HK 7: Structure and Dynamics of Nuclei 2

Time: Monday 14:30–16:30 Location: T/SR14

Group Report HK 7.1 Mon 14:30 T/SR14

Three-nucleon forces: From oxygen to calcium* — •JOHANNES SIMONIS[1,2], KAI HEBELER[1,2], JASON D. HOLT[3], JAVIER MENÉNDEZ[1,2,4], 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 7.2 Mon 15:00 T/SR14

Renormalization Group Approach to Density Functional Theory* — •SANDRA KEMLER and JENS BRAUN — Institut für Kernphysik, TU Darmstadt

We study a two-point particle irreducible (2PPI) approach to many-body physics which relies on a renormalization group (RG) flow equation for the associated effective action. This approach relates to Density Functional Theory and can in principle be used to study ground-state properties of non-relativistic many-body systems from microscopic interactions, such as (heavy) nuclei. We apply our formalism to a 0+1-dimensional model, namely the quantum anharmonic oscillator and use the well-known exact solution to benchmark our approximations of the full RG flow. Moreover, we present flow equations for specific types of 1+1-dimensional field theories which allow us study the ground-state properties of self-bound systems of spinless fermions which can also be viewed as toy models of nuclei.

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HK 7.3 Mon 15:15 T/SR14

From nuclear matter to finite nuclei* — •THOMAS KRÜGER[1,2], KAI HEBELER[1,2], and ACHIM SCHWENK[2,1] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung

Infinite neutron matter is a unique benchmark system for testing chiral effective field theory iteractions since all many-body forces are predicted to N^3LO. However, in finite nuclei shell and surface effects play an important role. These cannot be studied in infinite matter. Combining infinite neutron matter and neutron drops therefore provides important constraints for energy density functionals. For that we use the optimized effective potential method with local chiral interactions to calculate neutron drops in harmonic traps. Our calculations are a first step towards calculations of nuclei in ab initio density functional theory, which connects energy density functionals to chiral effective field theory interactions.

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HK 7.4 Mon 15:30 T/SR14

In-Medium Similarity Renormalization Group for Nuclei — •KLAUS VOBIG, SVEN BINDER, and ROBERT ROTH — Institut für Kernphysik, Technische Universität Darmstadt

The In-Medium Similarity Renormalization Group (IM-SRG) is a very flexible ab initio many-body method for the calculation of nuclear structure observables through an efficient SRG flow-equation approach. Based on nucleon-nucleon and three-nucleon interactions derived from chiral effective field theory that are transformed through the free-space SRG for improving the convergence behavior, we use the IM-SRG for systematic studies of closed-shell nuclei up to ^{132}Sn. Comparisons with the most advanced Coupled Cluster and No-Core Shell Model calculations are used to validate this new many-body approach. We explore extensions of the IM-SRG framework to other observables and excited states.

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HK 7.5 Mon 15:45 T/SR14

Towards Full N^3LO Calculations of Asymmetric 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 an improved method for including three-body forces (3N) in many-body calculations of infinite nuclear matter. We present first results for the equation of state for arbitrary isospin asymmetries based on chiral NN, 3N and 4N forces and study in detail the symmetry energy including contributions beyond the quadratic expansion. In addition, we perform first calculations of neutron matter at N^3LO that include the subleading 3N forces beyond the Hartree-Fock approximation.

*This work was supported by the ERC Grant No. 307986 STRONGINT and the Helmholtz Alliance HA216/EMMI.

HK 7.6 Mon 16:00 T/SR14

Second random-phase approximation with chiral two- plus three-body interactions — •RICHARD TRIPPEL and ROBERT ROTH — Institut für Kernphysik, Technische Universität Darmstadt

The random-phase approximation (RPA) is a standard tool for the description of collective excitations in nuclei. Its extension, the second RPA (SRPA) is applied to a number of doubly-magic nuclei using chiral interactions.

For the calculations we use normal-ordered two- plus three-body interactions derived from chiral effective field theory, which have successfully been applied to medium-mass nuclei in various frameworks. These bare interactions are transformed by means of the similarity renormalization group (SRG) to improve convergence. The calculations are performed for interactions with and without initial three-nucleon forces. From the solution of the SRPA problem we compute various electric transition strengths and examine the impact of second-order contributions. An investigation of the convergence properties of the results w.r.t. our model-space truncations is made. We compare the induced and initial three-nucleon forces with each other and with experimental values.

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HK 7.7 Mon 16:15 T/SR14

Towards chiral three-nucleon forces in heavy nuclei * — •VICTORIA DURANT[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 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 the triton and for normal-ordered matrix elements in calculations of medium-mass nuclei.

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