HK 48: Structure and Dynamics of Nuclei IX

Zeit: Donnerstag 14:00–16:00 Raum: HZO 70

HK 48.1 Do 14:00 HZO 70

Lifetime Measurement of Higher-Lying Excited States in ^{16}C — •Michael Mathy[1] and Marina Petri[2,1] — [1]IKP, TU Darmstadt, Germany — [2]DoP, University of York, United Kingdom

Electromagnetic properties of the neutron-rich carbon isotopes provide an exciting opportunity to directly test theoretical models using NN+3N Hamiltonians derived from chiral EFT. Indeed, the EM properties of ^{16}C are particularly sensitive to the inclusion of 3N forces in the calculations [1]. However, the experimental information on ^{16}C are limited to the lifetime of the first excited state and an upper limit of 4 ps for the higher-lying states [2,3]. To investigate lifetimes of the higher-lying states (2_2^+, 3^+, 4^+) a fusion-evaporation reaction has been performed at the Argonne National Laboratory. Evaporated charged particles were identified using the μ-Ball detector and emitted gamma rays were identified using the Gammasphere array. Lifetimes of the excited states can be extracted using the Doppler-shift attenuation method. In the talk the measurement techniques and preliminary gamma spectra of ^{16}C, which can be used to give a first approximation of the magnitude of the lifetime, will be presented. Also ideas for further analysis methods using realtistic Geant4 simulations will be outlined and illustrated for an example case. This work was supported by the DFG under contract No. SFB 1245 and The Royal Society.

[1] C. Forssén, et al., J. Phys. G: Nucl. Part. Phys. 40, 055105 (2013). [2] M. Wiedeking et al., PRL 100 152501 (2008). [3] M. Petri et al., Phys. Rev. C 86 044329 (2012).

HK 48.2 Do 14:15 HZO 70

Präzissionsmessung der B(E2)-Stärke des 2_1^+ Zustandes von ^{12}C — •Antonio D'Alessio, Sergej Bassauer, Michaela Hilcker, Tobias Klaus, Michael Mathy, Peter von Neumann-Cosel, Norbert Pietralla, Philipp C. Ries, Maxim Singer, Gerhart Steinhilber und Volker Werner — IKP TU Darmstadt

Das elektrische Quadrupolmoment des 2_+^1-Zustandes von ^{12}C ist ein Schlüsselfaktor, um ab-initio-Vorhersagen aus theoretischen Betrachtungen für Quadrupolkorrelationen zu begrenzen. Dieser Wert ist momentan nur mit einer Unsicherheit von 50% bekannt [W. Vermeer, et al., Physics Letters B 122, 23 (1983)].
Im November 2017 wurde am Magnetspektrometer LINTOTT an der TU Darmstadt ein Elektronenstreuexperiment am S-DALINAC durchgeführt, um das Erreichen einer Präzision von unter 2% der B(E2)-Stärke vorzubereiten. Es wurde der Formfaktor des angeregten Zustandes bei Impulsüberträgen kleiner 0,3 fm^{-1} gemessen, um eine möglichst präzise Extrapolation zum Photonenpunkt zu gewährleisten. Erste Ergebnisse der Analyse und das Messprogramm werden präsentiert.
Durch eine Kombination aus der so zu gewinnenden B(E2)-Stärke und Ergebnissen aus Coulex Experimenten unter Rückwärtswinkeln kann das Quadrupolmoment genauer extrahiert werden als bisher möglich. *Gefördert durch die DFG unter dem Sonderforschungsbereich 1245 und dem Graduiertenkolleg GRK 2128 AccelencE (Accelerator Science and Technology for Energy-Recovery Linacs).*

HK 48.3 Do 14:30 HZO 70

Electromagnetic transition rates in ^{21}O — •Sebastian Heil[1], Marina Petri[2], and Thomas Aumann[1,3] — [1]TU Darmstadt, Germany — [2]University of York, UK — [3]GSI Helmholtzzentrum

Experimental studies of electromagnetic transition rates in neutron-rich nuclei are very important for testing NN+3N calculations. The case of ^{21}O is particularly interesting because calculations show that the transition strengths from the first $\frac{1}{2}^+$ and second $\frac{3}{2}^+$ excited states to the ground state $\frac{5}{2}^+$ will discriminate between the NN+3N and USDB interactions.

An experiment at NSCL was performed, producing ^{21}O. The usage of the TRIPLEX plunger allows the determination of the lifetime of the state of interest. The S800 spectrometer and GRETINA were used for the fragment identification and gamma-ray detection. This presentation will report on the experiment as well as the current status of the analysis.

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Using the Doppler-shift attenuation method to extract lifetimes in ^{20}Ne — •David Werner[1], Andrey Blazhev[1], Alfred Dewald[1], Jan Jolie[1], Claus Müller-Gatermann[1], Pavel Petkov[1,2,3], and Karl Oskar Zell[1] — [1]Institute for Nuclear Physics, University of Cologne, Cologne — [2]INRNE, Bulgarian Academy of Sciences, Sofia, Bulgaria — [3]National Institute for Physics and Nuclear Engineering, Bucharest, Romania

In this investigation lifetimes in ^{20}Ne were determined using the Doppler-shift attenuation method. The experiment was performed at the Cologne FN-Tandem accelerator in October 2017 using a ^{16}O(^{9}Be,nα)^{20}Ne reaction with a 0.9 $\frac{mg}{cm^2}$ Be target on a 2.7 $\frac{mg}{cm^2}$ Mg backing at 4 beam energies between 30 and 38 MeV. For the line shape analysis an improved version of DESASTOP [1] was used. A detailed discussion of the used analysis method as well as preliminary results will be presented and compared to the systematics of light nuclei. In the series of Ne isotopes it becomes apparent that for ^{20}Ne and ^{22}Ne the increase in B(E2; $2^+ \rightarrow 0^+$) strength, compared to more neutron rich Ne isotopes, cannot be reproduced by shell model calculations. Because of this discrepancy we were motivated to revisit this topic experimentally.

[1] G.Winter, NIM **214** (1983) 537
[2] J. Le Blois *et al.*, Phys. Rev. C **89** (2014) 011306(R)

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Bestimmung der Lebensdauern von angeregten Zuständen der Grundzustandsbande von ^{46}Ti — •A. Goldkuhle, A. Dewald, K. Arnswald, M. Beckers, T. Braunroth, C. Fransen, J. Litzinger, C. Müller-Gatermann und D. Werner — Institut für Kernphysik, Köln

Neutronenreiche Titan Isotope sind für die Untersuchung der Schalenevolution in der Ti-Cr-Fe-Region jenseits von $N = 28$ von besonderem Interesse. Aus bereits existierenden Daten über 2_1^+-Zustände in $N = 32$ Isotonen wird das Auftreten eines Phasenübergangs von vorherrschenden kollektiven Strukturen in ^{58}Fe zu einem Neutronen-Unterschalenabschluss in ^{56}Cr, ^{54}Ti erwartet. Angeregte Zustände in $^{46-54}$Ti wurden von Multinukleonentransferreaktionen am GANIL zur Bestimmung von Lebensdauerinformationen mittels der Recoil Distance Doppler Shift Methode (RDDS) bevölkert. Aufgrund von strahlinduzierten Veränderungen des Targets konnten die Abstände von Target- und Degraderfolie nicht exakt bestimmt werden. Ein Ansatz zur Problemlösung ist die Bestimmung der Abstände aus präzisen Lebensdauerinformationen. Daher wurde ein RDDS Experiment mit der Reaktion ^{40}Ca(^{9}Be, $2p1n$)^{46}Ti und dem Kölner Plunger am Tandembeschleuniger Köln durchgeführt. Mit Hilfe von 12 Germanium-Detektoren wurden $\gamma\gamma$-Koinzidenzspektren gemessen, aus denen mittels der Differential Decay Curve Method präzise Niveau-Lebensdauern mit $\Delta\tau_{\mathrm{rel}} \leq 5\,\%$ der Grundzustandsbande von $J = 2^+$ bis 8^+ gewonnen werden konnten. Das Projekt wurde gefördert von der DFG, Fördernummer DE 1516/3-1.

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Lifetime measurements in the vicinity of doubly-magic ^{56}Ni — •K. Arnswald, P. Reiter, A. Blazhev, T. Braunroth, A. Dewald, M. Droste, C. Fransen, C. Müller-Gatermann, A. Goldkuhle, R. Hirsch, L. Kaya, L. Lewandowski, D. Rosiak, D. Schneiders, M. Seidlitz, A. Vogt, K. Wolf, and K.O. Zell — Institut für Kernphysik, Universität zu Köln

Reduced transition strengths expressed by B(E2) values are sensitive signatures to describe collective excitations of atomic nuclei and the evolution of shell structures. Along the $N = Z$ line in the $0f1p$ shell they provide stringent tests of present shell-model interactions. Recently determined $B(\mathrm{E2}, 2_1^+ \rightarrow 0_{\mathrm{g.s.}}^+)$ values for self-conjugate nuclei in the $0f_{7/2}$ shell showed an enhanced collective behavior [1]. The soft shell closure at $N = Z = 28$ is of particular interest as it has been shown that the doubly-closed shell structure is substantially broken [2]. In order to investigate the interplay between single-particle and collective characters of low-lying states, lifetime measurements employing the Doppler-shift attenuation method (DSAM) were performed at the FN tandem accelerator at the IKP, Cologne. Excited states in $^{44}_{22}$Ti, $^{48}_{24}$Cr, $^{52}_{26}$Fe, and $^{56}_{28}$Ni were populated with fusion-evaporation reactions. The emitted γ rays were detected by an array of 11 HPGe detectors.

First results on lifetimes and corresponding B(E2) values will be presented and discussed.

[1] K. Arnswald *et al.* Phys. Lett. B **772**, 599 (2017)
[2] Otsuka *et al.* Phys. Rev. Lett. **81**, 1588 (1998)

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Lifetime measurements in neutron-rich Mn isotopes — •Thomas Braunroth[1], Alfred Dewald[1], Christoph Fransen[1], Hironori Iwasaki[2], Jan Jolie[1], and Silvia M. Lenzi[3] — [1]Institut für Kernphysik, Universität zu Köln, Germany — [2]National Superconducting Cyclotron Laboratory, MSU, USA — [3]Dipartimento di Fisica e Astronomia, Universitá di Padova, Italy

The sudden increase in collective behavior along neutron-rich even-even chromium and iron isotopes toward $N = 40$ triggered several studies in recent years. Large-scale shell-model calculations can reproduce this trend, which demonstrates the crucial role of neutron scattering into the $g_{9/2}$ and $d_{5/2}$ orbitals [1] in this region. Less attention has been spent on neighbouring odd-mass manganese isotopes with $Z = 25$, although they are able to provide complementary sensitivity to state-of-the-art (shell model) interactions.
Within this talk, we will present new data on level lifetimes of low-lying excited states in ^{59,61,63}Mn, which were deduced from a recoil distance Doppler-shift measurement with fast radioactive beams. These isotopes were produced in side reactions of an experiment whose central aim was the determination of level-lifetimes in ^{58,60,62}Cr [2]. The present results are discussed within the shell-model framework using the established fp interaction KB3G as well as the modern interaction LNPS-m and indicate a phase transition close to $N = 36$. This work is supported by the BMBF under contract number 05P15PKFNA.

[1] S. M. Lenzi *et al.*, Phys. Rev. C **82**, 054301 (2010).
[2] T. Braunroth *et al.*, Phys. Rev. C **92**, 034306 (2015).

HK 48.8 Do 15:45 HZO 70

Cross-shell excitations from the fp shell: Lifetime measurements in ^{61}Zn — M. Queiser[1], A. Vogt[1], •M. Seidlitz[1], P. Reiter[1], T. Togashi[2], N. Shimizu[2], Y. Utsuno[3], T. Otsuka[2], M. Honma[4], P. Petkov[5], K. Arnswald[1], A. Blazhev[1], T. Braunroth[1], A. Dewald[1], J. Eberth[1], C. Fransen[1], R. Hetzenegger[1], R. Hirsch[1], J. Jolie[1], V. Karayonchev[1], L. Kaya[1], L. Lewandowski[1], C. Müller-Gatermann[1], J.M. Régis[1], D. Rosiak[1], K. Wolf[1], and K.O. Zell[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]University of Tokyo, Japan — [3]JAEA Tokai, Japan — [4]University of Aizu, Fukushima, Japan — [5]IFIN-HH, Bucharest, Romania

Lifetimes of excited states in the neutron-deficient nucleus ^{61}Zn were measured employing the Recoil-Distance Doppler-Shift (RDDS) and the Fast-Timing Method in fusion-evaporation reactions at the University of Cologne. Five lifetimes were measured for the first time, including the $5/2^- \rightarrow 3/2^-$ transition depopulating the 124-keV isomer. Short lifetimes from the RDDS analysis were corrected for Doppler-Shift Attentuation (DSA) effects in the stopper foil. Ambiguous results from previous measurements were resolved. The obtained lifetimes are compared to predictions from different sets of shell-model calculations in the fp, $f_{5/2}pg_{9/2}$, and multishell fp-$g_{9/2}d_{5/2}$ model spaces. The inclusion of cross-shell excitation into the $1d_{5/2}$ orbital is found to be decisive for the description of collectivity in the first excited positive-parity band.

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