HK 22: Structure and Dynamics of Nuclei VI

Time: Wednesday 13:45–15:45 Location: AM 00.021

Group Report HK 22.1 Wed 13:45 AM 00.021

Momentum-dependent electroweak currents in deformed nuclei — •Rui Han[1], Betânia Backes[2], Jacek Dobaczewski[2,3], Weiguang Jiang[4], Markus Kortelainen[5,6], Gabriel Martínez-Pinedo[1,7,8], and Herlik Wibowo[2] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [2]Department of Physics, University of York, York, United Kingdom — [3]Institute of Theoretical Physics, Faculty of Physics, University of Warsaw, Warsaw, Poland — [4]Institut für Kernphysik and PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität, Mainz, Germany — [5]Department of Physics, University of Jyväskylä, Jyväskylä, Finland — [6]Helsinki Institute of Physics, University of Helsinki, Helsinki, Finland — [7]Institut für Kernphysik (Theoriezentrum), Fachbereich Physik, Technische Universität Darmstadt, Darmstadt, Germany — [8]Helmholtz Forschungsakademie Hessen für FAIR, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

For weak processes such as neutrino-nucleus scattering and muon capture, the momentum transfer can be large enough that long-wavelength approximations break down, and chiral EFT two-body currents may contribute significantly. A framework is presented to evaluate momentum-dependent one- and two-body electroweak currents in deformed open-shell nuclei within nuclear DFT. Magnetic dipole moments serve as a benchmark for validating the consistent implementation of chiral two-body currents, and current progress toward a unified finite-q treatment for weak processes is outlined.

Group Report HK 22.2 Wed 14:15 AM 00.021

Two-body currents at finite momentum transfer and WIMP-nucleus scattering — •Catharina Brase[1,2,3], Zhen Li[1,2,3], Yukiya Chiba[4], Takayuki Miyagi[4], Javier Menéndez[5,6], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Center for Computational Sciences, University of Tsukuba — [5]Departament de Física Quántica i Astrofísica, Universitat de Barcelona — [6]Institut de Ciències del Cosmos, Universitat de Barcelona

We study two-body currents (2BCs) in scattering processes off medium-heavy nuclei. The inclusion of 2BCs at finite momentum transfer is important for various electroweak processes. In this work, we calculate structure factors for spin-dependent WIMP-nucleus scattering, which are needed for dark matter direct detection experiments. The structure factors encode the nuclear response and have to be calculated theoretically. We investigate the effects of 2BCs with full momentum transfer dependence on the structure factors for ^{19}F, ^{29}Si, ^{129,131}Xe. Our results are compared to previous calculations that used approximation schemes to include 2BCs.

HK 22.3 Wed 14:45 AM 00.021

Searching for signatures of the possible resonant neutrinoless double electron capture in ^{152}Gd at the Felsenkeller shallow-underground laboratory — •Lars Rudert, Björn Lehnert, Steffen Turkat, and Kai Zuber — TU Dresden

The hypothesized Majorana nature of neutrinos is a key motivation for many large-scale research projects in contemporary particle physics. While neutrinoless double-beta decay plays a central role in the experimental search for this property, double electron capture (ECEC) has gained increasing attention as an alternative probe. The two-neutrino mode of ECEC was first experimentally observed in 2019 by the XENON1T collaboration in ^{124}Xe. However, the observation of neutrinoless double electron capture remains an open experimental challenge.

A long-term measurement is currently being conducted using a ^{152}Gd-enriched gadolinium oxide sample, which is considered the most promising candidate for a resonance-enhanced neutrinoless double electron capture. This contribution focuses on an experiment employing an ultra-low-background well-type HPGe detector at the Felsenkeller shallow-underground laboratory, operated by the Nuclear Physics group at TU Dresden. During the ongoing measurement campaign, further optimizations of the background sensitivity are being performed and are currently under discussion. This includes an extended characterization of the detector with respect to the expected X-ray emissions from the theoretical decay.

HK 22.4 Wed 15:00 AM 00.021

Electron-capture decay of Tc-98 — •Dominik Elchine[1], Martin Müller[2], Markus Schiffer[3], and Erik Strub[1] — [1]Division of Nuclear Chemistry, University of Cologne, Zülpicher Str. 45, 50674 Cologne, Germany — [2]Institute for Nuclear Physics, University of Cologne, Zülpicher Str. 77, 50937 Cologne, Germany — [3]Faculty of Arts and Humanities, Department of Prehistoric Archaeology, Laboratory of Isotope Archaeology

From simple symmetry and energy considerations it can be concluded that ^{98}Tc might undergo electron capture decay (EC). In this work we provide evidence for an EC decay of ^{98}Tc measuring 2.67 g K[TcO_4] that contains approximately 1 GBq of ^{99}Tc. By use of a lead shielding for the sample, it was possible to identify the coincident $4^+ \rightarrow 2^+$ and $2^+ \rightarrow 0^+$ γ transitions in the daughter nuclide ^{98}Mo at the clover setup of the Institute for Nuclear Physics at the University of Cologne. For the first time, the EC/β^- branching ratio of 0.29(3)% was determined directly. With a log ft of 14.21(7) this decay does almost tie with the log ft of the ^{36}Cl EC decay [14.23(1)] for the same highest second forbidden nonunique transition.

HK 22.5 Wed 15:15 AM 00.021

Chasing the elusive nuclear two-photon decay in ^{72}Ge — •Michael Weinert[1], Wolfram Korten[2], Yury Litvinov[1,3], Markus Müllenmeister[1], Peter Reiter[1], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics, Germany — [2]IRFU, CEA, Université Paris-Saclay, France — [3]GSI Helmholtzsentrum für Schwerionenforschung, Darmstadt, Germany

A recent study at the ESR storage ring at GSI, Darmstadt, allowed to indirectly observe the nuclear two-photon (2γ) decay of the first excited state in ^{72}Ge [1]. By storing the excited and fully ionized nucleus in the ESR, conventional electron conversion can no longer depopulate the 0^+ isomer and the rare second-order electromagnetic process becomes the dominant decay path. It could be shown that the isomeric state has a much longer, yet finite lifetime in the ESR system, serving as an indirect observation of the 2γ decay. This contribution presents the current endeavors on complementary ^{72}Ge$(p,p'\gamma)$ experiments, hunting for the direct observation of this extremely rare decay process. Besides finding a way to strongly populate the isomeric state, several orders of magnitude of natural and beam induced γ-ray background have to be suppressed. An overview of the latest experiments witht he SONIC@HORUS setup in Cologne [2] and with the ELIFANT array [3] at IFIN-HH, Bucharest, will be given.

[1] D. Freire-Fernández *et al.*, Phys. Rev. Lett. **133**, 022502 (2024)
[2] S. G. Pickstone *et al.*, Nucl. Inst. Meth. A **875** (2017) 104-110
[3] D. L. Balabanski *et al.*, EPJ Web Conf. **342**, 01002 (2025)

HK 22.6 Wed 15:30 AM 00.021

Studies of the ^{76}Ge level scheme via neutron activation and γ-γ coincidence spectroscopy for germanium-based $0\nu\beta\beta$ decay experiments — •Marie Pichotta[1], Toralf Döring[2], Björn Lehnert[1], Max Osswald[1], Ronald Schwengner[2], Christoph Seibt[1], Steffen Turkat[1], and Kai Zuber[1] — [1]Technische Universität Dresden (IKTP), Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany

The still undetected neutrinoless double beta ($0\nu\beta\beta$) decay would prove the Majorana nature of neutrinos and thus provide clear evidence for physics beyond the Standard Model. ^{76}Ge is one of the most promising nuclides for its detection and is employed in several large-scale experiments, such as LEGEND. For a distinct identification of a potential ^{76}Ge $0\nu\beta\beta$ signal, a detailed understanding of all background contributions within the signal region is essential.

In a first experimental campaign at the DT neutron generator of TU Dresden, germanium isotopically enriched in ^{76}Ge was activated with 14 MeV neutrons, and the resulting γ radiation from the β^- decay of ^{76}Ga into excited states of ^{76}Ge was measured. The spectra from multiple irradiation cycles revealed several γ-ray peaks located in the vicinity of the $0\nu\beta\beta$ signal region, of partially unknown origin.

This talk focuses on a follow-up study, where multiple HPGe detectors equipped with active anti-Compton suppression were employed to perform γ-γ coincidence measurements. This enables a detailed reconstruction of decay cascades and aims at identifying unknown γ-ray transitions, thereby closing remaining gaps in the level scheme of ^{76}Ge.