MS 2: Precision Mass Spectrometry and Fundamental Applications II

Time: Monday 14:00–15:30 Location: F 442

Invited Talk MS 2.1 Mon 14:00 F 442

The application of high-precision atomic masses in neutrino physics — •Szilard Nagy — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt

The rest mass and the Majoranna or Dirac nature of neutrinos are still open questions in physics. By searching for neutrinoless double-beta decay or neutrinoless double-electron-capture transitions and studying the kinematics of beta-decays the true identity of neutrinos is expected to be uncovered. In these decay processes the mass difference of the mother and daughter atoms plays a key role therefore its accurate and precise knowledge is important. Penning-trap mass spectrometers are the most suitable tools for such measurements. Due to the contribution of Penning traps in the past years the interest in this field has been revived triggering also new theoretical calculations. Our latest results including the masses of several Cd, Pd, Os and W isotopes measured with TRIGA-TRAP will be presented [1,2].

[1] C. Smorra. *et al.*, Phys. Rev. C **85**, 027601 (2012)
[2] C. Smorra. *et al.*, Phys. Rev. C **86**, 044604 (2012)

MS 2.2 Mon 14:30 F 442

Mass separation with ISOLTRAP's MR-ToF — •R. Wolf[1], D. Atanasov[2], D. Beck[3], K. Blaum[2], Ch. Böhm[2], Ch. Borgmann[2], M. Breitenfeldt[4], R. B. Cakirli[2,5], N. Chamel[6], S. George[1], S. Goriely[6], F. Herfurth[3], M. Kowalska[7], S. Kreim[2,7], D. Lunney[8], V. Manea[8], E. Minaya Ramirez[3,9], S. Naimi[10], D. Neidherr[2,3], M. Rosenbusch[1], L. Schweikhard[1], J. Stanja[11], F. Wienholtz[1], and K. Zuber[11] — [1]Ernst-Moritz-Arndt-Universität, Institut für Physik, 17487 Greifswald — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [4]Katholieke Universiteit, 3000 Leuven, Belgium — [5]University of Istanbul, Istanbul, Turkey — [6]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, 1050 Brussels, Belgium — [7]CERN, CH-1211 Geneva, Switzerland — [8]CSNSM-IN2P3-CNRS, Université Paris-Sud, Orsay, France — [9]Helmholtz-Institut Mainz, 55099 Mainz — [10]RIKEN, Saitama 351-0198, Japan — [11]Technische Universität Dresden, 01069 Dresden

A contaminant-free beam is a crucial condition for mass measurements of short-lived nuclides on an uncertainty level of $\delta m/m = 10^{-8}$, as performed with ISOLTRAP at CERN-ISOLDE. The radioactive beam delivered by an ISOL facility contains a mixture of isobars, where far from stability the ions of interest often amount to only a minute fraction, drowned by contamination. ISOLTRAP has been upgraded with a multi-reflection time-of-flight (MR-ToF) mass analyzer and a Bradbury Nielsen gate, primarily intended as an auxiliary device to provide a faster purification of isobaric mixtures. Mass-resolving power of 10^5 and a contamination suppression of 10^4 have been reached in only a few tens of milliseconds, which decreases the purification period by over an order of magnitude compared to mass-selective buffer-gas centering in a dedicated Penning trap. On the one hand, the system can be used as the only mass separator and selector for very short-lived nuclides, where the buffer-gas filled Penning trap acts only for cooling and bunching. On the other hand, for intermediate half-lives and very high contamination to ion of interest ratios, several Penning-trap capture cycles can be performed to filter the few or even the only one ion of interest, for the actual mass measurement. This improves the ion-of-interest throughput by more than a factor of 10. The application of this method, e.g for the mass measurement of ^{82}Zn and its astrophysical impact on the neutron-star crust, will be presented.

MS 2.3 Mon 14:45 F 442

Precision mass measurements of exotic Calcium isotopes using ISOLTRAP's multi-reflection time-of-flight (MR-ToF) mass spectrometer — •Frank Wienholtz[1], Dietrich Beck[2], Klaus Blaum[3], Christopher Borgmann[3], Martin Breitenfeldt[4], R. Burcu Cakirli[3,5], Sebastian George[1], Frank Herfurth[2], Jason D. Holt[6,7], Magdalena Kowalska[8], Susanne Kreim[3,8], David Lunney[9], Vladimir Manea[9], Javier Menendez[7,6], Denis Neidherr[2], Marco Rosenbusch[1], Lutz Schweikhard[1], Achim Schwenk[7,6], Johannes Simonis[6,7], Juliane Stanja[10], Robert Wolf[1], and Kai Zuber[10] — [1]Ernst-Moritz-Arndt-Universität, Institut für Physik, 17487 Greifswald, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [3]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [4]Katholieke Universiteit,3000 Leuven, Belgium — [5]University of Istanbul, Istanbul, Turkey — [6]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [7]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [8]CERN, CH-1211 Geneva, Switzerland — [9]CSNSM-IN2P3-CNRS, Université Paris-Sud, Orsay, France — [10]Institut für Kern- und Teilchenphysik, Technische Universität Dresden, 01069 Dresden, Germany

State-of-the-art precision measurements on radioactive ions have been performed with the Penning-trap mass spectrometer ISOLTRAP at CERN. Minute production rates often accompanied by huge isobaric background and millisecond half-lives pose enormous challenges on the experimental setup and often require new experimental techniques. The ISOLTRAP setup has recently been enhanced with an electrostatic mirror ion trap acting as a multi-reflection time-of-flight mass separator (MR-ToF MS) for beam purification. It can likewise be used as a spectrometer in combination with a suitable detector increasing the mass-measurement capability of ISOLTRAP considerably. The measurements on the calcium isotopic chain will be presented together with the nuclear structure they reveal. The measurements up to ^{54}Ca are compared with predictions from models that utilize three-body nuclear forces.

MS 2.4 Mon 15:00 F 442

Development of the high-capacity, Penning-trap isobar separator: PIPERADE — •Michael Heck[1], Pauline Ascher[1], Bertram Blank[2], Klaus Blaum[1], Pierre Dupré[3], Mathias Gerbaux[2], Stephane Grévy[2], Hugo Guérin[2], and David Lunney[3] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Centre d'Etudes Nucléaires de Bordeaux Gradignan, Université Bordeaux 1, UMR 5797 CNRS/IN2P3, Chemin du Solarium, BP 120, F-33175 Gradignan Cedex, France — [3]Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, IN2P3/CNRS-Université de Paris Sud, F-91405, Orsay, France

The set-up of PIPERADE will be used to purify the radioactive ion beam at the future SPIRAL2 facility of GANIL. The mass separation will be performed with a double Penning trap which will be built in a collaboration between the MPIK in Heidelberg, the CENBG in Bordeaux and the CSNSM in Orsay. The main requirements for this system are a high resolving power (10^5) for the separation of close masses and a high loading capacity ($> 10^7$) due to the large ratio between the amount of the isobaric contaminants and the ions of interest. First results from simulations and test measurements, performed to find an efficient cleaning method, will be presented. In particular some Coulomb effects have been investigated and new excitation methods have been tested and simulated.

MS 2.5 Mon 15:15 F 442

Performance Results and Operation Modes of a Mobile High-Resolution MR-TOF Mass Spectrometer for in-situ Analytics — •Johannes Lang[1], Timo Dickel[1,2], Hans Geissel[1,2], Wayne Lippert[1], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], and Mikhail Yavor[3] — [1]II. Physikalisches Institut, JLU Giessen — [2]GSI, Darmstadt — [3]RAS St. Petersburg

While conventional mobile MS are restricted to moderate performance, this multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) allows for the first time a mass resolving power exceeding 100,000 and sub ppm accuracy in a transportable format. Thus it allows to resolve isobars and enables to accurately determine the composition and structure of large biomolecules. The instrument offers further features along with high resolution, such as high resolution tandem MS and isobar separation.

The MR-TOF-MS consists of an atmospheric pressure interface for various atmospheric ion sources, RFQ beam preparation system (mass filter, ion cooler, ion trap), time-of-flight analyzer and detector. The complete instrument is mounted into a single frame with a total volume of only 0.8m^3. Future versions can be reduced in size even further to fit specialized applications.

A characterization of the system and results with atmospheric ion sources will be demonstrated. Special operation modes will be explained and an overview of life science application will be given, including realtime tissue recognition in electrosurgery, identification of mycotoxins and the analysis of soil samples for environmental studies.