A 8: Precision Spectroscopy III

Zeit: Dienstag 14:00–16:00 Raum: 6G

Hauptvortrag A 8.1 Di 14:00 6G

Antihydrogen studies with ATHENA — •Alban Kellerbauer — Max-Planck-Institut für Kernphysik, Postfach 103980, 69029 Heidelberg

The ATHENA experiment at CERN was the first to produce cold antihydrogen atoms in 2002 by mixing antiprotons and a positron plasma. During the following years, the antihydrogen formation processes and the properties of the produced anti-atoms were studied in detail. The setup of the experiment will be briefly reviewed and the most recent results presented.

A 8.2 Di 14:30 6G

Relativistic coupled-cluster theory of parity non-conservation in atomic systems — •Bijaya Kumar Sahoo — Max-Planck institute for the physics of complex systems

Our present understanding of elementary particle physics is encapsulated in the Standard Model (SM). Despite the remarkable success of this model, it is assumed as an intermediate manifestation of a complete theory. Parity non-conservation (PNC) in atomic systems which arises primarily from the neutral weak interaction between the electrons, and the nucleus has the potential to probe new physics beyond the SM. By combining the results of high precision measurements, and many-body calculations of atomic PNC observables, it is possible to extract the nuclear weak charge (Q_W), and compare with the corresponding value in the SM. A discrepancy between these two values could reveal the possible existence of new physics. We shall demonstrate application of the full fledged relativistic coupled-cluster theory which incorporates all the single,double and leading triple excitations to calculate parity non-conserving E1 amplitude in Ba^+.

A 8.3 Di 14:45 6G

The HITRAP Cooler Trap: simulation of cooling of highly-charged ions in a Penning trap with a Particle-In-Cell code — •Giancarlo Maero[1], Frank Herfurth[1], Oliver Kester[1], Jürgen Kluge[1], Stephen Koszudowski[1], Wolfgang Quint[1], Stefan Schwarz[2], and Günter Zwicknagel[3] — [1]GSI Darmstadt, Germany — [2]MSU, East Lansing, USA — [3]Universität Erlangen, Germany

In the HITRAP facility heavy and highly-charged ions up to U^{92+} will be stopped and cooled in order to perform experiments on atomic properties, like collision studies, precision measurements and hyperfine spectroscopy. The Cooler Trap is designed to catch 10e5 particles, cool them down to 4 K and manipulate them before extraction in both pulsed and quasi-continuous modes. Therefore simulation of the dynamics of the bunch from injection to extraction is necessary. The processes occurring during the 10 s stay of the ions in the Penning trap, all of which need a numerical investigation, are particle cloud formation in the presence of space charge, electron and resistive cooling. We give an overview of the setup and show the results obtained with a PIC (Particle-In-Cell) code built for this purpose.

A 8.4 Di 15:00 6G

Mass measurements with SHIPTRAP in the endpoint-region of the rp-process — •Ana Martín[1], D. Ackermann[1], M. Block[2], A. Chaudhuri[3], S. Eliseev[1], F. Herfurth[1], F.P. Hessberger[1], S. Hofmann[1], H.-J. Kluge[1], G. Maero[1], J.B. Neumayr[4], W. Plass[5], C. Rauth[1], L. Schweikhard[3], P.G. Thirolf[4], and G. Vorobjev[1] — [1]GSI — [2]NSCL — [3]Universität Greifswald — [4]Universität München — [5]Universität Gießen, for the SHIPTRAP collaboration.

SHIPTRAP works nowadays as a precision Penning trap mass spectrometer for the products of the fusion-evaporation reactions generated at the velocity filter SHIP at GSI. The fusion evaporation residues are stopped in a helium-gas filled stopping cell. The ions are guided by an extraction RFQ structure, and enter an RFQ buncher for accumulation and cooling. The generated bunch of ions is later injected in the double Penning trap system placed in a superconducting magnet of 7 T. The first trap is dedicated to the isobaric selection of the sample and the second one to the mass measurement using the TOF-ICR method.

Mass measurements can help determining nucleo-synthesis paths if the uncertainty of the mass measurement is no larger than 10 keV for the waiting point nuclei. In February 2006, two runs took place at SHIPTRAP in order to study the end point region of the rp-process. A target of ^{58}Ni was irradiated with a ^{58}Cr beam during the first run and a ^{58}Ni beam during the second one. The masses of 24 isotopes in the ^{100}Sn region were determined with relative uncertainties between $1 \cdot 10^{-7}$ and $5 \cdot 10^{-8}$.

A 8.5 Di 15:15 6G

Status von HITRAP und Planung der Inbetriebnahme* — •Oliver Kester[1], Klaus Blaum[2], Sergey Eliseev[1], Frank Herfurth[1], Heinz-Jürgen Kluge[1], Christophor Kozhuharov[1], Stephen Koszudowski[1], Giancarlo Maero[1], Wolfgang Quint[1], Alexey Sokolov[1], Thomas Stöhlker[1], Gleb Vorobjev[1], Manuel Vogel[1], Danyal Winters[1], Wilfried Nörtershäuser[2] und Ludwig Dahl[1] — [1]GSI Darmstadt, Planckstrasse 1, D-64291 Darmstadt — [2]Institut für Physik, Uni-Mainz, Staudingerweg 7, 55128 Mainz

Das HITRAP Projekt zum Abbremsen, Einfangen und Kühlen höchstgeladener Ionen an der GSI, befindet sich im Aufbau im Re-Injektionskanal zwischen Experimentierspeichering (ESR) und Schwerionensynchrotron (SIS). Ziel des Projektes sind Experimente mit intensiven, gekühlten Strahlen von extrem hochgeladenen Ionen bis zu Uran 92+ bei niedrigen Energien. Die Experimente an HITRAP umfassen unter anderem Präzisions- und Laserspektroskopie, neuartige Studien zur Wechselwirkung von Ionen mit Oberflächen, sowie Stossexperimente mit vollständiger kinematischer Analyse. Nachdem die Berechnungen der Strahldynamik und der HF-Eigenschaften der Linearbeschleunigerstrukturen in 2006 fertiggestellt wurden, sind sämtliche Komponenten der Strahllinie in der Fertigung oder z.T. an die GSI ausgeliefert worden. Die erste Sektion des Linearbeschleunigers soll in einer Teststrahlzeit im Mai 2007 in Betrieb genommen werden.

A 8.6 Di 15:30 6G

Eine Penningfalle für die Präzisions-Laserspektroskopie an hochgeladenen Ionen — •Jörg Krämer[1], Zoran Andjelkovic[1], Christopher Geppert[2], Manuel Vogel[2], Danyal Winters[2] und Wilfried Nörtershäuser[1,2] — [1]Johannes Gutenberg Universität Mainz, Deutschland — [2]GSI Darmstadt, Deutschland

Mit Hilfe der Speicherung in einer kryogenen Penning-Falle soll Laserspektroskopie an Hyperfeinstruktur-Übergängen in hochgeladenen Ionen mit einer relativen Auflösung $\Delta\nu/\nu$ von 10^{-7} durchgeführt werden. Dies erlaubt Tests der QED auf dem Prozent-Niveau. Wir präsentieren eine zylindrische Penningfalle, die speziell für diesen Zweck entwickelt wurde und stellen off-line Testmessungen vor. Später sollen hochgeladene Ionen, wie etwa $^{207}Pb^{81+}$ an HITRAP an der GSI Darmstadt erzeugt und in diese Falle überführt werden. Es ist vorgesehen, etwa 10^5 dieser Ionen in die Falle einzufangen und auf Temperaturen von etwa 4 K zu kühlen. Dadurch kann die Dopplerverbreiterung der Resonanzlinien auf einige 10 MHz in etwa 10^{14} reduziert werden, was die geplanten Messungen zwei Größenordnungen präziser macht als alle vorangegangenen. Ebenso verwendet diese Falle eine "rotating wall"-Technik zur Kompression der gespeicherten Ionenwolke; damit werden Dichten von bis zu 10^9 Ionen pro Kubikzentimeter erreicht und entsprechend hohe Signal-zu-Rausch-Verhältnisse des Fluoreszenzlichts.

A 8.7 Di 15:45 6G

Test of a Penning Trap dedicated for Laser Spectroscopy of Highly Charged Ions — •Zoran Andjelkovic[1], Christopher Geppert[2], Jörg Krämer[1], Manuel Vogel[2], and Wilfried Nörtershäuser[1,2] — [1]Nuclear Chemistry, University of Mainz, Germany — [2]GSI, Darmstadt, Germany

Precision hyperfine structure measurements of highly charged ions are planed using a cryogenic Penning trap. Ions like $^{207}Pb^{81+}$, produced at the HITRAP at GSI Darmstadt, will be trapped and cooled down to temperatures of about 4 K via resistive cooling. Thus the Doppler broadening of the resonance lines can be reduced to some 10 MHz in a transition frequency of some 10^{14} Hz, which makes the planned measurements roughly two orders of magnitude more precise than all previous ones. We present the experimental setup for laser spectroscopy and first test measurements with $^{40}Ca^+$ ions where we operate the trap as an RF trap, as well as detection methods that will be applied.