

***Ab initio* widths and asymptotic normalizations**

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Ab initio treatments of nuclear structure describe the energy levels of light nuclei very successfully in terms of the underlying nucleon-nucleon interaction. As attention now shifts from energy spectra to other observables, development of *ab initio* descriptions of scattering and reactions is widely recognized as being particularly important.

Many narrow unbound states of nuclei already have approximate *ab initio* descriptions in the form of pseudobound wave functions with square-integrable wave functions. Their computed energies are believed to be accurate, but they differ from the true wave functions by having decaying instead of oscillating structure in their low-amplitude tails. If energy widths could be computed from these solutions, it would be considerably more efficient than separate calculations of the same widths using explicit scattering boundary conditions.

I will describe the calculation of energy widths using an integral over the accurately-computed interaction region of the pseudobound wave function. Such calculations strongly resemble the Lippman-Schwinger equation and generate accurate approximations to the long-range asymptotics of the wave function from variational solutions that are accurate at short range. I have applied this method to pseudobound states computed from the variational Monte Carlo (VMC) method using the Argonne v_{18} + Urbana IX Hamiltonian. I will show that the results correspond well to widths measured in the laboratory, and I will discuss their application to J^π assignments of states of ${}^9\text{Li}$, ${}^8\text{B}$, ${}^7\text{He}$, and ${}^9\text{He}$. I will also demonstrate that the integral method predicts widths more accurately than do approaches based on factorizing widths into products of computed spectroscopic factors and single-particle widths.

Bound states also possess “virtual widths” that specify the amplitudes of their tails in the energetically-forbidden region. The virtual widths are generally specified as *asymptotic normalization coefficients* (ANCs), which can be determined experimentally from either analytic continuation of scattering phase shifts or (more recently) from the same arsenal of transfer, knockout, and breakup reactions that is used in more traditional spectroscopic factor measurements. ANCs can be computed from *ab initio* wave functions by very nearly the same integral method as widths, and I will present ANCs calculated in this way for nearly every possible virtual emission of an $(A - 1)$ -body bound state from an A -body bound state with $A \leq 9$. Where experimental measurements exist, they are in good agreement with the calculations. However, several of our results remain ripe subjects for experimental tests.

References

- [1] K. M. Nollett and R. B. Wiringa, Phys. Rev. C **83** (2011), 041001(R).