A 37: Precision Spectroscopy of Atoms and Ions VII

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

Fachvortrag A 37.1 Fr 14:00 VMP 6 HS-B

Hochgeladene Ionen in Ruhe - Die HITRAP Anlage — •Frank Herfurth[1], Ludwig Dahl[1], Oliver Kester[1,2], H.-Jürgen Kluge[1], Christophor Kozhuharov[1], Wolfgang Quint[1], Thomas Stöhlker[1] und die HITRAP Kollaboration[1] — [1]GSI Helmholtzzentrum für Ionenforschung, Darmstadt — [2]NSCL/MSU, East Lansing, USA

HITRAP ist eine Anlage zum Abbremsen und Kühlen schwerer, hochgeladener Ionen wie z.B. wasserstoffähnliches Uran U^{91+}. Etwa 10^4 Ionen können pro Sekunde für Präzisionsexperimente in Atom- und Kernphysik bereitgestellt werden. Das sind zum Beispiel Präzisionsmassenmessungen, Messungen des g-Faktors des gebundenen Elektrons oder kinematisch komplette Reaktionsstudien. Produziert werden die hochgeladenen Ionen im GSI Beschleunigerkomplex bei relativistischen Energien. Für höchste Präzision müssen die Ionen dann bis auf 4 Kelvin abgebremst werden; eine Reduktion der kinetischen Energie um 14 Größenordnungen! Dies geschieht zuerst im Experimentierspeicherring der GSI (ESR), in dem sie von 400 MeV/u auf 4 MeV/u abgebremst und gleichzeitig mit Elektronen gekühlt werden. Danach werden sie aus dem ESR ausgeschossen, in zwei, umgekehrt betriebenen, linearen Beschleunigerstrukturen von 4 MeV/u auf 6 keV/u abgebremst und in eine Penningfalle eingefangen, wo sie erst mit Elektronen auf 10 eV und dann mit Widerstandskühlen auf 4K abgekühlt werden. Die erste Hälfte des linearen Abbremsers wurde kürzlich in Betrieb genommen und hochgeladene Ionen auf 0,5 MeV/u abgebremst.

Fachvortrag A 37.2 Fr 14:30 VMP 6 HS-B

Optical Hyperfine Structure and Isotope Shift Measurements on Os^- — •Arne Fischer, Carlo Canali, Ulrich Warring, and Alban Kellerbauer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

In 1999 the first bound–bound electric-dipole transition in a negative ion was observed in the transition metal osmium. Within the UNIC project (Ultracold Negative Ions by indirect laser Cooling) we studied this transition and performed measurements of the isotope shift for all naturally occurring isotopes and the hyperfine structure in $^{187}Os^-$ and $^{189}Os^-$. The hyperfine constants of the ground and the bound excited state of $^{187}Os^-$ and $^{189}Os^-$ were determined. For the spectroscopy a mass-separated beam of negative osmium ions was collinearly superimposed with a tunable narrow-bandwidth laser. Due to the velocity-bunching effect in a fast beam this geometry allows precise measurents with linewidths of some MHz and hence sufficient resolving power to resolve the hyperfine structure.

A 37.3 Fr 15:00 VMP 6 HS-B

High-resolution collinear laser spectroscopy as a tool for precise high-voltage determination — •R. Sánchez[1], A. Krieger[2], Z. Andjelkovic[2], R. Cazan[2], K. Blaum[3], M.L. Bissell[4], G.W.F. Drake[5], Ch. Geppert[1], M. Kowalska[4], J. Krämer[2], R. Neugart[2], F. Schmidt-Kaler[6], D. Tiedemann[2], Z.-C. Yan[7], D. Yordanov[4], M. Žáková[2], C. Zimmermann[8], and W. Nörtershäuser[1,2] — [1]GSI Helmholtzzentrum für Schwerionenförschung GmbH, Darmstadt, Germany — [2]Institut für Kernchiemie, Universität Mainz, Germany — [3]Max-Planck Institut für Kernphysik, Heidelberg, Germany — [4]Physics Department, CERN, Geneva, Switzerland — [5]Department of Physics, University of Windsor, Canada — [6]Quanteninformationsverarbeitung, Universität Ulm, Germany — [7]Department of Physics, University of New Brunswick, Canada — [8]Physikalisches Institut, Universität Tübingen, Germany

For more that 25 years collinear laser spectroscopy has provided outstanding results of ground-state nuclear structure properties. This technique has been successfully applied to measure isotope shifts (IS) of long chains of mid-Z isotopes at ISOL facilities. However IS measurements performed on low-Z do not reach the required accuracy mainly because the large uncertainty introduced in the determination of the high-voltage applied to the extraction electrodes at the target region. We have now found a way to determine precisely this parameter by measuring the transition frequencies via high-resolution collinear laser spectroscopy. In this contribution we report on the technique and the results we obtained at COLLAPS, ISOLDE-CERN.

A 37.4 Fr 15:15 VMP 6 HS-B

Spectroscopy of Os^- and a Route to Laser-Cooled Negative Ions — •Ulrich Warring, Carlo Canali, Arne Fischer, and Alban Kellerbauer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Typical binding energies of negative ions are in the range of 1–2 eV, hence at least one order of magnitude lower than in positive ions or atoms. Furthermore the potential experienced by the valence electron is short-ranged and thus only supports a finite number of bound states. Often these bound states are different fine-structure levels of the same configuration. An exceptional case can be found in the negative osmium ion. It has the unique property of a bound excited state with opposite parity with respect to the ground state – so far the only known electric-dipole transition in a negative ion. This fact enables the use of standard atomic-physics techniques, such as laser cooling. The goal of the UNIC project (Ultracold Negative Ions by indirect laser Cooling) is to demonstrate this method to work. As a first milestone we conducted high-resolution laser spectroscopy of the relevant transition on a Os^- beam. In this presentation we will report on the experimental results and outline the next steps towards trapping and laser cooling negative osmium ions.

A 37.5 Fr 15:30 VMP 6 HS-B

Mg frequency measurement via telecom fibre network — •Andre Pape[1], Jan Friebe[1], Matthias Riedmann[1], Temmo Wübbena[1], Ernst M. Rasel[1], Wolfgang Ertmer[1], Osama Terra[2], Gesine Grosche[2], Katharina Predehl[2,3], Thorsten Feldmann[2], Burghard Lipphardt[2], and Harald Schnatz[2] — [1]Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig — [3]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

The alkaline earth magnesium (Mg) is an interesting candidate for a future optical clock based on ensembles of neutral atoms. We report on a recently performed characterization of the Mg frequency standard at the Institute of Quantum Optics (IQ) in Hanover via a telecom fibre network connecting IQ with the optical frequency standards at the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig. The stability of PTB's Ca clock laser is transferred via an actively stabilized 73 km long telecom fibre for direct optical comparison to the Mg frequency standard by means of a telecom fibre laser and two fs frequency combs. The investigated clock transition $^1S_0 \rightarrow {}^3P_1$ in cold free falling Mg atoms is probed in a Ramsey-Bordé interferometer with subsequent detection of the excited atoms in a MOT in the triplet system. To enable long term stability and accuracy a passive hydrogen maser at IQ is used and compared to a Cs fountain clock at PTB. We present the results of the measurement of the Mg clock lasers' short term stability and the characterization of the Mg frequency standard.

A 37.6 Fr 15:45 VMP 6 HS-B

Experimental study of two-photon decay in He-like tin — •Sergiy Trotsenko[1,2], Ajay Kumar[2], Andrey Volotka[3], Dariusz Banas[4], Heinrich Beyer[2], Harald Bräuning[2], Alexandre Gumberidze[5], Siegbert Hagmann[1,2], Sebastian Hess[1,2], Christophor Kozhuharov[2], Regina Reuschl[1,2], Uwe Spillmann[1,2], Martino Trassinelli[2,5], Günter Weber[2,6], and Thomas Stöhlker[2,6] — [1]IKF, University of Frankfurt, Germany — [2]GSI, Darmstadt, Germany — [3]TU Dresden, Germany — [4]Swietokrzyska Academy, Kielce, Poland — [5]Institut des NanoSciences de Paris, France — [6]University of Heidelberg, Germany

The study of two-photon transitions (2E1) in the He-like heavy ions is of particular interest due to the sensitivity of its spectral shape to electron correlation and quantum electrodynamical effects. Numerous experimental and theoretical attempts to explore the process have been done in the past proving the high interest and importance of this rare decay mode. In the present investigation an alternative approach for studying the two-photon transitions in few-electron high-Z ions was applied. Here, relativistic collisions of the Li-like projectiles with a gaseous target were used to form the desired initial state allowing to measure the undistorted two-photon spectral shape. The decay of the [1s2s] singlet state in He-like tin (Z=50) was examined and the continuum shape of the two-photon energy distribution was compared with fully relativistic spectral distributions, which in turn are predicted to

be Z-dependent. The technique has allowed to confirm for the first time | fully relativistic calculations.