HK 32: Structure and Dynamics of Nuclei VI

Time: Wednesday 14:00–15:30 Location: SCH/A215

HK 32.1 Wed 14:00 SCH/A215

Probing the $N = 152$ neutron shell closure by laser spectroscopy of fermium isotopes — •Jessica Warbinek for the Fermium-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Germany — Johannes Gutenberg-Universität Mainz, Germany

Determining the limits of existence of the heaviest nuclides is a forefront topic in nuclear-physics research. Nuclei in this region are stabilized by shell effects that retard spontaneous fission and feature properties distinctly different from those of lighter nuclei. Experimental information on the deformed shell closures around the heavy actinides like fermium (Fm, $Z = 100$) can help to benchmark state-of-the-art theoretical models to improve their predictive power in the range of the heaviest elements.

Laser spectroscopy serves as a powerful tool to extract experimental information on nuclear parameters such as the change in the mean-square charge radius and nuclear moments in a nuclear-model independent manner. Recent studies in fermium allowed the determination of the isotope shift in an atomic transition for a long chain of eight isotopes ranging from the accelerator-produced ^{245}Fm to reactor-bred ^{257}Fm. Direct and indirect production methods were combined and associated on-line and off-line measurement techniques significantly advanced to access isotopes spanning well across the known deformed shell gap at $N = 152$. Results on the extracted changes in the mean-square charge radii revealing a discontinuity around the neutron shell closure will be discussed.

HK 32.2 Wed 14:15 SCH/A215

Proton-neutron interaction strength studies via accurate mass measurements far from stability — •Gabriella Kripkó-Koncz for the FRS Ion Catcher-Collaboration — Justus-Liebig-Universität Gießen, Gießen, Germany — Tel Aviv University, Tel Aviv, Israel

The average interaction strength between the last (highest energy orbitals) proton(s) and neutron(s) in a nucleus (denoted as δV_{pn}), may be derived from differences of accurate atomic masses, and in turn point empirically to various aspects of nuclear structure and interactions. The FRS Ion Catcher experiment at the in-flight fragment separator FRS at GSI enables highly accurate direct mass measurements ($\delta m/m \sim 10^{-8}$) with thermalized projectile and fission fragments by combining a cryogenic stopping cell and a multiple-reflection time-of-flight mass spectrometer. Confirmed by mass measurements at the FRS Ion Catcher, the detailed structure of δV_{pn} along the $N = Z$, $N - Z = 2$, $N - Z = 4$ lines near the $Z = 29 - 37$ region has been investigated [1]. These studies will be presented and an analysis of mass measurements via higher-order mass-difference indicators, the deviations of which from their expected trends may indicate questionable mass values in the Atomic Mass Evaluation and highlight distinctive nuclear structure effects, will be motivated.

[1] I. Mardor et al., Phys. Rev. C 103, 034319 (2021)

HK 32.3 Wed 14:30 SCH/A215

The search for double alpha decay of ^{224}Ra at the FRS Ion Catcher — •Heinrich Wilsenach for the Double Alpha IN2P3-CEA-GSI-Collaboration — Justus-Liebig-Universität Gießen, Gießen, Germany — Tel Aviv University, Tel Aviv, Israel

Double alpha decay has been predicted since the 1980s. The most probable scenario for this decay mode is the simultaneous tunnelling of two alpha particles through the coulomb barrier and their emission in opposite directions. Recent theoretical studies [1] have predicted a back-to-back double alpha decay branching ratio for ^{224}Ra of 1.8×10^{-7}%.

A project to measure this small branching ratio has been performed at the FRS (FRagment Separator) Ion Catcher at Gesellschaft für Schwerionenforschung (GSI). This project utilized the thermalization of ^{228}Th alpha recoils in a cryogenic stopping cell (CSC) and the preparation of a clean beam of ^{224}Ra by a radio-frequency-quadrupole (RFQ) beamline. Two double-sided silicon strip detectors (DSSD) were used to read out each alpha particle's position, time and energy coming from the implanted ^{224}Ra.

This talk will give insight into the design and setup of the experiment, including Monte Carlo simulations. It will conclude with preliminary results from the first 135 day long data taking run.

[1] F. Mercier *et al.*, PRL 127, 012501 (2021)

HK 32.4 Wed 14:45 SCH/A215

Precise measurement of the nn scattering length using a new neutron detector — •Meytal Duer[1], Thomas Aumann[1,2,3], Dominic Rossi[1,2], and Marco Knösel[1] for the SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung — [3]Helmholtz Forschungsakademie Hessen für FAIR

An accurate knowledge of the nucleon-nucleon (NN) scattering lengths, characterize the NN interaction at low energies, is fundamental for nuclear physics. The NN interaction is not only basis for the description of nuclei as a many-body systems, but the difference on the nn and pp interaction is also an important measure of charge symmetry breaking. For the nn scattering length, however, there is a systematic and significant discrepancy between values extracted from several measurements.

In this talk a new method will be presented to determine the nn scattering length with high accuracy. The basic idea of the measurement, which will take place at the SAMURAI experimental setup at RIBF in Japan, is to use a knockout reaction in inverse kinematics to produce a localized two-neutron system. By measuring the nn relative-energy spectrum after the reaction, the value of the nn scattering length can be extracted. To achieve sufficient precision, a newly developed high-resolution neutron detector HIME has been constructed. This work is supported by the DFG, Project-ID 279384907 - SFB 1245.

HK 32.5 Wed 15:00 SCH/A215

Fission Isomers studies at the FRS — •Nazarena Tortorelli for the S530-Collaboration — Ludwig-Maximilians-University, Munich, Germany — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The potential energy landscape in actinide nuclei ($Z = 92 - 97$, $N = 141 - 151$) shows a super-deformed second minimum. The ground state in this minimum is called a fission isomer, as it will preferably decay via isomeric (delayed) fission. So far 35 fission isomers with lifetimes between 5 ps and 14 ms have been observed using only direct reactions (like (d,pf)). At the FRS the fragmentation mechanism (i.e., the collision of a heavy relativistic beam on a light target) can be exploited to offer rapid production, hence access to isomers with short half-lives, and most importantly, highly pure fragmented beams and event-by-event identification. Recently, fission isomer studies have been made with the FRS at GSI, where a 1 GeV/u ^{238}U beam on a Be target was used. Different detection methods by implanting into a fast plastic scintillator and in the cryogenic stopping cell at the FRS Ion Catcher were used, and technical provisions have been implemented to cover a half-life range from about 50 ns to 50 ms. In this talk, the technical improvements as well as the status of the ongoing analysis will be presented. This work was supported by GSI R&D via LMTHI2023.

HK 32.6 Wed 15:15 SCH/A215

Study of the dipole response of ^{242}Pu with nuclear resonance fluorescence — •M. Beuschlein[1], J. Birkhan[1], J. Kleemann[1], O. Papst[1], N. Pietralla[1], R. Schwengner[2], S. Weiss[2], V. Werner[1], U. Ahmed[1], T. Beck[1,3], 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], M. Singer[1], T. Stetz[1], and R. Zidarova[1] — [1]Institute for Nuclear Physics, TU Darmstadt, Germany — [2]HZDR, Dresden, Germany — [3]FRIB, MSU, East Lansing, MI, USA

Nuclear resonance fluorescence (NRF) of a sample of ^{242}Pu was studied at the Darmstadt High-Intensity Photon setup. The superconducting Darmstadt linear electron accelerator S-DALINAC was used to produce bremsstrahlung up to an endpoint energy of 3.7 MeV to irradiate a sample of PuO_2, which had a total mass of about 1 g. It was highly enriched in the isotope of interest ^{242}Pu and kept in a special target container. Photons were detected with two high-purity Germanium detectors placed at different angles relative to the beam axis. NRF signals from the sample were identified by comparison with measurements using an empty target container and measurements of the sample's radioactivity. Evidence for NRF signals from ^{242}Pu was observed. This makes this isotope the heaviest nuclide for which NRF information is available. Details of the experiment will be described and γ-ray spectra will be presented and discussed.

We thank the Institute of Resource Ecology of HZDR for providing the ^{242}Pu-sample. This work was supported by the LOEWE research project 'Nukleare Photonik' by the State of Hesse.