HK 69: Structure and Dynamics of Nuclei XIV

Time: Thursday 15:45–17:15 Location: SCH/A118

HK 69.1 Thu 15:45 SCH/A118

Investigation of neutron-induced γ rays from Ge-nuclides in the region of interest of GERDA/LEGEND — •Marie Pichotta[1], Toralf Döring[1,2], Hans F. R. Hoffmann[1], Konrad Schmidt[2], Ronald Schwengner[2], Steffen Turkat[1], Birgit Zatschler[1,3], and Kai Zuber[1] — [1]Technische Universität Dresden (IKTP), Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [3]University of Toronto, Canada

GERDA has been a pioneering experiment in the search for the still undetected neutrinoless double beta ($0\nu\beta\beta$)-decay of ^{76}Ge and this will also hold for the successor experiment LEGEND. The discovery of this extremely rare process would prove the Majorana character of neutrinos and consequently physics beyond the Standard Model. For an explicit identification of a signal caused by the $0\nu\beta\beta$-decay, which correspond to an energy of 2039 keV for ^{76}Ge, a precise understanding of all background contributions in the ROI is crucial.

However, previous experiments indicated γ lines produced by neutron activation (n,p) and neutron scattering (n,n') processes on ^{76}Ge and ^{74}Ge but until now, their existence could not be confirmed adequately. In this experiment an enriched Ge-sample was alternately irradiated by 14 MeV neutrons from a DT generator and measured by an optimized HPGe detection setup. The γ spectrum of 51 irradiation cycles shows three peaks in the energy region around 2039 keV which means that germanium itself can contribute to potential background in all ^{76}Ge $0\nu\beta\beta$-decay experiments such as LEGEND and GERDA. The experimental procedure and the results will be presented.

HK 69.2 Thu 16:00 SCH/A118

Simulation of ordinary muon capture for nuclear matrix elements of $0v\beta\beta$ research — •Xianke He, Andreas Jansen, and Kai Zuber — Institute of Nuclear and Particle Physics, TU Dresden, Germany

The search for beyond the Standard Model neutrinoless double beta decay ($0v\beta\beta$) is currently one method of determining the Majorana nature of the neutrino. The decay requires a non-zero neutrino mass. The connection between any possibly measured half-life and the neutrino mass is provided by the nuclear matrix elements (NMEs).

Nuclear models aiming at the description of the NMEs of $0v\beta\beta$ decays at high-momentum-exchange could be tested with Ordinary Muon Capture. OMC is a semi-leptonic weak interaction process quite like electron capture but with 200 times the electron rest mass. This leads to a remarkably larger momentum exchange. The OMC process taking place in the mother nuclei produces multipolarities J^π states of daughter nuclei with large angular momenta and high excitation energies.

From an experimental point of view, the corresponding muon capture rates can be obtained by measuring the intensity of gamma rays emitted during the de-excitation of these excited state nuclei over time, which can be used to test the correctness of the model describing the NMEs.

This talk will show the proposed experimental design to measure gamma spectrum of OMC using cosmic muons.

HK 69.3 Thu 16:15 SCH/A118

Neutrinoless double-β decay in an effective field theory — •Catharina Brase[1,2,3], Javier Menéndez[4,5], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]Max-Planck-Institut für Kernphysik, Heidelberg — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [4]Departament de Física Quántica i Astrofísica, Universitat de Barcelona, 08028 Barcelona, Spain — [5]Institut de Ciències del Cosmos, Universitat de Barcelona, 08028 Barcelona, Spain

We study neutrinoless double-β decay in an effective field theory (EFT) for heavy nuclei, which are treated as a spherical core coupled to additional neutrons and/or protons. The low-energy constants for this unobserved decay are constrained through a correlation with double Gamow-Teller transitions. This correlation was recently found to hold for shell-model calculations, energy-density functionals, and other nuclear structure models. We therefore first calculate the nuclear matrix elements for double Gamow-Teller transitions in the EFT for heavy nuclei. The combination of the EFT uncertainty with the correlation uncertainty enables predictions of nuclear matrix elements for neutrinoless double-β decay for a broad range of isotopes with quantified uncertainties. Generally the EFT predicts smaller nuclear matrix elements compared to other approaches, but our EFT results are consistent with recent ab initio calculations.

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HK 69.4 Thu 16:30 SCH/A118

Lifetime measurements in ^{116,118}Sn — •Sarah Prill, Anna Bohn, Felix Heim, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The Doppler-shift attenuation method (DSAM) using particle-γ coincidences is a reliable technique to determine sub-picosecond lifetimes of excited nuclear levels without feeding contributions [1,2]. In recent years, it was used to determine level lifetimes of stable nuclei along isotopic chains around the Z=50 and N=50 and N=82 shell closures to study changes of nuclear structure phenomena along these chains.

For ^{112,114}Sn, lifetimes have already been determined with this method [3]. To continue the study across the semi-magic tin isotopic chain, inelastic proton and alpha particle scattering experiments have been performed on ^{116}Sn and ^{118}Sn at the SONIC@HORUS detector array [4] at the University of Cologne. The combined detector array can measure the backscattered projectiles in coincidence with the produced γ radiation. This enables the reconstruction of the reaction kinematics as well as the elimination of feeding by selecting the direct excitation of the level of interest from the particle energy.

From these experiments, numerous level lifetimes in ^{116,118}Sn could be determined.

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[1] A. Hennig *et al.*, Nucl. Instr. Meth. A **758**, 171 (2015).
[2] S. Prill *et al.*, Phys. Rev. C **105**, 034319 (2022).
[3] M. Spieker *et al.*, Phys. Rev. C **97**, 054319 (2018).
[4] S. G. Pickstone *et al.*, Nucl. Instr. Meth. A **875**, 104 (2017).

HK 69.5 Thu 16:45 SCH/A118

Lifetime determination in ^{99}Y, ^{99}Zr and ^{99}Nb via delayed γ-γ fast-timing spectroscopy — •Aaron Pfeil[1], Jean-Marc Régis[1], Jan Jolie[1], Arwin Esmaylzadeh[1], Mario Ley[1], Lukas Knafla[1], Ulli Köster[2] und Yung Hee Kim[2] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institut Laue-Langevin, Grenoble, France

The experiment was performed in 2020 at the mass spectrometer Lohengrin at the Institut Laue-Langevin in Grenoble, France [1]. Lifetimes of the low-lying excited states in the nuclei ^{99}Y, ^{99}Zr and ^{99}Nb were determined using the fast-timing technique [2]. This region is of special interest because of a rapid shape transition, which occurs by going from $N = 58$ to $N = 60$ and is especially pronounced in the Zr isotopes, where ^{98}Zr is spherical and ^{100}Zr is strongly deformed [3]. Therefore, the results from ^{99}Zr provide crucial information about the spherical-deformed border at $N = 59$. Experimental values are compared to predictions calculated in the framework of the interacting boson-fermion model [4,5]. Work supported by DFG grant JO391/18.1 and the Institut Laue Langevin.

[1] P. Armbruster et al., Nucl. Instrum. Methods 139 (1976)
[2] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. 726 (2013)
[3] K.L.G. Heyde and J. L. Wood, Rev. Mod. Phys. 83, 1467 (2011)
[4] N. Gavrielov et al., Phys. Rev. C 106, L051304 (2022)
[5] K. Nomura et al., Phys. Rev. C 102, 034315 (2020)

HK 69.6 Thu 17:00 SCH/A118

Investigation of the Nuclear Structure of ^{76}Ge Using Nuclear Resonance Fluorescence — •M. Heumüller, V. Werner, S. Bassauer, T. Beck, M. Berger, M. Beuschlein, I. Brandherm, K. Ide, J. Isaak, R. Kern, J. Kleemann, O. Papst, N. Pietralla, P. Ries, G. Steinhilber, M. Stoyanova, and R. Zidarova — IKP, TU Darmstadt

^{76}Ge is the heaviest stable of the Germanium isotopes, which have been discussed in terms of shape coexistence and triaxiality [1]. In addition, ^{76}Ge is the baseline isotope for experiments searching for neutrino-less double-beta decay, hence, especially its low-energy dipole response is of interest. The nuclear structure of ^{76}Ge was investigated previously by using the method of nuclear resonance fluorescence [2,3]. For minimizing systematic uncertainties for cross section measurements below 5 MeV, the energy region of the low lying scissors mode, a bremsstrahlung measurement with an endpoint energy of 5.5 MeV was performed. The photons were provided by the superconducting electron accelerator S-DALINAC, impinging the enriched target in the Darmstadt High Intensity Photon Setup (DHIPS) with three HPGe detectors for γ-ray detection. The data analysis and results will be presented in the talk.

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[2]A. Jung *et al.*, Nucl. Phys. A **584**, 103-132 (1995)
[3]R. Schwengner *et al.*, Phys. Rev. C **105**, 024303 (2022)