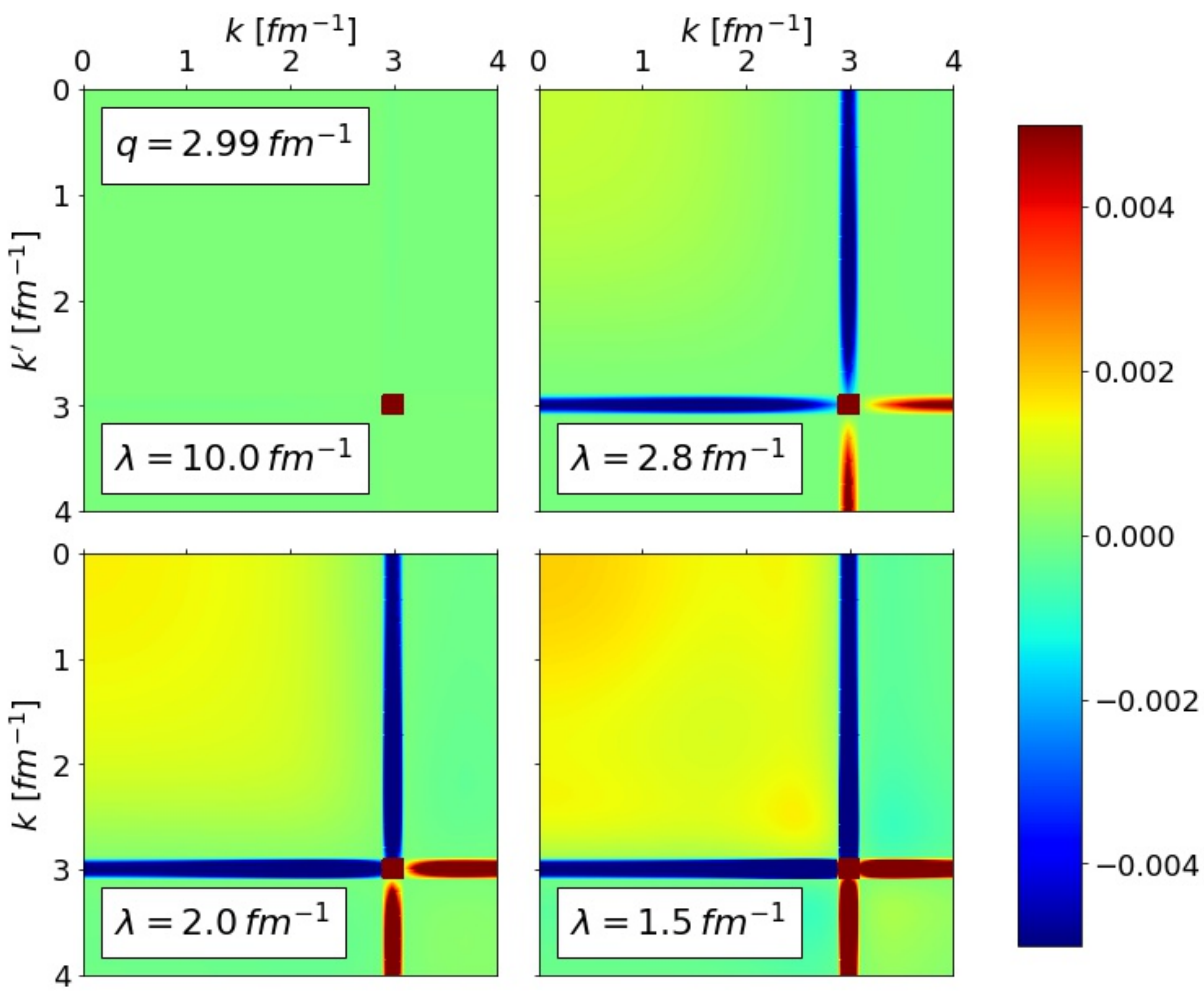
Using the Magnus expansion to SRG-evolve operators

Objectives

- Compare similarity renormalization group (SRG) operator evolution using Magnus expansion to standard approach.
- The Magnus expansion drastically reduces the memory needed to evolve operators besides the Hamiltonian, which is otherwise prohibitive for medium-mass nuclei. Test its numerical precision and stability.
- Investigate operator evolution with new chiral potentials.



Impact

- The SRG transformation shifts the strength of operators to low-energy in the form of smeared contact operators.
- Calculations of deuteron observables with evolved wave functions and operators show very small error relative to the unevolved value due to exact unitarity in Magnus transformations.
- Enables re-examination of SRG calculations with new chiral potentials and consistently evolved wave functions and operators. Applications to observables such as radii, electromagnetic moments and transitions, etc.
- Validated the Magnus expansion as an avenue for in-medium (IM)-SRG evolution of A-body operators.

Accomplishments

- A. J. Tropiano, work in progress.

Figure: SRG evolution of the momentum distribution operator $\langle k|a_q^\dagger a_q|k'\rangle$ for $q \doteq 3$ fm^{-1} in the $^3S_1$ partial wave evolved from $\lambda = 10$ to 1.5 fm^{-1}, with a semi-local chiral NN potential (Reinert et al., 2018). We SRG-evolve the potential using the Magnus expansion and apply the unitary transformation to the operator directly.