HK 33: Structure and Dynamics of Nuclei IX

Time: Wednesday 17:30–19:00 Location: HS 2 Physik

Group Report HK 33.1 Wed 17:30 HS 2 Physik

Advancements in R3B towards the FAIR Early Science Campaign — •Tobias Jenegger, Roman Gernhäuser, and Mrunmoy Jena for the R3B-Collaboration — Technische Universität München

The R3B (Reactions with Relativistic Radioactive ion Beams) experiment, a cornerstone of the NUSTAR collaboration at the FAIR research facility in Darmstadt, Germany, is designed to address a broad spectrum of fundamental questions in modern nuclear physics. The R3B setup, in conjunction to the fragment separator FRS, allows to make high precision studies on radioactive beams in inverse kinematics. With its large acceptance on the reaction products and the ability to do complete kinematic reconstruction measurements it offers the unique possibility for understanding the dynamics of nuclear reactions under extreme conditions as they occur in nucleosynthesis processes in astrophysical environments of significant interest such as supernovae and neutron stars. This presentation provides an overview of the experimental setup and its key detectors, as well as a summary of recent experimental campaigns conducted during the FAIR Phase-0 program. Furthermore, it highlights recent advancements and outlines the focus of the experimental studies within the FAIR Early Science Program. These studies will benefit significantly from the cutting-edge capabilities of the FAIR facility, particularly the state-of-the-art Super-FRS.

Supported by BMBF 05P24WO2 and Excellence Cluster Origins.

HK 33.2 Wed 18:00 HS 2 Physik

Pathway to nuclear structure in heavy neutron rich nuclei in the vicinity of N=126 and nuclei northwest of ^{132}Sn via multinucleon transfer reactions — •Rainer Abels and Peter Reiter for the AGATA22.04-Collaboration — IKP, Universität zu Köln, Germany

Multinucleon transfer reactions (MNT) are a competitive tool to populate exotic neutron-rich nuclei. Excited reaction products have been measured in ^{136}Xe + ^{208}Pb at 1 GeV with the high-resolution γ-ray tracking array AGATA coupled to the mass spectrometer PRISMA at LNL (INFN, Italy) positioned at the grazing angle. Energy E, nuclear charge Z, velocity β, charge state q and mass number A of the beam-like isotopes are measured in the range of Z=53-56 to select the nuclei of interest. Kinematic coincidences are exploited in order to achieve best possible identification of the hard-to-reach target-like neutron-rich lead-like isotopes. Based on relative cross-section distributions for various reaction channels, perspectives and limitations for the production of the neutron-rich isotopes with this experimental method will be presented. Preliminary results concerning excited states of the beam-like nuclei in the Xe-Ba region will be discussed.

Supported by the German BMBF (05P21PKFN9), ENSAR2-TNA.

HK 33.3 Wed 18:15 HS 2 Physik

LISA: LIfetime measurements with Solid Active targets — •Kathrin Wimmer for the LISA-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The coexistence of single-particle and collective degrees of freedom in atomic nuclei give rise to various exotic phenomena. In nuclei with very asymmetric proton-to-neutron ratios, the strong nuclear interaction drives shell evolution which alters the orbital spacing, and in some cases even the ordering present in stable nuclei. In the absence of large gaps between orbitals, nuclei can take on non-spherical shapes and their excitations proceed through coherent and collective motion of many nucleons. Where and how collectivity emerges from the single-particle dynamics of protons and neutrons is an open question in nuclear structure physics that will be addressed with LISA in a unique way. The aim of the LISA (LIfetime measurements with Solid Active targets) project is to develop a novel method for lifetime measurements in atomic nuclei. Lifetimes probe the collectivity of a nucleus through its electromagnetic transition properties. The experimental approach is based on active solid targets and will dramatically enhance the scope of measurements of excited-state lifetimes and thus transition probabilities achievable in exotic nuclei. Coupled to state-of-the-art gamma-ray tracking detectors such as AGATA, this novel instrument will overcome the present challenges of lifetime measurements with low-intensity beams of unstable nuclei. In this talk, I will present an overview of the LISA project and show the potential for future physics experiments at GSI, FAIR, and FRIB.

HK 33.4 Wed 18:30 HS 2 Physik

Precision Fragmentation Studies at the GSI FRS — •Justus Eder for the Super-FRS Experiment-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung — Justus-Liebig Universität Giessen

The study of nuclear properties and the development of nuclear models require detailed investigations of exotic nuclei at the limits of stability. Moreover, testing fragmentation models demands thorough investigations involving the production, separation and identification of these nuclei. In-flight separators are key instruments for achieving these objectives, enabling the spatial separation and precise identification of reaction products in terms of mass, charge, and momentum. These capabilities provide access to broad regions of the nuclear landscape, facilitating advancements in our understanding of nuclear phenomena. In this presentation, the preliminary analysis of ^{170}Er fragmentation products will be discussed, focusing on yield and cross-section estimates to enable accurate statistical predictions for future experiments. The results originate from measurements conducted at the GSI Fragment Separator (FRS), using a newly developed ^{170}Er beam with 1080 MeV/nucleon impinging on a beryllium target. The study provides insights into the exotic nuclear landscape near the atomic number $Z = 68$, providing valuable data for exploring highly deformed regions of the nuclear chart.

HK 33.5 Wed 18:45 HS 2 Physik

Study of short-range correlations in asymmetric nuclei at R^{3}B — •Manuel Xarepe[1,2,3], Andrea Lagni[4], Hang Qi[5], and Enis Lorentz[2] — [1]Faculty of Science of the University of Lisbon — [2]Technischen Universität Darmstadt — [3]Helmholtz Forschungsakademie Hessen für FAIR — [4]University of Santiago de Compostela — [5]Massachusetts Institute of Technology

Nucleon-nucleon short-range correlations (SRCs), primarily composed of neutron-proton pairs, are a universal feature in atomic nuclei. Previous studies using electron scattering have shown that protons are more likely to form SRCs in asymmetric nuclei as the neutron excess increases. However, such studies are constrained to stable nuclei with limited neutron excess and do not allow for a clear separation of the mass effect from the neutron excess.

To address this limitation, we conducted an inverse kinematics experiment with the R^{3}B setup at GSI-FAIR within the FAIR Phase-0 program. High-energy beams (E = 1.25 GeV/u) of the neutron-rich isotope ^{16}C and the symmetric ^{12}C were used with a liquid hydrogen target. In $(p,2p)$ reactions, single nucleons were knocked out at large momentum transfer, even when bound in an SRC pair.

We will present the experimental methodology, identification of SRC pairs, and preliminary findings on their behaviour in neutron-rich nuclei. These results set the stage for future experiments at FAIR, enhancing our understanding of SRCs and their role in asymmetric nuclear matter. Supported by the Portuguese FCT, Project Refs: 2021.05736.BD and the BMBF project 05P21RDFN2.