Operator evolution for *ab initio* theory of light nuclei

Micah Schuster and Calvin Johnson
San Diego State University

Sofia Quaglioni and Eric Jurgenson
Lawrence Livermore National Laboratory

Petr Navrátil
TRIUMF

SAN DIEGO STATE UNIVERSITY

TRIUMF
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Introduction

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Previous work on operator evolution:

- I. Stetcu *et al.*, PRC **71**, 044325 (2005)
  One and two-body effective operator via OLS

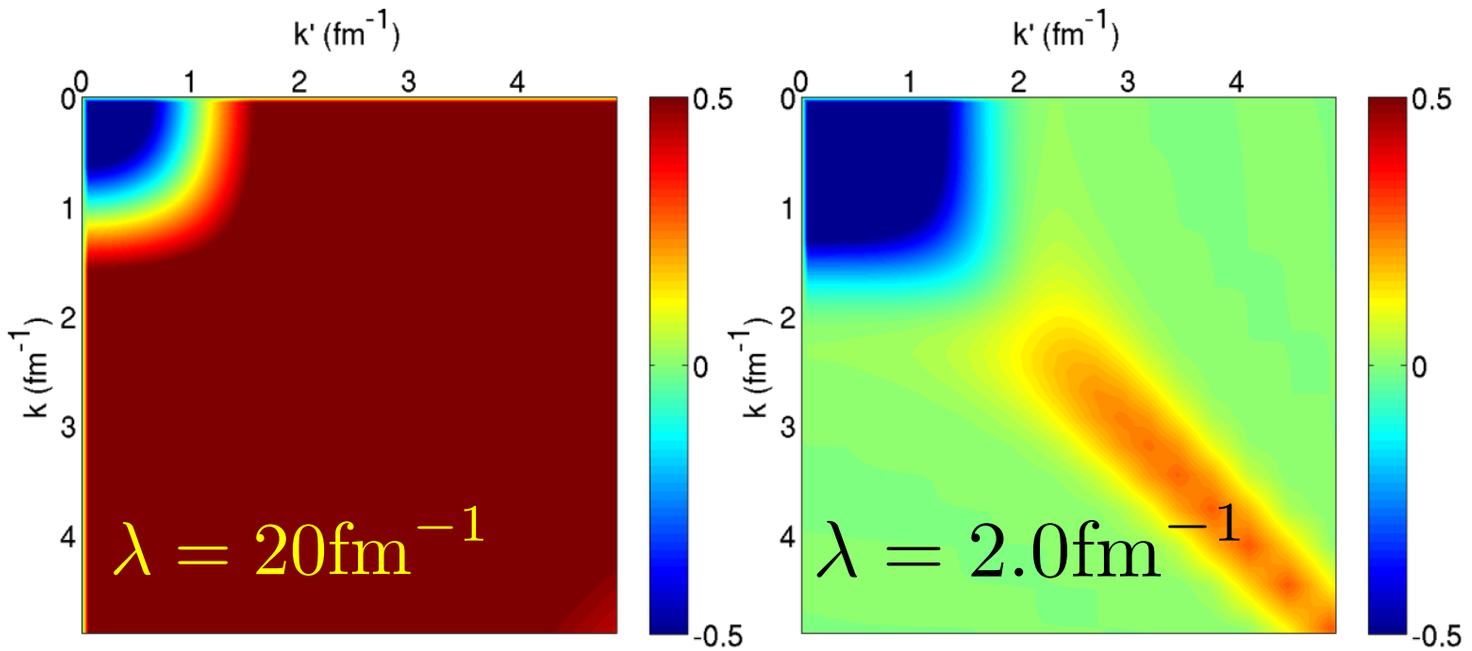
- E. Anderson *et al.,* PRC **82**, 054001 (2010)
  Two-body evolution for the A=2 system.

- M. Schuster *et al.,* PRC **90**, 011301(R) (2014)
  Two- and three-body operator evolution.
  Apply them to the A=3 and A=4 system.

For this work we use the NCSM in Jacobi coordinates with chiral interactions at N3LO for NN and N2LO for NNN

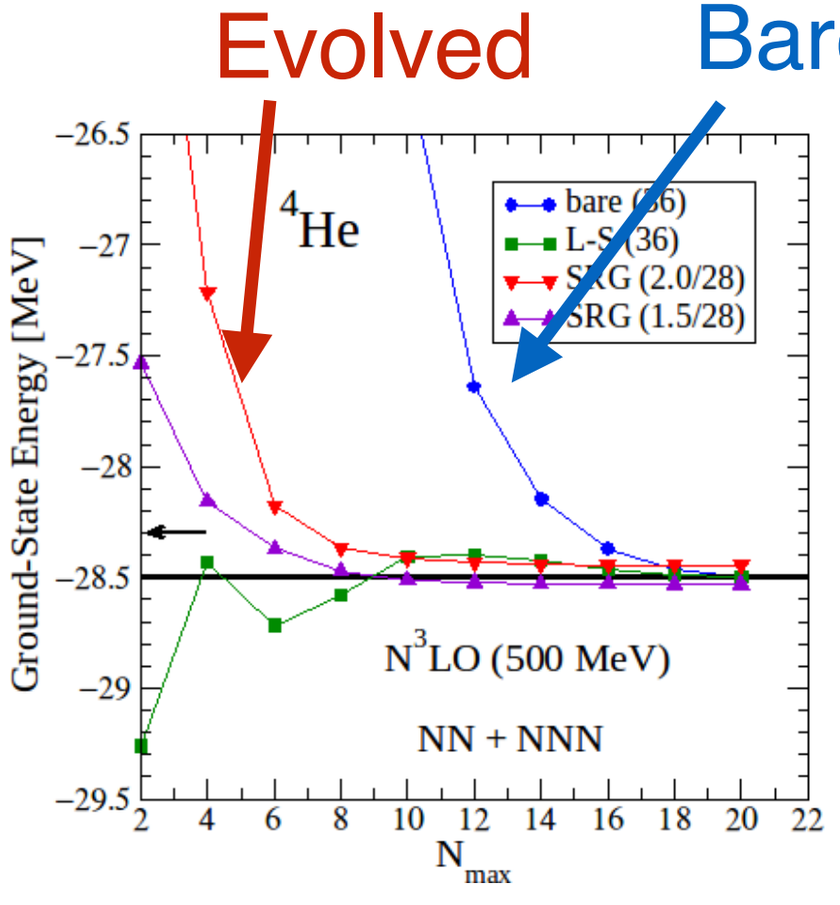
The similarity renormalization group

Series of unitary transformations on the Hamiltonian that decouple high- and low-momentum parts of the interaction



$$\frac{dH_s}{ds} = [[T, H_s], H_s] \qquad \lambda = s^{-1/4}$$

- Makes the many-body problem more tractable



Jurgenson, Navrátil & Furnstahl, Phys. Rev. C 83, 034301 (2011)

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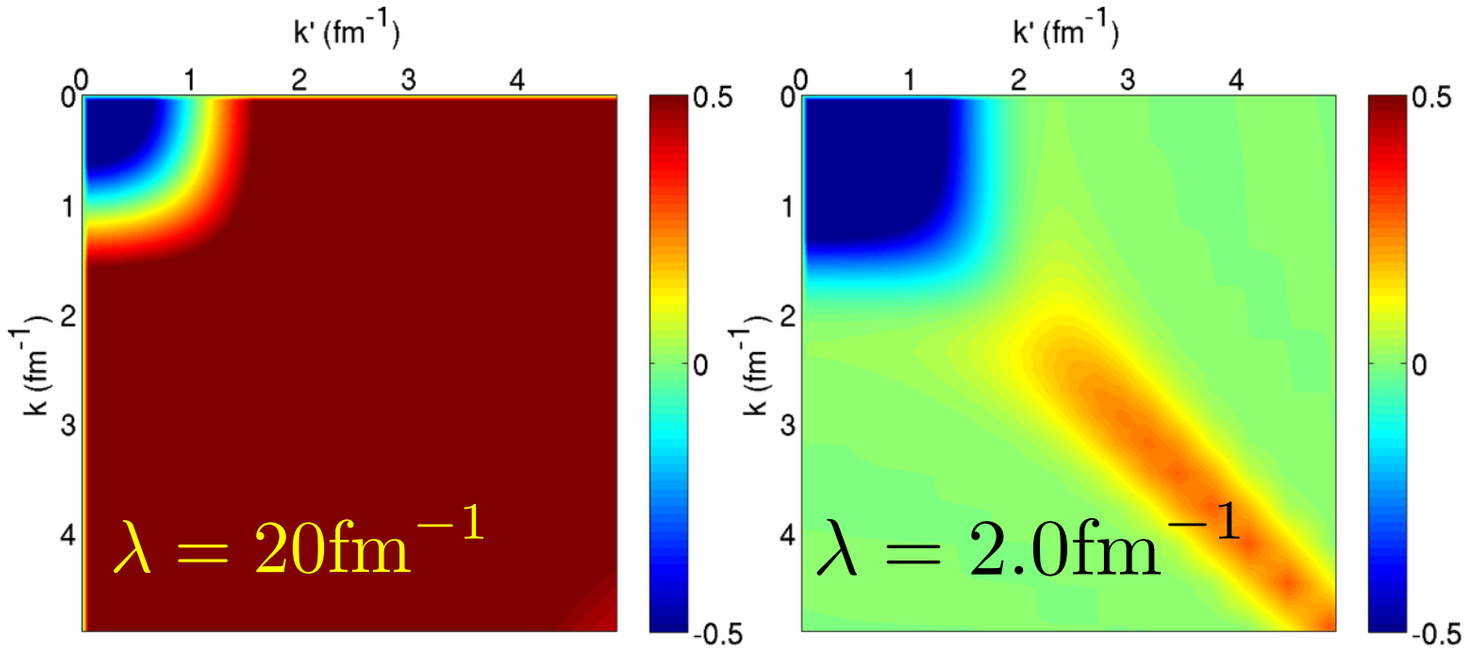
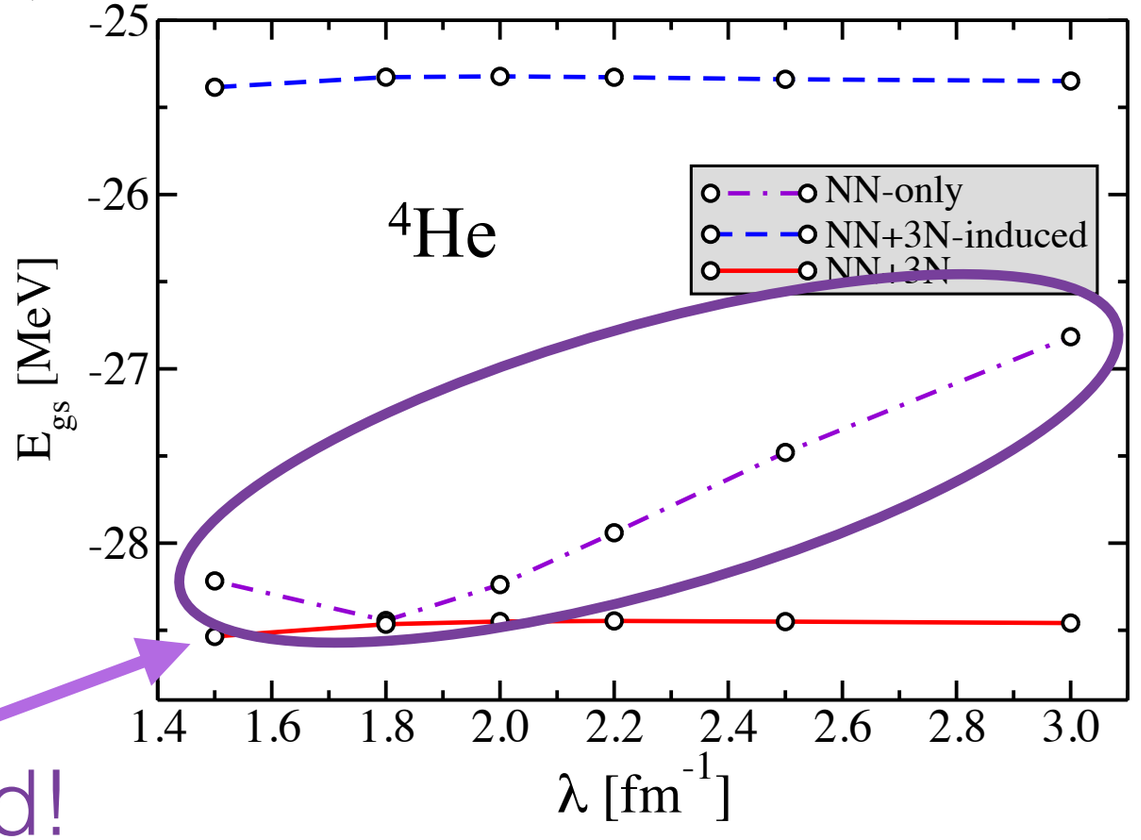


$$\frac{dH_s}{ds} = [[T, H_s], H_s] \qquad \lambda = s^{-1/4}$$

- Makes the many-body problem more tractable
- Induces higher-order terms into the Hamiltonian



No induced terms included!

Evolving operators

Use the same flow equation (with the same generator):

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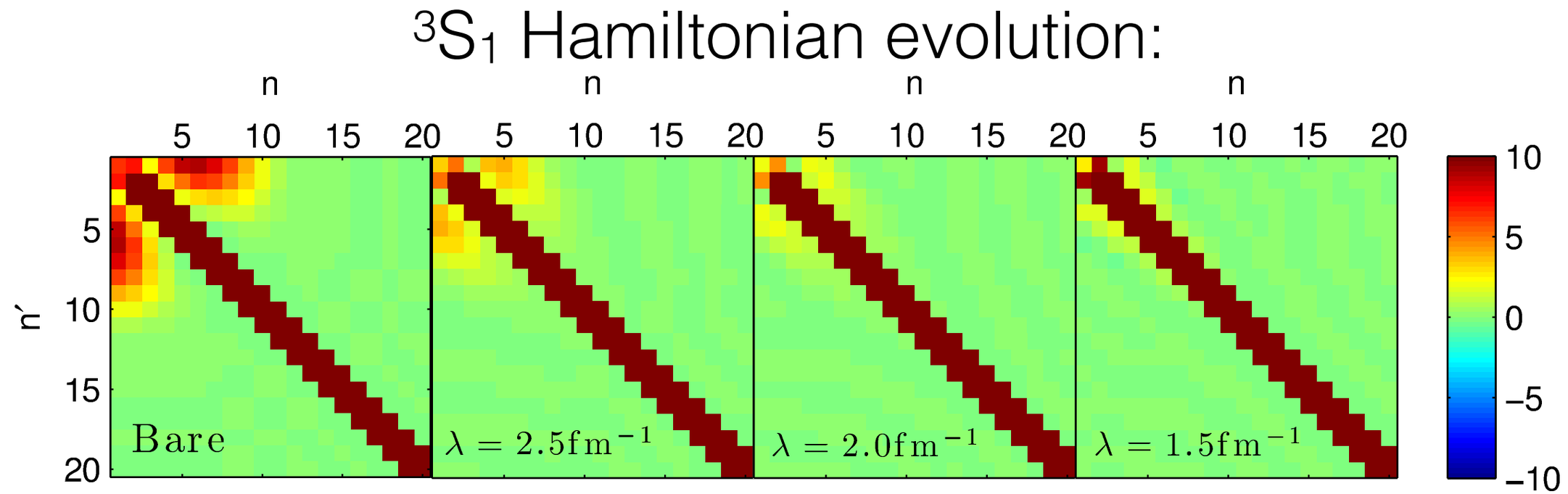
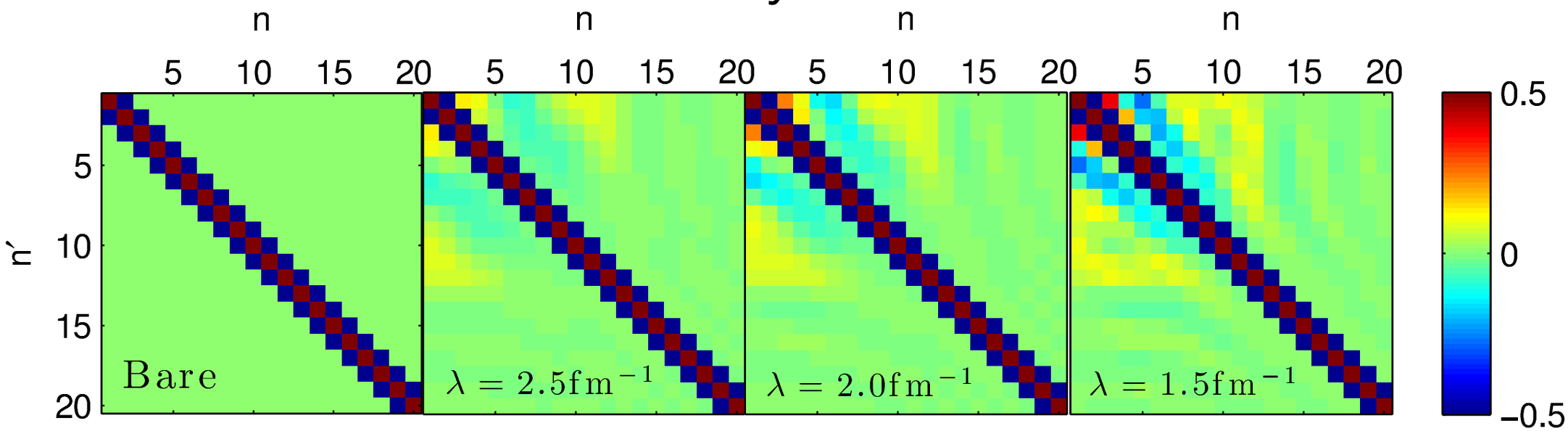
And apply via a matrix product:

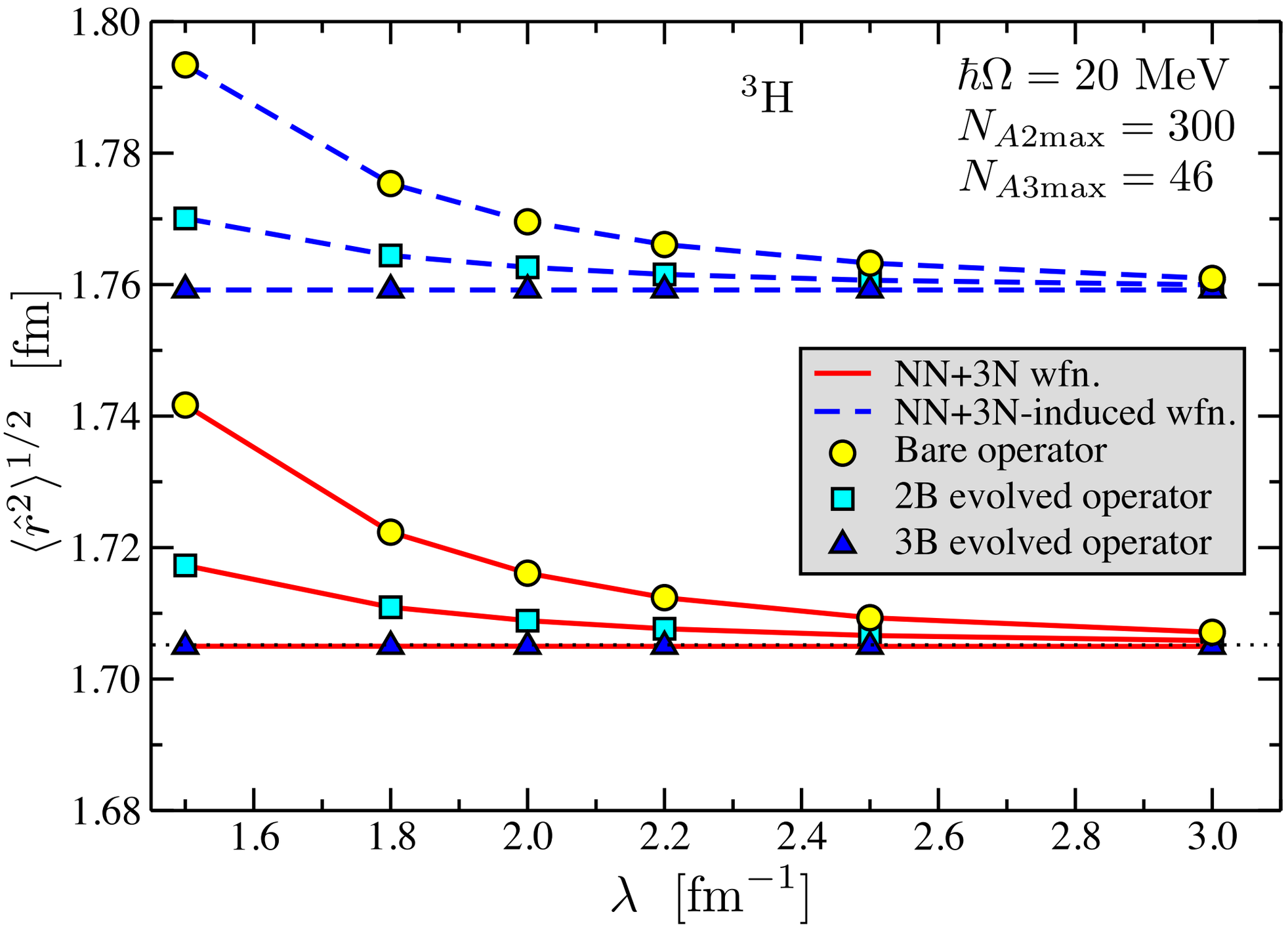
$$O_s = U_s O_{s=0} U_s^\dagger$$

A look in harmonic oscillator space





Hydrogen-3 rms radius



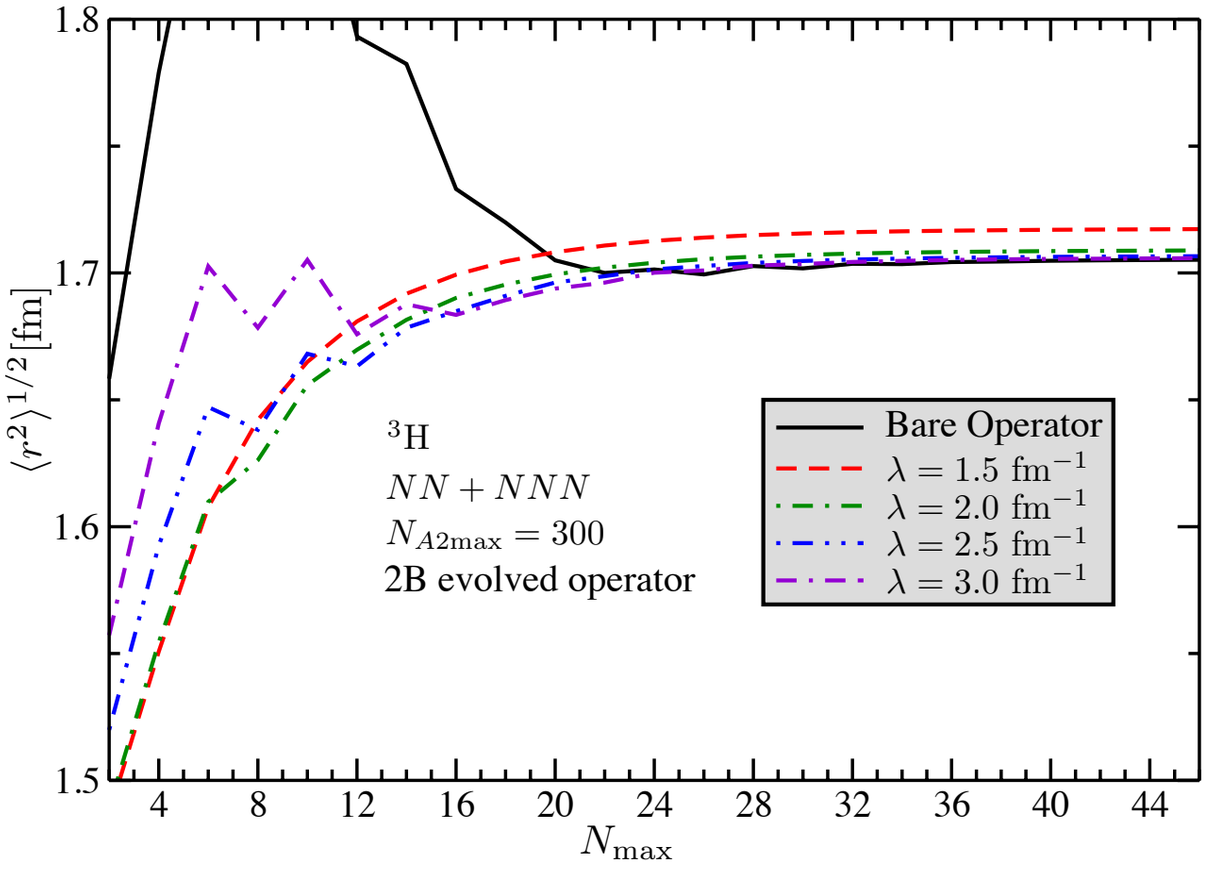
MS, Sofia Quaglioni, Calvin Johnson, Eric Jurgenson, Petr Navrátil.,
Phys. Rev. C **90**, 011301(R) (2014)

Hydrogen-3 rms radius

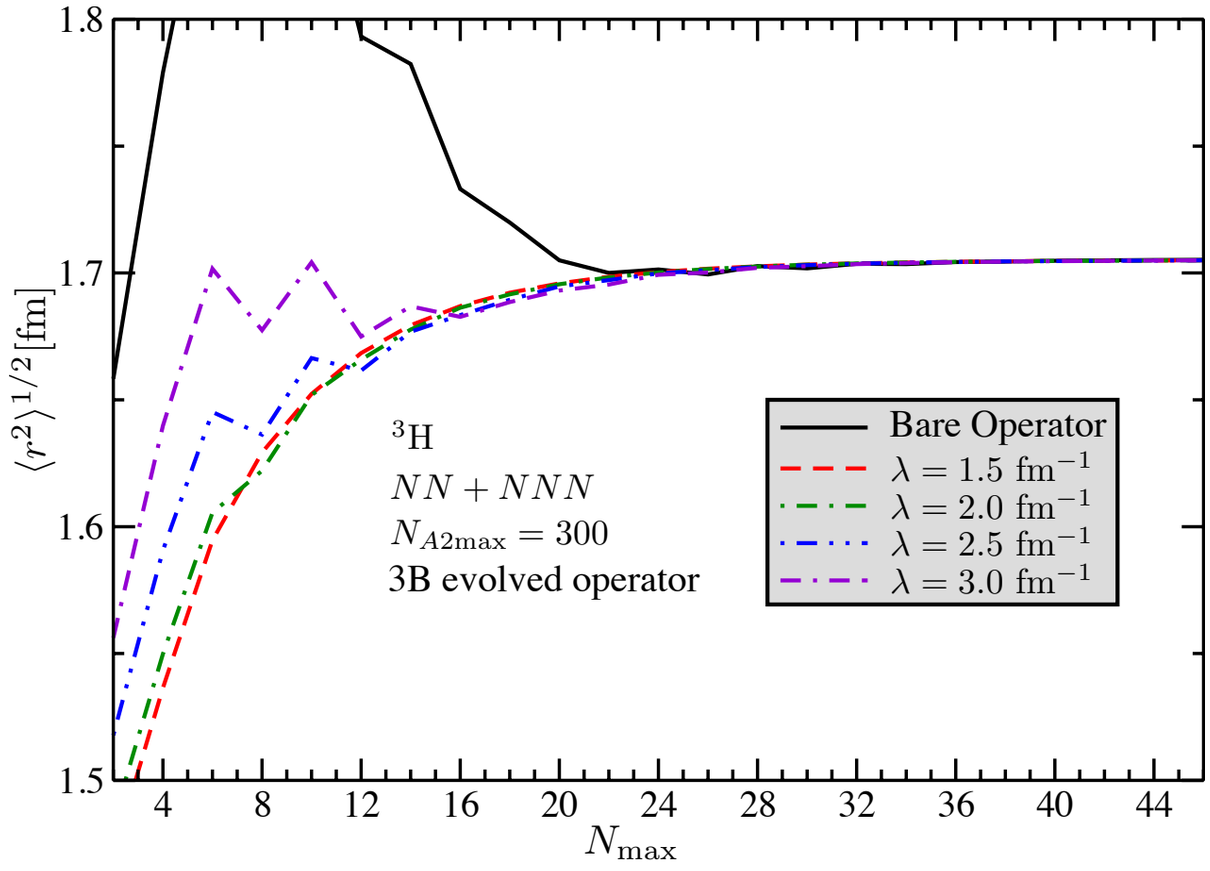
What about convergence?

Hydrogen-3 rms radius

2-Body Evolved Operator



3-Body Evolved Operator



Faster convergence?

Hydrogen-3 rms radius

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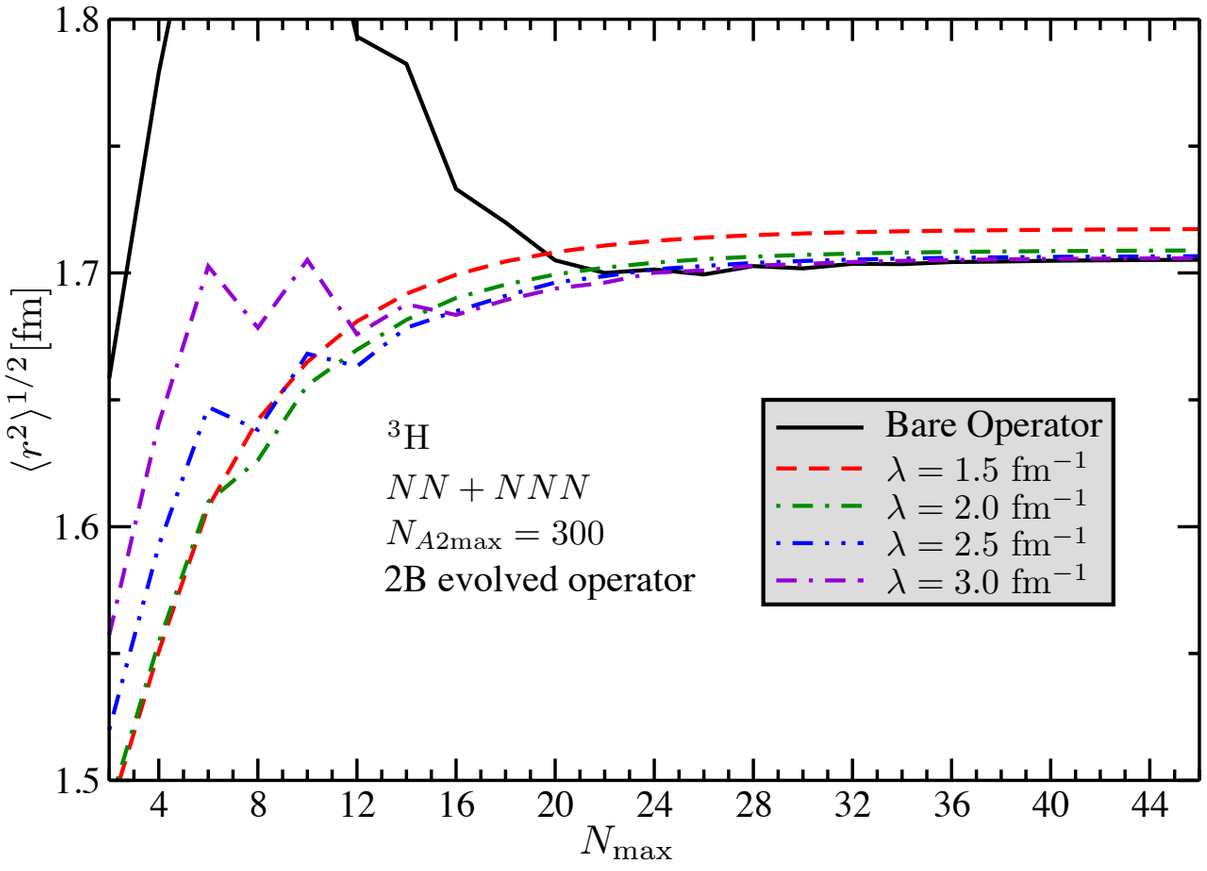

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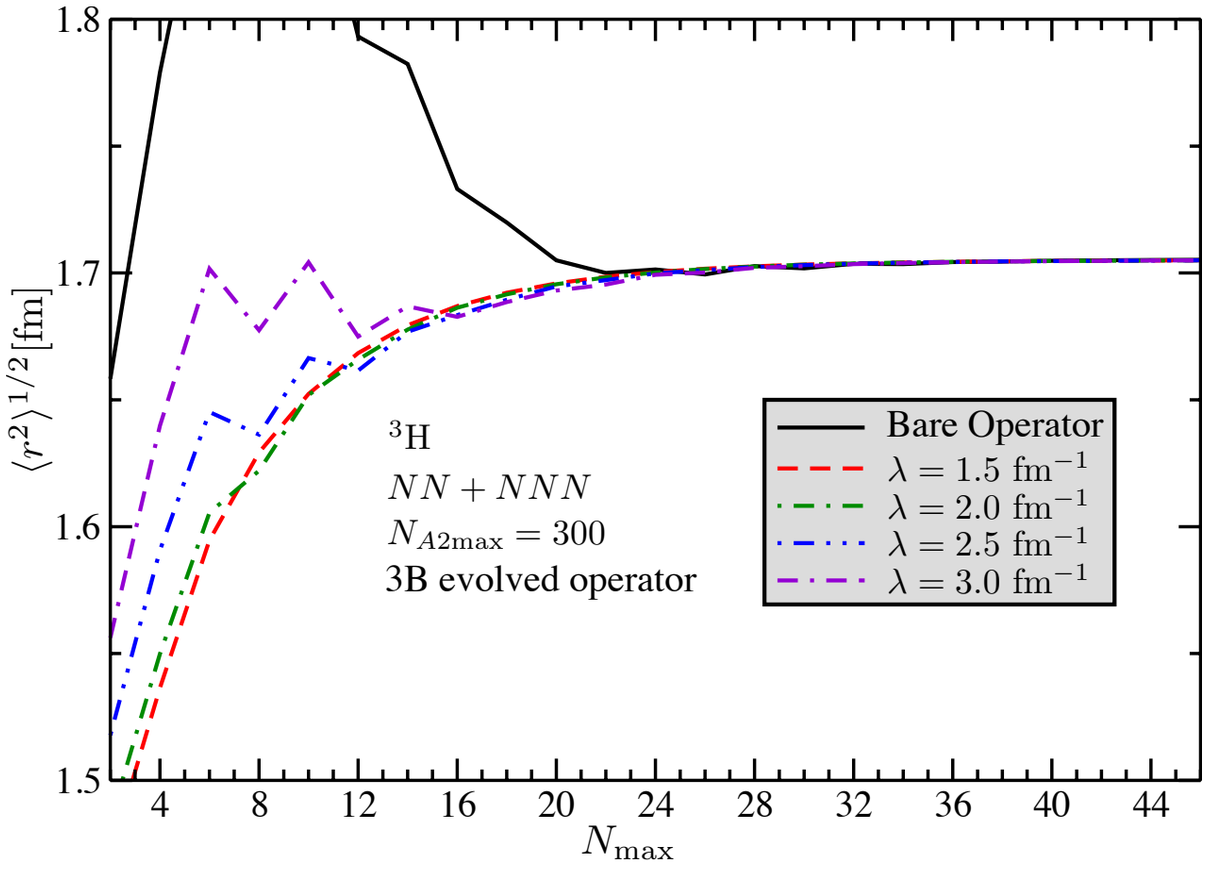


Faster convergence?

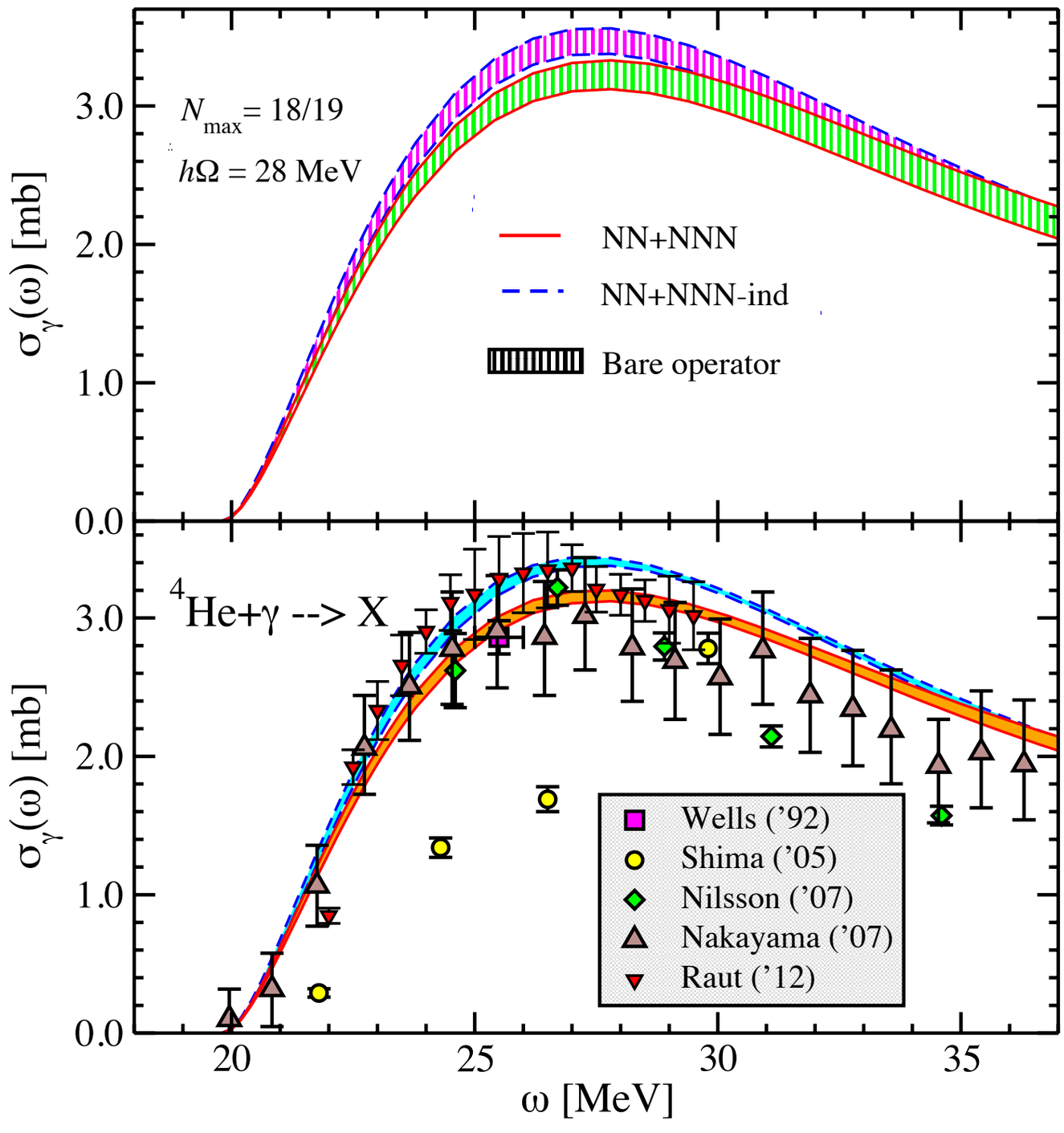
Probably not.

Total photo-absorption cross-section of ^{4}He

Non-scalar operator evolution:

$$O_s^{JT} = U_s^i O_{s=0}^{JT} U_s^{f\dagger}$$

Requires the unitary transformation from both the initial and final states.



Current work and prospects

Our goal is to expand this work to larger nuclei and to evolve additional operators.

- ^{6}Li rms radius - On the poster!
- ^{6}He rms radius - Very slow convergence

More work for three-body evolution:

- Applying in larger nuclei
- Non-scalar operators

Acknowledgements

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Thank You!