

Exploring alternative SRG generators in one dimension

Matthias Heinz, Kai Hebeler, Achim Schwenk

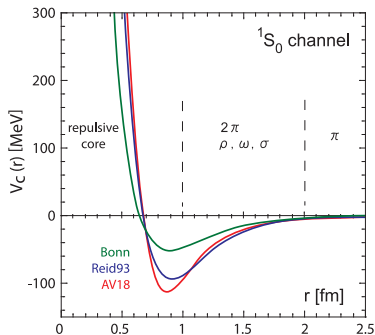


TECHNISCHE
UNIVERSITÄT
DARMSTADT



Potentials in Nuclear Physics

- ▶ Finite-range attractive force
- ▶ Short-range repulsion
- ▶ Repulsion couples low and high momenta
- ▶ Leads to poor many-body convergence



Aoki et al., Comput. Sci. Dis. (2008)

The Similarity Renormalization Group (SRG)



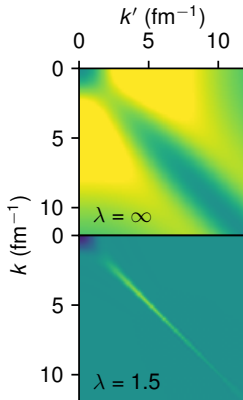
TECHNISCHE
UNIVERSITÄT
DARMSTADT

SRG:

- ▶ Class of continuous unitary transformations given by:

$$\frac{dH_s}{ds} = [[G, H_s], H_s]$$

- ▶ $s = 1/\lambda^4$
- ▶ H_s goes to form of G



The Similarity Renormalization Group (SRG)

SRG:

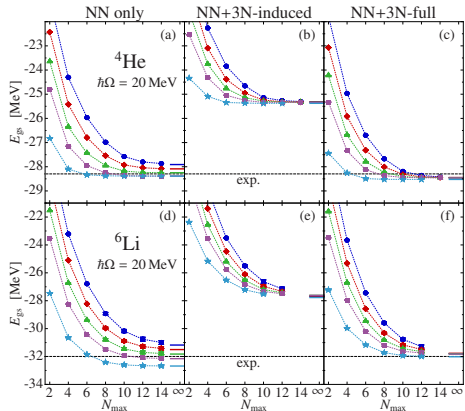
- ▶ Class of continuous unitary transformations given by:

$$\frac{dH_s}{ds} = [[G, H_s], H_s]$$

- ▶ $s = 1/\lambda^4$
- ▶ H_s goes to form of G

Features:

- ▶ Improved many-body convergence
- ▶ Induction of many-body forces



Roth et al., Phys.Rev.Lett. 107 (2011) 072501

The Similarity Renormalization Group (SRG)

SRG:

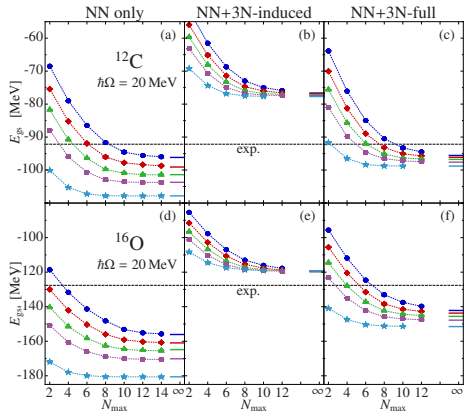
- ▶ Class of continuous unitary transformations given by:

$$\frac{dH_s}{ds} = [[G, H_s], H_s]$$

- ▶ $s = 1/\lambda^4$
- ▶ H_s goes to form of G

Features:

- ▶ Improved many-body convergence
- ▶ Induction of many-body forces



Roth et al., Phys.Rev.Lett. 107 (2011) 072501



For $G = T_{rel}$:

$$\frac{dV_s(k, k')}{ds} = -V_s(k, k')(k^2 - k'^2)^2 + \dots$$

- ▶ Exponential suppression for far off diagonal matrix elements

For $G_s = T_{rel} + X_s$ with $X_s(k, k') = W(k, k')V_s(k, k')$:

$$\frac{dV_s(k, k')}{ds} = -(V_s(k, k') - X_s(k, k'))(k^2 - k'^2)^2 + \dots$$

- ▶ Change in matrix elements small when $X_s(k, k') = V_s(k, k')$
- ▶ Choose $W(k, k')$ to reflect what we want SRG to do

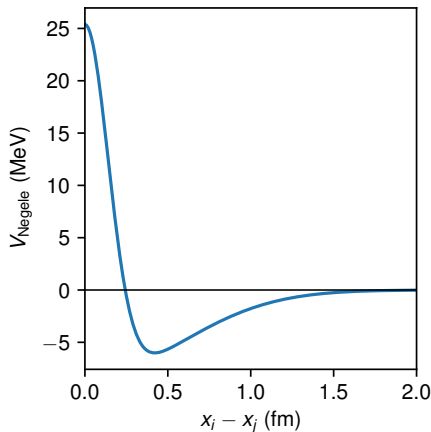
The “Jurgenson” Model

Features:

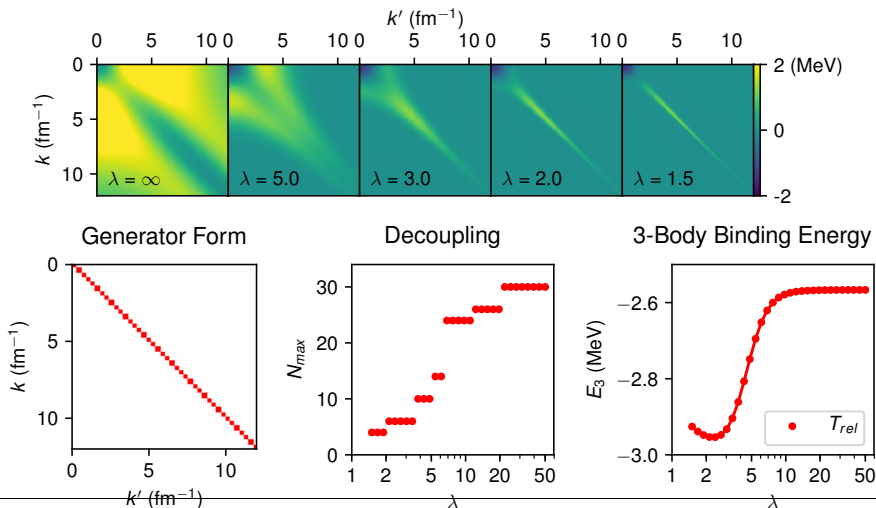
- ▶ 1-D
- ▶ Bosons
- ▶ Negele potential
- ▶ Jacobi harmonic oscillator for many-body results

Advantages:

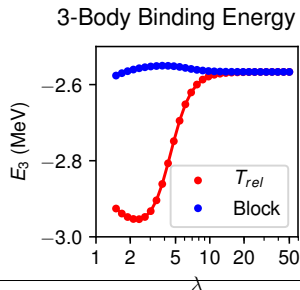
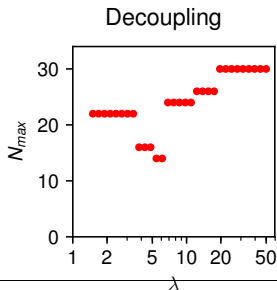
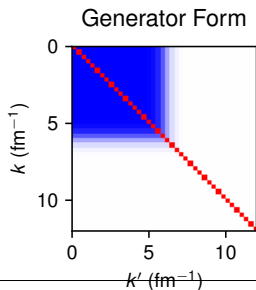
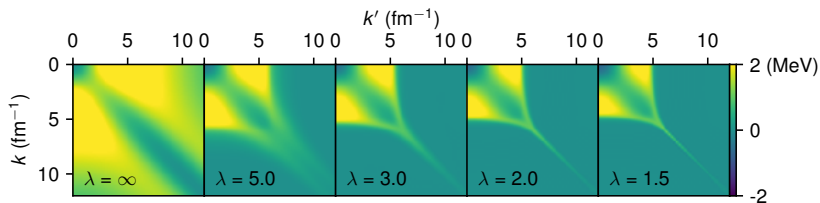
- ▶ Model is simple
- ▶ Results generalize well to 3-D calculations



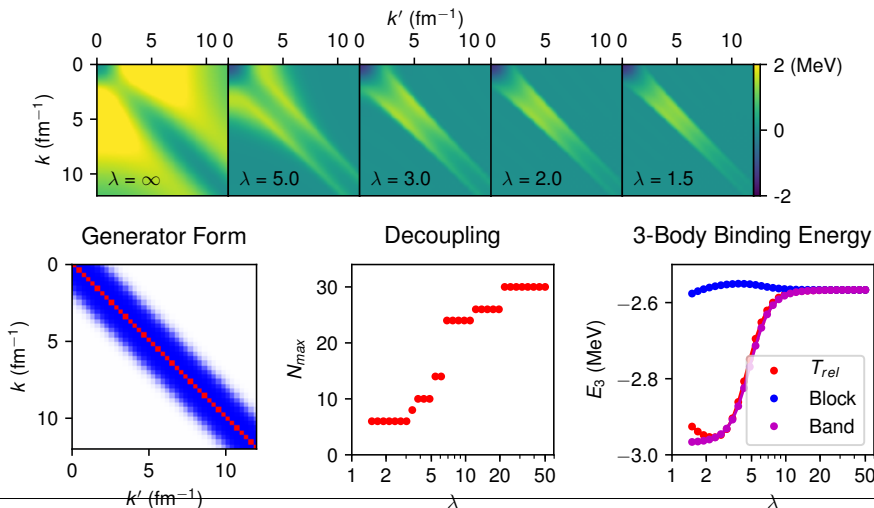
Generator: T_{rel}



Generator: Block Diagonal



Generator: Band Diagonal





Status:

- ▶ Have framework to test alternative generators
- ▶ Considering generators of form $T + WV$
makes implementation of new generators easy

Direction:

- ▶ Incorporate 4- and 5-body binding energies
- ▶ Learn what features of generators lead to what behavior
- ▶ Identify features that lead to optimal results