Exploring alternative SRG generators in one dimension

Matthias Heinz, Kai Hebeler, Achim Schwenk

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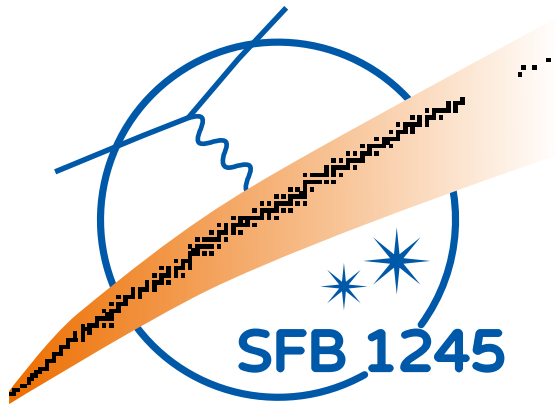

Potentials in Nuclear Physics

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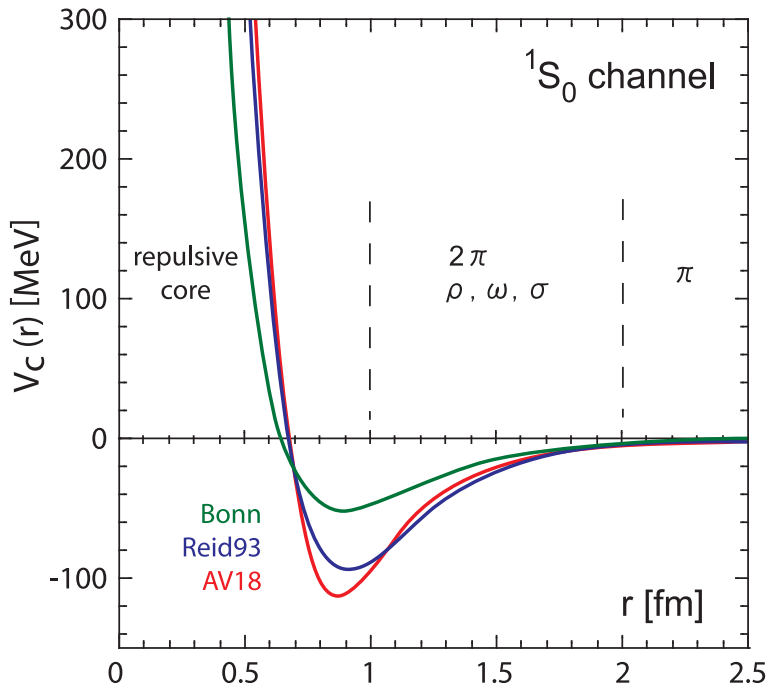
- Finite-range attractive force
- Short-range repulsion
- Repulsion couples low and high momenta
- Leads to poor many-body convergence



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

The Similarity Renormalization Group (SRG)

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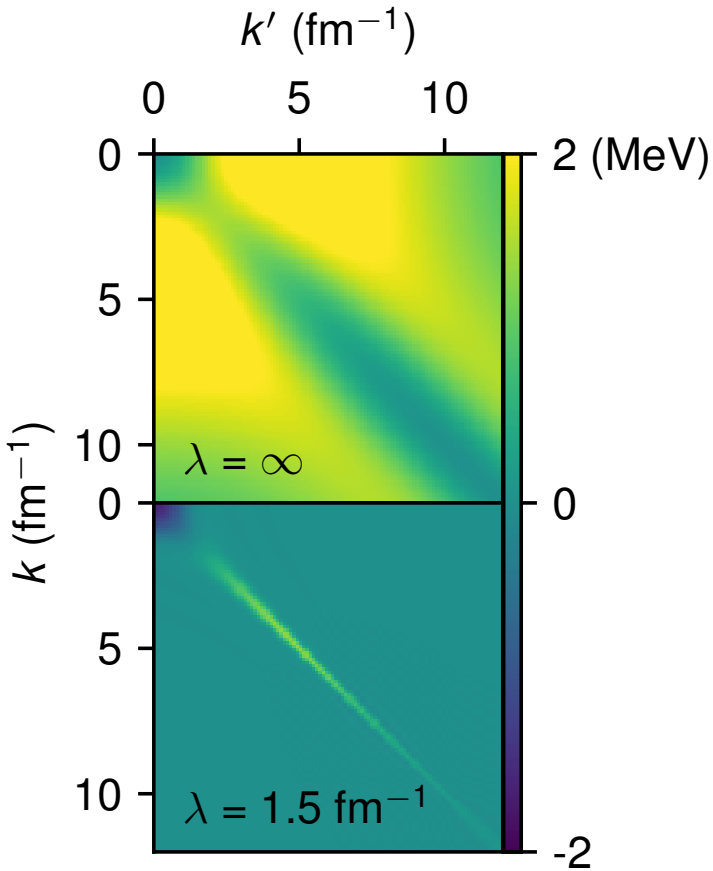
SRG:

- 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



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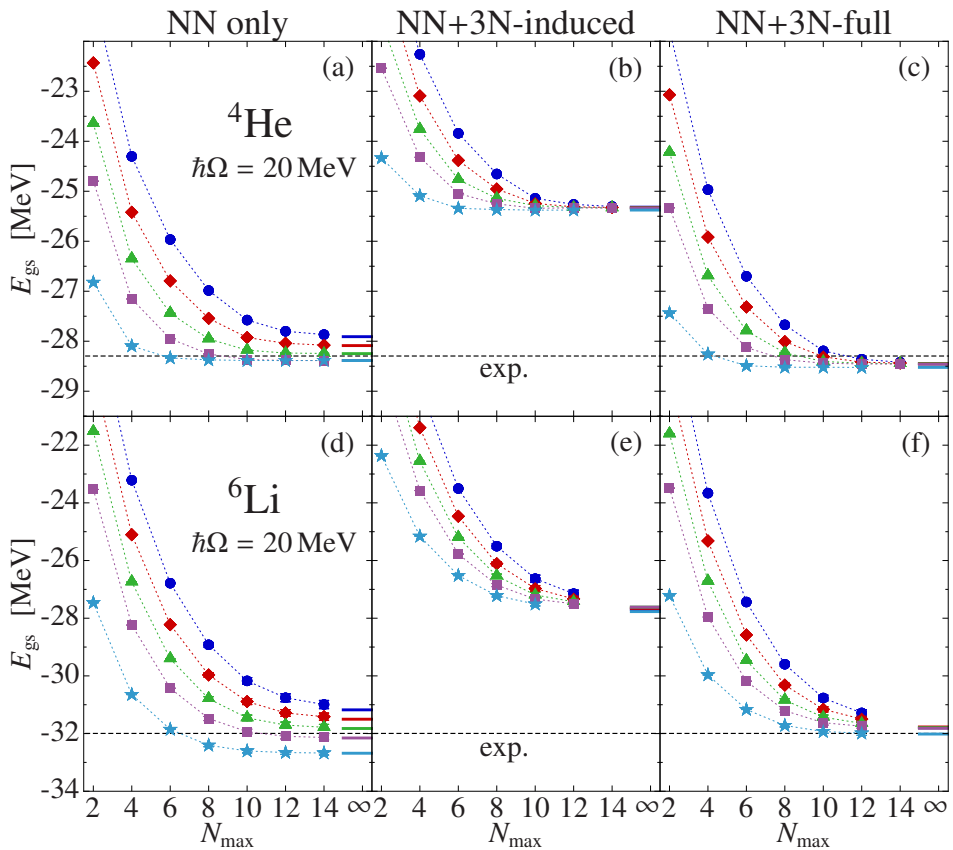
Features:

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



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

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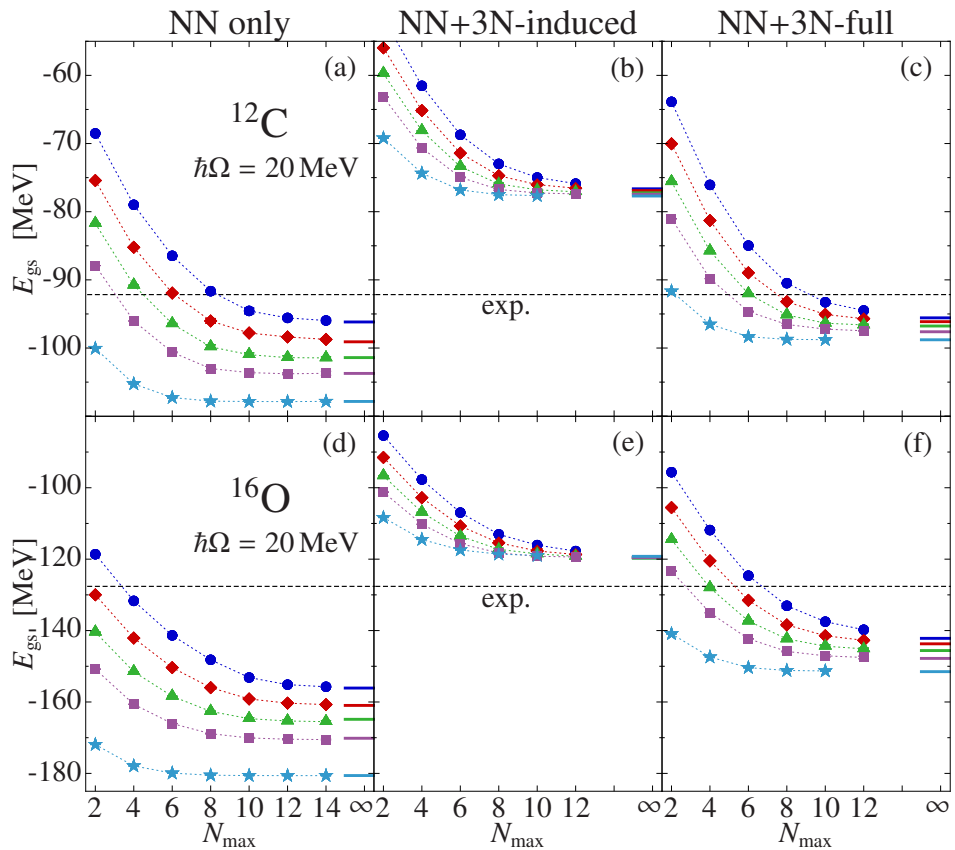

Roth et al., Phys.Rev.Lett. 107 (2011) 072501

The Case for Alternative Generators

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For $G = T_{rel}$:

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

- Exponential suppression for far off diagonal matrix elements

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

- Exponential suppression for far off diagonal matrix elements

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

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

- 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

Jurgenson, Furnstahl, Nucl.Phys. A818 (2009)

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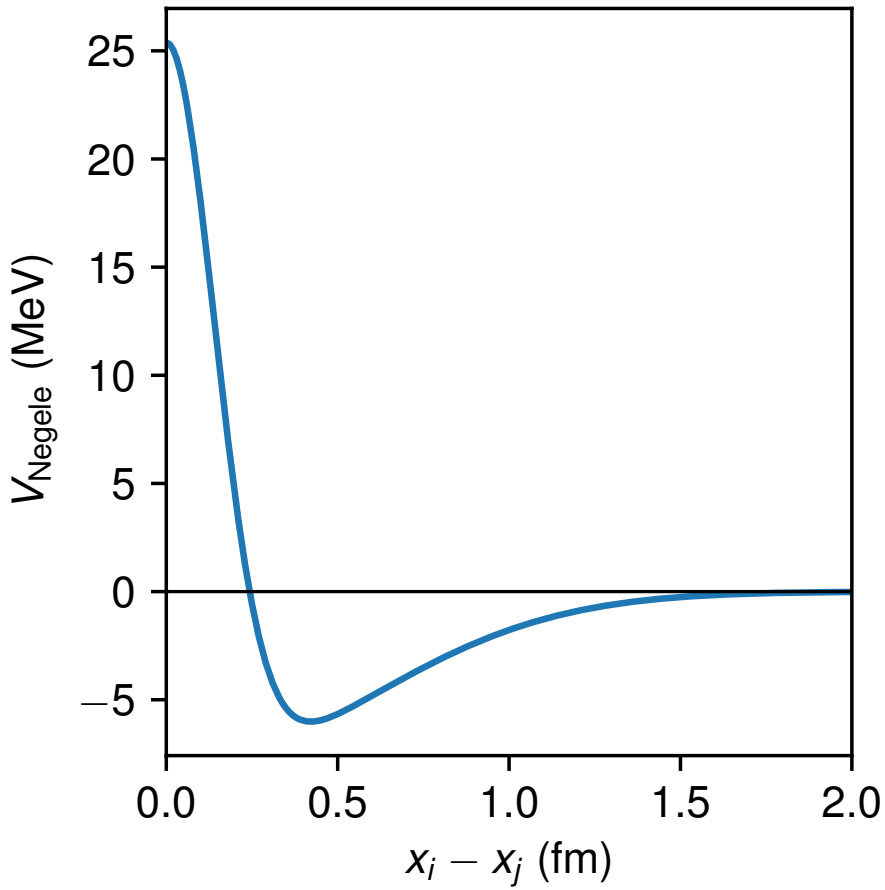
Features:

- 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}

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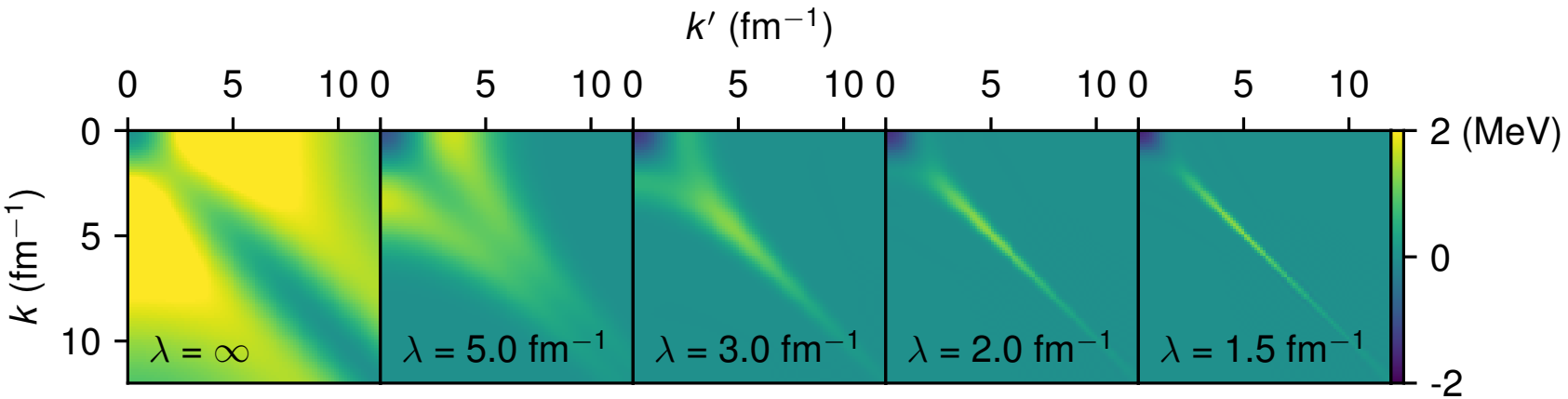
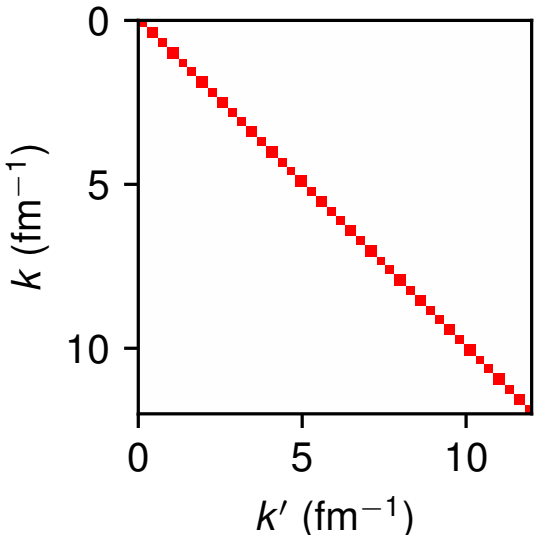
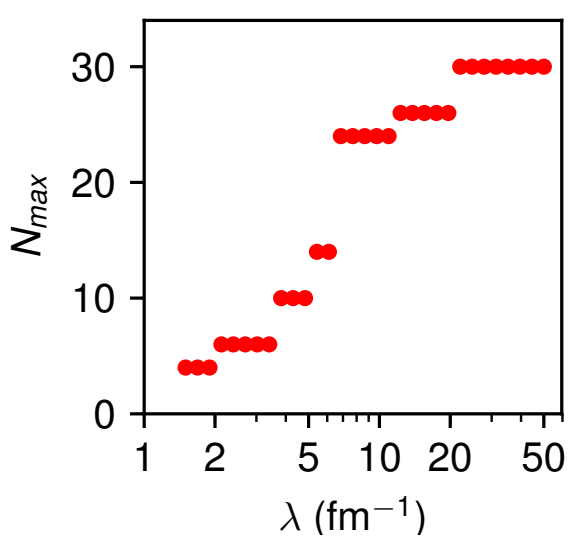


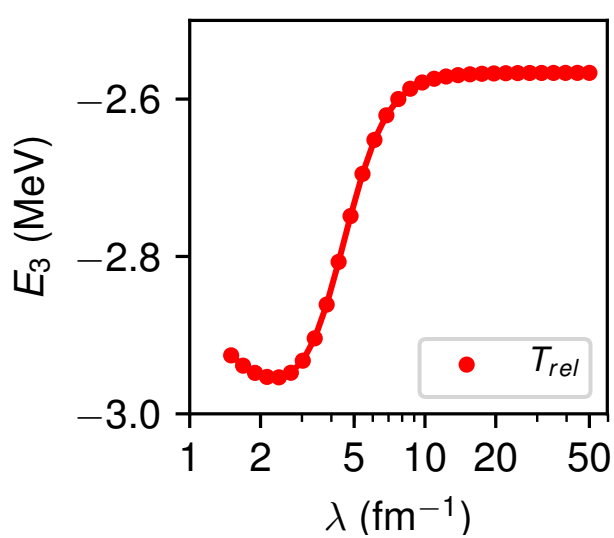
Generator Form



Decoupling



3-Body Binding Energy



Generator: Block Diagonal

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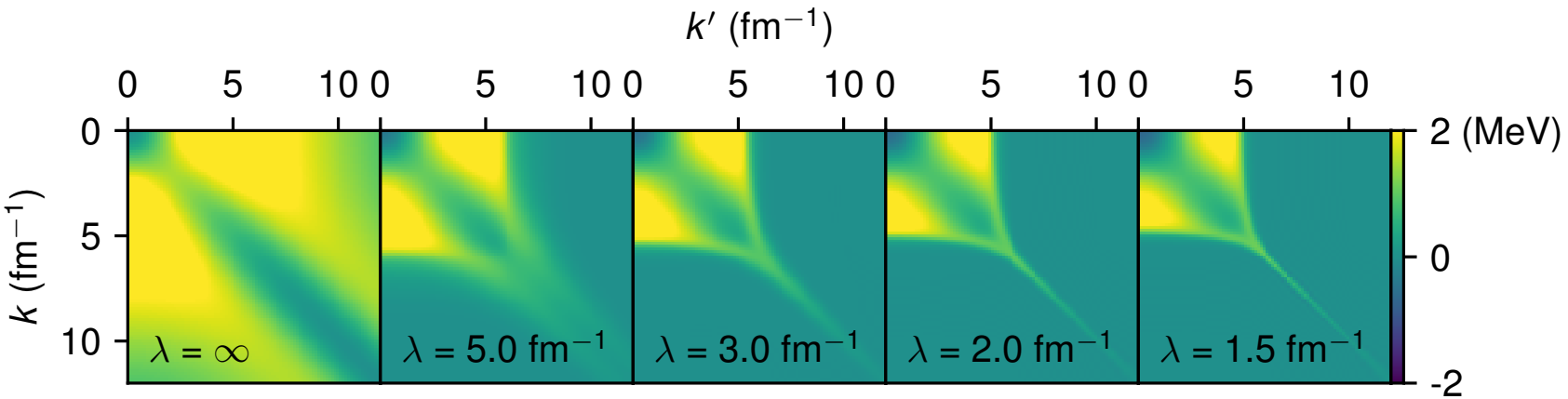
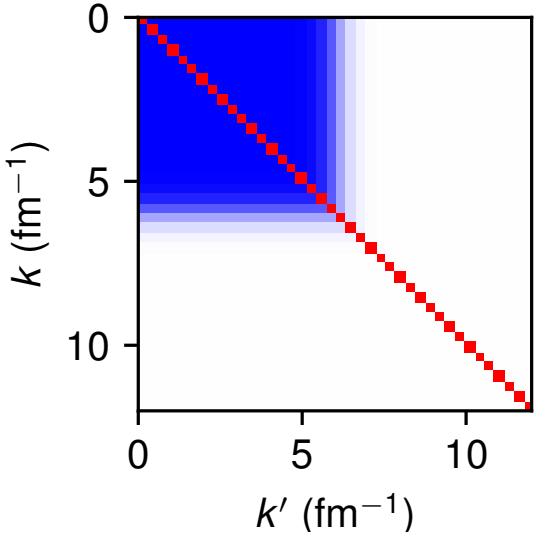


Generator Form



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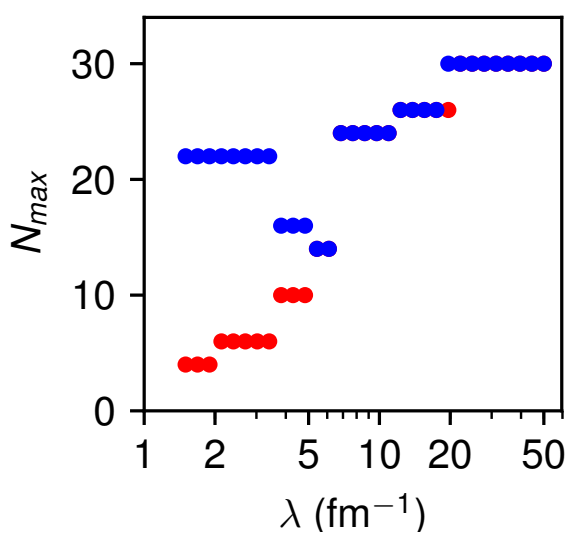

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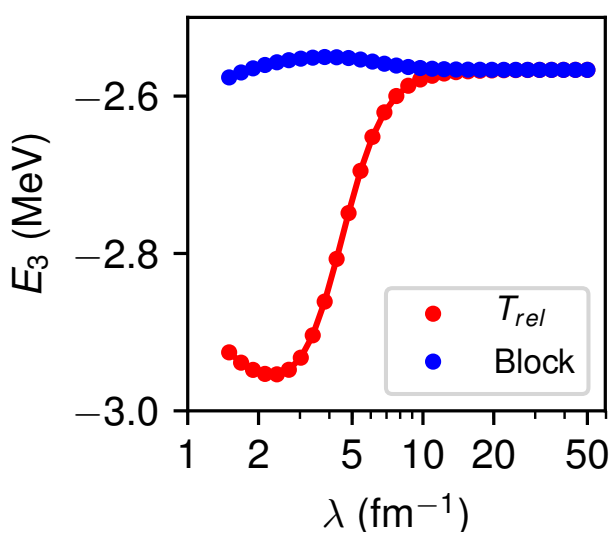

Generator: Band Diagonal

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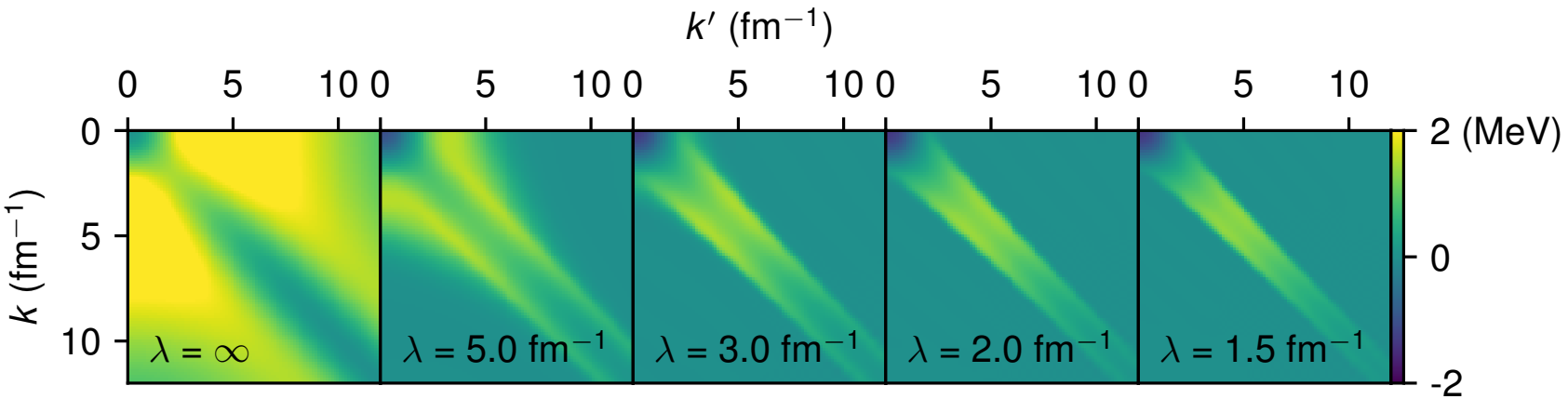

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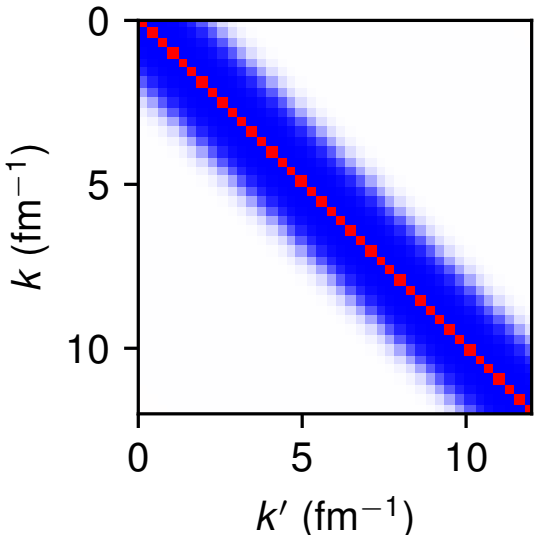

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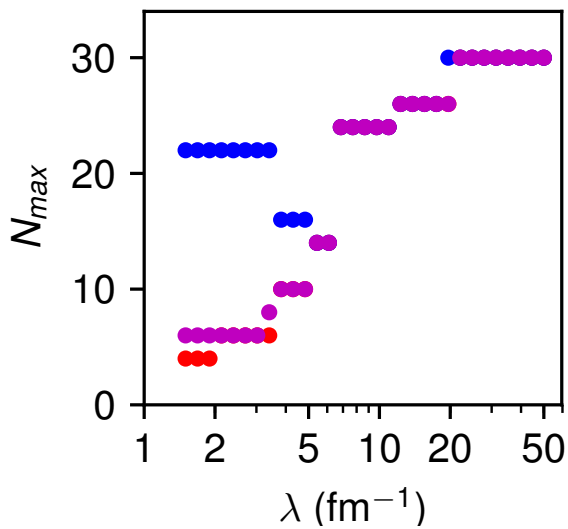

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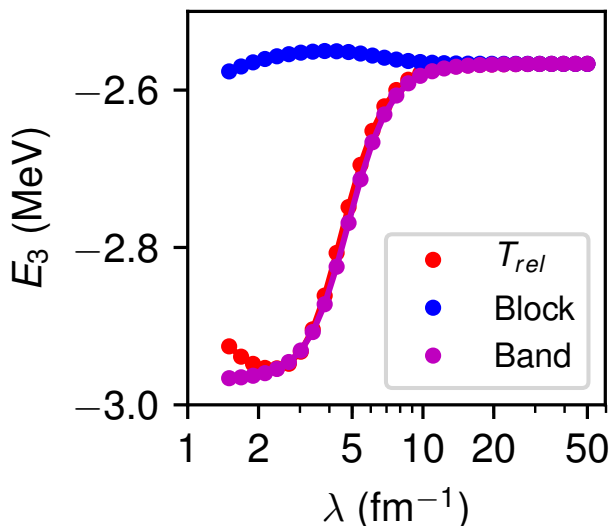

Outlook

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Status:

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

Direction:

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Thank you!