A 21: Poster: Precision spectroscopy of atoms and ions

Time: Tuesday 16:30–19:00 Location: Poster.V

A 21.1 Tue 16:30 Poster.V

Einfach- und Doppelionisation von Heliumatomen in schnellen Stößen mit S^{14+}-Ionen — •Helena Gassert[1], Hong-Keun Kim[1], Jasmin Titze[1], Florian Trinter[1], Jörg Voigtsberger[1], Markus Waitz[1], Jasper Becht[1], Till Jahnke[1], Amine Cassimi[2] und Reinhard Dörner[1] — [1]Institut für Kernphysik Frankfurt, Goethe-Universität Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt am Main — [2]CIMAP - GANIL, BP 5133, Bd H. Becquerel, 14070 Caen Cedex 5

Vor einigen Jahren durchgeführte Messungen zur Einfachionisation von Helium in schnellen Stößen mit C^{6+}[1] wiesen gravierende Unstimmigkeiten mit der Theorie auf. Die Impulsspektroskopie (COLTRIMS-Technologie) ist eine hervorragende Möglichkeit zur kinematisch vollständigen Untersuchung von Ionisationsprozessen. Diese wurde nun genutzt, um die Einfach- und Doppelionisation von Helium-Atomen in schnellen, nichtrelativistischen Stößen mit S^{14+}-Ionen (11 MeV/u) zu untersuchen und die Impulsvektoren aller geladenen Reaktionsprodukte zu rekonstruieren. Der koinzidente Nachweis erlaubt vor allem die Untersuchung von Korrelationseffekten.

[1] M.Schulz et al., Nature 422, 6927 (2003)

A 21.2 Tue 16:30 Poster.V

Spectroscopic reference for the measurement of the hyperfine transition frequency of highly charged bismuth ions — Sebastian Albrecht[1], •Heiko Jestädt[1], Sanah Altenburg[1], Tobias Murböck[1], Manuel Vogel[1,2], Gerhard Birkl[1], and the SPECTRAP collaboration[2] — [1]Institut für Angewandte Physik, Technische Universität Darmstadt, Schlossgartenstraße 7, 64289 Darmstadt — [2]GSI, Planckstraße 1, 64291 Darmstadt

The investigation of the ground state hyperfine splitting of highly charged ions is one of the objectives of the experiments planned to be carried out by the SPECTRAP collaboration within the HITRAP facility at GSI. For $^{209}Bi^{82+}$ ions, transitions between hyperfine ground states can be exited using light at 243.9 nm. This light is produced in a laser system and two frequency-doubling stages resulting in 15 mW in the UV [1].

At twice the target wavelength ($\approx$ 488 nm) the light frequency is compared to previously calibrated resonances of molecular tellurium. A maximum deviation of 6 MHz at 244 nm relative to the tellurium spectrum was found. We report on the configuration of the laser system, on an improved determination of the tellurium resonances and on further improvements in the laser system for a reduction in the remaining uncertainty of the laser frequency.

[1] S. Albrecht, S. Altenburg, C. Siegel, N. Herschbach, G. Birkl, Appl. Phys. B, DOI: 10.1007/s00340-011-4732-8 (2011)

A 21.3 Tue 16:30 Poster.V

Radiation Detection Resonance Ionisation Spectroscopy on Nobelium in a buffer gas cell - state of actual development and progess in 2012 — •F. Lautenschläger[1], M. Laatiaoui[1,2], Th. Walther[1], M. Block[2], W. Lauth[3], H. Backe[3], and F.P. Hessberger[2] — [1]Laser und Quantenoptik, Institut für Angewandte Physik, Technische Universität Darmstadt, 64289 Darmstadt — [2]Gesellschaft für Schwerionenforschung GmbH, 64291 Darmstadt — [3]Institut für Kernphysik der Universität Mainz, 55099 Mainz

A novel technique for exploration of the atomic structure of heavy elements has been developed. Based on the Radiation Detection Resonance Ionisation Spectroscopy, it is possible to investigate even isotopes with small half-liveslike nobelium, which can be produced with small rates of a few atoms per second at on-line facilities such as GSI/Darmstadt. After separation from the primary beam by the velocity filter SHIP, the fusion products enter a buffer gas cell, where they are stopped and collected on a tantalum filament. The next step is to re-evaporate the atoms and to ionize them with tunable lasers. Finally the ions will be identified by their characteristic α - decay. First online experiments were performed on Ytterbium and an efficiency of about 1% was obtained. For further improvements, a realistic simulation of the buffer gas cell has been performed. Some results of the simulation and off-line tests will be presented.

A 21.4 Tue 16:30 Poster.V

Prospects for quantum logic spectroscopy of molecular ions — •Yong Wan, Florian Gebert, and Piet O. Schmidt — QUEST Institute for Experimental Quantum Metrology, PTB, Braunschweig

The rapid development in laser cooling and coherent state manipulation over the past decades demonstrated exquisite control of the internal and external degrees of freedom of various species of atomic ions. The same technique can not be easily applied to molecular ions because of their rich internal level structure. On the other hand, ultra cold molecular ions lend themselves for a number of novel applications, ranging from cold chemistry to tests of fundamental theories.

To overcome the obstacle of laser cooling and to achieve a deterministic internal state preparation, we propose to employ the quantum logic technique [1] in which a laser-cooled atomic ion is simultaneously trapped with a single molecular ion. The cooling of the external degrees of freedom of the molecular ion is achieved via sympathetic cooling by the sideband-cooled atomic ion, while the preparation of its internal state will be achieved via a quantum-non-demolition measurement.

The investigated molecules MgH^+/CaH^+ are relevant for the search of a possible temporal variation of the electron-to-proton mass $\mu = m_e/m_p$ [2]. The transition frequency of rovibrational overtone transitions in the molecule depend on μ and can be compared to another optical reference, such as the Al^+ clock to obtain an improved upper limit for the time variation of μ.

[1] Schmidt et al., Science 309, 749 (2005)
[2] Kajita et al., J. Phys. B 42, 154022 (2009)

A 21.5 Tue 16:30 Poster.V

Spectroscopic studies of charge breeding processes in an electron beam ion trap — •Thomas Baumann, José Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik

A new generation of electron beam ion traps (EBITs) was developed at the Max-Planck-Institute für Kernphysik (MPIK) and recently introduced in facilities like TRIUMF (TITAN EBIT) and the Michigan State University (MSU EBIT) for charge breeding of rare radioactive isotope beams. Future, more powerful devices are under development. To achieve shorter breeding times, design efforts are aiming at the development of electron guns capable of delivering intensities of several amps. For this purpose a new high current EBIT has been built at MPIK.

The charge breeding process within this machine is studied spectroscopically using two grating spectrometers sensitive in the soft x-ray spectral region and a Silicon drift x-ray detector for photon energies above 1 keV. Soft x-ray spectra of highly charged Silicon ions are presented to show the charge state evolution in dependence of the electron beam energy. Furthermore, detailed spectra around the region of strong recombination resonances (KLL, KLM, KLN) in Si ions have been obtained and compared to structure calculations based on the Flexible Atomic Code (FAC). The data shows strong contribution arising from higher order multielectron resonant transitions.

A 21.6 Tue 16:30 Poster.V

Electromagnetic decay of nuclei by electron-positron pair conversion — •Nikolay Belov and Zoltan Harman — Max-Plank-Institute for Nuclear Physics, Heidelberg, Germany

The pair production process by γ-emission of nuclei has been investigated for a long time both theoretically and experimentally. But, in all theoretical works only the production of a free electron and positron was described. The case when an electron is "born" in the bound state of atom has been neglected as a relatively small effect.

We investigate this bound-free pair productions for different multipolarities of nuclear γ decay. We use a relativistic description of the electron and positron wave functions as it is necessary for heavy elements. It appeared that the contribution of this bound-free process for bare heavy ions at low γ-energies gives a contribution comparable to the free-free process.

These results for the bound-free pair production in bare or highly-stripped ions could be relevant in astrophysics, in the physics of heavy ion acceleration and in atomic spectroscopy.

A 21.7 Tue 16:30 Poster.V

Das SPECTRAP-Experiment zur Präzisionslaserspektrosko-

pie an hochgeladenen Ionen — •Tobias Murböck[1], Zoran Andjelkovic[2,3], Radu Cazan[2], Shailen Bharadia[4], Richard Thompson[4], Manuel Vogel[1,3], Alexander Martin[1], Sebastian Albrecht[1], Wilfried Nörtershäuser[2] und Gerhard Birkl[1] — [1]TU Darmstadt — [2]Uni Mainz — [3]GSI Darmstadt — [4]Imperial College London

Mittels Präzisionslaserspektropie der verbotenen Hyperfeinstruktur-Übergänge von hochgeladenen, wasserstoff- und lithiumähnlichen Ionen kann ein stringenter Test der Quantenelektrodyanmik (QED) gebundener Zustände in starken elektrischen Feldern vollzogen werden. Diesem Zweck dient das SPECTRAP-Experiment, das derzeit als Teil der HITRAP-Kollaboration an der GSI in Darmstadt aufgebaut wird. Wir stellen den Status des Experimentes vor und präsentieren erste Ergebnisse zum Transport, zur Speicherung und Kühlung der Mg^+-Ionen sowie erste Testmessungen mit der *"rotating wall"*-Technik an Ca^+-Ionen. Durch den Aufbau entsprechender Lasersysteme wird die direkte Laserkühlung gespeicherter Mg^+-Ionen und die sympathetische Kühlung anderer Ionenspezies ermöglicht. Darüber hinaus wird ein Ausblick auf geplante Messungen an Pb^+, Ca^{14+} und Ar^{13+} auf dem Weg zur Vermessung der Aufspaltung der Hyperfeinstruktur von hochgeladenen Ionen gegeben.

A 21.8 Tue 16:30 Poster.V

High-precision calculation of the structure of highly charged Fe ions — •Natalia Oreshkina, Zoltan Harman, and Christoph H. Keitel — Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany

We present accurate theoretical values of the visible and x-ray transition energies in highly charged ${}^{56}_{26}Fe^{13+}$ to ${}^{56}_{26}Fe^{16+}$ ions. Relativistic electron correlation calculations are performed within the framework of the configuration interaction method with Dirac-Fock-Sturmian basis functions. For the $3p_{3/2} \to 3p_{1/2}$ green magnetic dipole transition in ${}^{56}_{26}Fe^{13+}$, we take into account QED effects by employing an effective screening potential. High-precision calculations of these systems may be important for astronomical research, and in investigations towards the time variation of the fine-structure constant.

A 21.9 Tue 16:30 Poster.V

Nuclear Shape Effect on the g Factor of Hydrogenlike Ions — •Jacek Zatorski, Natalia S. Oreshkina, Christoph H. Keitel, and Zoltán Harman — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The nuclear shape correction to the g factor of a bound electron in $1S$-state is calculated for a number of nuclei in the range of charge numbers from $Z = 6$ up to $Z = 92$. The leading relativistic deformation correction has been derived analytically and also its influence on one-loop quantum electrodynamic terms has been evaluated. We show the leading corrections to become significant for mid-Z ions and for very heavy elements to even reach the 10^{-6} level.

[1] J. Zatorski, Natalia S. Oreshkina, Christoph H. Keitel, and Zoltán Harman, 2011arXiv1110.3330Z.

A 21.10 Tue 16:30 Poster.V

A cryogenic Paul trap for highly charged ions and molecular ions — •Maria Schwarz[1], Oscar Versolato[1], Alexander Windberger[1], José R. Crespo López-Urrutia[1], Piet O. Schmidt[2], Michael Drewsen[3], and Joachim Ullrich[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Gemany — [2]PTB, Braunschweig, Gemany — [3]University of Aarhus, Aarhus, Denmark

Electron beam ion traps are effective tools for spectroscopy of highly charged ions (HCIs). However, their deep trapping potential leads to high temperatures of the stored ions, and limits the final spectral resolution. A new linear cryogenic Paul trap experiment (CryPTEx) in-line with an EBIT will provide long storage times for HCIs due to the extremely low background pressure within a 4K enclosure. Since HCIs do not allow for direct laser cooling, as their optical transitions have low transition rates, one needs to apply sympathetic cooling. The trapped HCIs are coupled by Coulomb-interaction to a low-temperature bath of laser-cooled ions what ultimately should allow to resolve the natural linewidth of forbidden transitions. Our final goal is the application of quantum logic spectroscopy, where a singly charged ion species (Be^+) is responsible for the sympathetic cooling and state detection of the HCI. Crystals of Mg^+ ions and mixed crystals of Mg^+ and MgH^+ ions have been produced. Cooling of the MgH^+ ions allowed us to populate mainly the rovibrational ground state. The cryogenic trap allows to keep polar molecular ions in rotational and vibrational ground states by suppressing blackbody radiation. CryPTEx has been in Aarhus for such experiments in collaboration with the QUANTOP group.

A 21.11 Tue 16:30 Poster.V

Experimental Setup for Bound-Electron g-Factor Measurements by Double-Resonance Spectroscopy of a Fine Structure Transition — •Marco Wiesel[1,2], David von Lindenfels[1,2,4], Wolfgang Quint[1,2], Manuel Vogel[1,3], Alexander Martin[1,3], and Gerhard Birkl[3] — [1]GSI Darmstadt — [2]Universität Heidelberg — [3]TU Darmstadt — [4]MPIK Heidelberg

Magnetic moment measurements of electrons bound in highly charged ions provide access to QED effects in the extreme fields close to the ionic nucleus. Hence a cryogenic Penning trap setup is currently being built to determine the electronic g-factor of boron-like argon (Ar^{13+}) via double-resonance spectroscopy: A closed cycle between the fine structure levels $2^2P_{1/2}$ - $2^2P_{3/2}$ is driven by a laser whereas microwaves are tuned to get in resonance with the Zeeman-sublevel transition. With this frequency and the measurement of the cyclotron ion motion the g-factor can be determined with an expected accuracy of 10^{-9} or better. To this end, we employ an arrangement consisting of a creation trap and a spectroscopy trap. We present an overview of the experiment and give the details and status of the apparatus. In the future, the setup will be connected to the HITRAP beamline at GSI, so hyperfine structure transitions of hydrogen-like heavy ions can be studied and electronic and nuclear magnetic moments can be measured.

A 21.12 Tue 16:30 Poster.V

Discovery of new Praseodymium I energy levels with help of green laser light — •Shamim Khan, Imran Siddiqui, Syed Tanweer Iqbal, and Laurentius Windholz — Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, A 8010 Graz, Austria

The hyperfine structure (hfs) of Praseodymium I spectral lines were experimentally investigated using LIF technique in a hollow cathode discharge lamp. We report here the investigation of 100 spectral lines which resulted in a discovery of 20 new energy levels of even and odd parity. The excitation source is a tunable ring-dye laser system, operated with Coumarin 102. The laser wavelength is tuned to a strong hyperfine component of the investigated spectral line, and fluorescence signals from excited levels are searched. The hfs of the investigated line is recorded by scanning the laser frequency across the investigated region. Magnetic hf interaction constant "A" and angular momentum "J" of the combining lower and upper levels involved in the formation of the line are evaluated. If one of the combining levels is not known (in most cases upper level), the determined angular momentum "J" and hyperfine constant "A" are used to identify one of the involved levels (in most cases the lower level) and the energy of the unknown level is determined by using center of gravity wave number of line and the energy of the identified level. The level found in this way must explain most of the observed fluorescence wavelengths and the hyperfine structure of the fluorescence lines appearing in FT spectrum [1].

[1] B. Gamper et al., J.Phys.B 44, 045003 (2011)

A 21.13 Tue 16:30 Poster.V

Hyperfine structure investigations of Pr-I lines in the region 4200-4450 Å — •Imran Siddiqui, Shamim Khan, Syed Tanweer Iqbal, and Laurentius Windhoz — Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, A 8010 Graz, Austria

Praseodymium I spectral lines were investigated using laser induced fluorescence spectroscopy in a hollow cathode discharge lamp. The investigations led to the discovery of new Pr I energy levels of even and odd parity. A high resolution Fourier transform (FT) spectrum [1] was used to extract promising excitation wavelengths. In the FT spectrum the investigated line 4375.53 Å shows up as a narrow peak hfs with a weak SNR. Nevertheless, the line was excited and fluorescence signals were observed on 6 lines (4163 Å, 4816 Å, 5091 Å, 5164 Å, 5209 Å, 5233 Å). The hfs of the line was recorded by scanning the laser frequency and was fitted to obtain angular momentum J and hf constant A of the combining levels. We got $J_{up} = 5/2$, $A_{up} = 1028.30$ MHz, $J_{lo} = 7/2$ and $A_{lo} = 861.46$ MHz (the subscipts refer to upper and lower level). Assuming an unknown upper level, a known lower level was searched among the known levels having sufficient values of J and A.. The level 7617.440 cm^{-1}, even parity, $J_{lo} = 7/2$ and $A_{lo} = 868$ MHz fulfils these requirements. Using the center of gravity wave number of the line 4375.53 Å and the energy of the lower level, the unknown upper level was calculated to have 30465.424 cm^{-1}, odd parity, J_{up} = 5/2 and A_{up} = 1033(6) MHz.

[1] B. Gamper et al., J.Phys.B 44, 045003 (2011)

A 21.14 Tue 16:30 Poster.V

The PRIOC experiment - precision studies on ion collisions using a magneto-optically trapped lithium target — Dominik Globig[1], •Johannes Goullon[1], Renate Hubele[1], Vitor L. B. de Jesus[2], Deepankar Misra[1], Aaron LaForge[1], Hannes Lindenblatt[1], Katharina Schneider[1], Michael Schulz[1], Martin Sell[1], Xincheng Wang[1], and Daniel Fischer[1] — [1]Max-Planck Institut für Kernphysik, Heidelberg — [2]Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro (IFRJ), Nilópolis, RJ, Brazil

In the PRIOC experiment three innovative experimental techniques are combined in order to study ion-atom collisions with unprecedented detail: A magneto-optical trap (MOT) for target preparation is implemented in a Reaction Microscope that enables momentum detection of all collision partners. This 'MOTRemi' setup is operated in an ion storage ring where intense and brilliant ion beams can be provided. Lithium is used as target which is particularly interesting for its simplicity with only one weakly bound outer shell electron. In test experiments on photoionization the performance of the MOTRemi has been tested and an excellent resolution for recoil ion as well as electron momenta has been achieved. Results of first experimental runs on single ionization in ion-atom collisions will be presented.

A 21.15 Tue 16:30 Poster.V

Quadrupole interactions in the hyperfine structure of the titanium atom — Jarosław Ruczkowski, Magdalena Elantkowska, and •Jerzy Dembczyński — Chair of Quantum Engineering and Metrology, Faculty of Technical Physics, Poznan University of Technology, Nieszawska 13B, 60-965 Poznan, Poland

Analysis of the hyperfine structure experimental data for the even configuration system in the titanium atom allow to divide the observed hyperfine splittings into contributions of ranks K=1,2 and 3 of the hyperfine structure operator.

The direct diagonalization of the hyperfine structure matrix yield the corrected values of the hyperfine structure constants A, B and C. The observed and calculated hyperfine structure intervals were in good agreement within the experimental accuracy.

Using the fine structure eigenvectors and the quadrupole interactions angular coefficients matrix, the radial parameters of the magnetic quadrupole interactions were determined.

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A 21.16 Tue 16:30 Poster.V

Parametrization of the transition probabilities in Th II — •Przemysław Głowacki, Jerzy Dembczyński, Magdalena Elantkowska, and Jarosław Ruczkowski — Chair of Quantum Engineering and Metrology, Faculty of Technical Physics, Poznan University of Technology, Nieszawska 13B, 60-965 Poznan, Poland

In order to parametrize the transition probabilities, the matrix of angular coefficients of the possible transitions in multiconfiguration system were calculated.

Using the fine structure eigenvectors for both parities, the linear equations for the oscillator strengths were obtained.

The least square fit to experimental values for some transitions, allow to obtain the values of radial parameters and parametrize the transition probabilities.

This work was supported by The National Centre for Science under the project N N519 650740

A 21.17 Tue 16:30 Poster.V

A lattice-based magnesium frequency standard — •Dominika Fim, Hrishikesh Kelkar, Andre Pape, Temmo Wübbena, André Kulosa, Steffen Rühmann, Klaus Zipfel, Wolfgang Ertmer, and Ernst M. Rasel — Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany

Optical lattice clocks outperform the best microwave clocks. A key for the improvement is the confinement in a lattice at the Lamb-Dicke limit to suppress the influence of the first order Doppler effect in frequency measurements. The application of this method requires the existence of a magic wavelength for the lattice, where the AC Stark shift of the two clock states compensate each other. Thanks to these methods today's state-of-the-art optical clocks are limited by Stark effect of the blackbody radiation (BBR). The element magnesium allows to implement an optical lattice clock and shows in addition a lower sensitivity in terms of uncertainty to BBR. We report on the status of the magnesium lattice clock at LUH.

A 21.18 Tue 16:30 Poster.V

Resonant K-shell hole excitation in highly charged iron ions — •Jan Rudolph[1,2], Sven Bernitt[1], René Steinbrügge[1], and José Crespo López-Urrutia[1] — [1]Max Planck Institut für Kernphysik, Heidelberg — [2]Institut für Atom- und Molekülphysik, Universität Gießen

K-shell transitions and especially Kα features are most prominent in active galactic nuclei X-ray spectra. To perform laboratory astrophysics experiments on these processes in iron ions, high fluxes of X-ray photons near 6700eV are required. We used the transportable Heidelberg electron beam ion trap (FLASH-EBIT) to carry out high resolution resonant X-ray scattering measurements on He- and Li-like iron ions at PETRA III, a new 4th generation synchrotron radiation source.

The undulator beam line P01 which is equipped with a double crystal monochromator provided beams of $10^{13}\gamma\ s^{-1}$ at 6700eV. With a photon beam resolution of 0.1 eV, the natural line width of electric dipole allowed X-ray transitions and their corresponding energies could be determined.

A 21.19 Tue 16:30 Poster.V

Dynamic properties of $^{172}Yb^{+}$ ion Coulomb crystals in Paul trap — •Kristijan Kuhlmann[1], Karsten Pyka[1], Jonas Keller[1], David-Marcel Meier[1], and Tanja E. Mehlstäubler[1,2] — [1]Quest-Institute, Physikalisch-Technische Bundesanstalt, Braunschweig — [2]Department of Time & Frequency, Physikalisch-Technische Bundesanstalt, Braunschweig

Towards building an $^{172}Yb^{+}/^{115}In^{+}$ optical clock yielding a frequency standard with a relative inaccuracy $\Delta\nu/\nu \sim 10^{-18}$, we study the dynamic properties of $^{172}Yb^{+}$ ion Coulomb crystals in a linear Paul trap and the stability of linear ion chains close to the 'zigzag' phase transition. Furthermore, we present our new apparatus, the characterisation of our ion trap and results of micromotion measurements.

In order to obtain large secular frequencies, a helical resonator with a loaded Q=640 has been developed. In our experimental setup with a background pressure of $1\cdot10^{-10}$ mbar, single ion life times of up to 33h, linear chains of 50 ions and large 3D crystals have been realised. Also, using secular frequency measurements, decays in fluorescence of large laser cooled crystals were identified as $YbOH^{+}$ molecule formations.

A 21.20 Tue 16:30 Poster.V

Trapping of short lived Ra^{+} ions — •H. Bekker, M. Nunes Portela, D. Seelen, O. Dermois, K. Jungmann, C.J.G. Onderwater, R.G.E. Timmermans, L. Willmann, and H.W. Wilschut — KVI, University of Groningen, NL

A Precision measurement of atomic parity violation in order to determine electroweak mixing angle at low energy scale is underway at the KVI, University of Groningen. The experiment exploits the large sensitivity of a single trapped Ra^{+} ion. It requires the trapping of short lived radium ions in a Paul trap. Our first laser spectroscopy on an ensemble of trapped short-lived $^{209-214}Ra^{+}$ isotopes employed buffer gas cooled ions in a linear Paul trap. It provided hyperfine structure of the 6d $^2D_{3/2}$ states and isotope shift of the 6d $^2D_{3/2}$-7p $^2P_{1/2}$ transition [1,2]. In a next step the buffer gas cooled Ra ions are extracted from the trap and transported in an electrostatic transport system towards a small Paul trap in an UHV environment. Here the ion can be cooled and subsequently microwave transitions between hyperfine states in the 6d $^2D_{3/2}$ manifold can be driven in order to yield high precision results on the hyperfine constants. These results provide input for the ongoing precision atomic structure calculations.

[1] O. O. Versolato et al. Phys. Lett. A 375 (2011) 3130-3133.

[2] G. S. Giri et al. Phys. Rev. A 84 (2011) 020503(R).

A 21.21 Tue 16:30 Poster.V

maXs: Metallic Magnetic Calorimeters for High-Resolution X-ray Spectroscopy in Atomic Physics — •Christian Pies, Sönke Schäfer, Sebastian Kempf, Jan-Patrick Porst, Simon Uhl, Sebastian Heuser, Thomas Wolf, Loredana Gastaldo, Andreas Fleischmann, and Christian Enss — Kirchhoff Institut für Physik, INF 227, 69120 Heidelberg

Highly-charged ions are model systems for the investigation of quan-

tum electrodynamical effects in strong electromagnetic fields.

We are developing x-ray detectors based on 1x8 arrays of Metallic Magnetic Calorimeters (MMCs) optimized for x-ray spectroscopy of highly-charged ions at GSI/FAIR and the EBIT facility at the MPI for Nuclear Physics in Heidelberg. One of the detector arrays (maXs-20) is designed to provide an energy resolution below 3 eV (FWHM) and sufficient stopping power for x-rays in the energy range up to 20 keV. The second device (maXs-200) is optimized for the detection of x-rays up to 200 keV and should yield an energy resolution below 30 eV (FWHM).

We present detector designs, outline the micro-fabrication process and discuss the results of characterization measurements with ^{55}Fe and ^{241}Am calibration sources including energy resolution, signal shape and cross-talk between adjacent detectors of both arrays.

A 21.22 Tue 16:30 Poster.V

Aufbau und Inbetriebnahme eines verbesserten Laser-Raman-Systems für das KATRIN-Experiment — •Sebastian Mirz — für die KATRIN-Kollaboration - Institut für exp. Kernphysik, Karlsruher Institut für Technologie, Karlsruhe, Deutschland

Das Karlsruhe Tritium Neutrino Experiment KATRIN untersucht das Energiespektrum des Tritium β-Zerfalls nahe des Endpunkts zur Bestimmung der Neutrinomasse mit einer Sensitivität von 200 meV/c^2 (90% C.L.). Dazu wird kontinuierlich Tritiumgas in die fensterlose gasförmige Tritiumquelle eingespeist, deren physikalischen Eigenschaften auf 10^{-3} stabilisiert werden müssen. Zu diesen gehört die Tritiumreiheit des eingespeisten Gases, die durch ein Laser-Raman-Systems mit einer statistischen Unsicherheit von besser 10^{-3} überwacht wird. Mit den bereits am Tritiumlabor Karlsruhe aufgebauten Systemen konnte diese Anforderung innerhalb von 250 s Messzeit erreicht werden.

Im Rahmen dieser Arbeit wurde ein verbessertes Laser-Raman-System aufgebaut und Testmessungen mit Tritium durchgeführt. Durch eine verbesserte Strahlführung wurde die Laserintensität im Messvolumen nahezu verdoppelt. Das Rauschen im Spektrum wurde durch eine optimierte Auslese des verwendeten Bildsensors reduziert. Durch diese Maßnahmen konnte die Präzision der Raman-Messung verbessert werden. Mit den Testmessungen konnte entsprechend gezeigt werden, dass die Messzeit, bei Wahrung einer stat. Unsicherheit von 10^{-3}, von 250 s auf 60 s reduziert werden kann.

In diesem Beitrag werden die Verbesserungen des Laser-Raman-Systems vorgestellt und die Ergebnisse der Testmessung präsentiert.