HK 2: Structure and Dynamics of Nuclei II

Time: Monday 15:00–16:15 Location: HS 3 Physik

Group Report HK 2.1 Mon 15:00 HS 3 Physik

Latest Results from TITAN's Multiple-Reflection Time-Of-Flight Mass Spectrometer — •Ali Mollaebrahimi for the TITAN-Collaboration — Justus-Liebig-Universität Gießen

TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) specializes in high-precision measurements and isobaric separation of exotic nuclei using advanced electromagnetic traps. These precise mass measurements are crucial for investigating nuclear structure and studying astrophysical processes involving isotopes far from the valley of stability.

TITAN's Multiple-Reflection Time-of-Flight Mass Spectrometer (MR-TOF-MS) enables the study of short-lived and rare nuclei through its fast measurement cycles (on the order of milliseconds) and exceptional sensitivity. This presentation highlights recent developments and experimental results achieved with the MR-TOF-MS. The nuclear physics studies include the first-time mass measurement of neutron-rich 136-138Sn, providing insights into nuclear structure beyond the neutron shell closure at N=82, and exploring their astrophysical implications for the rapid neutron capture process (r-process). Additionally, high-precision mass measurements of 31-33Na and 31-35Mg for refining the topology of the N=20 island of inversions. Finally, measurements of neutron-deficient 74-76Sr isotopes along N=Z line for investigation of A = 74, T = 1 isospin triplet and the impact of the new mass data on the reaction flow of the rapid proton capture process (rp-process) in type I x-ray bursts.

HK 2.2 Mon 15:30 HS 3 Physik

Implementation of a Charge Exchange Cell for Collinear Laser Spectroscopy — •Imke Lopp, Kristian König, Julian Palmes, and Wilfried Nörtershäuser — Institut für Kerphysik, TU Darmstadt, Germany

Collinear Laser Spectroscopy is a high precision technique to record atomic spectra, from which the charge radius and nuclear moments can be extracted. For this purpose an atom or ion beam is superimposed with a laser beam. While ions can easily be accelerated and formed into a beam, their transitions are not always accessible with common laser systems – often it is easier to perform spectroscopy on neutral atoms. To still benefit from the advantages of collinear laser spectroscopy, a charge exchange cell, that neutralises the ion beam before the laser interaction, was newly installed at the Collinear Apparatus for Laser Spectroscopy and Applied Science (COALA) at TU Darmstadt. The very first atomic spectra at COALA were recorded using a strontium beam. The evaluation of these spectra and the resulting isotopic shifts, as well as the application of high-precision techniques enabled by the charge exchange cell – such as state-selective charge exchange measurements and background-free spectroscopy – will be presented, with the examples of strontium and phosphorus.

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HK 2.3 Mon 15:45 HS 3 Physik

Laser spectroscopy of neutron-deficient thulium — •Hendrik Bodnar for the COLLAPS/ISOLDE-Collaboration — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

Collinear laser spectroscopy is well suited to study nuclear properties of isotopes. Through measurements of the isotope shifts and hyperfine splittings, the differential mean-square charge radii, the magnetic dipole moments, electric quadrupole moments and the nuclear spin can be determined. It excels particularly for short-lived isotopes.

An interesting candidate to study is ^{147}Tm, as it is close to the proton drip line and has a decay branch for proton emission. So far, a charge radius of a proton emitter has never been measured and would constitute a benchmark for nuclear stucture theory, e.g., for Density Functional Theory (DFT). During two beam times at COLLAPS/ISOLDE in 2023 and 2024, the isotopic chain of thulium was measured from ^{175}Tm - ^{152}Tm and provided a wealth of nuclear structure data towards the final goal of studying ^{147}Tm. These results, as well as an outlook towards a measurement of the proton emitter, will be provided. Funding from the BMBF under contracts 05P21RDCI1 and 05P21RDFN1 is acknowledged.

HK 2.4 Mon 16:00 HS 3 Physik

QFS studies with STRASSE at RIBF RIKEN — •Alexandra Stefanescu — Technische Universität Darmstadt, Darmstadt, Germany

STRASSE (Silicon Tracker for RAdioactive nuclei Studies at SAMURAI Experiments) is an advanced tracking system designed for quasi-free scattering (QFS) studies. The setup is optimized for missing-mass spectroscopy in inverse kinematics using a thick liquid-hydrogen (LH2) target, surrounded by double-sided silicon strip detectors (DSSSD) mounted in a compact hexagonal geometry. The tracker array is characterized by fine granularity and high-density electronics readout, high-rate capability and maximized proton tracking efficiency[1].

STRASSE is developed to be used together with the SAMURAI spectrometer at RIBF RIKEN to study the evolution of single-particle states towards the neutron drip-line nuclei, through proton knockout reactions. The accepted experiments with STRASSE are dedicated to (p,2p) and (p,3p) reactions to selectively populate the states of interest in rare isotopes. The physics program with STRASSE will be summarized.

To validate the technical choices made for the STRASSE array, in particular the front-end and back-end readout, the PFAD (Prototype For Advanced Detectors) demonstrator has been developed. Preliminary results of the first experiment with PFAD at SAMURAI, will be presented. * *

[1] H.N. Liu, et al., Eur. Phys. J. A 59, 121 (2023).