HK 1: Invited Talks I

Time: Monday 11:15–12:45 Location: H-HS X

Prize Talk HK 1.1 Mon 11:15 H-HS X

50 Years of Online Optical Spectroscopy and Mass Spectrometry — •H.-Jürgen Kluge — GSI, Darmstadt — University of Heidelberg — Laureate of the Robert Wichard Pohl Prize 2020

Inspired by the observation of the parity violation in the fifties of the last century, Ernst Otten proposed and performed in 1970 at ISOLDE/CERN the very first online optical spectroscopy of short-lived isotopes at an accelerator facility. Neutron-deficient mercury isotopes were polarized by optical pumping by use of a spectral lamp. Its circular-polarized light was made tunable via the Zeeman effect by applying a magnetic field to the Hg discharge lamp. The resulting beta-asymmetry allowed to determine spin, moments, shape, and size. This led to the first observation of nuclear shape coexistence.

Before 1985, the binding energies or masses of radionuclides had been determined via observation of nuclear decays or reactions with often rather large uncertainties and were sometimes simply wrong. In 1985, ISOLTRAP was installed at ISOLDE, the very first online Penning trap facility for determining the masses of short-lived isotopes. Since then the atomic masses of over 400 radionuclides could be determined by ISOLTRAP with a relative uncertainty of 10-7 or better.

With the invention of tunable lasers by T. Hänsch in 1971 and the further development of ion traps, lasers, and spectroscopic methods, these atomic-physics methods have become workhorses for investigating nuclear ground state properties far from stability at accelerators world-wide.

Invited Talk HK 1.2 Mon 11:45 H-HS X

Precision laser spectroscopy studies on exotic tin isotopes. — •Liss Vazquez Rodriguez — Max-Planck-Institut für Kernphysik, D-69117 Heidelberg, Germany

The atomic nucleus is a complex many-body quantum system that possesses fundamental properties, such as spin and electromagnetic moments considered as valuable inputs for the determination and testing of nuclear models. The systematic investigation of these observables along an isotopic (isotonic) chain reveals progressive changes in structure with respect to the number of valence nucleons. The tin (Z=50) isotopes form the longest known isotopic chain in the nuclear landscape accessible to current experimental studies with the highest number of stable isotopes (ten). Therefore, they are in the center stage of this powerful line of inquiry.

High-resolution laser spectroscopy has been performed on a long sequence of tin species, spanning from N=58 to the very neutron-rich isotope ^{134}Sn, using the COLLAPS instrumentation at ISOLDE- CERN. From the perturbation and splitting of the electronic energy levels by the nucleus, nuclear spin and electromagnetic moments have been extracted for 38 nuclei including 11 isomers. The quadrupole moments, determined with higher precision than former measurements, show regularities that will be discussed in the framework of *"simple structure in complex nuclei"*. Special attention will be paid to the ^{133}Sn nucleus, one of the eight nuclei observed so far which has a single neutron outside a doubly-magic core, as a key for the investigation of single-particle characters away from stability.

Invited Talk HK 1.3 Mon 12:15 H-HS X

Pushing the frontiers in mass measurements of short-lived exotic nuclei — •Timo Dickel — Justus-Liebig-Universität Gießen — GSI Helmholtzzentrum für Schwerionenforschung

Recently, high-performance multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) have been developed at Justus Liebig University Gießen for the mass measurement of exotic nuclei. They have been used to perform experiments at the FRS Ion Catcher experiment at the in-flight fragment separator FRS at GSI and at the TITAN experiment at the ISOL facility of TRIUMF, Canada. Unprecedented sensitivity and mass resolving powers (up to one million) have been reached. Very exotic and short-lived ground and isomeric states (half-lives down to less than 2 ms) over a large range of elements have been measured. The experiments provide important information for nuclear structure and nuclear astrophysics. In addition, the use of these MR-TOF-MS goes even beyond these applications, e.g. they can be employed to unambiguously identify and analyze ions independent of their decay properties. This enables novel and universal approaches to measure reaction cross-sections, fission yields, half-lives, and branching ratios. Recent highlights and perspectives from both experiments at GSI and TRIUMF will be presented.