Benchmark calculation of inclusive responses in the four-body nuclear system

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New approaches will allow in the near future a more consistent treatment of both structure and reactions within an *ab initio* framework. In this context, the application of the Lorentz integral transform (LIT) method [1] for the description of electromagnetic processes will be described. This technique allows one to rigorously evaluate reaction observables, reducing the continuum problem to a bound−state problem. Therefore, a fully microscopic treatment of the dynamics in both the initial and final states can be reached through the use of bound−state techniques. The recent results of a benchmark calculation for the ^{4}He response functions to two external excitations, different in isospin nature and range, by means of the LIT method, within both the no−core shell model (NCSM) [2] and the effective interaction hyperspherical harmonic (EIHH) [3] expansion techniques will be presented. The aim of this study has been to investigate the reliability of the NCSM approach to the description of inclusive response functions via the LIT method. For the NN interaction, we have used the Minnesota potential model [4]. The obtained EIHH and NCSM ^{4}He response functions for the isovector dipole and isoscalar quadrupole transitions, respectively, will be given. We will also show that the NSCM can be successfully applied to the solutions of the bound−state equations required by the LIT method. However, due to differencies in the asymptotics of the wave functions and in the strength distribution in the continuum achieved with the harmonic oscillator (HO) and hyperspherical harmonic expansions, the practical implementation of the method, especially concerning the problems of convergence, might lead to difficulties. In particular, to ensure a small numerical uncertainty in the response function, obtained by numerical inversion [5], one has to achieve a very good accuracy in the calculation of the LIT. Consequently, it is necessary to find a range of HO frequencies $\hbar\Omega$, for which both the ground and the excited states of the system present good convergence properties. The actual choice of $\hbar\Omega$ depends on both the nucleus under consideration and the range of the transition operator. For ^{4}He we find that frequencies in the range $12\ \mathrm{Mev} \leq \hbar\Omega \leq 28\ \mathrm{MeV}$ have the required characteristics for both the isovector dipole and isoscalar quadrupole excitations.

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