HK 14: Structure and Dynamics of Nuclei V

Time: Tuesday 14:00–15:30 Location: HS 2 Physik

Group Report HK 14.1 Tue 14:00 HS 2 Physik

Key observables for quadrupole collectivity in N=80 isotones — •H. Mayr[1], T. Stetz[1], V. Werner[1], U. Ahmed[1], K. Gladnishki[2], K.E. Ide[1], D. Kocheva[2], C.M. Nickel[1], N. Pietralla[1], G. Rainovski[2], and R. Zidarova[1] — [1]TU Darmstadt, Germany — [2]Sofia University, Bulgaria

Quadrupole collectivity near shell closures dominates the structure of low-lying excited states. Predominantly of one-quadrupole phonon character are the isoscalar proton-neutron symmetric 2_1^+ state and the isovector mixed-symmetry $2^+_{1,\mathrm{ms}}$ state. Due to strong fragmentation of the $2^+_{1,\mathrm{ms}}$ state of ^{138}Ce, the underlying shell structure [1] spreads the M1 transition strength to the 2_1^+ state over several 2^+ states. This key feature of the $2^+_{1,\mathrm{ms}}$ state is concentrated in a single 2^+ state in nuclei below the $\pi g_{7/2}$ subshell closure [2,3]. This finding is supported by recently obtained $B(M1, 2^+_{2,3}{\to}2^+_1)$ strengths of ^{132}Te [4]. Shell stabilisation in the heavier N=80 isotones is restored in the $\pi d_{5/2}$ subshell [5,6]. With other key observables like the $B_{4/2}$ ratio, a comprehensive picture of quadrupole collectivity in the N=80 isotones will be drawn.

[1] G. Rainovski *et al.*, Phys. Rev. Lett. **96** (2006) 122501
[2] T. Ahn *et al.*, Phys. Lett. B **679** (2009) 1
[3] N. Pietralla *et al.*, Phys. Rev. C **58** (1998) 796
[4] T. Stetz *et al.*, Submitted to Phys. Rev. C
[5] R. Kern *et al.*, Phys. Rev. C **102** (2020) 041304
[6] T. Stetz *et al.*, Submission in preparation

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HK 14.2 Tue 14:30 HS 2 Physik

Many-body emulators for nuclear structure — •Margarida Companys Franzke[1,2,3], Kai Hebeler[1,2,3], Takayuki Miyagi[4,1,2,3], Alexander Tichai[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck Institut für Kernphysik, Heidelberg — [4]Center for Computational Sciences, University of Tsukuba

Emulation techniques have become a popular tool in nuclear physics to study Hamiltonians with an explicit parametric dependence. An important example is given by two- and three-nucleon interactions derived from chiral effective field theory that depend linearly on low-energy couplings (LECs). Eigenvector-continuation-based emulators allow for the sampling of millions of nuclear interaction models, which is needed, e.g., for large-scale sensitivity studies, lowering the computational cost significantly with respect to explicit many-body simulations. In this work, we construct an emulator from a set of Hartree-Fock training states to study the impact of variations of three-body couplings on the N=32 shell closure in calcium isotopes. The experimentally measured difference in charge radii of ^{52}Ca compared to ^{48}Ca is underpredicted in ab initio calculations and still poses a major challenge to nuclear theory. As an outcome of this work we identify domains in LECs space that can give predictions compatible with the experiments and help construct the next generation of chiral Hamiltonians.

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HK 14.3 Tue 14:45 HS 2 Physik

Uncertainty quantification for nuclear structure calculations using similarity-renormalization-group-evolved potentials — •Tom Plies[1,2], Matthias Heinz[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck Institut für Kernphysik, Heidelberg

Uncertainty quantification is a key aspect in modern nuclear theory. Nuclear Hamiltonians are uncertain, with the uncertainty residing in the low-energy constants (LECs) parametrizing the interactions. As these parameter-dependent interactions are used as input for nuclear structure calculations, distributions of many-body observables can be inferred from distributions of LECs. To apply these approaches to potentials transformed to low resolution through the similarity renormalization group, we deploy the singular value decomposition to recover a linear operator basis for our interactions. We use Bayesian methods to infer distributions for the LECs from the theoretical uncertainties in nucleon-nucleon phase shifts and triton observables. We then sample from the LEC posteriors to obtain distributions for the ground-state observables of calcium isotopes. Through this, we investigate the discrepancy between theoretical and experimental trends in calcium charge radii.

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HK 14.4 Tue 15:00 HS 2 Physik

One and two proton removal from neutron-rich nuclei in the region of 52Ca — •Christina Xanthopoulou — Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany

One and two proton removal from neutron-rich medium-mass nuclei are commonly used to populate different final states in a nucleus of interest. (p,2p) and (p,3p) knockout reactions have been investigated in inverse kinematics within the first two SEASTAR campaigns that took place at RIBF in RIKEN, Japan [1]. These studies have been extended to the third SEASTAR campaign where medium-mass radioactive nuclei in the region of 54Ca were sent at about 270 MeV/nucleon onto a 15 cm long liquid hydrogen target surrounded by the MINOS time-projection chamber. MINOS enabled to track the angular distribution of the knocked out protons. (p,2p) and (p,3p) cross sections have been obtained and compared to theoretical reaction models. In particular, the difference in sensitivity of (p,2p) and (p,3p) to the population of individual final states in the same nucleus will be discussed. References: [1] A. Frotscher et al., Phys. Rev. Lett. 125, 012591 (2020)

HK 14.5 Tue 15:15 HS 2 Physik

Basis optimization for in-medium similarity renormalization group calculations — •Max Cincar[1,2], Takayuki Miyagi[1,2,3,4], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Center for Computational Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba 305-8577, Japan

Advances in nuclear many-body methods have enabled the calculation of nuclei up to the lead region. Optimization of the underlying single-particle basis enables the calculation of nuclear observables in smaller model spaces reducing the required computational cost. We explore calculations using natural orbitals constructed from perturbatively improved density matrices. Ground- and excited-state energies of nuclei are obtained using the valence-space in-medium similarity renormalization group. The convergence behavior of ground-state and excitation energies is investigated for different truncation schemes of nuclear Hamiltonians.

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