HK 42: Structure and Dynamics of Nuclei IX

Time: Wednesday 15:45–17:15 Location: HBR 19: C 5b

HK 42.1 Wed 15:45 HBR 19: C 5b

Mass spectrometry as a tool for nuclear structure and astrophysics studies at TRIUMF — •Timo Dickel for the TITAN-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH — Justus-Liebig-Universität Giessen

A high-performance multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) is used for mass measurements of exotic nuclides at the TITAN experiment at the ISOL facility ISAC at TRIUMF, Canada. The system was developed at Justus Liebig University Gießen. The increased sensitivity due to very high efficiency and a novel method for background suppression applied in this MR-TOF-MS allows nuclear structure and nuclear astrophysics studies at the extremes of the nuclear chart. A wide range of results will be presented, from investigations of the astrophysical scenario of the r-process to nuclear structure effects like the island of inversion or the shell structure at the outskirts of the nuclear chart. Moreover, the first discovery of an isotope with an MR-TOF-MS will be discussed.

HK 42.2 Wed 16:00 HBR 19: C 5b

Discovery of isotopes and first broadband measurements of neutron-deficient light lanthanides via high precision mass spectrometry — •Christine Hornung for the S482-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The structure and properties of nuclei approaching the drip-lines is of great interest and attracts a lot of attention from both, experiment and theory. In a recent experiment carried out in FAIR Phase-0, new isotopes towards the proton drip-line could be identified in the elements between Nd and Tb at the fragment separator FRS via event-by-event particle identification in-flight. In the same experiment, direct mass measurements were carried out with the MR-TOF-MS at the FRS Ion Catcher. A new technical approach, the so called mean range bunching, was applied, which allows efficient stopping of exotic nuclei; in the present experiment, it enabled the simultaneous broadband measurement of more than 35 nuclides in a single setting. The masses of more than 10 nuclides were measured for the first time, and the mass uncertainties of more than 10 nuclides were significantly reduced. These results give an insight into the nuclear structure and for the first time allow tracking of the proton drip line between 100Sn and 150Lu. In this contribution, these recent results and the new technical approaches will be reported.

HK 42.3 Wed 16:15 HBR 19: C 5b

Laser spectroscopy in the ruthenium isotopic chain — •Bernhard Maass for the ATLANTIS-Collaboration — TU Darmstadt

Neutron-rich mid-shell nuclei of refractory metals below the magic number Z=50, such as ruthenium, exhibit rich phenomena such as ground-state deformations, shape coexistence, and triaxiality and thus are ideal testing grounds for theories describing these collective properties. Laser spectroscopy of isotopes and isomers in this region can contribute valuable and complementary data with high precision on nuclear shapes, sizes, and electromagnetic moments.

The talk will present an overview of the ATLANTIS setup, positioned at the low-energy branch of the CARIBU fission source at ATLAS, capable of generating sufficiently intense beams of refractory elements. The main emphasis will be the discussion of the results of laser spectroscopic measurements within the ruthenium isotopic chain. Differential mean-squared nuclear charge radii, moments, and shape parameters have been successfully extracted, spanning nine radioactive isotopes from mass 107 to 114.

This work was supported by DFG - Project-Id 279384907-SFB 1245, BMBF 05P19RDFN1 and NSF Grant No. PHY-21-11185, and by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357, with resources of ANL's ATLAS facility, an Office of Science User Facility.

HK 42.4 Wed 16:30 HBR 19: C 5b

First laser spectroscopy measurements across N=32 in the calcium isotopic chain — •Tim Lellinger for the COLLAPS-Collaboration — EP-SME-IS, CERN — TU-Darmstadt

Over a decade ago, the first experimental evidence for the N=32 sub shell closure in the calcium isotopic chain emerged [1,2]. Subsequent experimental and theoretical investigations have confirmed this finding. However, in laser spectroscopy measurements extending up to ^{52}Ca (N=32), no indications of this shell gap were apparent [3]. Crossing the shell gap with laser spectroscopy setups has proved difficult due to the simultaneous requirement of a sensitivity of approximately 10 ions/s and a measurement uncertainty on the order of MHz.

This contribution presents the first laser spectroscopy measurements of ^{53}Ca, facilitated by an extension of the collinear laser spectroscopy technique employed at the COLLAPS setup at ISOLDE/CERN. This technique, termed as *radioactive detection after optical pumping and state selective charge exchange* (ROC), combines the high sensitivity of a particle detection scheme with the high resolution of low-power, continuous wave lasers utilized in a collinear geometry. The methodology of this technique will be explained, followed by the presentation and discussion of preliminary values for the charge radius and magnetic dipole moment of ^{53}Ca in the context of the robustness of the N=32 sub shell closure.

[1] Wienholtz, F. et al. Nature vol. 498, 346-349 (2013)
[2] Steppenbeck, D. et al. Nature vol. 502, 207-210 (2013)
[3] R.F. Garcia Ruiz et al, Nature Physics vol. 12, 594-598 (2016)

HK 42.5 Wed 16:45 HBR 19: C 5b

Application of eigenvector continuation to nuclear many-body problems — •Margarida Companys Franzke[1,2,3], Kai Hebeler[1,2,3], Takayuki Miyagi[1,2,3], Alexander Tichai[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck Institut für Kernphysik, Heidelberg

The design of emulation techniques for the evaluation of many-body observables is attracting increasing attention over the past years. In particular the framework of eigenvector continuation (EC) has been identified as a powerful tool once the system's Hamiltonian admits for a parametric dependence. Since Hamiltonians generated by effective field theory have a parametric dependence on low-energy constants (LECs), EC is applicable. In this application the emulator is trained on a small set of data generated by the Hatree-Fock method for varying LECs. Once the ground state is emulated, it can be used to obtain other observables, such as radii, and explore the sensitivity to the LECs in nuclear forces.

* Funded by the ERC Grant Agreement No. 101020842

HK 42.6 Wed 17:00 HBR 19: C 5b

Collinear Laser Spectroscopy of $^{155-175}$Tm^{+} — •Hendrik Bodnar[1], Kristian König[1], Klaus Blaum[6], Andrey Bondarev[5], Bradley Cheal[3], Tim Lellinger[2], Edward Matthews[2], Patrick Müller[1], Gerda Neyens[7], Wilfried Nörtershäuser[1], Julian Palmes[1], Peter Plattner[6], Laura Renth[1], Liss Vázquez Rodríguez[2], and Deyan Yordanov[4] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]Experimental Physics Department, CERN, Geneva, Switzerland — [3]Oliver Lodge Laboratory, University of Liverpool, Liverpool, UK — [4]Universite Paris-Saclay, CNRS/IN2P3, IJCLab, 91405 Orsay, France — [5]Helmholtz Institute Jena, Jena, Germany — [6]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [7]Instituuut voor Kern- en Stralingsfysica, Celestijnenlaan 200D, 3001 Leuven, Belgium

Collinear Laser Spectroscopy of $^{155-175}$Tm^{+} was performed at COLLAPS/ISOLDE (CERN). Through measurements of the isotopic shifts and the hyperfine splitting, the magnetic dipole moments, electrical quadrupole moments, nuclear spin and charge radii relative to the stable ^{169}Tm were determined. ^{169}Tm was previously investigated in detail at the high-precision setup COALA at TU Darmstadt to identify suitable transitions for the online campaign. Results from both parts of the experiments are presented. The ultimate goal is the determination of the charge radius of the proton emitter ^{147}Tm since charge radii of nuclei exhibiting this decay channel have not been performed so far. Funding from the BMBF under contracts 05P21RDCI1 and 05P21RDFN1 is acknowledged.