HK 24: Structure and Dynamics of Nuclei IV

Zeit: Dienstag 16:30–18:30 Raum: HZO 70

Gruppenbericht HK 24.1 Di 16:30 HZO 70

NeuLAND Demonstrator at SAMURAI – Neutron Detection in Experiments with Radioactive Beams — •Julian Kahlbow[1], Thomas Aumann[1,2], Konstanze Boretzky[2], Igor Gasparic[3,2], Yosuke Kondo[4], Stefanos Paschalis[1,5], Dominic Rossi[1,2], Fabia Schindler[1], Haik Simon[2], and Hans Törnqvist[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]TU Darmstadt — [2]GSI, Darmstadt — [3]RBI, Zagreb — [4]TITech, Tokyo — [5]U of York

NeuLAND is the new high-resolution neutron time-of-flight spectrometer under construction for the R^{3}B setup at FAIR. After the completion of the NeuLAND demonstrator in 2015, it was sent to the RI Beam Factory in Japan to be integrated into the neutron detection system NEBULA at the SAMURAI setup. SAMURAI is an experimental setup designed for experiments with radioactive ion beams in complete kinematics. During the 2-year stay, a variety of experiments requiring (multi-)neutron detection was performed with NeuLAND as one of the key detectors. It became possible for the first time to study reactions with up to 4 coincident neutrons in the exit channel and to determine their momenta. The report will highlight experiments such as the spectroscopy of the 4-/3-neutron-unbound systems ^{28}O & ^{27}O. Furthermore, the search for a resonant tetraneutron system will be discussed as well as other experiments to show the unique capabilities of this setup.

This work is supported by the DFG through grant no. SFB 1245, the BMBF under contract no. 05P15RDFN1, and the GSI-TU Darmstadt cooperation agreement.

HK 24.2 Di 17:00 HZO 70

Investigation of the 2n system by quasi-free α-knockout from ^{6}He — •Marco Alexander Knösel, Thomas Aumann, Fabia Schindler, and Vadim Wagner for the NeuLAND-SAMURAI-Collaboration — Technische Universität Darmstadt

The investigation of pure neutron systems has been a long-lasting goal in nuclear physics. State-of-the-art nuclear theories agree that light neutron clusters do not form bound states but struggle to handle the resonant case. Experimental information on these systems are of great importance but still scarce. An experiment to study the properties of both the 4n and the 2n system was performed at the SAMURAI setup at RIKEN, using the reactions ^{8}He(p,pα)4n and ^{6}He(p,pα)2n, respectively. This contribution will focus on the latter case. To investigate the n-n scattering system, the α-knockout reaction has been performed in inverse kinematics using a radioactive ^{6}He-beam and a liquid hydrogen target. As a result of the α-knockout the binding potential vanishes to let the neutrons interact only with each other at low relative energies. The combination of the neutron detector NEBULA (SAMURAI) and the NeuLAND demonstrator (for R3B at GSI/FAIR) allows for a kinematically complete measurement with a high neutron detection efficiency. Consequently, the dineutron relative-energy distribution can be determined and information on the the scattering length can be extracted by both the missing mass method and by measurement of the invariant mass of the 2n system. This work is supported by the DFG through grant no. SFB 1245, the BMBF under contract number 05P15RDFN1 and the GSI-TU Darmstadt cooperation agreement.

HK 24.3 Di 17:15 HZO 70

Low-energy dipole response of the halo nuclei ^{6,8}He — •Christopher Lehr[1] and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]TU Darmstadt — [2]GSI Helmholtzzentrum

The heaviest bound helium isotopes ^{6}He and ^{8}He are 2- and 4-neutron halo nuclei with a clear alpha plus 2n and 4n structure. The multi-neutron decay of ^{6}He and ^{8}He after heavy-ion induced electromagnetic excitation reactions has been measured kinematically complete to study the dipole response of these nuclei. An experiment was performed at the RIBF facility at the RIKEN Nishina Center in Japan. The combination of the neutron detectors NEBULA and NeuLAND at the SAMURAI setup and the high beam intensities available at RIBF made this measurement possible for the first time. The experimental method is based on the measurement of the differential cross section via the invariant-mass method, which allows to extract the dipole strength distribution dB(E1)/dE and the photo-absorption cross section. To induce electromagnetic excitation reactions of ^{6}He and ^{8}He a lead target was used. Additionally a series of targets with increasing Z was used to get precise information about the nuclear contribution to the cross section. This is especially important in the region of high excitation energy, where the electromagnetic excitation might not be dominant. The experimental setup and the method are explained. Besides this the first steps of the ongoing analysis are presented.

This work is supported by the DFG through grant no. SFB 1245, the GSI-TU Darmstadt cooperation and the BMBF project 05P15RDFN1.

HK 24.4 Di 17:30 HZO 70

Proton Knockout Reactions from Neutron-Rich N Isotopes at R^{3}B — •Ina Syndikus[1,2], Marina Petri[3], and Thomas Aumann[1,2] for the R3B-Collaboration — [1]IKP, TU Darmstadt, Germany — [2]GSI, Germany — [3]University of York, UK

The R^{3}B/LAND setup at GSI was used to measure the proton-knockout reaction on neutron-rich N isotopes in a kinematically complete way.

The aim of this study is to determine the proton amplitude of the first 2^+ excited state of ^{16,18,20}C isotopes. This can be achieved by studying the proton-knockout reaction from ^{17,19,21}N to ^{16,18,20}C. By measuring the ratio of the cross sections for the population of the first excited 2^+ state and the ground state the proton amplitude can be determined.

An increase in the proton amplitude approaching the dripline can be explained by the reduction of the spin-orbit splitting between the proton $p_{3/2}$ and $p_{1/2}$ orbits due to the tensor and two-body spin-orbit components of the force between the protons and the added neutrons in the sd-shell [1]. This would explain the increase in the transition strength as observed in previous studies [2].

This work is supported by HIC for FAIR, GSI-TU Darmstadt cooperation and the BMBF project 05P15RDFN1.

[1] A. O. Macchiavelli et al., Phys. Rev. C **90** 067305 (2014)
[2] M. Petri et al., Phys. Rev. Lett. **107**, 102501 (2011)

HK 24.5 Di 17:45 HZO 70

Lifetime Measurement of the ^{26}O g.s. at SAMURAI — •Sonja Storck[1], Julian Kahlbow[1], Christoph Caesar[2], and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]Institut für Kernphysik TU Darmstadt, Darmstadt, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

A recent experiment and theory calculation suggest that the ground state of the neutron-unbound nucleus ^{26}O could have a lifetime in the pico-second regime. This would constitute the first case of a radioactive decay via neutron emission.

An experiment using a new method to determine the decay lifetime of the ^{26}O ground state with high sensitivity and precision was performed at the Superconducting Analyzer for multi-particle from Radio Isotope Beams (SAMURAI) at the Rare Isotope Beam Factory (RIBF) at RIKEN. Here, a ^{27}F beam was produced in the fragment separator BigRIPS and impinged on a W/Pt target stack where ^{26}O was produced. According to the lifetime, the decay of ^{26}O happens either in- or outside the target. Thus, the velocity difference between the decay neutrons and the fragment ^{24}O delivers a characteristic spectrum from which the lifetime can be extracted. In the report the new method as well as the experimental setup are introduced and the current analysis status is shown.

This work is supported by the DFG through grant no. SFB 1245, the BMBF under contract number 05P15RDFN1 and the GSI-TU Darmstadt cooperation agreement.

HK 24.6 Di 18:00 HZO 70

Prompt and delayed gamma-spectroscopy of neutron-rich krypton isotopes with N $\leq$ 60* — •Rosa-Belle Gerst, Kevin Moschner, and Andrey Blazhev — Institut für Kernphysik, Universität zu Köln

Low-lying excited states of the neutron-rich ^{94,95,96}Kr were measured at the RIBF at the RIKEN Nishina Center for Accelerator-Based Science as part of the SEASTAR campaign. The nuclei of interest were populated in nucleon knockout reactions using the MINOS device surrounded by the DALI2 array for prompt γ-spectroscopy. Additionally, the EURICA array was run in a parasitic mode to measure the delayed isomeric transitions in ^{95}Kr. In all three nuclei, previously unknown

γ-transitions were observed. Even-even Sr and Zr nuclei in the A = 100 region show a sudden onset of deformation at N = 60 while the lighter isotopes up to N = 58 are rather spherical. Contrarily, the even krypton isotopes exhibit a smooth onset of collectivity up to N = 60 [1]. For ^{96}Kr, the measured new transitions imply the existence of low-lying low-spin non-yrast states, which we interpret as the shape coexisting states becoming yrast above N = 60 [2] in agreement with very recent IBM calculations [3]. For ^{95}Kr, the analysis of prompt γ-radiation with and without coincidence of delayed radiation identified the prompt γ-rays as either feeding or bypassing the known isomeric state in ^{95}Kr.
*Supported by the DFG under Grant No. BL 1513/1-1
[1] M. Albers *et al.*, Phys. Rev. Lett. 108, 062701 (2012)
[2] F. Flavigny *et al.*, Phys. Rev. Lett. 118, 242501 (2017)
[3] K.Nomura *et al.*, Phys. Rev. C 96, 034310 (2017)

HK 24.7 Di 18:15 HZO 70

Performance Test of the CALIFA Detector using the ^{16}O(p,2p) reaction — Roman Gernhäuser, •Benjamin Heiss, Philipp Klenze, and Felix Stark for the R3B-Collaboration — Technische Universität München

The 4π-calorimeter CALIFA is one of the major detectors of the R^{3}B-experiment at the upcoming Facility for Antiproton and Ion Research (FAIR) in Darmstadt. This calorimeter with 2464 CsI(Tl) crystals and 96 Phoswich detectors provides a high efficiency, good energy resolution of about 5 % at 662 keV γ energies and a large dynamic range, allowing a simultaneous measurement of γ rays at E > 100 keV and scattered protons up to E < 700 MeV. Especially in the forward section of CALIFA, the Endcap, the highest particle rates and energies paired with highly doppler shifted γ rays are expected. This talk will show first results of an experiment with 3 CALIFA Demontrator Petal detectors at the Bronowice Cyclotron Center in November 2017 in Cracow. This presentation will be on the calibration reaction ^{1}H(p,p) and the ^{16}O(p,2p) in direct kinematics at 200 MeV proton beam energy irradiating a liquid water fiber target. Excitation energy spectra and angular correlation prove the excellent resolution of CALIFA as an ideal tool for QFS studies also in normal kinematics. Supported by BMBF Project 05P15WOFNA.