HK 5: Structure and Dynamics of Nuclei I

Zeit: Montag 14:00–16:00 Raum: S1/01 A03

Gruppenbericht HK 5.1 Mo 14:00 S1/01 A03

Quasi-free one nucleon knockout reactions on neutron-rich Oxygen Isotopes at the R3B-LAND setup — •Leyla Atar[1,2], Thomas Aumann[1,2], Carlos Bertulani[3], Stefanos Paschalis[1], and Chiara Nociforo[2] for the R3B-Collaboration — [1]TU Darmstadt, Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Texas A&M University-Commerce, Commerse, USA

Recent experiments have showed a reduction of spectroscopic strengths of about 60-70% for stable nuclei. When going to driplines this tendency is changing, loosely bound nucleons have spectroscopic strengths close unity while deeply bound nucleons have a large reduction of the strength. We aim to make a systematic study of spectroscopic factors (SF) of the Oxygen isotopes using quasi-free (p,2p) and (p,pn) knockout reactions in inverse kinematics. Quasi-free knockout reactions are a direct tool to study the occupancy and the location of valance and deeply bound single particle states. The Oxygen isotopes offer a large variation of separation energies which will allow us to obtain a qualitative and quantitative understanding of SF in a large variation of isospin asymmetry. For this we performed an experiment at the R3B-LAND setup at the GSI with a secondary beam $^{14-24}$O. The $^{16-18}$O and $^{21-23}$O isotopes have been analyzed and the preliminary results will be presented. The results include the partial cross sections, gamma ray spectra of the residual fragments in coincidence, and the SF obtained via comparison with theory. This work is supported by HIC for FAIR, GSI-TU Darmstadt cooperation, and the BMBF project 05P15RDFN1.

HK 5.2 Mo 14:30 S1/01 A03

Proton Knockout Reactions from Neutron-Rich N Isotopes at R^{3}B — •Ina Syndikus and Marina Petri for the R3B-Collaboration — IKP, TU Darmstadt, Germany

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 5.3 Mo 14:45 S1/01 A03

Erste SEASTAR Ergebnisse zu ^{86,88}Ge nach (p,2p) — •Marc Lettmann[1], Norbert Pietralla[1], Volker Werner[1], Pieter Doornenbal[2] und Alexandre Obertelli[3] für die SEASTAR-Kollaboration — [1]TU Darmstadt — [2]RIKEN — [3]CEA Saclay

Im Rahmen des SEASTAR Projekts wurde MINOS, ein Flüssigwasserstofftarget umschlossen von einer TPC, mit DALI2 verknüpft, um unter anderem die ersten angeregten Zustände der neutronenreichen Germaniumisotope ^{86,88}Ge zu untersuchen. Von den Zyklotrons des RIKEN-RIBF wurde ein ^{238}U Strahl mit einer Energie von 345 MeV/u und einem Strahlstrom von ungefähr 30 pnA erzeugt, der auf ein Berylliumtarget geschossen wurde. Die ausgehenden Spaltfragmente konnten mit dem BigRIPS Fragmentseparator getrennt, und die gewünschten Kerne zu MINOS weitergeleitet werden. Die im Wasserstofftarget entstehenden Reaktionsprodukte wurden mit dem ZeroDegree Spektrometer identifiziert. Die genaue Bestimmung des Ein- und Ausgangskanals der Reaktion durch BigRIPS und ZeroDegree ermöglicht eine genaue Bestimmung des Reaktionskanals. Mit Hilfe von MINOS erhält man den präzisen Reaktionsort im Wasserstofftarget und kann so eine bestmögliche Doppler-Korrektur gewährleisten. Ergebnisse zu den ersten angeregten Zuständen der Germaniumisotope ^{86,88}Ge, erzeugt durch die Reaktion ^{87,89}As(p,2p)^{86,88}Ge im Hinblick auf zukünftige Experimente an FAIR werden in diesem Vortrag präsentiert. Unterstützt vom BMBF unter der Fördernummer 05P15RDFN1.

HK 5.4 Mo 15:00 S1/01 A03

Inelastic scattering of neutron-rich ^{72,74}Ni off a proton target — •Martha Liliana Cortés for the SEASTAR-Collaboration — Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

One of the fundamental pillars of nuclear structure is the concept of shell structure governed by a mean-field with a strong spin-orbit interaction. Nevertheless, it has been observed that shell structure changes as one moves away from the stability line. Particularly important to study shell-evolution are nuclei around doubly-closed shells, for example around ^{78}Ni. Inelastic proton scattering of ^{72,74}Ni was performed at RIKEN as part of the first SEASTAR campaign. Isotopes were produced by the in-flight fission of ^{238}U ions on a 3 mm thick Be target. After production, neutron-rich isotopes were selected and identified on an event-by-event basis using the BigRIPS separator. Selected isotopes were focused onto the MINOS liquid hydrogen target and γ-rays from (p,p') reactions were detected with the DALI2 array. Outgoing particles were identified using the ZeroDegree spectrometer. Transitions from the first 2^+ and 4^+ states in both isotopes were identified in Doppler corrected γ-ray energy spectra. Using detailed Geant4 simulations, exclusive cross sections for inelastic proton scattering were obtained and the corresponding deformation lengths were derived. The ongoing data analysis will be presented and a discussion on the implications of the measured cross sections on the independent motion of protons and neutrons on neutron-rich Ni isotopes will be shown.

HK 5.5 Mo 15:15 S1/01 A03

Observation and spectroscopy of new proton-unbound isotopes ^{30}Ar and ^{29}Cl – an interplay of prompt two-proton and sequential decay — •Ivan Mukha — Helmholzzentrum GSI, Darmstadt

Previously unknown isotopes ^{30}Ar and ^{29}Cl have been identified by measurement of the trajectories of their in-flight decay products ^{28}S+p+p and ^{28}S+p, respectively. The analysis of angular correlations of the fragments provided information on decay energies and structure of the parent states [1]. The lowest states in ^{30}Ar, ^{29}Cl point to a violation of isobaric symmetry in structure of these unbound nuclei. The two-proton decay has been identified in a transition region between simultaneous two-proton and sequential proton emissions from the ^{30}Ar ground state, which is characterized by an interplay of three-body and two-body decay mechanisms. Such a phenomenon, never observed before, may be common in 2p-unbound nuclei, and could be of interest for other disciplines dealing with few-body systems. In addition, the dramatic change of odd-even mass staggering in 2p-unbound nuclei and the fine structure in the 2p decay of the ^{30}Ar*(2.9 MeV) state were indicated. An Optical Time-Projection Chamber was used in the same experiment to observe beta decays of stopped ^{31}Ar ions, which passed the secondary target intact. With this detector, β-delayed 3p emission from ^{31}Ar was observed [2].

[1] I. Mukha, *et al.,* Phys. Rev. Lett. 115 (2015) 202501.
[2] A.A. Lis, *et al.,* Phys. Rev. C 91 (2015) 064309.

HK 5.6 Mo 15:30 S1/01 A03

Spectroscopy in neutron-rich nuclei in the vicinitiy of N=40 — •Thomas Braunroth[1], Alfred Dewald[1], Christoph Fransen[1], Hironori Iwasaki[2], Jan Jolie[1], and Julia Litzinger[1] — [1]Institut für Kernphysik, Universität zu Köln, Germany — [2]National Superconducting Cyclotron Laboratory, MSU, USA

The development of collectivity towards $N = 40$ in neutron-rich nuclei between $_{20}$Ca and $_{28}$Ni shows a distinct Z-dependence. While ^{68}Ni exhibits features of a pronounced shell-gap, the evolution of key observables, e.g. excitation energies and B($E2$) values, in even-even $_{26}$Fe and $_{24}$Cr isotopes is interpreted as a rapidly evolving quadrupole deformation when $N = 40$ is approached. However, experimental information on level energies and reduced transitions strengths are still sparse in this particular region of the nuclear landscape. To shed more light on the evolution of collectivity along even-even Cr isotopes to-

wards $N = 40$, we performed an experiment at NSCL, MSU (USA) in which lifetimes of excited states were measured with the recoil distance Doppler-shift technique. The experiment focused on the 2_1^+ and 4_1^+ states in ^{58,60,62}Cr and corresponding results have been published recently [1]. In addition, various excited states in neighbouring nuclei with $23 \lesssim Z \lesssim 26$ close to $N = 40$ were populated and some spectroscopic information on transition energies and level lifetimes can be deduced. Some of them are determined for the first time. In this talk we will present preliminary results of such side reactions. This work is supported by the BMBF under contract number 05P12PKFNE.

[1] T. Braunroth *et al.*, Phys. Rev. C **92**, 034306 (2015)

HK 5.7 Mo 15:45 S1/01 A03

Determination of the Lifetime of the 1^+ State in ^{30}Na — •Sebastian Heil and Marina Petri for the E05122-Collaboration — TU Darmstadt, Darmstadt, Deutschland

^{30}Na is located at the "Island of Inversion" at N=20. The experiment E05122 was performed at the National Superconducting Cyclotron Laboratory and investigated the low-lying structure of the odd-odd nucleus ^{30}Na via nucleon removal reactions from ^{31}Mg, ^{30}Mg and ^{31}Na [1].

The aim of the work to be presented is the determination of the lifetime of the first excited 1^+ state in ^{30}Na. This is achieved via peak shape analysis of the obtained γ-ray spectrum. The analysis will be discussed and the results will be compared to large scale shell model calculations.

This work was supported by DOE contract No. DE-AC02-05CH11231, by the National Science Foundation under Grant PHY-1102511 and by the Helmholtz International Center for FAIR within the framework of the LOEWE program (Landesoffensive zur Entwicklung Wissenschaftlich-Ökonomischer Exzellenz) launched by the State of Hesse.

[1] M.Petri et al, Phys.Let.B **748** 173-177 (2015)