HK 28: Structure and Dynamics of Nuclei VIII

Time: Wednesday 15:45–17:15 Location: HS 2 Physik

Group Report HK 28.1 Wed 15:45 HS 2 Physik

Performance of the newly established electron-gamma coincidence facility at the S-DALINAC — •Bastian Hesbacher, Jonny Birkhan, Isabelle Brandherm, Johann Isaak, Igor Jurosevic, Oskar Möller, Norbert Pietralla, Tim Ramaker, Maximilian Rech, and Gerhart Steinhilber — Institut für Kernphysik, Technische Universität Darmstadt

The all-electromagnetic $(e, e'\gamma)$ reaction had first been used for nuclear structure measurements in the 1980s [1]. Since then very few experiments were based on this reaction. One of the challenges of this measurement technique lies in the coincident bremsstrahlung, which - apart from the angular distribution - cannot be distinguished from the γ-radiation of nuclei decaying to their ground state after excitation by inelastic electron scattering. In 2021 first successful $(e, e'\gamma)$ measurements were performed at the S-DALINAC with improved resolution of electron energy, gamma energy and coincidence time by two orders of magnitude [2]. The scattered electrons were registered with the QCLAM spectrometer. The γ-radiation was detected by 6 $LaBr_3$:Ce detectors. Measurements on ^{12}C and ^{96}Ru targets were performed and demonstrated the superior performance of the new facility over previous attempts to study $(e, e'\gamma)$ reactions. Results on the γ-decay behavior and angular distributions of ^{96}Ru will be presented.

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[1] C. N. Papanicolas et al., Phys. Rev. Lett. **54**, 26 (1985).
[2] G. Steinhilber, Doctoral thesis, TU Darmstadt (2023).

HK 28.2 Wed 16:15 HS 2 Physik

Dipole response of the $N = 84$ isotones ^{142}Ce and ^{144}Nd — •Florian Kluwig[1], Miriam Müscher[1], Deniz Savran[2], Ronald Schwengner[3], Tanja Schüttler[1], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics, Germany — [2]GSI, Darmstadt, Germany — [3]Helmholtz-Zentrum Dresden-Rossendorf, Germany

The Pygmy Dipole Resonance (PDR) is a component of the electric dipole response in atomic nuclei. Despite decades of extensive theoretical and experimental investigations [1-3], its structure and origin remain the subject of ongoing research. To address these unresolved questions, systematic studies, e.g. along isotopic or isotonic chains, are essential for deepening our understanding of this excitation mode. Such investigations have been conducted on isotopes near the $N = 82$ magic shell closure, including the $N = 84$ isotones ^{144}Nd and ^{142}Ce, through real-photon scattering experiments known as Nuclear Resonance Fluorescence (NRF). Photons are particularly effective probes for studying the PDR due to their ability to transfer only small angular momenta [4]. In this contribution, results from NRF experiments on ^{144}Nd and ^{142}Ce will be presented and compared.

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[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210.
[2] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019) 360.
[3] E.G. Lanza *et al.*, Prog. Part. Nucl. Phys. **129** (2023) 104006.
[4] A. Zilges *et al.*, Prog. Part. Nucl. Phys. **122** (2022) 103903.

HK 28.3 Wed 16:30 HS 2 Physik

Nuclear resonance fluorescence of ^{242}Pu — •M. Beuschlein[1], J. Birkhan[1], J. Kleemann[1], O. Papst[1], N. Pietralla[1], R. Schwengner[2], C. A. Ur[3], S. Weiss[2], V. Werner[1], U. Ahmed[1], T. Beck[1,4], I. Brandherm[1], A. Gupta[1], J. Hauf[1], K. E. Ide[1], P. Koseoglou[1], H. Mayr[1], C. M. Nickel[1], K. Prifti[1], T. Stetz[1], and R. Zidarova[1] — [1]IKP, Darmstadt, Germany — [2]HZDR, Dresden, Germany — [3]ELI-NP, IFIN-HH, Bucharest-Magurele, Romania — [4]FRIB, East Lansing, MI, USA

The availability of nuclear structure information of transuranium actinides impacts the modeling of stellar nucleosynthesis and supports isotope-selective material inspection via photonuclear reactions. However, available experimental data are scarce. The first nuclear resonance fluorescence (NRF) experiment on ^{242}Pu was conducted at the S-DALINAC at TU Darmstadt to probe its low-energy dipole response under stringent safety precautions. A PuO_2 sample of 1 g was irradiated by bremsstrahlung up to an endpoint energy of 3.7 MeV. The comparison of NRF spectra to measurements of the sample's activity and natural background revealed photo-excited dipole states of ^{242}Pu. Evidence for fragments of the $M1$ scissors mode and for low-lying $E1$ excitations was found, based on the assignment of intrinsic projection quantum numbers, K, from measured decay branching ratios. Experimental details, γ-ray spectra, and first results on the most prominent observed transitions in ^{242}Pu will be presented.

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Group Report HK 28.4 Wed 16:45 HS 2 Physik

Two-body currents at finite momentum transfer and M1 transitions — •Catharina Brase[1,2,3], Takayuki Miyagi[1,2,3,4], Kai Hebeler[1,2,3], 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, 1-1-1 Tennodai, Tsukuba 305-8577, Japan — [5]Departament de Física Quántica i Astrofísica, Universitat de Barcelona, 08028 Barcelona, Spain — [6]Institut de Ciències del Cosmos, Universitat de Barcelona, 08028 Barcelona, Spain

We derived a multipole decomposition of two-body currents (2BCs) to include 2BCs at finite momentum transfer in the calculation for processes with medium-mass nuclei, without approximating the 2BCs. We investigate the effects of 2BCs on the most dominant M1 transition at 10.23 MeV in ^{48}Ca using the valence-space in-medium similarity renormalization group with a set of non-implausible interactions. Experiments, such as (e, e') and (γ, n), disagree on the magnetic dipole transition strength $B(\mathrm{M1})$ of this transition. We find that our results favor larger $B(\mathrm{M1})$ values in agreement with recent coupled-cluster calculations. For validation of our results, we investigate additional observables in ^{48}Ca and M1 transitions in ^{48}Ti. Our predictions agree with these observables.

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