

11/24/14

Monday 8805 Class

left-over from 11/19/14

- Plazzo
- ⓐ Computational aspects of SRG 11/19/14 ③
 - ⓑ Wegner choice for SRG generator RG ⑩-⑪
 - ⓒ Vlowk RG equation RG ⑫
 - ⓓ Block diagonal SRG generator RG-⑬
 - ⓔ Perturbativeness see HUGS 2.72-86 and 11/19/14 ④-⑤

3-body forces

• A key feature of RG running of nuclear interactions, as well as any low-energy effective theory, is a prominent role for few-body forces.

• At least 3NF, for which quantitative evidence is clear for a wide range of Hamiltonians.

• We'll use HUGS lecture 4 as a basis for discussion

• Modern evidence for three-body force impact

• NCSM with 3NF (2007) HUGS 4.31 Spectrum of ^{10}B - ^{13}C

• We'll come back to the most clearest example: ^3H

• Ground-state ordering in some cases (eg. ^{10}B) matters

• States split by spin-orbit ($3/2^-$ - $1/2^-$ in ^{10}B , ^{13}C)

• Note that these are not large effects — just critical

for precision calculations (few MeV level out of 100 MeV binding)

• Oxygen spectra and electromagnetic transitions from MBPT (sic)

• Uses SRG-softened potentials HUGS 4.32

• compare NN to NN+3N

• again, fine structure, but critical for precision

• ^{14}C half-life HUGS 4.33-34

• step through HUGS 4.34 first, then come back to 4.33

1/24/14

- Important points: beta decay toward stability for light nuclei
- Used leading-order transition operator from $^{14}\text{C} \rightarrow ^{14}\text{N}$
 - \Rightarrow is the fine-tuning very sensitive to the Hamiltonian and/or higher-order (esp. 2-body) operators?
- High-performance computing was essential!
- Isotope chains in oxygen, nitrogen, fluorine, calcium
 - $2N+3N$ (induced) \rightarrow unitary evolution with initial NN -only
 - $2N+3N$ (Full) \rightarrow unitary evolution with initial NNN
 - "induced" includes the $3NF$ generated by the SRG evolution

• Now return to $3NF$ and evolution

- HUGS 4.4 shows win with SRG - but we included NNN already
- HUGS 4.5 shows the Tjon-line trajectory - different answers for energy eigenvalues at 5-10% level
 - \Rightarrow not unitary! What did we omit?
 - \Rightarrow induced 3-body

- Quick recap on source of 3-body

- HUGS 4.9 \Rightarrow decoupling high-momentum intermediate states is like not including Δ s \rightarrow why?
 - omission of induced $3NF$ means observables depend on λ
 - cut off dependence of λ is measure of approximation
 - \Rightarrow use as a tool to assess accuracy of many-body and SRG truncations.
 - HUGS 4.10 \rightarrow in 2nd quantization, taking the double commutator means the right side will have 3-body terms ($3a^\dagger$'s and $3a$'s) with respect to free space (vacuum) immediately induced
 - Main question: how big are they?
 - Tentative answer: need to keep $3NF$ and maybe $4NF$
- \Rightarrow see (RG-15)

3

11/24/14

- SRG technology and Jacobi basis \rightarrow see RG16
• softening by decoupling in harmonic oscillator basis seen in HUGS 4.11-22

- Size of corrections in ^3H and ^4He on HUGS 4.23
• revisit T_{jon} line on HUGS 4.24
• hierarchy on HUGS 4.25

Potential problem: HUGS 4.27-28

• looks like four-body contribution is significant