HK 36: Structure and Dynamics of Nuclei VIII

Zeit: Mittwoch 14:00–16:00 Raum: S1/01 A03

Gruppenbericht HK 36.1 Mi 14:00 S1/01 A03

Applications of chiral three-nucleon forces up to N^{3}LO to nuclear matter — •Christian Drischler[1,2], Kai Hebeler[1,2], and Achim Schwenk[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

We have developed recently an improved method for including normal-ordered three-nucleon (3N) forces to many-body calculations of nuclear matter. Applying these density-dependent effective two-body forces to matter of arbitrary proton fractions we show results for the equation of state based on chiral N^{3}LO two- and N^{2}LO three-body forces up second order and study the symmetry energy including contributions beyond the quadratic expansion. As our method allows to incorporate also the recent developed matrix elements of the subleading three-body forces we show in addition results for consistent N^{3}LO calculations of pure neutron matter at zero temperature.

Furthermore, these advances in treating chiral 3N forces up to N^{3}LO can directly be used for advanced studies of properties of neutron matter, such as the equation of state based on the nonperturbative approach of self-consistent Green's functions or the $^3PF_2$ BCS energy gap. We show first results for these.

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HK 36.2 Mi 14:30 S1/01 A03

Towards chiral three-nucleon forces in heavy nuclei — •Victoria Durant[1,2], Kai Hebeler[1,2], Johannes Simonis[1,2], and Achim Schwenk[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

We explore different approximation schemes for applying three-nucleon (3N) forces in microscopic calculations of medium-mass and heavy nuclei. To this end, we study different approximations for calculating 3N matrix elements. We benchmark these in few-nucleon systems and for normal-ordered matrix elements in calculations of medium-mass nuclei.

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HK 36.3 Mi 14:45 S1/01 A03

Three-nucleon forces: From oxygen to calcium* — •Johannes Simonis[1,2], Kai Hebeler[1,2], Jason D. Holt[3], Javier Menéndez[4], and Achim Schwenk[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]TRIUMF, Vancouver, Canada — [4]The University of Tokyo, Japan

We study ground- and excited-state properties of medium-mass nuclei based on chiral two- and three-nucleon interactions. Our results are based on a many-body perturbation theory approach combined with large-scale diagonalizations. In particular, we will focus on theoretical uncertainty estimates by considering Hamiltonians at different resolution and different sets of low-energy constants.

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HK 36.4 Mi 15:00 S1/01 A03

Two- and Three-Nucleon Chiral Interactions in Quantum Monte Carlo Calculations for Nuclear Physics — •Joel Lynn[1], Ingo Tews[2], Joseph Carlson[3], Stefano Gandolfi[3], Alexandros Gezerlis[4], Kevin Schmidt[5], and Achim Schwenk[1,6] — [1]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]Institute for Nuclear Theory, University of Washington, Seattle, Washington 98195, USA — [3]Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA — [4]Department of Physics, University of Guelph, Guelph, Ontario, N1G 2W1, Canada — [5]Department of Physics, Arizona State University, Tempe, Arizona 85287, USA — [6]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

I present our recent work on Green's function Monte Carlo calculations of light nuclei using local two- and three-nucleon interactions derived from chiral effective field theory up to next-to-next-to-leading order (N^{2}LO). I discuss the choice of observables we make to fit the two low-energy constants which enter in the three-nucleon sector at N^{2}LO: the ^{4}He binding energy and n–α elastic scattering P-wave phase shifts. I then show some results for light nuclei. I also show our results for the energy per neutron in pure neutron matter using the auxiliary-field diffusion Monte Carlo method and discuss regulator choices. Finally I discuss some exciting future projects which are now possible.

HK 36.5 Mi 15:15 S1/01 A03

Initial Four-Body Forces in Many-Body Calculations — •Stefan Schulz and Robert Roth — Institut für Kernphysik, Technische Universität Darmstadt

For the ab-initio description of light and medium-mass nuclei, chiral effective field theory is used successfully. Improving the precision and uncertainty estimation of chiral forces, especially an improved description of medium-mass nuclei, requires consistent order-by-order calculations. Starting at N^{3}LO, chiral four-body forces play a role and their impact on nuclei beyond few-body systems is currently unknown. Even without initial four-body forces, transformations such as the similarity renormalization group induce many-body forces.

We model the four-body forces using a simple contact interaction and investigate its effect on nuclear many-body observables, especially ground-state energies and radii, as well as correlations between them. The four-body forces are evaluated in a Jacobi harmonic oscillator (HO) basis and subsequently used in no-core shell model and Hartree-Fock calculations for light- and medium mass nuclei. Handling of chiral forces is identical to a contact interaction, once they are evaluated in a HO basis.

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HK 36.6 Mi 15:30 S1/01 A03

Quantum Monte Carlo calculations of two neutrons in finite volume with chiral effective field theory interactions* — •Philipp Klos[1,2], Martin Hoferichter[3], Joel Lynn[1,2], Ingo Tews[1,3], Stefano Gandolfi[4], Hans-Werner Hammer[1,2], and Achim Schwenk[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Institute for Nuclear Theory, University of Washington, Seattle — [4]Theoretical Division, Los Alamos National Laboratory

Few nucleon systems provide a unique testing ground for nuclear forces. We present auxiliary-field diffusion Monte Carlo simulations of the two-neutron system in finite volume with chiral effective field theory potentials. Both ground-state and excited-state energies in the S-wave channel are compared to results from the Lüscher formula, which provides exact solutions based on scattering data. Future calculations of few-body systems will help to constrain many-body forces, which are crucial for the description of nuclei and nuclear matter, and allow for comparisons with lattice QCD calculations that have approached the physical parameter space in the last years.

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HK 36.7 Mi 15:45 S1/01 A03

Fitting a chiral interaction to nuclear properties in the sd-shell — •Lukas Huth[1,2], Johannes Simonis[1,2], and Achim Schwenk[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

The nuclear shell model is a powerful tool to investigate medium-mass regions of the nuclear chart. Its main ingredient is an effective valence-space Hamiltonian. This Hamiltonian consists of single-particle energies, two-body matrix elements and additional many-body contributions. We construct a family of effective Hamiltonians in the sd-shell. The considered interactions are motivated by chiral effective field theory. Thus they incorporate basic QCD symmetry principles by default, allow to study an order-by-order convergence behavior, and come with a theoretically motivated error estimate for missing higher-order contributions.

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