MS 1: Precision Mass Spectrometry and Fundamental Applications I

Time: Monday 14:30–16:30 Location: RW 2

Invited Talk MS 1.1 Mon 14:30 RW 2

Mass Measurements at LEBIT — •Martin Eibach[1,2], G. Bollen[1,3], K. Gulyuz[1], C. Izzo[1,3], M. Redshaw[4], R. Ringle[1], and S. Schwarz[1] — [1]Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan 48824, USA — [2]Institut für Physik, Ernst-Moritz-Arndt-Universität, 17487 Greifswald, Germany — [3]Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824, USA — [4]Department of Physics, Central Michigan University, Mount Pleasant, Michigan 48859, USA

Reflecting the sum of all interactions inside a nucleus, its mass is an important characterizing property. Precisely known nuclear masses are an integral part in several different fields of fundamental science. Calculations of the astrophysical r-process, nuclear structure studies, and investigations of fundamental interactions require mass measurements of rare isotopes. Mass data of highest precision is obtained by Penning trap mass spectrometers such as LEBIT located at the National Superconducting Cyclotron Laboratory. The rare isotopes of interest are produced by heavy-ion fragmentation and subsequent in-flight separation and delivered to LEBIT which uses the destructive time-of-flight ion cyclotron resonance technique. As one moves further from the valley of stability, production rates of the exotic isotopes decline. In order to access rare isotopes being delivered at low rates, the Single Ion Penning trap is being developed using the FT-ICR technique.
We report on the present status of the SIPT development and also emphasize the impact of mass measurements with LEBIT on the topics of nuclear structure and fundamental interactions.

Invited Talk MS 1.2 Mon 15:00 RW 2

Precision mass measurements in the context of neutrino-nuclear physics — •Milad Alanssari[1], Dieter Frekers[2], and Tommi Eronen[3] — [1]University Muenster, Inst. f. Nucl. Phys., 48149 Muenster, Germany — [2]University Muenster, Inst. f. Nucl. Phys., 48149 Muenster, Germany — [3]University Jyvaskyla, Dept of Phys., Jyvaskyla FI-40014, Finland

High-precision mass measurements will be presented. The overall context is neutrino-nuclear physics. The measurements were performed at the IGISOL/JYFLTRAP facility of the University of Jyvaskyla, Finland.

After a brief and general introduction about precision mass measurements, double beta-decay and neutrino physics, emphasis will be on mass determinations for the A=96 triplet, i.e., 96Zr, 96Nb, and 96Mo. Of special importance is the 96Zr to 96Nb single beta-decay Q-value. The single beta-decay is an alternative decay to the 96Zr double beta-decay, and its observation could provide one of the most direct tests of theoretical models aimed at calculating the neutrinoless double beta-decay. The decay may also shed light onto the quenching of the axial-vector coupling constant gA.

The second part centers around a precision measurement of the 71Ga to 71Ge neutrino reaction Q-value. This Q-value had been discussed in the context of the "gallium anomaly" observed in the calibration of the SAGE and GALLEX neutrino detectors. The present precision value finally excludes the possibility of the observed "anomaly" being the result of wrongly assumed nuclear physics input.

MS 1.3 Mon 15:30 RW 2

A high-precision experiment for the determination of the atomic mass of the proton — •Fabian Heisse[1,2], Sven Junck[3], Florian Köhler-Langes[1], Andreas Mooser[4], Wolfgang Quint[2], Sascha Rau[1], Stefan Ulmer[4], Günter Werth[3], Klaus Blaum[1], and Sven Sturm[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]GSI-Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [4]RIKEN Ulmer Initiative Research Unit, Saitama 351-0198, Japan

The proton, together with the electron and the neutron, form the central building blocks of the visible universe. The precise knowledge of its properties, among others its atomic mass, is of great interest for high-precision tests as well as for metrology.
We have started an experiment to determine the proton's atomic mass $\mathrm{m_p}$ to $\delta\mathrm{m_p}/\mathrm{m_p} = 10^{-11}$ or better. The measurement principle is based on a simultaneous phase-sensitive comparison of the proton's cyclotron frequency to that of a bare carbon nucleus ($^{12}C^{6+}$) in a Penning trap. A new cryogenic Penning-trap setup with a highly advanced magnetic shimming system has been built to achieve ultra stable measurement results.
The status of the experiment, such as the detection of single protons and carbon ions as well as the first results of the optimization of the seven-electrode cylindrical Penning trap, will be presented.

MS 1.4 Mon 15:45 RW 2

HF switches for high-precision experiments including ultra cold ions — •Sven Junck[1], Fabian Heisse[2,3], Florian Köhler - Langes[2], and Sven Sturm[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, D - 55099 Mainz — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D - 69117 Heidelberg — [3]GSI-Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt

A new generation of Penning trap experiments, aiming for high-precision QED tests in extremely strong fields, a new approach to determine the fine-structure constant and most precise measurements of the atomic masses of the proton as well as the neutron, are currently commissioned. The central measurement routine will be based on the phase-sensitive measurement technique PnA [1]. Tapping its full potential by working at the lowest accessible temperatures, resonators for detection and cooling need to be tuned and detuned in a fast and reliable way. Such tuning requires cryogenic switches for various capacities that feature negligible noise in either open or closed state. Because this is not the fact for commonly used semiconductor switches a new kind of switch has been designed which is based on the principle of bistable relays. The design's status and its applicability to improve the phase-sensitive image charge detection technique will be discussed.
[1] Sturm, S., A. Wagner, B. Schabinger, and K. Blaum: 'Phase-Sensitive Cyclotron Frequency Measurements at Ultralow Energies'. Phys. Rev. Lett. (14 2011), vol. 107: p. 143003.

MS 1.5 Mon 16:00 RW 2

Implementation of the phase-imaging ion-cyclotron resonance detection technique at ISOLTRAP/CERN — •J. Karthein[1], P. Ascher[2], D. Atanasov[1], K. Blaum[1], T. E. Cocolios[3], F. Herfurth[4], M. Kowalska[5], D. Lunney[6], V. Manea[5], M. Mougeot[6], D. Neidherr[4], M. Rosenbusch[7], L. Schweikhard[7], A. Welker[5,8], F. Wienholtz[5,7], R. Wolf[1], and K. Zuber[8] — [1]MPIK, Heidelberg, Germany — [2]CENBG, France — [3]KU Leuven IKS, Belgium — [4]GSI, Darmstadt, Germany — [5]CERN, Geneva, Switzerland — [6]CSNSM-IN2P3-CNRS, Université Paris-Sud, Orsay, France — [7]Institut für Physik, Universität Greifswald, Germany — [8]TU Dresden, Germany

The Penning-trap mass spectrometer ISOLTRAP located at the radioactive ion beam facility ISOLDE at CERN performs high-precision mass measurements of short-lived nuclides. This gives access to the study of nuclear structure effects like the location of shell and sub-shell closures and beta-decay Q-values, providing tests of nuclear models and even the Standard Model of elementary particles. For three decades the measurement principle was based on a destructive time-of-flight ion cyclotron resonance detection method, which is reaching its limits now in accessible half-lives and relative uncertainties. With the new phase-imaging ion-cyclotron-resonance (PI-ICR) [PRL 110, 082501] detection technique, experiments can be performed with much less measurement time, providing access to new areas of the nuclear chart. This talk will report on the implementation of the PI-ICR technique as well as results from our first offline and online studies.

MS 1.6 Mon 16:15 RW 2

Status report on the on-line coupling of the TRIGA-TRAP experiment to the research reactor TRIGA Mainz — •Jessica Grund[1,2,3], Klaus Blaum[4], Michael Block[2,3,5], Stanislav Chenmarev[4], Christoph E. Düllmann[1,2,3,5], Klaus Eberhardt[1,2,3], Jacques J. W. van de Laar[1,2,3], Steffen Lohse[2,3], Szilard Nagy[4], Pascal Naubereit[6], Fabian Schneider[2,3], and Klaus Wendt[1,2] — [1]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität, Mainz — [2]Institut für Kernchemie, Johannes Gutenberg-Universität, Mainz — [3]Helmholtz-Institut Mainz, Mainz — [4]Max-Planck-Institut für Kernphysik, Hei-

delberg — [5]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [6]Institut für Physik, Johannes Gutenberg-Universität, Mainz

Experimental data on ground-state properties of exotic nuclei are of interest for nuclear structure studies and allow testing the predictive power of nuclear mass models. Besides off-line measurements on long-lived transuranium isotopes, high-precision mass measurements on short lived nuclides can be performed at TRIGA-TRAP, thanks to the on-line coupling to the research reactor TRIGA Mainz. Neutron rich nuclides are produced by neutron-induced fission of U-235 inside the reactor, extracted by an aerosol-based gas-jet system and guided through a skimmer system to a high-temperature surface ion source. To improve the ionization efficiency, a new ion source has been successfully implemented in collaboration with JAEA/Tokai. An overview of the current status and latest results on the performance will be presented.