HK 49: Structure and Dynamics of Nuclei VIII

Zeit: Donnerstag 16:45–19:00 Raum: F 33

Gruppenbericht HK 49.1 Do 16:45 F 33

Shell model interactions from chiral effective field theory* — •Lukas Huth[1,2], Victoria Durant[1,2], Johannes Simonis[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

We construct effective valence-space interactions for the use in shell model calculations, where the residual two-body interaction is based on symmetry principles and the low-momentum expansion from chiral effective field theory. In addition to the usual free-space operators we also include center-of-mass momentum operator terms that arise due to the translational and Galilean invariance breaking by in-medium effects. We fitted the low-energy constants and single particle energies to 442 ground- and excited-state energies in the *sd* shell and obtained a root mean square derivation of 442 keV. Our valence-space interactions provide uncertainty estimates and show promising predictions.

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Precision calculations of M1 observables in light nuclei — •Laura Mertes, Thomas Huether, and Robert Roth — IKP, TU Darmstadt

In *ab initio* nuclear structure calculations we use nuclear interactions derived in chiral EFT, softened by a unitary transformation to accelerate the convergence of many-body calculations. One method is the Similarity Renormalization Group (SRG) transformation that decouples high- and low-energy physics through a flow evolution of the Hamiltonian and other operators, such as electromagnetic observables. Up to now, electromagnetic observables were almost always calculated with the bare, unevolved operator on evolved wave functions obtained as eigenstates from solving the many-body eigenvalue problem. The effects of a consistent SRG transformation are in the range of a few percent and thus performing a consistent SRG transformation is essential for precision calculations. We present first results for M1 observables in light nuclei obtained with a consistent SRG transformation.

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Effective Field Theory for three-body hypernuclei — •Fabian Hildenbrand and Hans-Werner Hammer — Institut für Kernphysik, TU Darmstadt, 64289 Darmstadt, Germany

We construct a short-range effective field theory with contact interactions for three-body hypernuclei in the strangeness $S = -1$ sector. An asymptotic analysis is performed in the $I = 0$ and $I = 1$ isospin channels and the corresponding effective Lagrangians are constructed. It turns out that a ΛNN three-body force is required for consistent renormalisation in both channels. We present universal correlations between observables and discuss the possibility of a Λnn bound state in this effective theory.

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Uncertainties in constraining low-energy constants from ^{3}H β decay* — •Philipp Klos[1,2], Arianna Carbone[1,2], Kai Hebeler[1,2], Javier Menéndez[1,2,3], and Achim Schwenk[1,2,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Department of Physics, University of Tokyo — [4]Max-Planck-Institut für Kernphysik, Heidelberg

We discuss the uncertainties in constraining low-energy constants of chiral effective field theory from ^{3}H β decay. The half-life is very precisely known, so that the Gamow-Teller matrix element has been used to fit the coupling c_D of the axial-vector current to a short-range two-nucleon pair. As the same coupling also describes the leading one-pion-exchange three-nucleon force, this in principle provides a very constraining fit. However, the ^{3}H half-life fit has only been performed at a fixed cutoff value. We show that the cutoff dependence due to the regulator in the axial-vector two-body current affects significantly the Gamow-Teller matrix element. We provide a range of c_D values that is compatible within cutoff variation with the experimental ^{3}H half-life and estimate the resulting uncertainties for many-body systems by performing calculations of symmetric nuclear matter.

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Towards chiral three-nucleon forces in heavy nuclei* — •Victoria Durant[1,2], Kai Hebeler[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

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 approaches for calculating 3N normal-ordered matrix elements that are benchmarked in calculations of medium-mass nuclei.

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HK 49.6 Do 18:15 F 33

Third-order particle-hole ring contributions from contact-interactions and chiral NN-potentials — •Norbert Kaiser — Physik Department, Technische Universität München, 85748 Garching

A missing piece in perturbative calculations of nuclear matter with chiral low-momentum interactions are the particle-hole ring contributions at third-order. We evaluate the 3rd-order particle-hole ring diagrams for a momentum-dependent NN-contact interaction of the Skyrme-type. By working with the antisymmetrized contact-interaction just one 4-loop diagram needs to be computed. The corresponding result for the 3-ring energy per particle $\bar{E}(k_f)$ is a cubic expression in the Skyrme-parameters t_i, x_i, W_0 with numerical coefficients N_j that are given by double-integrals over cubic expressions in euclidean (scalar, vector, tensor) polarizations functions $Q_j(s, \kappa)$. Dimensional regularization of these integrals is realized by subtracting power-divergences and the validity of the method is checked against analytical results at 2nd order. The 3rd-order ring-energy from 1π-exchange is calculated semi-analytically and found to be very strongly attractive, with $\bar{E}(k_{f0}) \simeq -92\,\mathrm{MeV}$. For the N^{3}LO chiral NN-potential the 3-ring energy in symmetric nuclear matter and neutron matter is weakly attractive and it decreases for softer potentials (with lower cutoffs). The extensive computations based on partial-wave matrix elements are checked against semi-analytical treatments for model interactions.

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Pairing in neutron matter: New uncertainty estimates and three-body forces — •Christian Drischler[1,2], Thomas Krüger[1,2], Kai Hebeler[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

We discuss BCS pairing gaps in the partial-wave channels ^{1}S$_0$ and ^{3}P$_2$-^{3}F$_2$ in neutron matter based on nucleon-nucleon (NN) and three-nucleon (3N) interactions derived within chiral effective field theory.

Applying new uncertainty estimates that rely on an order-by-order analysis in the chiral expansion, we show first results for the recent local and semilocal NN-only potentials up to next-to-next-to leading order (N^{2}LO) and N^{4}LO, respectively, with different regulator cutoffs. Our recent improved normal-ordering method allows us to investigate pairing gaps with consistent NN and 3N forces up to N^{3}LO. We show results for three more traditional chiral potentials including both leading and subleading 3N contributions.

Finally, we report on a robust method to solve the non-linear BCS gap equation which allows to assess the numerical convergence.

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HK 49.8 Do 18:45 F 33

Density-matrix expansion for local three-nucleon interactions — •Lars Zurek[1,2], Arianna Carbone[1,2], Eduardo Antonio Coello Pérez[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

The Negele-Vautherin density-matrix expansion is applied to the Hartree-Fock energy due to three-nucleon interactions. Using the density-matrix expansion, off-diagonal density matrices can be rewritten in terms of local densities and their derivatives. The resulting approximations for the density matrices are applied to calculate the contributions to the Hartree-Fock energy due to different local three-nucleon interactions derived from chiral effective field theory and fit in recent quantum Monte-Carlo calculations. The resulting energy-density functionals are presented and compared to other results.

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