A 23: Precision spectroscopy II

Zeit: Donnerstag 14:00–16:00 Raum: 3C

A 23.1 Do 14:00 3C

Design of a stable battery-based voltage — •Anke Wagner[1], Klaus Blaum[1,2], Wolfgang Quint[2], Birgit Schabinger[1], and Sven Sturm[1] — [1]Institute of Physics, Johannes Gutenberg-University, 55099 Mainz, Germany — [2]GSI Darmstadt, 64291 Darmstadt, Germany

For the high-precision measurement of the magnetic moment of the electron bound in highly-charged hydrogen-like calcium ions highly stable voltage sources are needed. [1] For those again a very stable supply voltage is required, which has to be independent of the electricity network in order to avoid noise and ground loops. Therefore, a battery-based voltage source was designed. Only one car-battery (12V) was used to generate the required output voltages (±15V, ±5V) by converting the dc-voltage into ac-voltage, amplifying, commutating and, finally, flattening it again. To control and monitor the voltages as well as the currents, a microcontroller, connected to the PC, is used. The circuit diagrams and the achieved voltage stability will be presented.

[1] M. Vogel *et al.*, Nucl. Inst. Meth. B **235**, 7 (2005)

A 23.2 Do 14:15 3C

Simulation of the dynamics of a cloud of highly-charged ions in a Penning trap for the HITRAP project — •Giancarlo Maero[1], Irene Chiarelli[1], Frank Herfurth[1], Oliver Kester[1], H.-Jürgen Kluge[1], Stephen Koszudowski[1], Wolfgang Quint[1], and Stefan Schwarz[2] — [1]GSI Darmstadt, Germany — [2]MSU, East Lansing, USA

Atomic physics investigations on cold, highly-charged ions will be possible in the next years at HITRAP, the GSI facility for the deceleration of heavy, highly-charged ions up to U^{92+}. Bunches of 10^5 ions will be trapped and cooled down to 4 K in the cooler Penning trap via electron and resistive cooling. A Particle-In-Cell (PIC) code has been developed to study the dynamics of the ion cloud during the cooling process. The challenges were the incorporation of the strong magnetic field and the implementation of the resistive cooling mechanism for a cloud of interacting ions. We discuss the results with emphasis on the space charge effects and the resistive cooling technique.

A 23.3 Do 14:30 3C

Inbetriebnahme und Status von HITRAP — •Oliver Kester, Ludwig Dahl, Frank Herfurth, Heinz-Jürgen Kluge, Christophor Kozhuharov, Wolfgang Quint und Thomas Stöhlker für die HITRAP-Kollaboration — GSI Darmstadt, Planckstrasse 1, D-64291 Darmstadt

An der GSI Darmstadt wird seit 2005 die "Highly charged Ion Trap"(HITRAP) Anlage aufgebaut. HITRAP dient zum Abbremsen, Einfangen und Kühlen hochgeladener schwerer Ionen bis zu nacktem Uran und soll Experimente mit solchen hochgeladenen Ionen mit extrem niederigen kinetischen Energien bedienen. Die Experimente an HITRAP umfassen unter anderem Präzisions- und Laserspektroskopie in Penningfallen, neuartige Studien zur Wechselwirkung von Ionen mit Oberflächen, sowie Stossexperimente mit vollständiger kinematischer Analyse. Die erste Sektion des HITRAP Linearbeschleunigers, welche die beiden Buncher Strukturen umfasst, ist in 2007 aufgebaut und mit Strahlen aus dem ESR getestet worden. Sämtliche Strahllinien-Komponenten bis zur Kühler-Penningfalle stehen zur Verfügung und werden sukzessive in die Strahllinie eingebaut. In 2008 werden die Kühler-Penningfalle, welche das Einfangen und Kühlen der hochgeladenen Ionen übernimmt und die restlichen Beschleunigerstrukturen in Betrieb genommen werden. Parallel dazu läuft der Aufbau der verschiedenen Experimente. Ergebnisse der Inbetriebnahme, der Status von HITRAP und die Vorbereitungen für die Experimente sollen vorgestellt werden.

A 23.4 Do 14:45 3C

A non-destructive detection of highly-charged ions for the measurement of the magnetic moment of the bound electron in ^{40,48}Ca$^{17+,19+}$ — •Sven Sturm[1], Klaus Blaum[1,2], Wolfgang Quint[2], Birgit Schabinger[1], Anke Wagner[1], and Günter Werth[1] — [1]Institute of Physics, Johannes Gutenberg-University, 55099 Mainz, Germany — [2]GSI Darmstadt, 64291 Darmstadt, Germany

The high-precision measurement of the magnetic moment of the bound electron in highly-charged ions yields a stringent test for Bound-State quantum electrodynamical (BS-QED) calculations. Since the BS-QED contribution to the *g*-factor calculation increases with the nuclear charge, we plan to measure the *g*-factor of ^{40,48}Ca$^{17+,19+}$ ions stored in a triple-Penning trap system with a relative uncertainty of 10^{-9} using the "continuous Stern-Gerlach-effect" [1]. To this end, a novel Penning trap setup and highly sensitive detection methods at cryogenic temperatures have been developed and tested. The principle of the non-destructive detection technique for multi-species ion-clouds as well as single ions is introduced and recent results are presented.

[1] M. Vogel *et al.*, Nucl. Inst. Meth. B **235**, 7 (2005)

A 23.5 Do 15:00 3C

X-Ray Transitions from Antiprotonic Noble Gases — Detlev Gotta[1], •Khalid Rashid[2], Burkhard Fricke[3], Paul Indelicato[4], and Leon Simon[5] — [1]Institut für Kernphysik, Forschungszentrum Jülich, D-52425 Jülich, Germanny — [2]Bahria University, E-8, Islamabad, Pakistan — [3]Institut für Physik, Universität Kassel, D-34132 Kassel, Germany — [4]Laboratoire Kastler Brossel, UPMC-Paris 6 ENS CNRS; Case 74, 4 Place Jussieu, F-75005 Paris, France — [5]Laboratory for Particle Physics, Paul Scherer Institut, CH-5232 Villingen, Switzerland

The onset of antiprotonic X-ray transitions at high principal quantum numbers and the occurrence of electronic X-ray in antiprotonic argon krypton, and xenon is analysed with Multiconfiguration Dirac-Fock calculations. The shell by shell ionisation by Auger electron emission, characterised by appearance and disappearance of X-ray lines, is followed through the antiprotonic cascade by considering transition and binding energies of both the antiproton and remaining electrons. A number of additional lines in the X-ray spectra have been tentatively assigned to electronic transitions caused by electronic de-excitation after Auger emission during the antiprotonic cascade. A few lines remain unexplained so far or are not unambiguously assigned. The complexity of the electronic states cannot be resolved with semiconductor detectors. Hopefully, in future high resolution devices like crystal spectrometers and Auger electron spectroscopy at antiproton at GSI will resolve this complexity.

A 23.6 Do 15:15 3C

Precision Measurements of Metastable Hydrogen and Deuterium with a modified Lamb-shift Polarimeter — •M. Westig[1], R. Engels[1], K. Grigoryev[1,2], M. Mikirtychyants[1,2], H. Paetz gen. Schieck[3], F. Rathmann[1], G. Schug[1], H. Stroeher[1], V. Trofimov[2], and A. Vasilyev[2] — [1]Institut für Kernphysik, Forschungszentrum Jülich, Leo-Brandt-Str. 1, 52425 Jülich, Germany — [2]Petersburg Nuclear Physics Institut, Orlova Rosha 2, 188300 Gatchina, Russia — [3]Institut für Kernphysik, Universität zu Köln, Zülpicher Str.77, 50937 Köln, Germany

Precision spectroscopy of hydrogen and deuterium is an established method to test bound state quantum electrodynamics (bsqed). State of the art theoretical atomic physics calculations obtain precise values from bsqed for both atomic systems, which provide a real challenge to experimentalists. We are setting up a spectroscopy experiment for metastable hydrogen and deuterium atoms in the IKP of FZ-Jülich. With a spinfilter as a part of a Lamb-shift Polarimeter, we can prepare metastable atomic beams with a well defined energy in one Zeeman state of the hyperfine structure (hfs). In a high frequency device with $\vec{k}$ perpendicular to the beam axis and surrounded by a magnetic field with variable geometry and strength we can induce selected transitions in the atoms. A precise determination of the $2S_{1/2}(\Delta f \approx 10\text{Hz})$, $2P_{1/2}(\Delta f \approx 1\text{kHz})$ hfs intervall, the classical Lamb-shift ($\Delta f \approx 1$kHz) and relative measurements of the $2S_{1/2}$, $2P_{1/2}$ Breit-Rabi-Diagrams with the same uncertainty in both atoms will be possible. The experimental setup and first results will be presented.

A 23.7 Do 15:30 3C

QED effects in high precision lifetime measurements — •José R. Crespo López-Urrutia, Günter Brenner, Volkhard Mäckel, Sascha W. Epp, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, 69117 Heidelberg

The precision achieved recently in the determination of lifetimes of metastable states by using electron beam ion traps, with total uncertainties of the order of 0.15%, has allowed for the first time to become sensitive to QED contributions to the transition probability, such as the effect of the electron anomalous magnetic moment (0.45% contribution). Electric-dipole forbidden transitions are of particular interest, because of the relatively weak dependence of their line strengths on the radial part of the wave function. By systematically improving the related measurement techniques at the Heidelberg electron beam ion trap, highly accurate results for FeXIV, FeX and ArXIV have been obtained. These values, when compared with the most sophisticated predictions, allow to distinguish between the different models used for the calculation of the transition matrix elements. The lines studied are also the strongest visible coronal lines observed in the Sun, and the exact knowledge of their lifetimes has crucial importance for the determining the parameters of those and other astrophysical plasmas.

A 23.8 Do 15:45 3C

Entwicklung hochsensitiver Radiofrequenzdetektoren zum Nachweis einzelner geladener Teilchen — •Stefan Ulmer[1,2], Klaus Blaum[1,2], Holger Kracke[1], Susanne Kreim[1], Wolfgang Quint[3], Cricia Rodegheri[1], Stefan Stahl[4] und Jochen Walz[1] — [1]Institut für Physik,Universität Mainz, 55099 Mainz — [2]MPI für Kernphysik, 69029 Heidelberg — [3]GSI Darmstadt, 64291 Darmstadt — [4]Stahl Electronics, 57582 Mettenheim

Die Spektroskopie von einzelnen, in einer Penning-Falle gespeicherten Teilchen erfordert die Verwendung von hochsensitiven Radiofrequenzdetektoren. Solche Nachweissysteme bestehen aus Resonatoren hoher Güte und einer nachfolgenden rauscharmen Verstärkerstufe. Durch den Betrieb der Detektoren unter kryogenen Bedingungen und der damit einhergehenden Möglichkeit supraleitende Materialien zu verwenden kann ein hohes Signal zu Rausch Verhältnis erreicht werden. Ein supraleitendes Nachweissystem für die Messung der axialen Frequenz eines in einer Penning-Falle gespeicherten Protons wird vorgestellt. Mit dem freien Resonator wurde eine Güte von 41000, mit angekoppeltem Verstärker von 12000 erreicht. Es wird auf Verlustmechanismen in Resonatoren eingegangen, insbesondere auf die Abhängigkeit der Güte von einem externen Magnetfeld. Ferner werden Studien zum Aufbau von rückkopplungsfreien, rauscharmen Hochfrequenzverstärkern präsentiert.