HK 7: Structure and Dynamics of Nuclei II

Time: Monday 16:30–18:00 Location: J-HS H

Group Report HK 7.1 Mon 16:30 J-HS H

Investigation of the low-lying dipole response in photon-scattering experiments — •Miriam Müscher[1], Johann Isaak[2], Deniz Savran[3], Ronald Schwengner[4], Werner Tornow[5], Julius Wilhelmy[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institute for Nuclear Physics, TU Darmstadt — [3]GSI, Darmstadt — [4]Helmholtz-Zentrum Dresden-Rossendorf — [5]Department of Physics, Duke University

The photoabsorption cross sections of atomic nuclei have great impact on reaction rates in nucleosynthesis processes. For instance, the occurrence of additional dipole strength below and around the particle separation threshold, often denoted by Pygmy Dipole Resonance [1], enhances the reaction rates in the rapid neutron-capture process [2].

Photon-scattering experiments are well-suited to selectively study dipole excited states [3]. Photoabsorption cross sections as well as spin and parity quantum numbers can be extracted in a model-independent way. Recent results of complementary (γ,γ') experiments with "white" bremsstrahlung beams (at DHIPS [4] and γELBE [5]) and with quasi-monoenergetic photons (at HIγS [6]) will be presented.

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[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210
[2] S. Goriely, Phys. Lett. B **436** (1998) 10
[3] U. Kneissl *et al.*, Prog. Part. Nucl. Phys. **37** (1996) 349
[4] K. Sonnabend *et al.*, Nucl. Instr. and Meth. A **640** (2011) 6
[5] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211
[6] H.R. Weller *et al.*, Prog. Part. Nucl. Phys. **62** (2009) 257

HK 7.2 Mon 17:00 J-HS H

Test of photon strength functions for the well-deformed ^{164}Dy — •O. Papst[1], V. Werner[1,2], N. Pietralla[1], T. Beck[1], C. Bernards[2], N. Cooper[2], B.P. Crider[3,4], U. Friman-Gayer[1], J. Isaak[1], J. Kleemann[1], FNU Krishichayan[5], B. Löher[6], F. Naqvi[2,7], E.E. Peters[3], F.M. Prados-Estevez[3], R.S. Ilieva[2,8], T.J. Ross[3], D. Savran[6], M. Scheck[1,9], W. Tornow[5], and J.R. Vanhoy[10] — [1]IKP, TU Darmstadt — [2]WNSL, Yale U., New Haven, CT, USA — [3]UKY, Lexington, KY, USA — [4]MSU, East Lansing, MI, USA — [5]Duke U. & TUNL, Durham, NC, USA — [6]GSI, Darmstadt — [7]U. Delhi, India — [8]UNIS, Guildford, UK — [9]UWS, Paisley & SUPA, Glasgow, UK — [10]USNA, Annapolis, MD, USA

For heavy nulei, low-lying E1 strength referred to as Pygmy Dipole Resonance is often related to a semi-collective oscillation of a neutron skin. A sensitivity to the nucleus' symmetry axes can be expected, resulting in a separation into two parts (K-splitting) for axially deformed nuclei. Data is sparse for such nuclei. In nuclear resonance fluorescence experiments performed at the High Intensity γ-ray Source (HIγS), the dipole strength of the deformed ^{164}Dy was probed using a polarized, quasi-monochromatic γ-ray beam.

Above 4 MeV, a dominance of E1 strength is observed. Due to high level densities, only mean properties such as the average decay behavior are accessible above 5 MeV. The results are compared to experiments using complementary probes and statistical model simulations.

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HK 7.3 Mon 17:15 J-HS H

Isovector-$E2$ strength of the scissors mode of ^{152}Sm — •K.E. Ide[1], T. Beck[1], M. Berger[1], S. Finch[2], U. Friman-Gayer[1], J. Kleemann[1], FNU Krishichayan[2], B. Löher[1], O. Papst[1], N. Pietralla[1], D. Savran[3], W. Tornow[2], M. Weinert[4], V. Werner[1], and J. Wiederhold[1] — [1]IKP, TU Darmstadt — [2]TUNL, Duke University, Durham NC, USA — [3]GSI, Darmstadt — [4]IKP, Universität zu Köln

The nucleus ^{152}Sm is well known to be located at the $N = 90$ quantum shape-phase transition (QSPT) boundary, mainly set by the residual forces between valence protons and neutrons. Since the scissors mode (SM) is a collective, isovector excitation, its decay characteristics are highly dependent on these forces and sensitive to the QSPT. The SM is known for its $M1$-excitation strength, however, data on isovector $E2$ properties are sparse [1]. The SM of ^{152}Sm was investigated in a nuclear resonance fluorescence experiment performed at the High-Intensity γ-Ray Source with a quasi-monoenergetic, polarized photon beam with an energy of 2.99(5) MeV. Emitted photons were detected by four high-purity germanium detectors positioned at angles sensitive to the multipolarities of the decay radiation of 1^π states. The isovector $E2$ transition of the SM of ^{152}Sm to its first 2^+ state has been deduced from the $E2/M1$ multipole mixing ratio of the $1^+_{\rm sc} \to 2^+_1$ transition. Experimental results are compared to predictions of the interacting boson model 2, yielding proton and neutron effective boson charges.

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

HK 7.4 Mon 17:30 J-HS H

Constraining $0\nu\beta\beta$-decay nuclear matrix elements with NRF* — •J. Kleemann[1], T. Beck[1], U. Friman-Gayer[1], N. Pietralla[1], V. Werner[1], S. Finch[2], J. Kotila[3], FNU Krishichayan[2], B. Löher[1], H. Pai[1,4], O. Papst[1], W. Tornow[2], M. Weinert[5], and A. Zilges[5] — [1]IKP, TU Darmstadt — [2]TUNL, Duke University, Durham NC, USA — [3]University of Jyväskylä, Finland — [4]SINP, Kolkata, India — [5]IKP, Universität zu Köln

The search for neutrinoless double beta ($0\nu\beta\beta$) decay, a process only allowed if the neutrino is a Majorana particle, recently gained much attention with numerous experiments being dedicated to it. While the neutrino mass could be determined from its decay rate, to do so a nuclear matrix element (NME) is required, which has to be calculated using nuclear structure models. To constrain such calculations for the $0\nu\beta\beta$-decay of ^{150}Nd to ^{150}Sm new data on the decay characteristics of the scissors mode of these nuclei was recently taken in nuclear resonance fluorescence (NRF) experiments performed at the High Intensity γ-ray Source at Duke University. The decay characteristics of the scissors mode are sensitive to the nuclear deformation and allow inducing constraints on model parameters, especially the Majorana parameters of the Interacting Boson Model 2 (IBM-2), in turn resulting in a more reliable prediction of the $0\nu\beta\beta$-NME [1]. The experimental results and updated IBM-2 calculations will be presented and discussed.

[1] J. Beller *et al.* Phys. Rev. Lett. **111**, 172501 (2013)

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HK 7.5 Mon 17:45 J-HS H

Sudden regime of laser-nucleus interaction with neutron evaporation — •Sergei Kobzak, Hans Weidenmüller, and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

At the Extreme Light Infrastructure facility under construction in Romania or at the Gamma Factory envisaged at the LHC, intense and partially coherent photon beams with energies ranging up to several MeV should soon become available. Novel experiments employing a laser beam with photon energies comparable to typical nuclear excitation energies will shed light on a number of questions and will open new unexplored avenues for nuclear physics [1,2].

In this work we investigate theoretically the interaction of such intense MeV gamma-ray pulses with medium-weight nuclei. The time-dependent interplay between the rates of average photon absorption, statistical equilibration and neutron evaporation is studied with the help of the master equation [2]. The sudden regime of laser-nucleus interaction refers to the case when photon absorption occurs faster than the complete nuclear equilibration of the nucleus. Consequently, multiple photon absorptions lead to neutron evaporation. We investigate the time scales of compound nucleus equilibration, as well as lifetimes of state classes with different particle-hole numbers and refer them to the spreading width of the giant dipole resonance.

[1] A. Pálffy and H. A. Weidenmüller, PRL 112, 192502 (2014).
[2] A. Pálffy, O. Buss, A. Hoefer and H. A. Weidenmüller, PRC 92, 044619 (2015).