HK 5: Structure and Dynamics of Nuclei II

Time: Monday 16:15–18:30 Location: AM 00.021

Group Report HK 5.1 Mon 16:15 AM 00.021

Emulators for Hartree-Fock and In-Medium Similarity Renormalization Group — •Margarida Companys Franzke[1,2,3], Tom Plies[1,2], Alexander Tichai[1,2,3], Kai Hebeler[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

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). To extensively explore the LEC parameter space even simpler methods like Hartree Fock can become computationally costly, which makes the use of emulators necessary. While methods like Hartree-Fock can be emulated with reduced basis methods like eigenvector continuation, the problem is more complex for in-medium similarity renormalization group calculations. For this, more data-driven approaches like Gaussian Processes are more promising. Funded by the ERC Grant Agreement No. 101020842 and by the DFG - Project-ID 279384907 - SFB 1245.

HK 5.2 Mon 16:45 AM 00.021

A Bayesian approach to the Coulomb breakup of 19C — •Quentin Bozet and Pierre Capel — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany

The breakup of weakly bound nuclei is a key probe of nuclear structure at the limits of stability. In this work, we investigate the breakup of the one-neutron halo nucleus 19C on a lead target at 69AMeV using the Coulomb-Corrected Eikonal approximation (CCE). To rigorously quantify uncertainties and constrain model parameters, we employ a Bayesian analysis framework for the description of 19C, more specifically on its binding energy and asymptotic normalization constant (ANC). Posterior distributions on these two quantities are inferred from the comparison of precise reaction calculations to experimental cross sections measured at RIKEN as a function of the 18C-n relative energy. Using these posteriors leads also to a good agreement with the cross sections measured as a function of the scattering angle.These experimental cross section as a function of the center of mass energy are indeed used during the computation of the posteriors. Comparison between the posteriors and the experimental cross sections as a function of the scattering angle. Our results demonstrate that Bayesian inference, when combined with the CCE, provides a powerful methodology for interpreting breakup data of exotic nuclei. It enables us to infer reliable estimates of structure observables with meaningful uncertainties.

HK 5.3 Mon 17:00 AM 00.021

Correlated mass models for calcium isotopes from ab initio calculations — •Max Cincar[1,2,3], Zhen Li[1,2,3], Tom Plies[1,2], Urban Vernik[1,2], Matthias Heinz[4,5], Takayuki Miyagi[6], 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]National Center for Computational Sciences, ORNL — [5]Physics Division, ORNL — [6]Center for Computational Sciences, University of Tsukuba

Neutron-rich nuclei offer an opportunity to investigate exotic nuclear structure phenomena and properties of the underlying nuclear forces. We present ab initio calculations for neutron-rich calcium isotopes, quantifying various sources of theoretical uncertainties. Based on these calculations we construct correlated mass models for different interactions from chiral effective field theory. Conditioning these models on experimentally known data, we make predictions for unknown two-neutron separation energies.

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Group Report HK 5.4 Mon 17:15 AM 00.021

Exploring the Nuclear Structure and Collectivity of Neutron-Rich Tin Isotopes around ^{132}Sn — Maximilian Droste[1], •Peter Reiter[1], and Thorsten Kröll[2] — [1]IKP, Universität zu Köln — [2]IKP, TU Darmstadt

Evolution of nuclear collectivity and structure in the region surrounding the doubly-magic nucleus ^{132}Sn remains a central open question in nuclear structure physics. Recent large-scale shell-model calculations, employing realistic interactions, predict an enhancement of collectivity in the even-even isotopes adjacent to ^{132}Sn. However, a long-standing discrepancy between experimental data for ^{130}Sn and ^{134}Sn and corresponding theoretical predictions has persisted. Two safe Coulomb excitation experiments were conducted at ISOLDE. Post-accelerated radioactive ion beams of ^{130}Sn and ^{134}Sn, delivered by the HIE-ISOLDE accelerator at 4.4 MeV/u, were incident on ^{206}Pb and ^{194}Pt targets. The first excited states of ^{130}Sn and ^{134}Sn were selectively populated and the de-exciting γ rays were measured using the Miniball high-resolution γ-ray spectrometer in coincidence with scattered particles. The newly extracted $B(E2)$ values provide significantly improved experimental constraints and resolve the previously observed tension between theory and experiment, offering a clearer picture of the evolution of collectivity around the $N = 82$ shell closure.

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HK 5.5 Mon 17:45 AM 00.021

Low-Lying Dipole Response of ^{42}Ca via Real-Photon Scattering — •Tanja Schüttler[1], Florian Kluwig[1], Ronald Schwengner[2], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany

Systematic investigations along isotopic and isotonic chains are of key importance for understanding the influence of shell structure, neutron excess, or nuclear deformation on the low-lying dipole strength of atomic nuclei. In the medium-mass region, the calcium (Z=20) isotopic chain is particularly well suited for such studies, comprising four stable even-even isotopes with N/Z ratios ranging from 1.0 to 1.4. Furthermore, the occurrence of two doubly magic isotopes (^{40,48}Ca) allows probing the evolution of the dipole response with changing shell structure. While the isotopes ^{40,44,48}Ca have already been studied in real-photon scattering experiments [1-4], the low-abundance isotope ^{42}Ca has not yet been investigated. Hence, two (γ,γ') bremsstrahlung experiments on ^{42}Ca were conducted up to the neutron separation threshold S_n = 11.5 MeV at the γELBE facility of the Helmholtz-Zentrum Dresden-Rossendorf [5]. The first results of these measurements will be presented. Supported by the DFG (ZI510/10-2).

[1] T. Hartmann *et al.*, Phys. Rev. Lett. **85** (2000) 274.
[2] T. Hartmann *et al.*, Phys. Rev. C **65** (2002) 034301.
[3] T. Hartmann *et al.*, Phys. Rev. Lett. **93** (2004) 192501.
[4] J. Isaak *et al.*, Phys. Rev. C **83** (2011) 034304 .
[5] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211.

HK 5.6 Mon 18:00 AM 00.021

Nuclear resonance fluorescence study of ^{70}Zn as a probe for nuclear structure at $N = 40$ — •J. Hauf[1], V. Werner[1], N. Pietralla[1], R. V. F. Janssens[2,3], A. D. Ayangeakaa[2,3], D. Balabanski[4], M. Beuschlein[1], R. Beyer[5], S. W. Finch[2,6], A. Gupta[1], D. Gribble[2,3], T. Hensel[5], M. Heumüller[1], F. E. Idoku[2,3], J. Isaak[1], X. James[2,3], S. R. Johnson[2,3], A. Junghans[5], J. Kleemann[1], P. Koseoglou[1], T. Kowalewski[2,3], A. Kusoglu[4], E. Masha[5], C. M. Nickel[1], O. Papst[1], M. Pichotta[5], K. Prifti[1], K. Römer[5], A. Saracino[2,3], L. Shaeding[2,3], P.-A. Söderström[4], K. Schmidt[5], R. Schwengner[5], A. Thees[5], N. Tsoneva[4], S. Turkat[5], A. Wagner[5], and A. Yadav[5] — [1]TU Darmstadt, IKP — [2]TUNL — [3]University of North Carolina — [4]ELI-NP — [5]Helmholtz-Zentrum Dresden-Rossendorf — [6]Duke University

Properties of nuclei at the $N = 40$ subshell closure are strongly influenced by several nuclear-structure effects, such as shape coexistence originating in Type-II shell evolution. This study aims to achieve a better understanding of these effects by investigating the $N = 40$ nucleus ^{70}Zn using the nuclear resonance fluorescence method with bremsstrahlung and quasi-monoenergetic photon beams at γELBE and HIγS, respectively. Preliminary results for the average $E1$- and $M1$-strength distributions and decay branches of ^{70}Zn are shown and discussed. This work is supported by DFG under Project-IDs 499256822 GRK 2891, 279384907 SFB 1245, ELI-RO under ELI-RO/RDI/2024 002, ELI-RO/RDI/2024 007 and US DOE by No. DE-FG02-97ER41041 (UNC), No. DE-FG02-97ER41033 (TUNL).

HK 5.7 Mon 18:15 AM 00.021

Low-Lying Dipole Strength in ^{144}Nd and ^{142}Ce studied via Nuclear Resonance Fluorescence — •Florian Kluwig[1], Deniz Savran[2], Tanja Schüttler[1], Ronald Schwengner[3], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics, Germany — [2]GSI, Darmstadt, Germany — [3]Helmholtz-Zentrum Dresden-Rossendorf, Germany

The Pygmy Dipole Resonance (PDR) constitutes a low-energy excitation component within the electric dipole response of atomic nuclei. Despite extensive experimental and theoretical efforts over several decades [1-3], the structure and precise origin of the PDR remain subjects of ongoing investigation. Systematic studies, particularly along isotopic and isotonic chains, serve to resolve these open questions. Our work focuses on the $N = 84$ isotones, ^{144}Nd and ^{142}Ce, situated near the $N = 82$ magic shell closure. These nuclei were probed using the Nuclear Resonance Fluorescence (NRF) technique, based on real-photon scattering. Given their low-angular-momentum transfer capability, real photons are uniquely effective probes for isolating and characterizing the PDR strength [4]. This contribution presents and compares NRF data obtained for ^{144}Nd and ^{142}Ce, thereby contributing to the understanding of the PDR systematics in this mass region.
Supported by the DFG (ZI510/10-2).
[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210.
[2] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019) 360.
[3] E.G. Lanza *et al.*, Prog. Part. Nucl. Phys. **129** (2023) 104006.
[4] A. Zilges *et al.*, Prog. Part. Nucl. Phys. **122** (2022) 103903.