論文内容の要旨

論文題目

In-Medium Similarity Renormalization Group for Nuclear Many-Body Systems

（和訳： 媒質中の相似繰りこみ群による核子多体系の記述）

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We present a new ab-initio method that uses similarity renormalization group (SRG) techniques to continuously transform nuclear many-body Hamiltonians toward a desired form. In contrast to applications of the SRG to two- and three-nucleon interactions in free space, we perform the SRG evolution ``in-medium" directly in the *A*-body system of interest. The in-medium approach has the advantage that one can approximately evolve *3*,..., *A*-body operators using only two-body machinery based on normal-ordering techniques. The method is non perturbative and can be tailored to a variety of problems ranging from the diagonalization of closed-shell nuclei to the construction of effective valence shell-model Hamiltonians and operators. We also show the connection between the In-medium SRG (IM-SRG) and the many-body perturbation theory (MBPT) and demonstrate that the solution of the IM-SRG contains the low order perturbation diagrams exactly, by expanding the IM-SRG flow equation in terms of the bare coupling of the interaction in an initial Hamiltonian. In addition, the perturbative solution of the flow equation does not encounter the divergence due to the zero denominator, which pertains conventional Q-box expansion with non-degenerate model space. The perturbative analysis of the IM-SRG provides the machinery to make a systematic improvement of accuracy, making the theory controllable. We apply the IM-SRG to nuclei and present first results for the ground-state energies of ^{4}He, ^{16}O and ^{40}Ca, which have accuracies comparable to coupled-cluster calculations. An important advantage of the IM-SRG is that an arbitral operator can be evolved in the same machinery as Hamiltonian. We show this feature by applying the IM-SRG to the calculation of radius. Moreover, we investigate the contamination of the spurious center of mass excitation into the *A*-body wave functions obtained in the IM-SRG. We demonstrate that the *A*-body wave function of the IM-SRG decouples to a large extent into its intrinsic and center of mass part, and the obtained ground-state energies indeed correspond to the intrinsic energy, where non-interesting center-of-mass excitation is eliminated. Furthermore, we show the first application of the IM-SRG to the derivation of effective valence interactions in nuclear shell model, taking ^{6}Li with *p*-shell as an example. The obtained spectra shows the clear similarity between the IM-SRG and a non-perturbative Q-box expansion. Finally, we investigate the structure of low-lying states in drip-line Oxygen isotope, to which the fully *ab-initio* description has not been reachable. We employ the Gamow shell model, where the coupling to the continuum is treated in a well-defined procedure and the realistic nucleon-nucleon (NN) interactions are taken. We have reached the conclusion that the continuum coupling is important for excited states but not for the ground state thus not crucial to determine the drip line in the case of Oxygen. This conclusion is consistent with the recent microscopic approach including the effects of three-nucleon forces.