# HK 61: Structure and Dynamics of Nuclei XIII

Time: Thursday 14:00–15:15 Location: SCH/A117

HK 61.1 Thu 14:00 SCH/A117

**Reconstructed gamma-ray spectra by CALIFA after proton knockout reactions (experiment s467)** — •Christian Sürder[1], Ryo Taniuchi[2], Luke Rose[2], Leyla Atar[1], Marina Petri[2], Stefanos Paschalis[2], and Thorsten Kröll[1] for the R3B-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]School of Physics, Engineering and Technology, University of York, York, United Kingdom

An experiment to study single-particle properties of isotopes around the Ca isotopic chain was performed with the R$^3$B setup at GSI, Darmstadt, Germany. This experiment was part of the Phase 0 program at FAIR. A cocktail beam was produced via fragmentation of a $^{86}$Kr primary beam impinging on a $^{9}$Be target at a beam energy of 580MeV/A. One goal is to extract exclusive reaction cross sections in proton knockout (p,2p) reactions. Therefore it is essential to detect the knocked out protons and the coincident gammas from a de-excitation of the residual nucleus. CALIFA is a highly segmented CsI(Tl) detector which is capable of this task. To show the performance of CALIFA a strongly populated isotope is selected as a benchmark and the corresponding protons and gammas are reconstructed. The status of the analysis will be presented.

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HK 61.2 Thu 14:15 SCH/A117

**"Comparison of the probability of Bi-209 ($\gamma$, p5n) Pb-203 reaction at 60 MeV and 80 MeV "** — •Jelena Bardak[1], Miodrag Krmar[2], and NIkola Jovančević[2] — [1]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany and Faculty of Sciences, University of Novi Sad, Serbia — [2]Faculty of Sciences, University of Novi Sad, Serbia

In several recently published papers, photonuclear reactions with a target of natural bismuth were studied. Irradiation of some heavy elements by the photons having energies up to 80 MeV, will give several products of ($\gamma$,xn) reactions. The emission of protons or other charged particles is less probable due to the Coulomb barrier. In this paper, an attempt was made to gain experimental evidence of Bi-209($\gamma$,p5n)Pb-203 nuclear reaction by comparison of intensities of gamma lines following EC decay of Bi-203 and Pb-203. Pb-203 can be formed by ($\gamma$,p5n) nuclear reaction, but it is certainly created after the decay of Bi-203, obtained in Bi-209($\gamma$,6n)Bi-203 reaction. After activation of the target from natural bismuth in photon beams of maximum energies of 60 MeV and 80 MeV, several gamma spectra were successively measured. Based on selected gamma lines from the measured spectra, the activities of Pb-203 and Bi-203 were monitored to assess the probability ratio for the occurrence of ($\gamma$,6n) and ($\gamma$,p5n) nuclear reactions. Furthermore, quantitative data concerning the probability of the mentioned reactions is extracted and compared to theoretical predictions.

HK 61.3 Thu 14:30 SCH/A117

**Investigation of the internal conversion lifetime of $^{229m}$Th in a solid** — •Lilli Löbell[1], Sandro Kraemer[1], Daniel Moritz[1], Kevin Scharl[1], Benedict Seiferle[1], Lars von der Wense[2], Florian Zacherl[1], and Peter Thirolf[1] — [1]LMU München — [2]Max-Planck-Institut für Quantenoptik, Garching

The first excited nuclear state of $^{229}$Th has an exceptionally low excitation energy of $8.338 \pm 0.024$ eV ($\lambda = 148.71 \pm 0.42$ nm), allowing potentially a laser excitation of the nuclear transition. Consequently, $^{229}$Th is the so far only candidate for a nuclear clock, which can possibly outperform optical atomic clocks and be used amongst a manifold of other applications to investigate variations of fundamental constants. For the decay of the thorium isomer to the ground state, the dominant decay channel in neutral $^{229m}$Th atoms is internal conversion (IC), in which the nuclear transition energy is transferred to an electron of the atomic shell. The lifetime of the IC decay was measured on a metallic surface as $7 \pm 1$ $\mu$s, but there are indications of a dependence on the electronic environment surrounding the thorium atom. A possible way to investigate the IC lifetime within a solid state environment is the implantation of $^{229m}$Th atoms into the depletion region of a semiconductor detector, where the IC electrons can be detected. This could be a scenario for a solid-state nuclear clock where the clock transition would occur via IC in an active detector medium. The talk will present ongoing experiments using VUV-sensitive silicon photomultipliers for the IC electron detection. This work was supported by the European Research Council (ERC): ERC Synergy Grant 'ThoriumNuclearClock'.

HK 61.4 Thu 14:45 SCH/A117

**Investigations of the internal conversion lifetime of $^{229m}$Th on various metal surfaces** — •Daniel Moritz[1], Sandro Kraemer[1], Lilli Löbell[1], Kevin Scharl[1], Benedict Seiferle[1], Lars von der Wense[2], Florian Zacherl[1], and Peter G. Thirolf[1] — [1]LMU München — [2]Max-Plank-Institut für Quantenoptik

With its exceptionally low energy of the isomeric first excited nuclear state, which has most recently been constrained to 8.338(24) eV (i.e. $\lambda$=148.71(42) nm) [1], $^{229m}$Th is in the focus of current research as the only suitable candidate to build a nuclear clock based on it. One of the isomer's properties to be further investigated is its internal conversion (IC) lifetime when IC is triggered by neutralization of $^{229m}$Th on a metallic catcher surface. After first hints on its dependence on the electronic environment of $^{229m}$Th [2], the IC lifetime of $^{229m}$Th$^{2+,3+}$ ions will now be evaluated systematically for various metal surfaces with different work functions. This talk presents the current status of these investigations at LMU.

This work was supported by the ERC Synergy Grant "ThoriumNuclearClock", Grant agreement No. 856415.

[1] S. Kraemer et al., arXiv:2209.10276 (2022)
[2] B. Seiferle, Diss., LMU (2019)

HK 61.5 Thu 15:00 SCH/A117

**Benchmark of proton detection using CALIFA at R3B** — •Luke Rose[1], Stefanos Paschalis[1], Ryo Taniuchi[1], Valerii Panin[2], Leyla Atar[2,3], Christian Suerder[3], and Marina Petri[1] for the R3B-Collaboration — [1]University of York, York, United Kingdom — [2]GSI, Darmstadt, Germany — [3]TU-Da, Darmstadt, Germany

Quasi-free scattering (p,2p) experiment of the Calcium isotopic chain $^{38-50}Ca$ at 450 MeV/u were performed by the R3B collaboration as part of FAIR phase 0. We performed a systematic study on the dependency of the quenching of spectroscopic factors to the isospin asymmetry by employing quasi-free scattering reactions in inverse kinematics, extending our previous investigation [Atar et al.] towards this medium-mass region. CALIFA has been used to measure the momentum of both the recoil and the knocked-out proton. In this contribution, we will discuss the simulations that were performed to study (p,2p) reactions using the CALIFA detector to quantify the detector efficiency for protons. This is a critical step in extracting the measured cross sections for the quasi-free scattering (p,2p) process.