HK 4: Structure and Dynamics of Nuclei I

Time: Monday 16:15–18:30 Location: AM 00.011

Group Report HK 4.1 Mon 16:15 AM 00.011

Implementation of the recoil distance Doppler-shift technique at the radioactive beam facility ISOLDE — •Christoph Fransen[1], Alina Didik[1], Andrey Blazhev[1], Rob Bark[2], Max Droste[1], Casper-David Lakenbrink[1], Peter Reiter[1], Carlotta Porzio[3], and Nigel Warr[1,4] for the IS 656-Collaboration — [1]University of Cologne, Institute for Nuclear Physics, Germany — [2]iThemba LABS, South Africa — [3]CERN, Switzerland — [4]University of Liverpool, UK

Absolute transition strengths between excited states yield fundamental information on nuclear structure and can be determined from level lifetimes. The recoil distance Doppler-shift (RDDS) technique employing so-called plunger devices is valuable to measure lifetimes in the picosecond range and has been in the focus of our Cologne group for many years. In this talk, we will present the first RDDS campaign at ISOLDE. Particular emphasis will be paid to the special conditions for such experiments at ISOLDE, e.g., with respect to radioactive beams, the sophisticated plunger device, the reaction kinematics, and the special requirements for targets. As a main example, we will focus on an experiment on ^{144}Ba done recently by our group aiming for the implementation of the RDDS technique at ISOLDE and the search for octupole correlations. Further, RDDS experiments on ^{162}Yb and ^{207}Tl performed within the same campaign will be briefly discussed that support the high potential of this technique for investigations of exotic nuclei. Supported by the BMFTR, Joint Project 05P2024 - ISOLDE, Grant No. 05P24PK2.

Group Report HK 4.2 Mon 16:45 AM 00.011

Employing Coincidence Doppler-Shift Attenuation Method approaches to inelastic ion-scattering experiments in the A ≈ 100 mass region — •Anna Bohn, Elias Binger, Tobias Langel, Markus Müllenmeister, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, Germany

The $A \approx 100$ mass region is a major focus of current research on various nuclear structure phenomena, such as shape evolution and proton-neutron symmetry mixing. Several inelastic ion-scattering experiments have been performed on stable even-even nuclei [1–4], including Te, Sn, Pd, Ru, Mo, and Zr isotopes, at the SONIC@HORUS [5] setup at the University of Cologne. Fundamental properties such as nuclear-level lifetimes, level schemes, and spin information could be investigated. This contribution provides an overview of the most recent results and different analysis approaches employing the Coincidence Doppler-Shift Attenuation Method [1,4].
Supported by the DFG (ZI 510/9-2).

[1] A. Hennig *et al.*, Phys. Rev. C **92** (2015) 064317.
[2] S. Prill *et al.*, Phys. Conf. Ser. **1643** (2020) 012157.
[3] S. Prill *et al.*, Phys. Rev. C **105** (2022) 034319.
[4] A. Bohn *et al.*, EPJ Web Conf. **329** (2025) 03004.
[5] S. Pickstone *et al.*, Nucl. Instr. Meth. A **875** (2017) 104.

HK 4.3 Mon 17:15 AM 00.011

Multi-method analysis of the dipole response in the tin isotopic chain — •Markus Müllenmeister[1], Johann Isaak[2], Michael Weinert[1], Florian Kluwig[1], Tanja Schüttler[1], Paula Behrendt[1], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics, Germany — [2]Technische Universität Darmstadt, Institute for Nuclear Physics, Germany

Model-independent determination of nuclear properties provides essential benchmarks for both statistical observables, and the assumptions underlying several experimental methods. Such approaches are central to constraining quantities relevant for stellar nucleosynthesis [1] and nuclear structure phenomena [2].

This contribution presents a set of continuum and state-to-state methods applied to the tin isotopes ^{116,118,120}Sn, especially the $^{A-1}\mathrm{Sn}(d,p\gamma)^{A}\mathrm{Sn}$ reactions as seen in [3], to extract information in a consistent manner. The combination of selective electromagnetic [4] and hadronic probes and modern analysis techniques [5] enables direct determination of nuclear structure properties, like nuclear level densities (NLDs).

This work is supported by the DFG under (ZI 510/10-2) and (Project-ID 499256822 * GRK 2891 'Nuclear Photonics').

[1] M. Wiedeking *et al.*, Phil. Trans. R. Soc. A. **382** (2024), 20230125.
[2] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019), 360.
[3] M. Weinert *et al.*, Phys. Rev. Lett. **127** (2021), 242501.
[4] M. Müscher *et al.*, Phys. Rev. C **102** (2020), 014317.
[5] O. Papst *et al.*, Phys. Rev. Lett. **135** (2025), 052501.

HK 4.4 Mon 17:30 AM 00.011

Lifetime measurements of excited states in ^{101}Pd — •Sven Wagner, Maximilian Droste, Peter Reiter, Ramona Burggraf, Christoph Fransen, Hannah Kleis, and Casper-David Lakenbrink — Institut für Kernpyhsik, Universität zu Köln, Zülpicher Straße 77 D-50937 Köln, Germany

The nucleus ^{101}Pd lies four protons and five neutrons away from the doubly magic ^{100}Sn. Nuclei in this region of the nuclear chart have traditionally been regarded as prototypical vibrational systems, exhibiting characteristic level structures in their low-lying excited states. However, precise lifetime measurements for even-even Pd isotopes have revealed notable deviations from this vibrational behaviour [1]. Experimental information on ^{101}Pd remains limited, with earlier studies reporting discrepant lifetimes for the first excited state [2] and for higher-lying members of the $\nu h_{11/2}$ band [3,4]. Excited states in ^{101}Pd were populated via the fusion-evaporation reaction $^{92}\mathrm{Zr}(^{12}\mathrm{C},3\mathrm{n})^{101}\mathrm{Pd}$ using a 50 MeV beam. A precise lifetime measurement was performed at the FN Tandem accelerator of the IKP Cologne employing the recoil-distance Doppler-shift (RDDS) technique to extract reduced transition strengths. New lifetimes for states in the $\nu d_{5/2}$, $\nu g_{7/2}$, and $\nu h_{11/2}$ bands have been obtained. The results will be discussed in the context of nuclear structure in the vicinity of ^{100}Sn.
[1] M. Droste et al., Phys. Rev. C 106, 024329 (2022) [2] D. Ivanova et al., Phys. Rev. C 105, 034337 (2022) [3] M. Sugawara et al., Phys. Rev. C 92, 024309 (2015) [4] V. Singh et al., J. Phys. G 44, 075105 (2017)

HK 4.5 Mon 17:45 AM 00.011

Lifetime Measurements Excited States in ^{99}Pd — •Ramona Burggraf, Peter Reiter, Rainer Abels, Timo Biesenbach, Andrey Blazhev, Maximilian Droste, Arwin Esmaylzadeh, Christoph Fransen, Kai Henseler, Hannah Kleis, Mario Ley, Aaron Pfeil, Joe Roob, Alessandro Salice, Timon Sültenfuss, and David Werner — IKP, Universität zu Köln

Excited states in ^{99}Pd were populated in the $^{90}\mathrm{Zr}(^{12}\mathrm{C},3\mathrm{n})$ fusion-evaporation reaction at a beam energy of 55 MeV using the Cologne plunger setup in combination with the CATHEDRAL γ-ray spectrometer, which consists of 24 HPGe and eight $LaBr_3$ detectors. The setup enabled simultaneous recoil-distance Doppler-shift and fast-timing measurements. The lifetimes of the first excited state and several previously unknown higher-lying levels were extracted using the differential decay-curve method. Longer-lived states were additionally characterised using γ-γ fast timing. Transitional nuclei located south-east of the doubly magic ^{100}Sn have long been considered as prototypical vibrational systems, although recent lifetime data have questioned this interpretation [1]. For ^{99}Pd, however, experimental information on excited states remains scarce. Prior to the present work, only a single lifetime had been reported by Ivanova *et al.* [2], which disagreed with the results obtained in this study. The new set of level lifetimes, including those for higher-lying states, will be presented and compared with large-scale shell-model calculations.
[1] M. Droste et al., Phys. Rev. C 106, 024329 (2022)
[2] D. Ivanova et al., Phys Rev. C 105, 034337 (2022)

HK 4.6 Mon 18:00 AM 00.011

The isovector spin-M1 response of ^{90}Zr and ^{92}Mo — •A. Gupta[1], V. Werner[1], A. D. Ayangeakaa[2,3], M. Beuschlein[1], S. W. Finch[3,4], U. F. Gayer[3,4,5], D. Gribble[2,3], J. Hauf[1], K. E. Ide[1], J. Isaak[1], X. James[2,3], R. V. F. Janssens[2,3], S. R. Johnson[2,3], J. Kleemann[1], P. Koseoglou[1], T. Kowalewski[2,3], B. Löher[6], O. Papst[1], N. Pietralla[1], A. Saracino[2,3], D. Savran[6], and N. Sensharma[2,3] — [1]IKP, TU Darmstadt — [2]UNC, Chapel Hill, NC, USA — [3]TUNL, Durham, NC, USA — [4]Duke U., Durham, NC, USA — [5]ESS, Lund, SE — [6]GSI, Darmstadt

Electron-capture rates in medium-heavy nuclei are crucial for deleptonization in late core-collapse supernovae. These rates depend strongly on Gamow-Teller (GT) strength [1], though direct measurements remain difficult. The isovector spin-flip M1 (IVSM1) response, an isospin analogue of GT transitions, provides an alternative probe, which we investigate in the N = 50 isotones ^{90}Zr and ^{92}Mo. The two extra protons in ^{92}Mo's $g_{9/2}$ orbital beyond the closed pf shell may enhance its IVSM1 strength relative to ^{90}Zr. The dipole response of both nuclei was studied via nuclear resonance fluorescence using a new hybrid HPGe Clover-LaBr$_3$ array at the HIγS facility. Ground-state transition asymmetries will be used to extract the total $M1/E1$ strength up to 10 MeV. The experimental details and preliminary results for the total $M1$ strength distribution will be presented.

Supported by DFG Project No.279384907-SFB 1245 and the U.S. DOE Grant No. DE-FG02-97ER41041 and No. DE-FG02-97ER41033.

[1] K. Langanke et al., Rep. Prog. Phys. **84**, 066301 (2021)

HK 4.7 Mon 18:15 AM 00.011

Lifetime Determination in ^{98}Ru using the Reverse Coincidence Doppler-Shift Attenuation Method — •Tobias Langel, Elias Binger, Anna Bohn, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, Germany

The Coincidence Doppler-Shift Attenuation Method (CDSAM) is a powerful tool to determine nuclear level lifetimes in the sub-picosecond regime [1–2]. At the SONIC@HORUS detector array [3], located at the University of Cologne, both HPGe γ-detectors and silicon particle-detectors are used to enable coincident detection of inelastically scattered protons and subsequently emitted photons. This significantly suppresses background and feeding contributions, allowing for high-precision lifetime measurements.

The newly developed Reverse CDSAM approach [4] improves the accessibility of lower-intensity transitions. In addition to other experiments conducted in the $A \approx 100$ mass region, a ^{98}Ru(p,p$'\gamma$) experiment was performed and analyzed using both the standard CDSA method and the new reverse approach. This contribution presents the experimental results and discusses the differences between the approaches.

Supported by the DFG (ZI 510/9-2).

[1] A. Hennig *et al.*, Nucl. Instr. Meth. A **758**, 171 (2015)
[2] S. Prill *et al.*, Phys. Rev. C **105**, 034319 (2022)
[3] S. G. Pickstone *et al.*, Nucl. Instr. Meth. A **875**, 104 (2017)
[4] A. Bohn *et al.*, EPJ Web Conf. **329**, 03004 (2025)