HK 18: Structure and Dynamics of Nuclei III

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

Gruppenbericht HK 18.1 Di 14:00 HZO 70

Nuclear structure studies with SONIC@HORUS - Using p-γ coincidences to selectively measure the γ-decay behaviour of nuclear excited states — •Michael Weinert[1], Anna Bohn[1], Michelle Färber[1], Miriam Müscher[1], Simon G. Pickstone[1], Sarah Prill[1], Philipp Scholz[1], Mark Spieker[1,2], Vera Vielmetter[1], Julius Wilhelmy[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]NSCL, Michigan State University, MI 48824, USA

The SONIC@HORUS setup has been developed and improved over the last years in Cologne, optimizing it for the investigation of level lifetimes and the γ-decay behaviour of low-spin states [1]. Housing 14 HPGe and twelve silicon detectors (single or telescope), it is well suited for scattering and transfer reactions over a wide mass region. By measuring the ejectile energy and requiring the coincident detection of γ-rays, the excitation of single states and their subsequent γ-decay can be observed. Level lifetimes can be extracted using the Doppler-shift attenuation method and avoiding feeding problems. γ-decay branchings to excited states are observed with high sensitivity and particle-γ angular correlations reveal spins and parities of excited states. This contribution will introduce the setup, present results of several experiments performed with it, and discuss further developments.

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[1] S. G. Pickstone *et al.*, NIM A 875 (2017) 104

HK 18.2 Di 14:30 HZO 70

Studying p-γ angular distributions in inelastic proton scattering on ^{60}Ni with SONIC@HORUS — •Michelle Färber[1], Anna Bohn[1], Miriam Müscher[1], Simon G. Pickstone[1], Sarah Prill[1], Philipp Scholz[1], Mark Spieker[1,2], Vera Vielmetter[1], Michael Weinert[1], Julius Wilhelmy[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]NSCL, Michigan State University, MI 48824, USA

The combined setup SONIC@HORUS [1] at the Cologne tandem accelerator, consisting of 12 Silicon and 14 HPGe detectors, is the central setup for nuclear structure experiments using inelastic scattering of light ions. The coincident measurement of the excitation energy and the decaying γ-rays enables a very selective study of properties of nuclear states.

In a previous experiment it could be shown that the measured p-γ angular distribution of transitions in ^{94}Mo can be reproduced by the distorted wave born approximation (DWBA), enabling a spin and parity assignment for low-spin states. A second (p,p'γ) experiment was performed at the 10 MV FN tandem accelerator in Cologne with the aim to verify the spin and parity determination using the DWBA, and to assign multipolarities of the transitions in the low-energy region in ^{60}Ni by studying intensity ratios for different p-γ angle groups. This contribution will present the current status of the analysis of the ^{60}Ni(p,p'γ) experiment.

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[1] S. G. Pickstone *et al.*, NIM A 875 (2017) 104

HK 18.3 Di 14:45 HZO 70

Nuclear structure of ^{82}Se and ^{82}Kr relevant for $0\nu\beta\beta$ decay — •Udo Gayer[1], Tobias Beck[1], Jörn Kleemann[1], FNU Krishichayan[2], Bastian Löher[1], Oliver Papst[1], Norbert Pietralla[1], Philipp Christian Ries[1], Deniz Savran[3], Michael Weinert[4], Werner Tornow[2], and Volker Werner[1] — [1]IKP, TU Darmstadt — [2]Duke University, Durham NC, USA — [3]GSI, Darmstadt — [4]IKP, Universität zu Köln

The nuclei ^{82}Se and ^{82}Kr are candidates for the hypothetical neutrinoless double-beta ($0\nu\beta\beta$) decay process, and a precise knowledge of their nuclear structure is necessary to estimate decay rates and extract neutrino properties from a possible observation. Therefore, we have studied the decay properties of low-lying dipole excitations up to 4.2 MeV in both isotopes in a nuclear resonance fluorescence experiment with quasi-monoenergetic, polarized photons at the High-Intensity Gamma-Ray Source (HIγS). The experiment used the γ^3 setup [1] and a second setup with four HPGe detectors for a simultaneous measurement of ^{82}Se and ^{82}Kr. In this energy range, several dipole excitations were newly identified, and their relative excitation strengths were estimated from nonresonant scattering off the targets. Transitions of 1^+ scissors mode states to lower-lying excited states with branching ratios as low as 1 % were observed, which can give an insight into shape coexistence effects [2]. Results of the experiment will be presented and interpreted.

*Supported by DFG research grant SFB 1245

[1] B. Löher et al., NIMA **723** (2013) 136-142
[2] J. Beller et al., Phys. Rev. Lett. **111** (2013) 172501

HK 18.4 Di 15:00 HZO 70

Decay Characteristics of the Scissors Mode in the $0\nu\beta\beta$-Decay Mother ^{150}Nd* — •Jörn Kleemann[1], T. Beck[1], U. Gayer[1], N. Pietralla[1], V. Werner[1], S. Finch[2], FNU Krishichayan[2], B. Löher[1], O. Papst[1], P. C. Ries[1], M. Schilling[1], W. Tornow[2], M. Weinert[3], and M. Zweidinger[1] — [1]IKP, TU Darmstadt — [2]Duke University, Durham NC, USA — [3]IKP, Universität zu Köln

^{150}Nd is a candidate for a potential neutrinoless double beta ($0\nu\beta\beta$) decay to ^{150}Sm. If such a decay were to be measured the neutrino mass could be extracted from the decay rate. To do so, however, precise knowledge of the nuclear structure of both nuclei is necessary. Therefore, nuclear resonance fluorescence experiments were conducted on both isobars using the γ^3 setup [1] at the High Intensity γ-ray Source (HIγS) of the Triangle Universities Nuclear Laboratory in Durham, NC, USA. The experiments focused on the decay characteristics of the scissors mode, namely the ratio of its transition strengths to the 0_2^+ and ground state, as it induces constraints on nuclear matrix elements involved in the extraction of the neutrino mass [2]. By using HIγS' intense, nearly monochromatic, linearly polarized γ-ray beam, dipole states were selectively excited. Their parities were determined through the angular distribution of their ground-state transition and a decay to the 0_2^+ state was observed. Preliminary results of the experiment on ^{150}Nd will be presented and compared to analogous results on ^{150}Sm.

*Supported by the DFG through the research grant SFB 1245.

[1] B. Löher *et al.* Nucl. Instr. Meth. Phys. Res. A **723**, 136 (2013)
[2] J. Beller *et al.* Phys. Rev. Lett. **111**, 172501 (2013)

HK 18.5 Di 15:15 HZO 70

Probing the $E2$ properties of the scissors mode with real photons⋆ — •Tobias Beck[1], Norbert Pietralla[1], Udo Gayer[1], Volker Werner[1], Bastian Löher[1], Deniz Savran[2], Andreas Zilges[3], Vera Derya[3], and Werner Tornow[4] — [1]IKP, TU Darmstadt — [2]GSI, Darmstadt — [3]IKP, Universität zu Köln — [4]Duke University, Durham, NC, USA

The study of the properties of the nuclear scissors mode provides an essential insight into the nature of the restoring forces between the proton and neutron subsystems. Recently, first information on the $E2$ decay transition strength of the scissors mode was extracted [1] from a high-statistics photon-scattering experiment on ^{156}Gd using quasi-monochromatic photon beams provided by the High Intensity γ-ray Source (HIγS). The data allowed for measuring a finite value of the $E2/M1$ multipole mixing ratio and, thus, the first measurement of an F-vector $E2$ transition in axially deformed nuclei. A similar continuative experiment has been performed on the well-deformed nuclei ^{162,164}Dy at HIγS. The obtained results indicate that highest-precision photon-scattering experiments with linearly polarized photons are highly sensitive to the electric quadrupole-decay properties of the scissors mode. The obtained results will be presented in detail and discussed in terms of the underlying nuclear physics. An outlook for future research will be given.

[1] T. Beck *et al.*, Phys. Rev. Lett. **118**, 212502 (2017).

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HK 18.6 Di 15:30 HZO 70

γ-Zerfallsverhalten von Scherenmoden-Zuständen von ^{76}Ge* — •Marcel Schilling[1], Tobias Beck[1], Malte Cordts[1], Vera Derya[2], Udo Gayer[1], Bastian Löher[3], Norbert Pietralla[1], Philipp C. Ries[1], Christopher Romig[1], Deniz Savran[3], Volker Werner[1], Werner Tornow[4], Henry R. Weller[4], Volker Werner[1] und Markus Zweidinger[1] — [1]IKP, TU Darmstadt — [2]IKP, Universität zu Köln — [3]GSI, Darmstadt — [4]Duke University, Durham, USA

Die Erforschung des neutrinolosen doppelten Betazerfalls ($0\nu\beta\beta$) ist

eine der wichtigsten offenen Fragen der Teilchenphysik, da dieser über die Grenzen des Standardmodells hinaus geht. Die Beobachtung eines solchen Zerfalls würde zeigen, dass Neutrinos Majoranateilchen sind. Hierfür ist ^{76}Ge ein potentieller Mutterkern. Mittels eines Kernresonanzfluoreszenzexperiments wurde an der High Intensity γ-Ray Source in Durham, NC, USA, das Zerfallsverhalten der Scherenmode von ^{76}Ge untersucht. Die Zerfälle konnten mittels $\gamma\gamma$-Koinzidenzen nachgewiesen und analysiert werden. Das Verzweigungsverhältnis der Scherenmode in den 0_2^+-Zustand und deren Stärke ist hierbei von Interesse, da sich hieraus Parameter festlegen lassen, die sensitiv auf die nuklearen Matrixelemente und die Zerfallsrate des $0\nu\beta\beta$-Zerfalls von ^{76}Ge nach ^{76}Se sind[2]. Es werden die bisherigen Schritte der Analyse und erste Ergebnisse präsentiert.

[1] B. Löher et al., Nucl. Instr. Meth. Phys. Res. A 723, 136 (2013).
[2] J. Beller et al. Phys. Rev. Lett. 111, 172501 (2013).

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HK 18.7 Di 15:45 HZO 70

Investigation of isovector valence-shell excitations in nuclei around the N = 82 shell closure — •Ralph Kern[1], Robert Stegmann[1], Georgi Rainovski[2], Norbert Pietralla[1], Liam Gaffney[3], Kalin Gladnishki[2], Vasil Karayonchev[4], Pär-Anders Söderström[1], Pietro Spagnoletti[5], Andreas Vogt[4], Nigel Warr[4], Andree Welker[3], Volker Werner[1], Johannes Wiederhold[1], and Radostina Zidarova[2] — [1]Technische Universität Darmstadt — [2]University of Sofia — [3]CERN — [4]Universität zu Köln — [5]University of the West of Scotland

In near-spherical nuclei, the two most fundamental quadrupole-collective excitations can be understood as a mixture of the collective 2^+ proton and 2^+ neutron excitations: the fully symmetric 2_1^+ state and the so-called mixed-symmetric $2_{1,\mathrm{ms}}^+$ state. Based on the evolution of these states in the N = 80 isotonic chain, it has been suggested that the properties of the mixed-symmetry states are sensitive to the underlying subshell structure. In particular, the observed fragmentation of the $2_{1,\mathrm{ms}}^+$ of ^{138}Ce has been explained as due to the absence of a mechanism dubbed shell stabilization. In order to examine further the effect of shell stabilization of the MSSs, it is necessary to identify and study the properties of these states in the next heavy N = 80 isotones beyond Z = 58: ^{140}Nd and ^{142}Sm. This Coulomb excitation experiment was performend at the RIB facility ISOLDE at CERN using the MINIBALL HPGe-array. Preliminary results from the experiment will be shown.

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