HK 30: Structure and Dynamics of Nuclei II

Time: Friday 14:00–16:30 Location: H4

Group Report HK 30.1 Fri 14:00 H4

Studying the Low-Energy Electric Dipole Response of Different Nuclei with SONIC@HORUS — •Michael Weinert, Florian Kluwig, Miriam Müscher, Julius Wilhelmy, Barbara Wasilewska, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The specific structures that generate the low-energy electric dipole response (LEDR) in medium to heavy mass nuclei have been highly debated and investigated over the past two decades. Deeper knowledge was obtained by comparing direct measurements of the nuclear photo-response in real-photon scattering experiments with the response to other probes, such as alpha particles or high energy protons, and trying to reproduce the differing responses with theoretical models. This contribution will present the recent developments in Cologne, where specific single-particle structures in the LEDR of ^{120}Sn could be studied in a $(d,p\gamma)$ reaction at E_d=8.5 MeV using the SONIC@HORUS setup, extending the established capabilities of the transfer reaction [1]. Also, for the first time, a consistent theoretical approach was developed to predict the shape of the LEDR, and also the excitation and decay behavior in the experiment. A comparison to $^{120}\mathrm{Sn}(\alpha,\alpha'\gamma)$ under forward angles will be drawn and results from $^{124}\mathrm{Sn}(p,p'\gamma)$ [2] and a recent $^{40,44,48}\mathrm{Ca}(p,p'\gamma)$ campaign with SONIC@HORUS will be presented.

[1] M. Spieker, *et al.*, Phys. Rev. Lett. **125**, 102503 (2020)
[2] M. Färber, *et al.*, Eur. Phys. J. A (2021) 57:191

Group Report HK 30.2 Fri 14:30 H4

Study of the dipole response in ^{58}Ni — •Isabelle Brandherm[1], Johann Isaak[1], Peter von Neumann-Cosel[1], Hiroaki Matsubara[2], Achim Richter[1], Marcus Scheck[3], Jaqueline Sinclair[3], and Atsushi Tamii[2] — [1]IKP, TU Darmstadt, Germany — [2]RCNP, Osaka, Japan — [3]UWS, Paisley, UK

Inelastic proton scattering at very forward angles is an excellent tool for studying the dipole response in nuclei [1]. Reactions with intermediate proton energies and scattering angles close to 0° are particularly suited to investigate the isovector spin-flip M1 resonance. In addition the electric dipole response can be measured over a wide excitation energy range. This provides information about the electric dipole polarizability which is related to the neutron-skin thickness and the density dependence of the symmetry energy. In this talk the analysis of an experiment with a 295 MeV proton beam on a ^{58}Ni target will be presented, which was performed at the Research Centre for Nuclear Physics (RCNP) in Osaka. The dipole strength distribution of ^{58}Ni has been extensively measured with nuclear resonance fluorescence [2,3] and inelastic electron scattering [4]. A comparison of the different methods can shed light on various features of nuclear structure such as spin and orbital contributions to the magnetic dipole strength.

[1] P. von Neumann-Cosel and A. Tamii, Eur. Phys. J. A 55, 110 (2019). [2] M. Scheck et al., Phys. Rev. C 88, 044304 (2013). [3] J. Sinclair, priv. com. (2019). [4] W. Mettner et al., Nucl. Phys. A473, 160 (1987). Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907, SFB 1245.

HK 30.3 Fri 15:00 H4

Status report on the progress on the analysis of the NewSUBARU data — •Nikolina Lalić[1], Thomas Aumann[1,2], Takashi Ariizumi[3], Martin Baumann[1], Patrick van Beek[1], Ioana Gheorghe[4], Philipp Kuchenbrod[1], Heiko Scheit[1], Dmytro Symochko[5], and Hiroaki Utsunomiya[3] — [1]TU Darmstadt, Germany — [2]GSI Helmholtzzentrum, Germany — [3]Department of Physics, Konan University, Japan — [4]"Horia Hulubei" National Insitute for R & D in Physics and Nuclear Engineering (IFIN-HH), 30, Reactorului 077125, Bucharest-Magurele, Romania — [5]Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

The photoneutron cross sections of ^{112}Sn, ^{116}Sn, ^{120}Sn and ^{124}Sn were measured in (γ,xn) reactions, where $x \in [1,4]$, using a quasi-monochromatic laser Compton-scattering γ-ray beam at the NewSUBARU facility. The goal of the experiment is to resolve the long-standing discrepancy of the total and partial cross sections measured by the Livermore and the Saclay groups. Measurements were done with γ energies from 8 MeV to 38 MeV. As a neutron counter a detector with a flat efficiency was used to take advantage of the direct neutron*multiplicity sorting technique. The (γ,xn) cross sections $x \in [1,4]$ will be determined as well as the total photo absorption cross sections.

In this report the experiment and the current state of the ongoing analysis will be presented.

Suported by HMWK (LOEWE centre "Nuclear Photonics") and DFG (SFB 1245).

HK 30.4 Fri 15:15 H4

Collinear laser spectroscopy across the ^{56}Ni doubly magic nucleus — •Sommer Felix[1], König Kristian[2], Rossi Dominic[1], Everett Nathan[2], Garand David[2], de Groote Ruben[3], Incorvati Anthony[2], Imgram Phillip[1], Kalman Colton[2], Klose Andrew[5], Lantis Jeremy[2], Liu Yuan[4], Miller Andrew[2], Minamisono Kei[2], Nörtershäuser Wilfried[1], Pineda Skyy[2], Powel Robert[2], Renth Laura[1], Romero-Romero Elisa[4], Sumithrarachchi Chandana[2], and Teigelhöfer Andrea[6] — [1]Technische Universität Darmstadt — [2]Michigan State University — [3]University of Jyväskylä — [4]Oak Ridge National Laboratory — [5]Augustana University — [6]TRIUMF

We will present laser spectroscopic measurements of neutron-deficient nickel isotopes at and across the N=28 neutron shell closure. Nickel is a particularly interesting case to study nuclear shell evolution. Its isotopic chain includes the N=Z=28 doubly magic nucleus ^{56}Ni, which is the first self-conjugated doubly magic nucleus that occurs due to a shell gap driven by the spin-orbit force and is considered to be a soft core. Using the BECOLA facility at the National Superconducting Cyclotron Laboratory at Michigan State University, we achieved the first determination of the mean-square charge radii of ^{54}Ni, ^{55}Ni, and ^{56}Ni as well as an updated value of the magnetic dipole moment of ^{55}Ni. Details of the experiment and results will be discussed.

HK 30.5 Fri 15:30 H4

Mass measurements of neutron-deficient Yb isotopes and nuclear structure at the extreme proton-rich side of the N = 82 shell — •Beck Sönke[1,2], Kootte Brian[3,4], and Dedes Irene[5,6] for the TITAN-Collaboration — [1]Justus-Liebig Universität, Giessen — [2]GSI, Darmstadt — [3]TRIUMF, Vancouver, Canada — [4]University of Manitoba, Winnipeg, Canada — [5]Polish Academy of Sciences, Kraków, Poland — [6]Marie Curie-Skłodowska University, Lublin, Poland

The nuclear mass reflects the binding energy of a nucleus and provides key information for nuclear structure, nuclear reactions and related fields like nuclear astrophysics.

High-accuracy mass measurements of neutron-deficient Yb isotopes were performed at TRIUMF using TITAN's multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). For the first time, the novel technique of mass selective re-trapping was used in an on-line experiment with short-lived ions. With this technique, the MR-TOF-MS can act as its own isobar separator, enabling measurements two isotopes further away from stability.

The ground state masses of ^{150,153}Yb and the excitation energy of the long lived $J^\pi = 11/2^-$ isomer $^{151}\mathrm{Yb}^m$ were measured for the first time. As a result, the persistence of the $N = 82$ shell with almost unmodified shell gap energies was established up to the proton dripline. Furthermore, the puzzling systematics of the $h_{11/2}$-excited isomeric states of the $N = 81$ isotones were unraveled using state-of-the-art mean field calculations.

HK 30.6 Fri 15:45 H4

Mass measurements and spectroscopy of actinides at IGISOL and FRS Ion Catcher — •Ilkka Pohjalainen for the FRS Ion Catcher-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

There is a significant lack of experimental data on fundamental nuclear properties such as nuclear masses of actinides. At the IGISOL facility of the University of Jyväskylä, Finland, light-ion fusion reactions with actinide targets provide unique possibilities to perform decay- and optical spectroscopy as well as direct mass measurements of actinide isotopes. Recently, decay spectroscopy of several short-lived isotopes including ^{225,226}Pa have been performed with protons (up to 65 MeV) on ^{232}Th targets. Penning trap mass spectrometry utilizing the Phase-

Imaging Ion Cyclotron Resonance method at JYFLTRAP is to be used for high-precision mass measurements, but also to obtain production yield of long-lived isotopes such as ^{229}Th, which is of special interest due to the extremely low energy isomer. A wider range of isotopes is now also available due to more exotic targets fabricated via a novel drop-on-demand printing technique at the Nuclear Chemistry Institute of Johannes Gutenberg-Universität of Mainz.

In addition, the recently performed mass measurements in the actinide region at the FRS Ion Catcher (FRSIC) at the Fragment Separator at GSI will be presented. By impinging a 1 GeVA ^{238}U beam on a Be target, the isotopes are produced in fragmentation reactions. The ions are stopped in the cryogenic stopping cell and measured with the high resolution multiple-reflection time-of-flight mass spectrometer.

HK 30.7 Fri 16:00 H4

High-precision mass spectrometry of heavy and superheavy nuclides at SHIPTRAP: overview of the latest experiments — •Francesca Giacoppo for the SHIPTRAP-Collaboration — GSI Darmstadt, Germany — HIM Mainz, Germany

In 2018 high-precision Penning Trap Mass Spectrometry (PTMS) crossed the doorway towards the region of superheavy elements (Z≥104) with the first direct mass measurement of the ground state of ^{257}Rf accomplished with a small number of detected ions (<10) with the SHIPTRAP setup. This was made possible by the first application of the highly efficient Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique in the region of the heaviest nuclides. In addition, exploiting the superior mass resolving power and precision of PI-ICR, several low-lying isomeric states in elements with $Z = 102 - 103$ have been probed with high accuracy. These results have been achieved thanks to careful investigations and improvements of the efficiency of the SHIPTRAP setup. In an online run in 2020, the rate of ^{257}Rf extracted from the cryogenic gas cell was increased by about an order of magnitude. This boost allowed in the latest campaign in spring 2021 to carefully investigate both the ground state and the low-lying isomer of ^{257}Rf and the more exotic element dubnium with Z=105, available at even lower yields. The PI-ICR technique, established nowadays as a complementary tool to decay spectroscopy, was also applied to disentangle many isomeric states in heavy nuclei with $Z = 82 - 98$. In this contribution, the results of the latest campaigns performed within the FAIR Phase-0 program will be reviewed.

HK 30.8 Fri 16:15 H4

Subatomic particles represented as focal points — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

Examples of approaches to represent subatomic particles (SPs) are point-like, strings, wave-packets, etc. The present work is based on an approach where (SPs) are represented as focal points of rays of Fundamental Particles (FPs) that move from infinite to infinite. FPs are emitted from the focal point and at the same time regenerate it. FPs store the energy of a SP as rotation defining angular momenta. Interactions between SPs are the product of the interactions of the angular momenta of their FPs. One important finding is that the interaction between two charged SPs tends to zero for the distance between them tending to zero. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. The charge quantum number Q of a quark is now interpreted as the relative charge of electrons and positrons. No fractional charges Q are required and the charge of an electron or positron is thus the unit charge of nature. Another important finding is that all four forces are electromagnetic forces and described by QED. As quantum-mechanics rely heavily on classical physics, all new findings of the latter have repercussions on the former. More at: www.odomann.com