HK 61: Structure and Dynamics of Nuclei X

Zeit: Freitag 14:00–16:15 Raum: F 33

HK 61.1 Fr 14:00 F 33

Laser spectroscopy of the heaviest elements at GSI — •Premaditya Chhetri for the RADRIS-Collaboration — TU Darmstadt — GSI Darmstadt

Laser spectroscopy of the heaviest elements with $Z>100$ allows studying the influence of relativistic and QED effects on the atomic shell structure but is hampered by the low production rates available. Applying the sensitive Radiation Detected Resonance Ionization Spectroscopy [1] technique at the SHIP velocity filter at GSI, we identified optical transitions in the element nobelium (Z=102) for the first time [2]. Besides the identification of a strong optical ground state transition, its hyperfine structure splitting in the isotope ^{253}No was measured along with the isotope shifts in $^{252-254}$No. These results will be discussed and an outlook on first attempts in extending laser spectroscopy to the next heavier element, lawrencium, will be given.

[1] H. Backe, W. Lauth, M. Block, M. Laatiaoui, Nuclear Physics A **944** (2015) 492

[2] M. Laatiaoui, W. Lauth, H. Backe, M. Block et. al. Nature **538** (2016) 495

HK 61.2 Fr 14:15 F 33

Recent developments at the SHIPTRAP setup — •Oliver Kaleja[1,2,3], Klaus Blaum[1], Michael Block[2,3,4], Stanislav Chenmarev[1,5], Premaditya Chhetri[3,6], Christian Droese[7], Sergey Eliseev[1], Pavel Filianin[1], Francesca Giacoppo[3,4], Yuri Gusev[5], Fritz-Peter Hessberger[3,4], Mustapha Laatiaoui[3,4], Steffen Lohse[2,4], Enrique Minaya Ramirez[8], Andrew Mistry[3,4], Yuri Novikov[5], Sebastian Raeder[3,4], Daniel Rodriguez[9], Lutz Schweikhard[7], and Peter Thirolf[10] — [1]MPIK Heidelberg — [2]Universität Mainz — [3]GSI Darmstadt — [4]Helmholtz-Institut Mainz — [5]PNPI KI Gatchina — [6]TU Darmstadt — [7]Universität Greifswald — [8]IPN Orsay — [9]Universidad de Granada — [10]LMU München

The Penning-trap mass spectrometer SHIPTRAP enables direct high-precision measurements of the heaviest elements produced at the velocity filter SHIP. The results allow us to probe and refine nuclear and nuclear astrophysics theories. In order to extend direct mass measurements to superheavy elements (Z $\geq$ 104) the setup was recently relocated with respect to SHIP. To this end a cryogenic buffer-gas stopping cell was implemented, which improves the efficiency in the thermalization and extraction of the produced nuclides. In addition, a second superconducting magnet was placed perpendicular to the current beam line to implement the non-destructive Fourier-Transform Ion-Cyclotron-Resonance technique. In this contribution an overview of the technical developments and the latest offline measurements will be presented.

HK 61.3 Fr 14:30 F 33

Decay Spectroscopy at SHIP in the neutron deficient neptunium region — •Andrew Mistry for the SHIP decay spectroscopy-Collaboration — Helmholtz Institute Mainz, Germany — GSI Helmholtzzentrum, Darmstadt, Germany

In the heavy element region of the nuclear landscape, a variety of theoretical models predict location of the enhanced shell stabilization region above the spherical closure at ^{208}Pb (Z=82, N=126) [1]. Whilst current understanding of the spherical shell closures up to ^{208}Pb is well established, experimental knowledge on the evolution of the shell closures towards the proton dripline remains limited due to low production cross sections and short half-lives. To this end, recent efforts have focused on the weakening effect of the N=126 shell closure in the neutron deficient region with $Z>91$ [2], employing increasingly advanced experimental apparatus. The focal plane detection system at SHIP [3] was employed online at GSI, Darmstadt with the two-fold purpose of performing an advanced commissioning of the setup and subsequently to produce neutron deficient neptunium isotopes (Z=93). The setup comprises a double sided silicon strip implantation detector surrounded by 4 single sided silicon strip detectors, with a Ge clover detector located downstream. Digital signal processing was employed. Results will be presented from the production of neptunium isotopes.

[1] R-D. Herzberg, P.T. Greenlees Progress in Particle and Nuclear Physics 61, 674 (2008)

[2] J. Khugyagbaatar et. al. PRL 115, 242502 (2015)

[3] A.K. Mistry, GSI Annual report 2015 p.109 (2016)

HK 61.4 Fr 14:45 F 33

Investigation of the spectral shape of the fourfold forbidden beta-decay of ^{113}Cd with the COBRA experiment — •Arne Heimbold for the COBRA-Collaboration — TU Dresden, Institut für Kern und Teilchenphysik

Recently, the scientific discussion about the so-called quenching of the axial vector coupling constant g_A has triggered some new calculations in nuclear physics. The possibility of a quenched coupling strength has been introduced to reproduce experimental data of double beta-decay studies with theoretical models. Of special interest are highly forbidden single beta-decays since the spectral shape of the electron momentum distribution strongly depends on the effective value of g_A, but in a highly non-trivial way. The COBRA experiment at the LNGS in Italy uses CdZnTe semiconductor detectors to search for the existence of neutrinoless double beta-decay. The material acts at the same time as source of the sought double beta-decay and consists of all isotopes of Cadmium, Zinc and Tellurium according to the natural isotopic composition of those elements. One of the isotopes present is ^{113}Cd with an abundance of about 12%. The ^{113}Cd nucleus undergoes a fourfold forbidden, non-unique single beta-decay with a half-life of $8{\cdot}10^{15}$ years, which is the most prominent signal for the COBRA demonstrator. In this talk, a first approach to compare the measured ^{113}Cd beta spectrum of COBRA with the spectral shapes resulting from nuclear shell model calculations for various values of g_A will be presented.

HK 61.5 Fr 15:00 F 33

Low-Level-Counting of an ^{129}I-sample with high-precission X-Ray spectroscopy — Lukas Bott[1], •Alexander Robert Domula[2], Klaus Eberhardt[3], Jan Glorius[1,4], Kathrin Göbel[1], Tanja Heftrich[1], Kafa Khasawneh[1], Rene Reifarth[1], Stefan Schmidt[1], Kerstin Sonnabend[1], Mario Weigand[1], Norbert Wiehl[3], Stephan Zauner[3], Mathilde Ziegler-Himmelreich[1], and Kai Zuber[2] — [1]Goethe University Frankfurt, Germany — [2]TU Dresden, Germany — [3]University of Mainz, Germany — [4]GSI Darmstadt, Germany

The exact half-life-determination of beta decays plays an important role in modern physics - amongst others for dating or the understanding of nucleosynthesis. The progress in instrumentation and technology during the last decade suggested a re-measurement of previously investigated nuclides with reduced systematic and statitical uncertainties. One possible access to a nuclides half-live is given by the activity of a suitable, well characterised sample. In order to determine the activity of the long-lived nuclide ^{129}I, an adequate sample was produced via neutron irradiation of ^{128}Te at the TRIGA reactor Mainz. The long-lived activity of the sample was characterised via γ- and X-Ray-spectroscopy at the "Niederniveau-Messlabor-Felsenkeller (VKTA)" in Dresden. The reduced background from cosmic-radiation, in particular muon-induced background in the underground laboratory enables the detection of very low activities. The results from ^{129}I activity measurements with a high-resolution Silicon-Drift-Detector at low-background-conditions and a corresponding half-life estimation will be presented.

HK 61.6 Fr 15:15 F 33

Determination of lifetimes of excited states in fission fragments from ^{252}Cf using $LaBr_3$(Ce) detectors — •Guillermo Fernández Martínez, Stoyanka Ilieva, and Thorsten Kröll for the FATIMA-Collaboration — Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt

The experimental determination of transition probabilities of excited states in exotic nuclei by direct lifetimes measurements is crucial for the understanding of nuclear structure. The **FA**st-**TIM**ing **A**rray (FATIMA), that the upcoming FAIR will house, will consist of a set of $LaBr_3$(Ce) detectors, well known for their combination of good energy resolution and very fast response, and will be able to determine very short lifetimes. However, prior to the construction of FATIMA and its final placement at FAIR, some experiments have to be performed. One of these experimental campaigns was carried out at the Argonne National Laboratory, and aimed for the measurement of lifetimes of excited states in the fission products from the spontaneous fission of ^{252}Cf. The FATIMA demonstrator, made out of 25 of the aforementioned $LaBr_3$(Ce) crystals, was used in combination with an array of 55 HPGe detectors from the existing Gammasphere. For the determination of lifetimes in the region from some nanoseconds down to few tens of picoseconds, the generalised centroid difference (GCD) method, that has been already proven to provide reliable results, was used. In the present work, first preliminary results for the first excited states of neutron-rich even-even nuclei are shown.

HK 61.7 Fr 15:30 F 33

Application of Calorimetric Low Temperature Detectors for the Investigation of Z-Yield Distributions of Fission Fragments — •Santwana Dubey[1,2], Shawn Bishop[5], Aurelien Blanc[4], Johannes O. Denschlag[2], Artur Echler[1,2], Peter Egelhof[1,2], Friedrich Goennenwein[6], Jose Gomez[4], Patrick Grabitz[1,2], Ulli Koester[5], Saskia Kraft-Bermuth[3], Werner Lauterfeld[2], Manfred Mutterer[1], Pascal Scholz[3], and Stefan Stolte[2] — [1]GSI, Germany — [2]Univ. Mainz, Germany — [3]Univ. Giessen, Germany — [4]Technical Univ. Munich, Germany — [5]ILL Grenoble, France — [6]Univ. Tübingen, Germany

Precise fission fragment yield data are of great interest for a better understanding of the fission process. In a recent experiment, performed at the research reactor ILL Grenoble, Calorimetric Low Temperature Detectors (CLTDs) were applied for the first time for the investigation of Z-yield distributions of fission fragments. The concept of CLTDs, which is based on the collection of phonons, provides considerable advantage over conventional heavy ion detectors, based on charge collection, with respect to basic detector properties. Fission fragments, produced by thermal neutron induced fission of 235U, were passed through the LOHENGRIN separator to filter required mass and energy, followed by SiN degrader foils to separate elements with different Z within a mass, and were detected on an array of CLTDs. Preliminary data for the mass region $82<A<132$ will be presented, which would lead to a better understanding of the fission process, as well as of reactor neutrino oscillations and the reactor neutrino anomaly.

HK 61.8 Fr 15:45 F 33

Determination of the fast neutron-induced fission cross section of ^{242}Pu at *n*ELBE — •Toni Kögler[1,2], Roland Beyer[1], Arnd R. Junghans[1], Stefan E. Müller[1], and Ralf Nolte[3] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V. — [2]Technische Universität Dresden — [3]Physikalisch-Technische Bundesanstalt Braunschweig

Neutron induced fission cross sections of actinides like the Pu-isotopes are of relevance for the development of nuclear transmutation technologies. For ^{242}Pu current uncertainties are of around 21 %, the target uncertainties in the order of 7 %. Sensitivity studies show that the total uncertainty has to be reduced below 5 %, to allow for reliable neutron physics simulations. This challenging task was performed at the neutron time-of-flight facility *n*ELBE at HZDR, Dresden. Improved experimental conditions and beam power, paired with the right spectral shape of the *n*ELBE neutron source provided excellent conditions to achieve this aim. Within the TRAKULA project, large and homogeneous deposits of ^{235}U and ^{242}Pu have been produced successfully. Using them in two consecutively placed fission chambers allows the determination of the neutron induced fission cross section of ^{242}Pu relative to ^{235}U. Experimental results will be presented and compared to recent experiments and evaluated data. Corrections addressing the neutron scattering are discussed by using results of different neutron transport simulations (Geant 4, MCNP 6 and FLUKA). This work was supported by the EURATOM FP7 project CHANDA and by the German Federal Ministry of Education and Research (03NUK13A).

HK 61.9 Fr 16:00 F 33

Structure Studies from 16O(p, 2p)15N Reactions with the Missing Mass Spectroscopy — •Sebastian Reichert for the TUM-RIKEN-p2p-Collaboration — TU München, James Franck Str., 85748 Garching

The manifestation of the role of fission in the element synthesis appears to be of great importance in the r-process which is responsible for a big fraction of the elements heavier than iron in the Universe: Its termination point is marked by the onset of fission. The abundances of the elements are determined also by a detailed understanding of the elemental pattern of fission. A key technology is the missing mass spectroscopy of quasi-free scattering (p,2p) reactions in inverse kinematics.

Therefore a new detector setup was developed and tested at the HIMAC Accelerator Facility in Japan. Results of the reconstructed excitation energy spectrum of 15N are presented.

Providing nuclei as RI beam, this setup will give us the unique opportunity to assign the fission barrier heights for many short lived nuclei for the first time. Plus, the fission fragments can be measured in flight, thereby enabling us to determine its mass and charge distribution accurately utilizing the features of the probe in conjunction with the unique and powerful capability of RIBF.

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