A 3: Precision Spectroscopy of Atoms and Ions I

Zeit: Montag 14:00–16:00 Raum: VMP 6 HS-B

Hauptvortrag A 3.1 Mo 14:00 VMP 6 HS-B

Laser spectroscopy of highly charged argon at the Heidelberg electron beam ion trap — •Volkhard Mäckel, Renee Klawitter, Sven Bernitt, Günter Brenner, José Ramon Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernpysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The study of forbidden transitions in highly charged ions opens a broad window for analyzing and diagnosing plasmas found in astronomy and fusion research. Since those plasmas have a low density, excited levels mainly decay to the ground state configuration through magnetic dipole (M1) transitions. Electron beam ion traps (EBIT) are especially suited for the investigation of such transitions, since their monoenergetic electron beam allows for specific charge state selection, while their extremely high vacuum level faciliates the simulation of low density plasmas.

We report a laser fluorescence measurement of such a transition in boron-like Ar^{13+} produced and trapped at the Heidelberg electron beam ion trap. The M1 $1s^22s^22p\ ^3P_2 -^3 P_1$ transition was resonantly excited using a frequency variable pulsed dye laser, while simultaneously monitoring the fluorescence photons. For the first time a forbidden transition has been excited in highly charged ions trapped inside an EBIT. In combination with enhanced ion cooling and two-photon excitation, large gains in accuracy can be expected.

Fachvortrag A 3.2 Mo 14:30 VMP 6 HS-B

Proposed gravity measurement with antihydrogen — •Carlo Canali, Arne Fischer, Ulrich Warring, and Alban Kellerbauer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The gravitational interaction between matter and antimatter has never been tested experimentally. The AEGIS experiment (Antimatter Experiment: Gravity, Interferometry, Spectroscopy) intends to measure for the first time the gravitational acceleration of antihydrogen. $\overline{\mathrm{H}}$ will be obtained through a charge exchange process between Rydberg positronium atoms and antiprotons. The antiprotons will be delivered by the CERN AD (Antiproton Decelerator). After being captured and confined inside a cylindrical Penning trap, they will be cooled down to $\approx$ 100 mK. At the same time, positronium will be produced by bombardment of a nanoporous insulator material with positrons. A double laser pulse will excite the positronium to a Rydberg state immediately before the interaction with the antiprotons, such as to increase the cross-section for the charge exchange process. The produced antihydrogen atoms will be accelerated to form a horizontal beam and projected through a Moiré deflectometer with a velocity of a few 100 m/s along a path of about 1 m length. The deflectometer consists of two gratings and a position-sensitive detector able to measure the vertical displacement and the time of flight of $\overline{\mathrm{H}}$ atoms. With this setup an initial precision on the measurement of $g(\overline{\mathrm{H}})$ of 1% is expected.

A 3.3 Mo 15:00 VMP 6 HS-B

A temperature stabilization system for the spin-flip detection in the *g*-factor experiment on highly-charged ions — •Anke Wagner[1], Klaus Blaum[1], Wolfgang Quint[2], Birgit Schabinger[3], and Sven Sturm[3] — [1]MPI für Kernphysik, D-69117 Heidelberg, Germany — [2]GSI Darmstadt, D-64291 Darmstadt, Germany — [3]Institut für Physik, Johannes Gutenberg-University, D-55099 Mainz, Germany

For the high-precision measurement of the magnetic moment of the electron bound in highly-charged calcium ions, the Larmor spin-precession frequency has to be measured [1]. To this end the so called continuous Stern-Gerlach-effect is employed using a magnetic bottle where the axial frequency of an ion stored in a Penning trap depends slightly on its spin orientation, which provides a possibility to detect the spin state [2]. Microwaves are used to induce a spin-flip. By scanning the microwave frequency and measuring the particular spin-flip rate, the Larmor frequency can be determined. To be able to detect the spin-flip, the axial frequency and accordingly the electrode voltage needs to be very stable. To minimize voltage changes due to temperature drifts during the g-factor measurement, a temperature stabilization for the whole setup is under construction. Therefore, a Fuzzy Logic controller was implemented. Its principle and first results, as well as the microwave setup and the spin flip detection technique will be presented.

[1] B. Schabinger *et al.*, J. Phys. **58**, 121-124 (2007)
[2] M. Vogel *et al.*, Nucl. Inst. Meth. B **235**, 7-16 (2005)

A 3.4 Mo 15:15 VMP 6 HS-B

Fundamental constants and tests of theory in Rydberg states of hydrogen-like ions — Ulrich D. Jentschura[1,2], Peter J. Mohr[3], Joseph N. Tan[3], and •Benedikt J. Wundt[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg — [2]Departement of Physics, Missouri University of Science and Technology, Rolla, MO 65409-0640, USA — [3]National Institue of Standards and Technology, Gaithersburg, MD 20899-8420, USA

Higher-order QED binding corrections constitute an old but still very efficient and successful tool to determine the energy levels in atomic systems to high precision. We will describe here the self-energy contribution to the Lamb shift for highly excited Rydberg states. With the results of a recent calculation of a key QED contribution, the uncertainty in the theory of the energy levels can be greatly reduced. These new results allow for a comparison of precision frequency measurements and quantum electrodynamics prediction for Rydberg states that can lead to an improved value for the Rydberg constant. Experiments at NIST are underway.

A 3.5 Mo 15:30 VMP 6 HS-B

Preparation of a single proton in a Penning trap experiment for the determination of the *g*-factor of the proton — •Cricia Rodegheri[1], Klaus Blaum[2,3], Holger Kracke[1], Susanne Kreim[1], Andreas Mooser[1], Christian Mrozik[1], Wolfgang Quint[4], Stefan Ulmer[1,2,4], and Jochen Walz[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Ruprecht-Karls-Universität, 69047 Heidelberg — [4]GSI, 64291 Darmstadt

The determination of the proton g-factor results from the accurate measurement of two frequencies of the stored particle in a double Penning trap setup, as it can be calculated as $g = 2\frac{\nu_L}{\nu_c}$. The free cyclotron frequency ν_c is determined in the homogeneous magnetic field of the precision trap. The Larmor frequency ν_L will be measured by means of the continuos Stern-Gerlach effect in the analysis trap. The preparation of a single proton from a particle cloud loaded in the precision trap is presented. The undesired species, products of the in-trap ion creation process, are removed by applying a strong dipolar excitation at the axial frequency of the ions and lowering the trap potential. The resulting proton cloud is successively reduced up to one single proton by exciting the cyclotron motion in a detuned trap. In an anharmonic potential the frequency of the ion depends on its energy. Thus, with a broad band excitation one can spread the ion cloud and then remove the protons individually with a stronger discrete excitation. Due to the extremely low background pressure inside the trap chamber the storage time of the isolated proton is longer than several weeks.

A 3.6 Mo 15:45 VMP 6 HS-B

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