HK 18: Structure and Dynamics of Nuclei IV

Time: Tuesday 17:00–19:00 Location: J-HS H

Group Report HK 18.1 Tue 17:00 J-HS H

Recent results from the FRS Ion Catcher — •Gabriella Kripkó-Koncz for the FRS Ion Catcher-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

The atomic masses of exotic nuclei provide key information for the understanding of nuclear structure and astrophysics. Combining a cryogenic stopping cell (CSC) and a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS), the FRS Ion Catcher experiment (FRS-IC) at the Fragment Separator (FRS), GSI enables high precision mass measurements or isobar and isomer separation with thermalized projectile and fission fragments. Incorporating several novel and unique concepts, the system enables the highest performance, such as a mass resolving power up to 1,000,000 and mass accuracies down to $6 \cdot 10^{-8}$.

The first direct mass measurements of seven isotopes close to the double magic nucleus ^{208}Pb allowed to study the evolution of the two-neutron separation energies. Mass measurements of projectile fragments in the vicinity of ^{100}Sn were performed, including the first mass measurement of the ^{101}In ground state. Two new isomeric states were discovered in ^{97}Ag and ^{101}In. A novel technique for measuring half-lives and decay branching ratios was developed and demonstrated experimentally. These results, recent technical upgrades, and approved experiments for FAIR Phase-0 will be presented.

The FRS-IC also serves as a prototype for the future Ion Catcher at the Low-Energy-Branch (LEB) of the Super-FRS at FAIR. Latest results of the next-generation CSC for the LEB will be discussed.

HK 18.2 Tue 17:30 J-HS H

Weak decays within an effective theory — •Catharina Brase[1,2], Eduardo A. Coello Peréz[3], Javier Menéndez[4], and Achim Schwenk[1,2,5] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Lawrence Livermore National Laboratory, Livermore, CA — [4]Department of Quantum Physics and Astrophysics, University of Barcelona — [5]Max-Planck-Institut für Kernphysik, Heidelberg

We study Gamow-Teller and unique forbidden β decays within an effective theory. In this approach nuclei are described as spherical cores coupled to a neutron and/or proton, depending on the nuclei of interest. We calculate matrix elements for β decays into low-lying states of the daughter nucleus, explore their applications and investigate the associated theoretical uncertainty based on a power counting and Bayesian methods. Our effective theory results are found to be in good agreement with experiment within theoretical uncertainties.

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HK 18.3 Tue 17:45 J-HS H

Lifetime measurements in N=Z nuclei ^{44}Ti and ^{56}Ni — •K. Arnswald[1], P. Petkov[2,1], P. Reiter[1], A. Blazhev[1], T. Braunroth[1], L. Kaya[1], C. Müller-Gatermann[1], and D. Werner[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]*„Horia Hulubei“* National Institute for Physics and Nuclear Engineering, Bucharest-Măgurele, Romania

Reduced transition strengths are sensitive signatures to describe collective excitations of atomic nuclei and the evolution of shell structures. They provide stringent tests of present shell-model interactions in the $0f1p$ shell along the $N = Z$ line. Recently determined B(E2) values showed an enhanced collective behavior for ^{44}Ti, ^{48}Cr, and ^{52}Fe [1]. In ^{44}Ti the collective behavior has been associated with core excitations. However, there is a lack of information on precise values along the negative parity band in this nucleus. These states arise from a strong interplay between sd- and pf-shell orbitals and allow for refined tests of cross-shell contributions. For the doubly-magic nucleus ^{56}Ni only the $B(\mathrm{E2}, 2^+_1 \rightarrow 0^+_{\mathrm{g.s.}})$ value is known [2]. Lifetime measurements employing the recoil distance Doppler-shift (RDDS) and the Doppler-shift attenuation method (DSAM) were performed at the FN tandem accelerator at the IKP, Cologne. Excited states in ^{44}Ti and ^{56}Ni were populated via fusion-evaporation reactions. Lifetimes were determined for excited states up to $J^\pi = 6^+$. They will be presented and compared to shell-model calculations.

[1] K. Arnswald *et al.* Phys. Lett. B **772**, 599 (2017)
[2] K.L. Yurkewicz *et al.* Phys. Rev. C **70**, 054319 (2004)

HK 18.4 Tue 18:00 J-HS H

Laser Spectroscopy of Nickel 56 and a new Charge Exchange Cell — •Felix Sommer[1], Nathan Everett[2], David Garand[2], Ruben De Groote[3], Phillip Imgram[1], Colton Kalman[2], Jeremy Lantis[2], Yuan Liu[4], Andrew Klose[5], Paul Mantica[2], Andrew Miller[2], Kei Minamisono[2], Witold Nazarewicz[2], Wilfried Nörtershäuser[1], Robert Powel[2], Paul-Gerhard Reinhard[6], Elisa Romero-Romero[7], Dominic Rossi[1], Achim Schwenk[1], Chandana Sumithrarachchi[2], and Andrea Teigelhöfer[8] — [1]TU Darmstadt, DE — [2]NSCL, US — [3]Oak Ridge Laboratory, US — [4]University of Jyväskylä, FI — [5]Augustana University, US — [6]Universität Erlangen-Nürnberg, DE — [7]University of Tennessee, US — [8]TRIUMF, CA

We present laser spectroscopic measurements of Nickel charge radii at and across the n=28 shell closure. Using the BECOLA experiment at NSCL, we achieved the first laser spectroscopic measurements of Nickel 55 and 56. Values for the difference in rms charge radii have been extracted for these isotopes and showcase the evolution across the shell closure. The results allow a comparison of ab initio calculations for Nickel 56 with those of Nickel 68 at the sub shell closure n=40. The measurements were done on the atomic system using a charge exchange cell, since no suitable transition is available in the ion. To extend future capabilities, we developed a new design that will allow the use of Magnesium vapor instead of the typically used alkalis.

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HK 18.5 Tue 18:15 J-HS H

Übergangswahrscheinlichkeiten angeregter Zustände der Yrast-Bande in ^{53}Ti — •Alina Goldkuhle für die AGATA-Kollaboration — Institut für Kernphysik, Köln

Für das Verständnis der Schalenstruktur, insbesondere der (Unter-)Schalenabschlüsse bei $N = 30, 32$, spielen die Übergangswahrscheinlichkeiten in neutronenreichen Ti Isotopen eine besondere Rolle. Neben zahlreichen Untersuchungen der gerade-gerade Ti Isotope mit $A \leq 54$, sind zudem bereits einige ungerade Ti Isotope mit $A \leq 51$ in dieser Region untersucht worden. Allerdings liegen noch wenige Informationen über ^{53}Ti vor. Daher wurden in dieser Arbeit angeregte Zustände in $^{46-54}$Ti mit Hilfe von Multinukleonentransferreaktionen bevölkert und Lebensdauern mittels der Recoil distance Doppler-shift Methode gemessen. Das Experiment wurde 2016 am GANIL mit dem Detektorsystem AGATA, dem Spektrometer VAMOS++ zur Teilchenidentifikation sowie dem Kölner Kompakt-Plunger für tiefinelastische Reaktionen durchgeführt. Nachdem Zustandslebensdauern in ^{52,54}Ti aus dem Datensatz bestimmt wurden und mittels derer die Schalenstruktur Nähe der (Unter-)Schalenabschlüsse bei $N = 30, 32$ untersucht wurde, wurden anschließend zunächst vorläufige Lebensdauern der $(5/2^-)$ bis $13/2^-$ Zustände in ^{53}Ti mittels der Differential decay curve Methode zum ersten Mal ermittelt und nachfolgend mit auf Geant4 basierenden Monte-Carlo-Simulationen geprüft und reduzierte Übergangswahrscheinlichkeiten berechnet. Die Ergebnisse werden in diesem Vortrag vorgestellt und mit aktuellen Schalenmodellrechnungen verglichen.

HK 18.6 Tue 18:30 J-HS H

Probing novel nuclear forces with the IM-SRG — •Jan Hoppe[1,2], Christian Drischler[3,4], Kai Hebeler[1,2], Achim Schwenk[1,2,5], and Johannes Simonis[6] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Department of Physics, University of California, Berkeley — [4]Lawrence Berkeley National Laboratory, Berkeley — [5]Max-Planck-Institut für Kernphysik, Heidelberg — [6]Institut für Kernphysik and PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität Mainz

We apply consistent nucleon-nucleon plus three-nucleon interactions at N^{3}LO in chiral effective field theory with realistic saturation properties in the in-medium similarity renormalization group. To this end we use three-nucleon forces fitted to saturation properties and the triton binding energy. We present results for ground-state energies as well as charge radii of closed-shell medium-mass nuclei, with the goal to explore connections between predictions for finite nuclei and nuclear-matter properties. We further investigate variations of the low-energy constants to test their sensitivity in nuclei.

*This work was supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245.

HK 18.7 Tue 18:45 J-HS H

One-nucleon removal from ^{14}O at 100 MeV/nucleon with a thin hydrogen target — •Thomas Pohl, Yelei Sun, Alexandre Obertelli, and SAMURAI 31 Collaboration — TU Darmstadt, Darmstadt, Germany

Direct reactions at intermediate energies are an important tool for nuclear structure studies, but some reaction mechanisms are still not understood. One debated phenomenon is the asymmetric parallel momentum distribution (PMD) of the residual nucleus occurring occasional in one nucleon removal reactions [1-3]. Recent theoretical calculations of *(p,pN)* reactions with ^{14}O at 100 MeV/nucleon with the distorted-wave impulse approximation (DWIA) predict a large asymmetric PMD [4]. The low momentum tail is due to the phase volume effect and the high momentum fall off due to the attractive potential of the residues and the outgoing nucleons. Comparison with experimental data is necessary for validation and will be a basis for further spectroscopic factor studies. We performed an experiment with ^{14}O beam at 100 MeV/nucleon impinging on a 2-mm thick solid hydrogen target at RIBF at RIKEN. Momentum of the residues is extracted from the SAMURAI spectrometer. Details of the experiment, the analysis procedure and preliminary results will be presented.

[1] A. Gade *et al.*, Phys. Rev. C 71, 051301(R)(2005).
[2] K.L. Yurkewicz *et al.*, Phys. Rev. C 74, 024304 (2006).
[3] F. Flavigny *et al.*, Phys. Rev. Lett. 108, 252501 (2012).
[4] K. Ogata *et al.*, J. Phys. Rev. C 92, 034616 (2015).