HK 13: Struktur und Dynamik von Kernen

Zeit: Montag 16:30–19:00 Raum: P 4

Gruppenbericht HK 13.1 Mo 16:30 P 4

Experimental Studies of Pygmy and Giant Resonances in Exotic Nuclei - Status and Perspectives — •Dominic Rossi[1], Thomas Aumann[2], Konstanze Boretzky[1], Roman Gernhäuser[3], Jens Volker Kratz[4], Reiner Krücken[3], Christoph Langer[5], Tudi Le Bleis[3], Olga Lepyoshkina[3], Ralf Plag[1], and Rene Reifarth[5] for the R3B-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Technische Universität Darmstadt — [3]Technische Universität München — [4]Johannes Gutenberg-Universität, Mainz — [5]Goethe-Universität, Frankfurt am Main

Coulomb excitation is a powerful tool to investigate the collective response of exotic nuclei, providing a unique insight into the dynamical properties of nuclei located far from stability. Using this technique, their dipole strength can be measured, providing valuable information not only for the nuclear equation-of-state through the observation of the Pygmy Dipole Resonance (PDR), but also for nucleosynthesis scenarios, such as the rp-process.

Several experiments have been carried out in the past years using the R^3B-LAND setup at GSI in Darmstadt, in which the Coulomb excitation of unstable nuclei has been investigated in a kinematicaly complete manner. Selected results of these campaigns will be presented, with a main focus on the PDR mode. The experimental goals of future experiments at the R^3B setup will be discussed as well, revealing a strategy to not only gain a deeper understanding of the PDR, but also to disentangle the dipole and quadrupole contributions in exotic nuclei.

HK 13.2 Mo 17:00 P 4

Nuclear Breakup of 17Ne and its Two-Proton Halo Structure — •Felix Wamers[1], Thomas Aumann[1], Carlos Bertulani[2], Leonid Chulkov[3], Michael Heil[3], Justyna Marganiec[4,5], Ralf Plag[3,6], and Haik Simon[3] for the R3B-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]Texas A&M University-Commerce, Commerce, USA — [3]Kernreaktionen und Nukleare Astrophysik, GSI, Darmstadt, Germany — [4]ExtreMe Matter Institute, GSI, Darmstadt, Germany — [5]JINA, Notre Dame, USA — [6]Goethe Universität, Frankfurt, Germany

17Ne is a proton-dripline nucleus that has raised interest in nuclear-structure physics in recent years. As a (15O+2p) Borromean 3-body system, it is often considered to be a 2-proton-halo nucleus, yet lacking concluding experimental quantification of its structure. We have studied breakup reactions of 500 AMeV 17Ne secondary beams in inverse kinematics using the R3B-LAND setup at GSI. The foci were on (p,2p) quasi-free scattering on a CH2 target, and on one-proton-knockout reactions on a carbon target. Recoil protons have been detected with Si-Strip detectors and a surrounding 4pi NaI spectrometer. Furthermore, projectile-like forward protons after one-proton knockout from 17Ne have been measured in coincidence with the 15O residual core. The resulting relative-energy spectrum of the unbound 16F, as well as proton-removal cross sections with CH2 and C targets, and the transverse-momentum distributions of the residual fragments will be presented. Conclusions on the ground-state structure of 17Ne will be discussed. This work was supported by HIC for FAIR.

HK 13.3 Mo 17:15 P 4

Exclusive measurements of (p,pX) neutron and proton knockout reactions on ^{57}Ni — •Alina Movsesyan for the LAND-R3B-Collaboration — TUD, Schlossgartenstr.9, 64289 Darmstadt, Germany

In this presentation, an exclusive experimental approach for the investigation of the shell structure of exotic nuclei using proton-induced knockout reactions is discussed. The experiment performed at the LAND-R^3B facility at GSI allowed for an analysis of (p,2p) as well as for the first time (p,pn) reactions in inverse kinematics from kinematically complete measurements of the incoming and outgoing channels. Hereby, results for one-proton and one-neutron knockout reactions on the radioactive isotope ^{57}Ni will be discussed. The quasi-free-knockout character of the reactions was identified event-by-event by the reconstructed angular correlations of the scattered nucleons. Inclusive momentum distributions of the residual ^{56}Co and ^{56}Ni fragments and corresponding (p,2p) and (p,pn) reaction cross sections were deduced. The experimental setup is also capable to distinguish different reaction channels by observing the gamma decay of excited fragments. Particularly, an analysis of excited ^{56}Ni residues was carried out, allowing the separation of different angular momentum states of the knocked-out neutron in the ^{57}Ni ground state. The results will be compared to knockout reactions induced by a Be target and to theoretical estimates.

This work is supported by HIC for FAIR and EMMI.

HK 13.4 Mo 17:30 P 4

Quasi-free knock-out reactions in inverse kinematics at R3B/LAND-setup — •Valerii Panin[1], Thomas Aumann[1], and Jonathan Taylor[2] for the LAND-R3B-Collaboration — [1]TU Darmstadt, Germany — [2]University of Liverpool, UK

An important part of the physics program at the future R3B (Reactions with Relativistic Radioactive Beams) experiment at FAIR will be based on the study of a kinematical complete measurement of proton-induced reactions. These are in particular the quasi-free scattering processes of the type (p,2p), (p,pn), (p,pα) etc, which will be used to study the single-particle and cluster structure of neutron-proton asymmetric nuclei and the role of nucleon-nucleon correlations in nuclei. A prototype setup for the detection of high-energy protons in (p,2p) reactions in coincidence with forward emitted light particles and heavy fragments has been built based on an array of Si micro-strip detectors for tracking and thick NaI scintilators for energy measurements. In the present bemchmark experiment with ^{12}C the knock-out reactions from different single-particle states have been identified, including knock-out from the 0s state by reconstructing the excitation-energy spectrum of residual ^{11}B utilizing γ spectrometry and the invariant-mass method. This work is supported by the Hessian LOEWE initiative through HIC for FAIR.

HK 13.5 Mo 17:45 P 4

Gesamte Dipolstärke in ^{120}Sn mit polarisierter Protonenstreuung — •Anna Maria Krumbholz[1], Peter Neumann-Cosel[1], Iryna Poltoratska[1], Andreas Krugmann[1], Johannes Simonis[1] und AtsushiT Tamii[2] — [1]TU Darmstadt — [2]Research Center for Nuclear Physics, Osaka, Japan

Mit Protonenstreuung unter extremen Vorwärtswinkeln lassen sich elektrische und magnetische Dipolanregungen ober- und unterhalb der Neutronenseparationsenergie messen [1]. Durch experimentelle Entwicklungen am Research Center for Nuclear Physics in Osaka, Japan [2] kann bei mittlerer Energie von 300 MeV mit einem polarisierten Protonenstrahl unter 0° gemessen werden. Dabei wird eine hohe Energieauflösung von 25 keV erreicht. Für die Separation von E1- und M1-Anteilen werden zwei unterschiedliche Methoden eingesetzt: Eine Multipolentfaltung der Winkelverteilung der Wirkungsquerschnitte mit Hilfe von DWBA Rechnungen, und eine modellunabhängige Analyse von Polarisationstransferobservablen. Ergebnisse der aktuellen Analyse werden präsentiert.

[1] A. Tamii et al., Phys. Rev. Lett. 107, 062502 (2011).
[2] A. Tamii et al., Nucl. Inst. Meth. A 605, 326 (2009).

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HK 13.6 Mo 18:00 P 4

Discovery and Cross-Section Measurement of Neutron-Rich Isotopes in the Element Range from Neodymium to Platinum at the FRS — •Fabio Farinon for the S392-Collaboration — GSI, Darmstadt, Germany

With a new detector setup and the high-resolution performance of the fragment separator FRS at GSI we discovered 57 new isotopes in the atomic number range of $60 \leq Z \leq 78$: $^{159-161}$Nd, $^{160-163}$Pm, $^{163-166}$Sm, $^{167-168}$Eu, $^{167-171}$Gd, $^{169-171}$Tb, $^{171-174}$Dy, $^{173-176}$Ho, $^{176-178}$Er, $^{178-181}$Tm, $^{183-185}$Yb, $^{187-188}$Lu, ^{191}Hf, $^{193-194}$Ta, $^{196-197}$W, $^{199-200}$Re, $^{201-203}$Os, $^{204-205}$Ir and $^{206-209}$Pt. The new isotopes have been unambiguously identified in reactions with a ^{238}U beam impinging on a Be target at 1 GeV/u. The isotopic production cross-section for the new isotopes have been measured and compared with predictions of different model calculations. These results will be presented.

HK 13.7 Mo 18:15 P 4

Pygmy dipole resonance and neutron skin in ^{208}Pb* — •Iryna Poltoratska[1], Peter von Neumann-Cosel[1], Vladimir

Yu. Ponomarev[1], Atsushi Tamii[2], and Sergej Bassauer[1] — [1]Institut für Kernphysik, TU Darmstadt, Deutschland — [2]RCNP, Osaka University, Japan

A benchmark experiment on ^{208}Pb shows that polarized proton inelastic scattering at very forward angles including 0° is a powerful tool for studies of electric dipole ($E1$) and spin magnetic dipole ($M1$) modes in nuclei over a broad excitation energy range to test up-to-date nuclear models. For the separation of E1/M1 contributions two different independent methods are applied, viz. a multipole decomposition of the angular distribution of the cross sections utilizing DWBA calculations and a model-independent analysis based on polarization transfer coefficients. Such an experiment allows the extraction of the complete electric dipole strength including the pygmy dipole resonance and determine its global features. Utilizing recent theoretical results [1,2] in combination with the extracted electric dipole nuclear polarizability α_D one is able to constrin the neutron skin in ^{208}Pb [3] and thereby the symmetry energy relevant for the description of the neutron stars.
[1] P.-G. Reinhard and W. Nazarewicz, Phys. Rev. C **81**, 051303(R) (2010).
[2] J. Piekarewicz, Phys. Rev. C **83**, 034319 (2011).
[3] A. Tamii et al., Phys. Rev. Lett. **107**, 062502 (2011).
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HK 13.8 Mo 18:30 P 4

Untersuchung der Pygmydipolresonanz in ^{124}Sn — •Friederike Schlüter[1], Janis Endres[1], Matthias Fritzsche[2], Norbert Pietralla[2], Christopher Romig[2], Deniz Savran[3,4], Kerstin Sonnabend[5], Andreas Zilges[1] und Markus Zweidinger[2] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Kernphysik, Technische Universität Darmstadt — [3]ExtreMe Matter Institute EMMI and Research Division, GSI — [4]Frankfurt Institute for Advanced Studies — [5]Institut für Angewandte Physik, Goethe Universität, Frankfurt

In den letzten Jahren wurde die elektrische Pygmydipolresonanz mit verschiedenen experimentellen Methoden erforscht. Die Pygmydipolresonanz des Kerns ^{124}Sn wurde anhand eines $(\alpha, \alpha'\gamma)$ Experiments untersucht [1], wobei Zustände beobachtet wurden, die aus einem vorherigen (γ, γ') Experiment [2] nicht bekannt waren. Aus diesem Grund wurde der Kern ^{124}Sn in einem Kernresonanzfluoreszenz-Experiment erneut untersucht. Das Experiment wurde am supraleitenden Darmstädter Elektronen-Linearenbeschleuniger S-DALINAC mit einer Endpunktsenergie von 7,8 MeV durchgeführt. Die zuvor in (γ, γ') unbeobachteten Zustände konnten in diesem neuen Experiment beobachtet werden. Für alle Übergänge wurde die $B(E1)\uparrow$-Stärke berechnet und mit einer QPM Rechnung [1] verglichen und bezüglich ihrer Fragmentierung und Verteilung der $B(E1)\uparrow$-Stärke analysiert.

Gefördert durch die DFG (ZI 510/4-1), SFB 634 und EMMI.

[1] J. Endres *et al.*, Phys. Rev. Lett. **105** (2010) 212503.
[2] K. Govaert *et al.*, Phys. Rev. C **57** (1998) 2229.

HK 13.9 Mo 18:45 P 4

Search for pygmy resonances in proton-rich Argon isotopes — •Olga Lepyoshkina[1,2] and Christoph Langer[2,3] for the LAND-R3B-Collaboration — [1]Physik Department TU München, Garching, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]IKP Institut für Kernphysik, Universität Frankfurt am Main, Germany

Since the discovery of pygmy resonances in neutron-rich nuclei a particular attention was paid to their analogues in proton-rich nuclei. Conceptually, RQRPA calculations predict the appearance of dipole strength for proton-rich nuclei like ^{32}Ar in the low-energy region between 8-10 MeV excitation energy. However a significant drop of resonance strength is expected for the ^{34}Ar. In contrast to the neutron-rich nuclei for which the existence of the pygmy resonances was justified by both theory and experiment, the proton-rich nuclei study is lacking a clear experimental confirmation yet. Aiming on the observation of the proton pygmy resonances, we have performed an experiment with a production of radioactive isotopes ^{32}Ar and ^{34}Ar via fragmentation of a 800 AMeV primary ^{36}Ar beam on a beryllium target. The produced proton-rich isotopes are subsequently sent onto a lead target of the LAND-R3B setup. The dipole response is observed using the Coulomb excitation method in inverse and complete kinematics. Current status of the data analysis and preliminary results will be presented.
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