International Nuclear Physics Conference INPC2013: 2-7 June 2013, Firenze, Italy

The No Core Gamow Shell Model for ab-initio Nuclear Structure Calculations

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The *ab initio* No Core Shell Model (NCSM) is a microscopic approach for calculating the properties of atomic nuclei up to mass A ≈16, using any realistic NN (and NNN) interaction and treating all A nucleons as being active. Since its inception in the 1990s, it has had considerable success not only in explaining the binding and excitation energies and other properties of light atomic nuclei, but also in making predictions for properties not yet observed experimentally [1]. The NCSM calculations are usually performed utilizing a basis of harmonic-oscillator single-particle states, thus leading to well-bound states. With the recent advent of rare-isotope-beam accelerators, there is now considerable interest also in loosely-bound and unbound states, representing so-called open-quantum systems. To investigate such exotic nuclear states, we have adapted the Gamow Shell Model approach to the NCSM, which we call the No Core Gamow Shell Model (NCGSM). Our model is formulated in the rigged Hilbert space and employs a complete Berggren ensemble, allowing us to treat bound, resonant, and scattering states on an equal footing [2,3,4]. By including loosely bound states, we make the basis dimensional problem with increasing number of nucleons in the nucleus even more serious than in the NCSM. This difficulty can, however, be alleviated by using the Density Matrix Renormalization Group (DMRG) method to solve the many-body Schrödinger equation [5,6]. To test the validity of our approach, we first performed calculations for ^{3}H and ^{4}He and compared our results against exact Faddeev and Faddeev-Yakubovsky calculations, respectively. We will also present our results for the ground-state energy and decay width of the unstable nucleus ^{5}He, employing a realistic N^{3}LO interaction.

Acknowledgements: We acknowledge partial support of this work through FUSTIPEN (French-U.S. Theory Institute for Physics with Exotic Nuclei) under DOE grant number DE-FG02-10ER41700. Partial support of this work is also acknowledged by B.R.B. and G.P. through NSF grant number PHY-0854912 and by J.R. through the European Research Council under the European Community's Seventh Framework Programme (EP7/2007-2013)/ERC grant agreement no. 240603.

[1] B.R. Barrett, P. Navrátil, and J.P. Vary, "Ab initio No Core Shell Model," Prog. Part. Nucl. Phys. **69**, 131 (2013); http://dx.doi.org/10.1016/j.ppnp.2012.10.003;
[2] T. Berggren, Nucl. Phys. A **109**, 265 (1968);
[3] N. Michel, *et al.*, J. Phys. G: Nucl. Part. Phys. **36**, 013101 (2009);
[4] G. Papadimitriou, *et al.*, Phys. Rev. C **84**, 051304(R) (2011);
[5] J. Rotureau, *et al.*, Phys. Rev. Lett. **97**, 110603 (2006);
[6] J. Rotureau, *et al.*, Phys. Rev. C **79**, 014304 (2009).