HK 22: Structure and Dynamics of Nuclei IV

Zeit: Dienstag 14:00–15:45 Raum: HS 16

Gruppenbericht HK 22.1 Di 14:00 HS 16

Towards Laser Spectroscopy of Boron-8 — •Felix Sommer[1], Jason Clark[2], Phillip Imgram[1], Simon Kaufmann[1], Kristian König[1], Jörg Krämer[1], Jan Krause[1], Alessandro Lovato[2], Bernhard Maass[1], Peter Müller[2], Krzysztof Pachucki[5], Mariusz Puchalski[6], Maria Piarulli[3], Robert Roth[1], Rodolfo Sánchez[4], Guy Savard[2], Robert Wiringa[2], and Wilfried Nörtershäuser[1] — [1]TU Darmstadt, DE — [2]ANL, Lemont, IL, US — [3]Washington University, St. Louis, MO, US — [4]GSI, Darmstadt, DE — [5]University of Warsaw, PL — [6]AM University, Poznan, PL

We report on the status of the charge radius determination of the proton halo candidate ^{8}B via collinear laser spectroscopy at Argonne National Laboratory. By combining high-resolution measurements of the isotope shift in an atomic ground state transition and high-accuracy *ab initio* mass-shift calculations of the five-electron system, the difference in mean-square charge radii between the short-lived ^{8}B and the stable isotopes ^{10,11}B can be extracted and will deliver a model-independent test of the ^{8}B proton halo character. In preparation, we installed a collinear laser spectroscopy beamline at ANL and investigated the production of ^{8}B-ions, including molecule breakup through few-nm carbon foils. Furthermore, we determined the nuclear charge radii of the stable boron isotopes ^{10,11}B by resonance ionization mass spectrometry (RIMS) at TU Darmstadt.

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HK 22.2 Di 14:30 HS 16

β-decay Q-value measurements using the phase-imaging ion-cyclotron-resonance detection with ISOLTRAP at CERN — •Jonas Karthein for the ISOLTRAP-Collaboration — CERN, Geneva, Switzerland — MPI für Kernphysik, Heidelberg, Germany

ISOLTRAP, located at the radioactive ion beam facility ISOLDE at CERN, is a high-precision Penning-trap mass spectrometer for short-lived nuclides. This gives access to the study of nuclear-structure effects and provides precision β-decay Q-values to test nuclear models and fundamental interactions. Previously, the measurement principle has been the time-of-flight ion-cyclotron-resonance (ToF-ICR) technique, which limits accessible half-lives and relative uncertainties. With the new phase-imaging ion-cyclotron-resonance (PI-ICR) technique [S. Eliseev et al., Phys. Rev. Lett. 110 082501 (2013)], experiments can be performed with fewer ions and higher resolving power, providing access to new areas of the nuclear chart and to new physics.

This contribution will report on the status of PI-ICR mass spectrometry (MS) with ISOLTRAP, including results from first on-line measurements in both the high-resolution and high-precision regimes. In particular, the Q-value of the ^{131}Cs$\rightarrow^{131}$Xe β-decay, previously considered as a candidate for the direct neutrino-mass determination, was measured with a precision $\delta m/m = 1.4 \cdot 10^{-9}$ and a mass resolving power $m/\Delta m > 7 \cdot 10^6$ in only 100 ms measurement time allowing to preclude it as a possible candidate in the neutrino-mass search.

HK 22.3 Di 14:45 HS 16

High-Precision Collinear Laser Spectroscopy - Towards All-Optical Nuclear Charge Radius Determination — •Phillip Imgram, Kristian König, Jörg Krämer, Tim Ratajczyk, and Wilfried Nörtershäuser — Institut für Kernphysik, TU Darmstadt

In recent measurements with the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at TU Darmstadt, the rest-frame transition frequencies of Ba$^+$ ions were determined with unprecedented accuracy. This precision will be used in the future to test precise atomic many-body calculations and especially for the determination of nuclear charge radii from an all-optical approach by the spectroscopy of Li-like light ions. Such ions will be produced in an Electron Beam Ion Source (EBIS) with a rather large energy spread and a widely broadened spectral linewidth is expected. A so-called pump-and-probe procedure will be used to reduce the experimentally observed linewidth. Here, only one velocity class is selected with a laser through optical pumping in a first step. Afterwards, only the selected ions are probed with a second laser and a largely reduced linewidth will be observed. This procedure has been demonstrated with In$^+$ ions and the results are presented in this talk.

HK 22.4 Di 15:00 HS 16

Testing the mass surface of the nuclear chart with ISOLTRAP — •Ivan Kulikov for the ISOLTRAP-Collaboration — GSI, Darmstadt, Germany

The atomic nucleus is pictured as a system of bound nucleons. The mass of each nuclide results from the sum of the masses of the nucleons minus the binding energy of the system. The mass surface of the nuclear chart is built from the masses of all stable and radioactive nuclides. On this surface nuclear structure effects are seen as sudden irregularities. Additionally, nucleosynthesis and nuclear structure models are constrained by accurately known masses of nuclei.

Precise mass measurements are routinely carried out by the online Penning-trap mass spectrometer ISOLTRAP, based at the radioactive ion-beam facility ISOLDE/CERN [S. Kreim et al., Nucl. Instrum. Meth. B 317, 492-500 (2013)]. New mass investigations of ^{69,70}As, $^{49-51}$Sc and ^{72,73}Br were performed during the latest experiment campaigns. The measurements were accomplished by using multi-reflection time-of-flight mass spectrometry and the Penning-trap based time-of-flight ion-cyclotron-resonance detection technique. The masses of ^{69,70}As and $^{49-51}$Sc were previously known only through their β decay Q-values.

The new mass data provides an important test of the nuclear models in this region of the mass surface. This contribution will present results of the aforementioned measurements and discuss the impact of the refined mass values on the neighbouring isotopes.

HK 22.5 Di 15:15 HS 16

MIRACLS: The Multi Ion Reflection Time of Flight Apparatus for Collinear Laser Spectroscopy — •Simon Lechner[1,2], Paul Fischer[3], Hanne Heylen[1], Varvara Lagaki[1,3], Franziska Maier[4], Wilfried Nörtershäuser[5], Peter Plattner[1,6], Marco Rosenbusch[3], Lutz Schweikhard[3], Simon Sels[1], Frank Wienholtz[1,3], and Stephan Malbrunot-Ettenauer[1] — [1]CERN, Switzerland — [2]TU Wien, Österreich — [3]Universität Greifswald, Deutschland — [4]Johannes Kepler Universität, Österreich — [5]TU Darmstadt, Deutschland — [6]Universität Innsbruck, Österreich

Collinear laser spectroscopy (CLS) is a powerful tool to access nuclear ground state properties of short-lived radionuclides [1]. However, in order to explore the most exotic nuclides far away from stability, more sensitive methods are needed.

For this reason, the novel MIRACLS project at ISOLDE/CERN, aims to combine the high spectral resolution of conventional CLS with high experimental sensitivity. This is achieved by trapping ion bunches in a 30 keV MR-ToF (Multi-Reflection Time of Flight) device, which greatly enhances the observation time and hence, the sensitivity, while retaining the high resolution of CLS.

This presentation will introduce the MIRACLS concept, present the first results from a proof-of-principle experiment and give an outlook to the design of a 30 keV MR-ToF apparatus including a compact, linear Paul trap for optimal beam preparation.

[1] K. Blaum, et al., Phys. Scr. T152, 014017 (2013)

HK 22.6 Di 15:30 HS 16

Recent upgrades of the multiple-reflection time-of-flight isobar separator and mass spectrometer at TITAN, TRIUMF — •Gabriella Kripkó-Koncz for the TITAN-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

Measuring the atomic mass is critical to understand nuclear structure and astrophysics. Exotic nuclei can be produced with very high rates at the ISOL facility ISAC at TRIUMF (Vancouver, Canada). TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) is a multiple ion-trap system for high-precision mass measurements and in-trap decay spectroscopy. A multiple-reflection time-of-flight isobar separator and mass spectrometer (MR-TOF-MS) has been integrated into the TITAN experiment. It is based on an established concept tested at the FRS Ion-Catcher at GSI. The ion of interest can be temporally separated from isobaric contaminations with mass-selective dynamic re-trapping. Furthermore, the device is well suited to perform high precision mass measurements, particularly for short-lived isotopes produced at low rate.

The improved capabilities of TITAN have been used in the first experiments to investigate the sub-shell closure of neutron-rich nuclides at N=32 and the r-process nucleo-synthesis for masses at A$\sim$85. Besides these first results, several technical upgrades of the MR-TOF-MS have been made and will be presented.