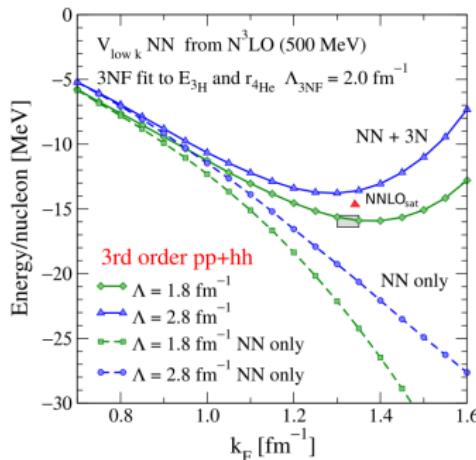


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Motivation

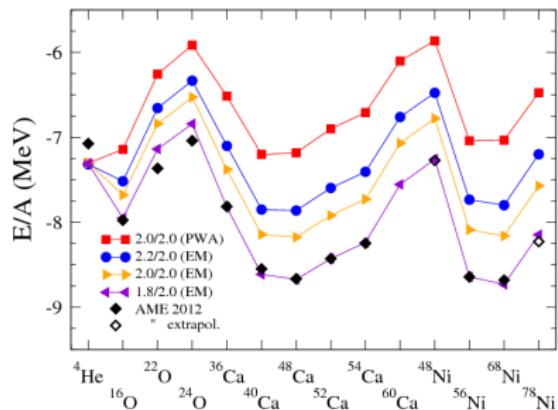
Connection between nuclear matter and finite nuclei



NN evolved + 3N Hamiltonians fit to only few-body data reasonably describe saturation point

Hebeler *et al.*, PRC 83 (2011)

1.8/2.0 (EM) reproduces ground-state energies for closed-shell nuclei



IM-SRG calculations of closed-shell nuclei indicate connection to nuclear matter

Simonis *et al.*, PRC 96 (2017)

Motivation

NN+3N Hamiltonians fit to ^3H and the saturation point

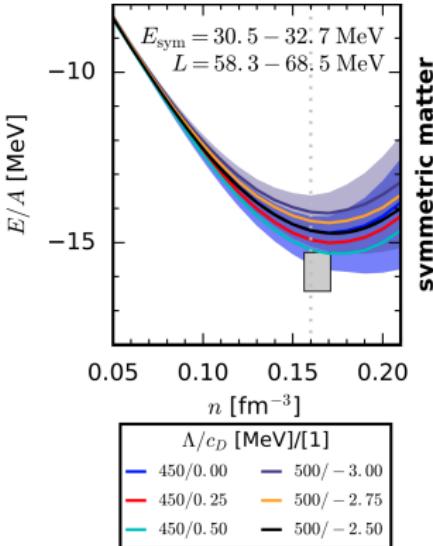
novel 3N fits to empirical saturation point and ^3H binding energy

Drischler *et al.*, PRL 122 (2019)

NN forces by Entem, Machleidt, Nosyk (EMN)

Entem *et al.*, PRC 96 (2017)

→ NN+3N Hamiltonians at N³LO
fit to saturation point



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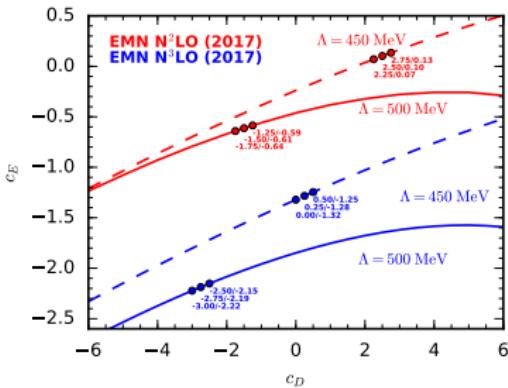
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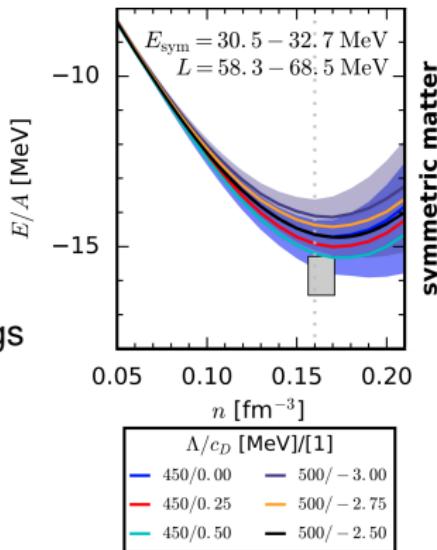
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range of 3N couplings
 c_D and c_E in ^3H fit



Motivation

NN+3N Hamiltonians fit to ^3H and the saturation point

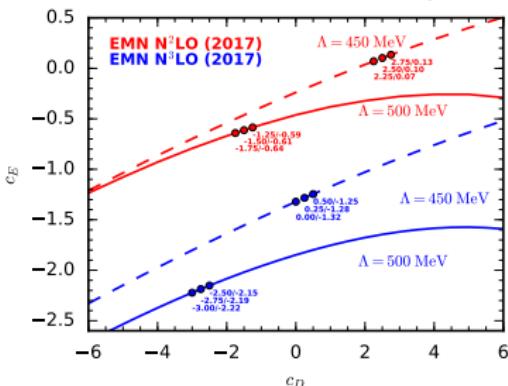
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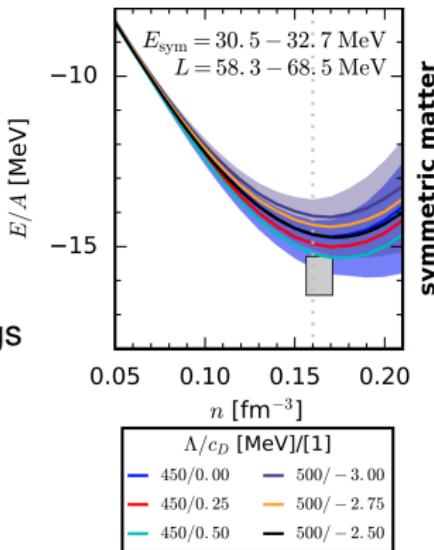
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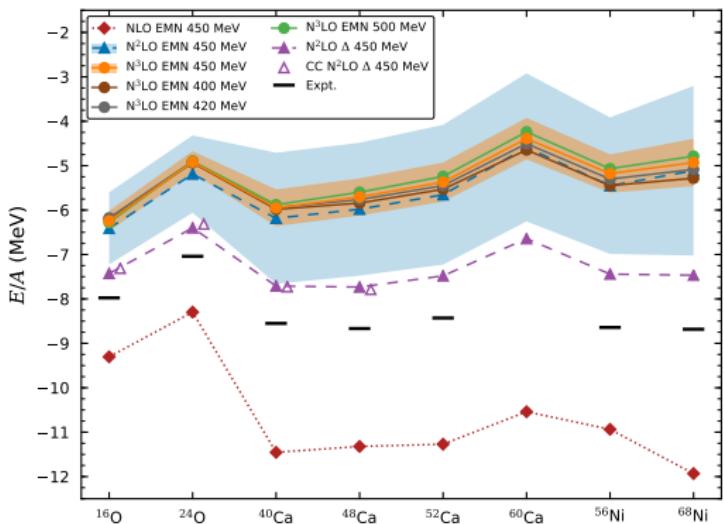
Impact and predictions of novel 3N forces for finite nuclei in the IM-SRG?

Application to closed-shell medium-mass nuclei



NLO, N²LO, and N³LO interactions (EMN) with EFT uncertainty estimates

Epelbaum *et al.*, EPJA 51 (2015)



recent Δ -full interaction at N²LO

Ekström *et al.*, PRC 97 (2018)

underbound ground-state energies

small cutoff dependence at N³LO

JH, Drischler, Hebeler, Schwenk, Simonis, PRC 100 (2019)

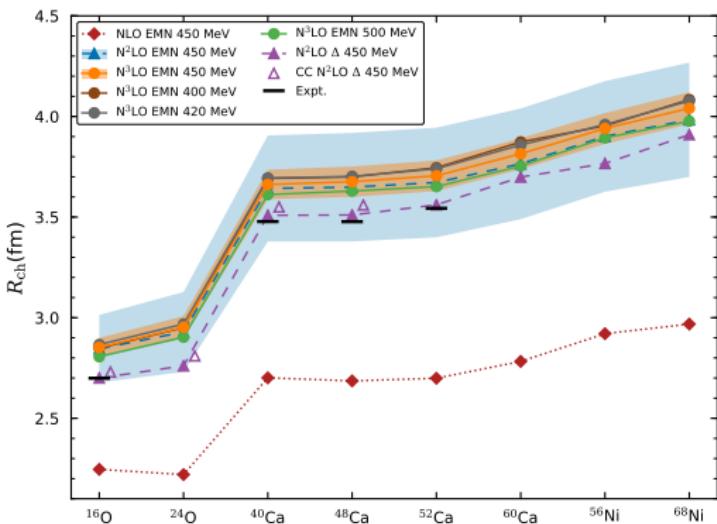
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charge radii predicted slightly too large

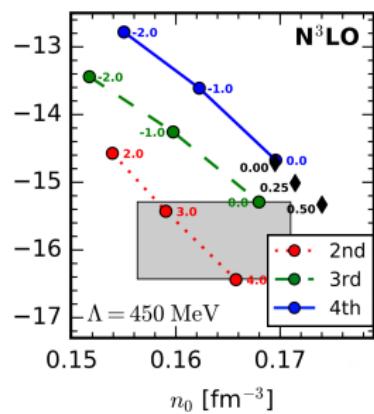
JH, Drischler, Hebeler, Schwenk, Simonis, PRC 100 (2019)

Comparing trends for nuclear matter and finite nuclei

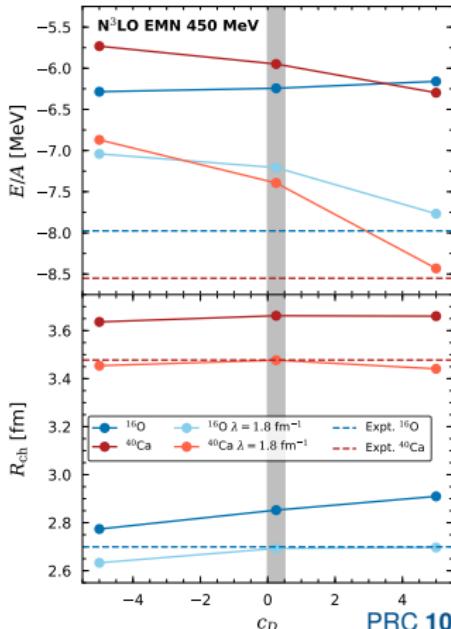


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study c_D/c_E variations constrained by ^3H independent of saturation point



Drischler *et al.*, PRL 122 (2019)



only small changes
of energies and radii
for unevolved potentials

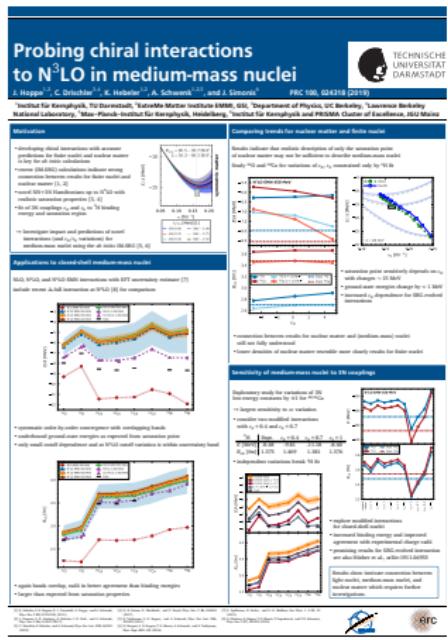
stronger energy
dependence
for consistently
SRG-evolved potentials

→ explore sensitivity to
3N couplings
independently of ^3H fit

PRC 100, 024318 (2019)

Conclusion

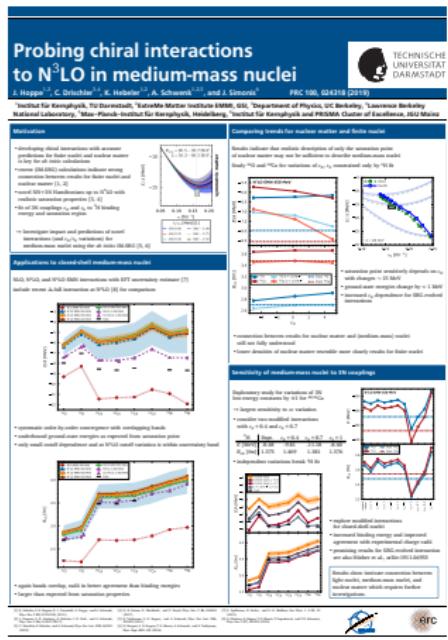
- ▶ chiral NN+3N Hamiltonians at N^3LO fit to 3H and the saturation point
- ▶ underbinding for closed-shell medium-mass nuclei
- ▶ somewhat too large charge radii
- ▶ exploratory study for 3N low-energy constant variations



Conclusion

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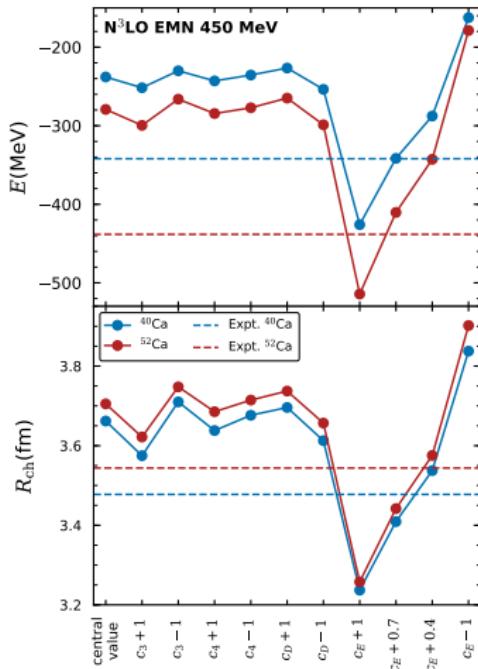
**Thank you for your attention.
See you at the poster!**



Impact of N²LO LEC variations on ground-state energies and charge radii



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vibrations of long-range LECs
 c_1, c_3, c_4 by $\pm 1 \text{ GeV}^{-1}$

vibrations of 3N couplings
 c_D and c_E by ± 1

largest sensitivity to c_E

two modified interactions
with $c_E + 0.7$ and $c_E + 0.4$