MS 6: Präzisionsmassenspektrometrie und grundlegende Anwendungen

Zeit: Dienstag 14:30–16:00 Raum: 3E

Hauptvortrag MS 6.1 Di 14:30 3E

Penning Trap Mass Spectrometry for studies of short-lived nuclides — •Christine Weber — Department of Physics, University of Jyväskylä, Finland

The mass determination with a Penning trap spectrometer is based on a measurement of an ion's cyclotron frequency in a strong, homogeneous magnetic field. In recent years dedicated setups have been installed at on-line facilities, for example at ISOLDE/CERN, JYFL/Jyväskylä, and SHIP/GSI, where exotic nuclides are provided for direct experimental studies. Relative mass uncertainties of $\delta m/m$ around 10^{-8} are typically achieved for short-lived species.

Atomic masses or binding energies are among the fundamental properties of nuclides with a given proton and neutron number (Z, N). Their accurate knowledge is required for studies of nuclear structure or the modeling of astrophysical processes. Here, the masses of more than 50 nuclides in the vicinity of the rp-process path have been determined with SHIPTRAP and JYFLTRAP. Furthermore, relative measurements of mass differences allow a precise Q-value determination of selected species, for example superallowed beta-emitters for weak-interaction studies. In this presentation recent results as well as further applications and planned setups such as TRIGATRAP/Mainz will be presented.

MS 6.2 Di 15:00 3E

Nuclear mass measurements for nucleosynthesis studies at ISOLTRAP — •Martin Breitenfeldt for the ISOLTRAP-Collaboration — Institut für Physik, Ernst-Moritz-Arnd-Universität Greifswald

At the tripple trap mass spectrometer ISOLTRAP at ISOLDE/CERN mass measurements on exotic nuclides are performed down to a precision of $\delta m/m = 8 \cdot 10^{-9}$. These fundamental ground state property finds applications in many theoretical calculations in the broad field of nuclear physics and astrophysics. In 2007 the ISOLTRAP mass measurements focussed on nuclear structure and nucleosynthesis studies. The beam times were dedicated to the mass determination of neutron-deficient and neutron-rich nuclides relevant for the investigation of the rp- and r-process, respectively. For neutron-deficient Cd isotopes, close to the doubly magic ^{100}Sn and the end-point region of the rp-process, the first direct mass measurement of ^{99}Cd was performed, giving accurate data at the neutron shell closure N=50. Furthermore, measurements aimed at the masses of neutron-rich Ag and Cd nuclides, which will give input values for astrophysics calculations for the r-process, especially at the waiting point ^{130}Cd.

MS 6.3 Di 15:15 3E

Direkte Neutrinomassenbestimmung mit dem KATRIN-Experiment — •Kathrin Valerius für die KATRIN-Kollaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, D-48149 Münster

Das KArlsruher TRItium Neutrinomassenexperiment wird die Endpunktregion des Tritium-β-Spektrums mit hoher Präzision vermessen, um eine direkte Bestimmung der Masse des Elektron-Antineutrinos mit einer Sensitivität von 0.2 eV/c^2 durchzuführen. Eine fensterlose, gasförmige Tritiumquelle und ein hochauflösendes elektrostatisches Spektrometer mit magnetischer adiabatischer Kollimation ($\Delta E \approx 1$ eV bei einer maximalen Elektronenenergie von $E = 18.6$ keV), sowie ein segmentierter Elektronendetektor, bilden die Kernkomponenten des Experiments.

Das Experiment wird zur Zeit von einer internationalen Kollaboration am Forschungszentrum Karlsruhe aufgebaut. Der 23 m lange und 10 m durchmessende Ultrahochvakuumbehälter des Hauptspektrometers ist bereits seit Ende 2006 installiert. Zur Feinformung des Retardierungspotentials und zur Reduzierung der durch Sekundärelektronen aus Umgebungs- oder kosmischer Strahlung verursachten Untergrundrate wird der Tank mit einer abschirmenden zweilagigen Drahtelektrode ausgekleidet werden. Die weiteren KATRIN-Komponenten werden bis 2009/10 aufgebaut, so dass der Beginn der Messungen für 2010 erwartet wird.

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MS 6.4 Di 15:30 3E

Towards high-precision mass measurements of short-lived He, Li and Be nuclides at ISOLTRAP — •Dennis Neidherr[1], Klaus Blaum[1,2], Martin Breitenfeldt[3], Frank Herfurth[2], Alexander Herlert[4], Magdalena Kowalska[4], Sarah Naimi[5], and Lutz Schweikhard[3] — [1]Johannes Gutenberg-Universität, 55099 Mainz, Germany — [2]GSI, 64291 Darmstadt, Germany — [3]Ernst-Moritz-Arndt-Universität, 17487 Greifswald, Germany — [4]CERN, 1211 Geneva 23, Switzerland — [5]CSNSM, 91405 Orsay, France

Light nuclides are rather simple systems that can be calculated based on the basic nucleon-nucleon interaction . Some of these nuclei, like ^{6,8}He, ^{11}Li or ^{11}Be, exhibit a very interesting halo structure which can be probed by study of their ground state properties, such as the magnetic moment or the charge radius. The double-Penning-trap mass spectrometer ISOLTRAP at ISOLDE/CERN can address another important ground state property, the mass, which is crucial to derive a precise value of the charge radius. To this end, the cyclotron frequency of the short-lived radionuclides is measured. The ions produced and delivered by ISOLDE with a kinetic energy of 60 keV are decelerated in several steps. In the first step a RFQ buncher is used to stop, accumulate and cool the quasi-continuous ion beam. For light nuclides hydrogen gas has to be used in the buncher instead of helium to keep up the efficiency of the cooling process that would be hampered by RF heating. First results for the transmission and cooling efficiency of stable ^{4}He ions in the buncher, as well as simulation studies will be presented.

MS 6.5 Di 15:45 3E

Mass Measurements of Rare Isotopes with SHIPTRAP — •Michael Block for the SHIPTRAP-Collaboration — GSI, Planckstr. 1, 64291 Darmstadt

Accurate mass values of rare isotopes far away from the valley of β-stability are critical for the study of nuclear shell structure and for the benchmarking of nuclear models. Masses of rare isotopes are also of great importance for nuclear astrophysics to support the understanding of nucleosynthesis in the different capture processes. Penning trap mass spectrometers are powerful tools for performing mass measurements with high accuracy. The combination of in-flight separation with gas stopping and advanced ion-beam manipulation techniques has paved the way for mass measurements of rare isotopes produced in fusion-evaporation reactions. With these prerequisites the Penning trap mass spectrometer SHIPTRAP installed behind the SHIP velocity filter has been used for high-precision mass measurements of about sixty neutron-deficient rare isotopes. In two campaigns the masses of nuclei along the pathway of the rapid proton-capture process and of exotic rare-earth isotopes near and beyond the proton drip line were determined. For the first time the mass of the ground state proton emitter ^{147}Tm was measured. In addition, the location of the proton drip line for holmium was established unambiguously. Recently, a first step toward direct mass measurements of transactinides was made. The isotope ^{254}No was delivered from SHIP at a rate of about 4 ions/s and extracted from the SHIPTRAP gas cell as ^{254}No^{2+} with a rate that is sufficient to perform a direct mass measurement.