HK 21: Structure and Dynamics of Nuclei III

Zeit: Dienstag 14:00–16:00 Raum: HS 14

Gruppenbericht HK 21.1 Di 14:00 HS 14

Lifetime determination via the Doppler-shift attenuation method using particle-γ coincidences in Cologne — •S. Prill[1], A. Bohn[1], V. Everwyn[1], M. Färber[1], F. Kluwig[1], P. Petkov[1,2], S.G. Pickstone[1], P. Scholz[1], M. Spieker[3], M. Weinert[1], J. Wilhelmy[1], and A. Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]National Institute for Physics and Nuclear Engineering, Bucharest-Magurele — [3]NSCL, Michigan State University, MI48824, USA

The Doppler-shift attenuation method using proton-γ coincidences as performed in Cologne is a well established method to extract lifetimes of excited nuclear levels in the sub-picosecond range [1]. In the past two years, the particle spectrometer SONIC with up to 12 silicon detectors in combination with the γ-ray detection array HORUS with its 14 HPGe detectors was used for p-γ coincidence measurements on various nuclei, such as ^{96}Ru [1], ^{112,114}Sn [2], ^{128,130}Te and ^{164}Dy. Numerous extracted lifetimes were derived and used to identify mixed-symmetry states and analyse the systematics of low-spin states. In this contribution, the method as well as recent improvements and additions in combination with experimental results will be presented. Supported by DFG (ZI 510/9-1). A.B. is supported by the Bonn-Cologne Graduate School of Physics and Astronomy.

[1] A. Hennig *et al.*, NIM A **794**, 171 (2015)
[2] M. Spieker *et al.*, Phys. Rev. C **97**, 054319 (2018)
[3] S.G. Pickstone *et al.*, NIM A **875**, 104 (2017)

HK 21.2 Di 14:30 HS 14

A new approach to determine nuclear-level lifetimes using the Doppler-shift attenuation method — •A. Bohn[1], V. Everwyn[1], M. Färber[1], F. Kluwig[1], M. Müscher[1], S. G. Pickstone[1], S. Prill[1], P. Scholz[1], M. Spieker[2], M. Weinert[1], J. Wilhelmy[1], and A. Zilges[1] — [1]University ofCologne, Institute for Nuclear Physics — [2]NSCL, Michigan State University, MI 48824, USA

The combination of the γ-ray detector array HORUS, consisting of 14 HPGe detectors, and the target chamber SONIC, housing 12 silicon detectors, enables the determination of nuclear-level lifetimes in the range of sub-picoseconds via the Doppler-shift attenuation method (DSAM) [1,2,3]. The measurement of p-γ-coincidences allows to determine the complete reaction kinematics. Hence, centroid-energy shifts can be extracted in proton-gated γ-ray spectra, depending on the γ-emission angle θ. In the standard analysis, the attenuation factor F(τ) is determined by using its correlation with the slope of $E_\gamma(cos(\theta))$. Alternatively, the spectra measured at different angles can be corrected for their expected Doppler shifts assuming different F(τ) values. Then, a FWHM minimization for the transition of interest can be performed to obtain the final value of F(τ). This procedure might be more efficient to determine lifetimes of weakly excited states. First results from DSAM experiments on ^{130}Te will be presented. Supported by DFG (ZI 510/9-1). A.B. is supported by the BCGS.

[1] A. Hennig *et al.*, NIM A **794** (2015) 171.
[2] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319.
[3] S. G. Pickstone *et al.*, NIM A **875** (2017) 104.

HK 21.3 Di 14:45 HS 14

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], and Karl Oskar Zell[1] — [1]University of Cologne, Institute for Nuclear Physics, Cologne — [2]National Institute for Physics and Nuclear Engineering, Bucharest, Romania

In the series of Ne isotopes it becomes apparent that for ^{20,22}Ne the drastic increase in B(E2; $2^+ \rightarrow 0^+$) strength, compared to the double-magic ^{16}O, is difficult to be reproduced by modern configuration-mixing models [1] or shell model calculations without changing parameters, such that they deviate drastically from those describing neighbouring nuclei. Because of this discrepancy, we remeasured lifetimes in ^{20}Ne and ^{22}Ne using the Doppler-shift attenuation method. The experiments were performed at the Cologne FN Tandem accelerator in October 2017 using the ^{9}Be(^{16}O,nα)^{20}Ne and ^{9}Be(^{18}O,nα)^{22}Ne reactions with a 0.9 $\frac{mg}{cm^2}$ Be target on a 2.7 $\frac{mg}{cm^2}$ Mg backing at multiple beam energies between 30 and 38 MeV. The stopping powers of the reaction products in target and backing were measured at the Cologne Accelerator Mass Spectrometer in March 2018. For the line shape analysis an improved version of DESASTOP [2] was used, which utilizes a Monte-Carlo simulation of the stopping process of the recoil nuclei. Detailed discussion of the used analysis method as well as results will be presented and compared to the systematics of light nuclei.

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

HK 21.4 Di 15:00 HS 14

Lifetime measurements in the self-conjugate nucleus ^{44}Ti — •K. Arnswald, P. Reiter, A. Blazhev, T. Braunroth, A. Dewald, M. Droste, C. Fransen, A. Goldkuhle, R. Hetzenegger, R. Hirsch, E. Hoemann, L. Kaya, L. Lewandowski, C. Müller-Gatermann, D. Rosiak, M. Seidlitz, B. Siebeck, K. Wolf, and K.O. Zell — Institut für Kernphysik, Universität zu Köln

Reduced transition strengths are sensitive signatures to describe collective excitations of atomic nuclei and the evolution of shell structures. They provide stringent tests of present shell-model interactions in the $0f1p$ shell along the $N = Z$ line. Recently determined $B(\mathrm{E2}, 2^+_1 \rightarrow 0^+_{\mathrm{g.s.}})$ values for ^{44}Ti showed an enhanced collective behavior which was associated with core excitations from the *sd*-shell [1]. However, there is a lack of information on precise values along the negative parity band in this nucleus. These states arise from a strong interplay between *sd*- and *pf*-shell orbitals and allow for refined tests of cross-shell contributions. In order to investigate the single-particle and collective characters of low-lying states, lifetime measurements employing the Recoil-Distance Doppler Shift (RDDS) and the Doppler-Shift Attenuation Method (DSAM) were performed at the FN tandem accelerator at the IKP, Cologne. Excited states in ^{44}Ti were populated with a ^{40}Ca(^{6}Li,pn)^{44}Ti fusion-evaporation reaction. The emitted γ rays were detected by an array of 11 HPGe detectors. First lifetime results will be presented and compared to shell-model calculations including multi particle-hole cross-shell excitations.

[1] K. Arnswald *et al.* Phys. Lett. B **772**, 599 (2017)

HK 21.5 Di 15:15 HS 14

Lifetime determination in ^{97}Sr via delayed γ-γ fast-timing spectroscopy — •Arwin Esmaylzadeh[1], Jean-Marc Régis[1], Jan Jolie[1], Ulli Köster[2], and Yung Hee Kim[2] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institut Laue-Langevin, Grenoble

Delayed γ rays from neutron rich A=97 fission fragments were measured using the Lohengrin spectrometer at the reactor of the Institut Laue-Langevin in Grenoble [1]. Several lifetimes of excited states in ^{97}Sr were measured using the fast-timing technique [2]. The rapid change in ground-state deformation between the spherical ^{96}Sr (N=58) and the deformed ^{98}Sr (N=60) is well known [3,4]. Therefore, it is of particular interest to study the shape-coexisting structures at the spherical-deformed border (N=59). With the extracted transition probabilities the type of excitation of some states could be studied and assigned.

[1] P. Armbruster et al., Nucl. Instrum. Methods 139 (1976)
[2] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. 726 (2013)
[3] J.-M. Régis et al., Phys. Rev. C 95, 054319 (2017)
[4] E. Clément et al., Phys. Rev. Lett. 116, 022701 (2016)

HK 21.6 Di 15:30 HS 14

Direct lifetime measurements in ^{104}Pd — •Maximilian Droste, Peter Reiter, Konrad Arnswald, Robert Hetzenegger, Rouven Hirsch, Levent Kaya, Lars Lewandowski, Claus Müller-Gatermann, Michael Seidlitz, Burkhard Siebeck, and Kai Wolf — Institut für Kernphysik, Universität zu Köln

Coulomb excitation is a powerful tool to determine reduced transition probabilities of exotic nuclei far off stability. Therefore, the radioactive ion beam impinges onto target nuclei with well-known transition probabilities. Typically, unknown transition probabilities of the projectiles are determined relative to the established target values and detailed knowledge of standard target nuclei like ^{104}Pd is key. The B(E2:$2^+ \rightarrow 0^+$) value of the first excited state in ^{104}Pd and the correlated quadruple moments have so far only been investigated via Coulomb excitation. A precise lifetime measurement, as a complementary approach to determine reduced transition strengths in ^{104}Pd and to minimize the systematic errors, was performed at the FN Tandem accelerator of the IKP Cologne employing the Recoil-Distance Doppler-Shift (RDDS) method. Excited states of ^{104}Pd were populated via the fusion evaporation reaction ^{96}Zr(^{12}C,4n)^{104}Pd at 55 MeV upto 18 $\hbar$. Measured lifetimes in ^{104}Pd will be presented and reduced transition probabilities will be compared to Coulomb excitation results.

HK 21.7 Di 15:45 HS 14

Lifetime measurement of excited states in ^{124}Ba via RDDS — •Marcel Beckers[1], Alfred Dewald[1], Marcel Bast[1], Thomas Braunroth[1], Christoph Fransen[1], Kalin Gladnishki[2], Alina Goldkuhle[1], Jan Jolie[1], Julia Litzinger[1], and Claus Müller-Gatermann[1] — [1]Institute for Nuclear Physics, University of Cologne, Germany — [2]Faculty of Physics, University of Sofia, Bulgaria

Yrast B(E2) values in the Ce-Ba-Xe region around A=124 show an unexpected behaviour if compared to collective model predictions in various nuclei (^{122}Ba,^{124}Xe,^{126}Ce), since they decrease with higher spins. In contrast to this, other nuclei in that region show a normal behaviour, as expected within the framework of the collective model (e.g. ^{122}Xe, ^{126}Ba). For ^{124}Ba no B(E2) values above the $2^+_1 \rightarrow 0^+_{gs}$ transition are published. It is therefore not clear if the observed behaviour is indeed systematic in this mass region. To shed light on the situation we performed a lifetime measurement on ^{124}Ba using the Recoil-Distance Doppler-shift method. The results of this measurement will be presented, together with a comparison of the $B_{4/2}$, $B_{6/2}$ values with the $X(5)$ model, which predicts the empirical $R_{4/2}$, $R_{6/2}$ values of ^{124}Ba extremely well.