SYAM 2 Atomare Präzisionsmassenspektrometrie

Zeit: Montag 14:00–16:00 Raum: HU Senatssaal

Hauptvortrag SYAM 2.1 Mo 14:00 HU Senatssaal

Recent trends in the determination of nuclear masses — •Juha Äystö — Department of Physics, University of Jyväskylä, Finland

Mass of a nucleus results from its binding energy and masses of its constituent nucleons. Strength of binding, a result of strong interaction acting in a finite many-body system of protons and neutrons, carries fundamental information on the microscopic structure of the nucleus. Measurement of binding energy with relative precisions in the range from 10-6 to 10-8 is necessary to unravel predicted new phenomena in nuclear structure of exotic nuclei with abnormal proton to neutron number ratios. Precision measurements of nuclear masses have also important role in nuclear astrophysics and fundamental symmetries and interactions.

This talk presents recent trends and some precision studies of masses of exotic nuclei with high neutron-excess of interest for nuclear structure and shapes of nuclei, as well as of neutron-deficient nuclei of interest for nucleosynthesis in stellar processes. These measurements have become possible only recently due to employment of Penning traps coupled to fast injection of ions. The talk will discuss selected results from the ISOLTRAP facility at CERN and the IGISOL facility at the University of Jyväskylä in Finland.

Hauptvortrag SYAM 2.2 Mo 14:30 HU Senatssaal

A Precision Mass Balance Using Highly Charged Ions — •Reinhold Schuch[1], Szilard Nagy[1], Birgit Brandner[1], Marcus Suhonen[1], Tomas Fritioff[2], Klaus Blaum[2], and Ingmar Bergström[3] — [1]Atomic Physics Division, Stockholm University, AlbaNova, S-10691 Stockholm, Sweden, e-mail: schuch@physto.se — [2]CERN, 1211 Geneva, Switzerland — [3]Manne Siegbahn Laboratory(MSL), 104 05 Stockholm, Sweden

Precision mass measurements are done with the SMILETRAP Penning trap mass spectrometer, located at MSL in Stockholm. It exploits the merits of highly charged ions retrapped from an electron beam ion source. These ions are retarded in a first cylindrical Penning trap and a fraction of them is sent to the hyperbolic precision Penning trap. There it is possible to measure the cyclotron frequencies of such ions with 10-8 resolution [1] using the time-of-flight technique. The relevant observable in our mass measurement is the ratio of the cyclotron frequencies of the ion of interest and an ion used as a mass reference. In order to reduce the influence of changes to the magnetic field, both frequencies are measured within as short a time as two minutes. Several mass measurements with a relative uncertainty in the region of 0.3 to a few ppb have been performed, using ions with charge states 1+ to 52+[2]. The latest achievements will be reported.

[1] I. Bergström, C. Carlberg, T. Fritioff, G. Douysset, J. Schönfelder and R. Schuch, NIM A487, 618-651 (2002)
[2] T. Fritioff, H. Bluhme, R. Schuch, I. Bergström and M. Björkhage, Nuclear Physics A, Volume 723, 3-12 (2003)

Hauptvortrag SYAM 2.3 Mo 15:00 HU Senatssaal

Precision mass spectrometry with one and two ions in a Penning trap — •Edmund Myers — Florida State University

In the 1990's the development of the MIT atomic mass spectrometer produced 13 atomic masses at 10^{-10} relative precision. These results formed the MIT precision atomic mass table with application to fundamental constants. This mass spectrometer has several special features such as a detector based on a dc-SQUID, and the use of a 'pulse and phase' technique, analogous to the Ramsey Separated-Oscillatory-Field method, for measuring the cyclotron frequency. In the last few years another new and unique technique has been developed. The two ions to be compared are created in the same trap and positioned in a coupled magnetron orbit. Their cyclotron frequencies are then measured simultaneously. This method suppresses sensitivity to magnetic field fluctuations and uncertainty in the measurement of the axial frequency by two or three orders of magnitude. Successful demonstration of this technique at MIT has led to mass comparison at 7×10^{-12} precision, discovery of rotational-state-dependent polarization-induced cyclotron frequency shifts, and a new test of Einstein's '$E = mc^2$'. In 2003 the system was relocated to Florida State University. In Tallahassee additional mass measurements at the 10^{-10} level using single-ion techniques have been completed. Further development of the sub-10^{-11} two-ion technique, for a high precision atomic mass comparison of tritium/helium-3 relevant to neutrino mass, is in progress.

Hauptvortrag SYAM 2.4 Mo 15:30 HU Senatssaal

Highly Accurate Measurements of Particle and Antiparticle Masses — •Gerald Gabrielse — University of Harvard, 17 Oxford Street, Cambridge, MA 02138, USA

The mass of individual elementary particles can be probed with exquisite precision by listening to the radio signal from a single elementary particle. The annihilation of antimatter particles can be avoided by suspending them in electric and magnetic fields. Examples of direct and indirect mass measurements of particles and antiparticles will be given.