A 8 Poster I: Präzisionsspektroskopie

Zeit: Dienstag 16:30–18:30 Raum: Labsaal

A 8.1 Di 16:30 Labsaal

Experimental and theoretical wavelength of EUV emission lines from highly charged xenon ions — •Christoph Biedermann[1], Rainer Radtke[1], Jean-Louis Schwob[2], and Pinhas Mandelbaum[2] — [1]Institut für Physik der Humboldt-Universität, Lehrstuhl Plasmaphysik, Newtonstraße 15, 12489 Berlin und Max-Planck-Institut für Plasmaphysik, EURATOM Association, Germany — [2]Racah Institute of Physics, The Hebrew University, 91904

In the effort to support fusion work with atomic physics data at the Berlin electron beam ion trap (EBIT), we investigate the line radiation from highly charged xenon ions. Xenon has been proposed as a coolant of the plasma edge region of future large tokamaks, such as the International Thermonuclear Experimental Reactor (ITER). To estimate the radiated power, it is important to obtain information on the ionization state and the transitions producing line emission. With EBIT a narrow range of ion charge states can be selectively produced, stored for extended periods of time and excited by the electron beam. The EUV emission lines have been measured with high resolution over a wide wavelength range from 50 to 800 Å. We observe and identify lines or groups of lines for individual ion charge states ranging from Tc-like Xenon (11+) to Li-like xenon (51+). The data is compared with theoretical calculations using the multiconfiguration relativistic HULLAC computer code (helping to classify the observed lines) as well as measurements at the TFR-tokamak and the W7-AS stellerator.

A 8.2 Di 16:30 Labsaal

Eine laserspektroskopische Methode zur Kernladungsradienbestimmung des Neutronen Halokerns ^{11}Be — •W. Nörtershäuser[1,2], B. A. Bushaw[3], G. W.F. Drake[4], G. Ewald[5], Ch. Geppert[2], H.-J. Kluge[2], N. Miski-Oglu[2], R. Sanchez[2], F. Schmidt-Kaler[6], D. Tiedemann[1], Z.-C. Yan[7] und C. Zimmermann[5] — [1]Universität Mainz — [2]GSI Darmstadt — [3]Pacific Northwest National Laboratory, USA — [4]University Windsor, Kanada — [5]Universität Tübingen — [6]Universität Ulm — [7]University New Brunswick, Kanada

Die Messung der Kernladungsradien von Halokernen ist von größtem Interesse. Sie gibt Aufschluß über den Einfluß der Haloneutronen auf den Rumpfkern. Ladungsradien kurzlebiger Isotope können kernmodelunabhängig nur durch die Messung des Kernvolumeneffektes der Isotopieverschiebung in einem elektronischen Übergang bestimmt werden. Er beträgt bei leichten Elementen nur etwa 10^{-5} des dominanten Masseneffektes. Daher ist eine präzise Bestimmung der Übergangsfrequenzen ebenso wie eine genaue theoretische Berechnung des Masseneffektes nötig. Dies gelang in den vergangenen 2 Jahren für die Zwei-Neutronen-Halokerne ^{11}Li mittels Resonanzionisationsspektroskopie und ^{6}He mittels Spektroskopie in einer magneto-optischen Falle. Die BeTINa Kollaboration (**Be**ryllium **T**rap for the **I**nvestigation of **N**uclear Ch**a**rge Radii) hat das Ziel den Ladungsradius des Ein-Neutronen-Halokerns ^{11}Be durch Laserspektroskopie an lasergekühlten Berylliumionen in einer Paulfalle zu bestimmen. Das im Aufbau befindliche Experiment und Anforderungen an die Präzision der Messung werden diskutiert.

A 8.3 Di 16:30 Labsaal

Spektroskopische Untersuchungen an gespeicherten relativistischen ^{7}Li^{+*}-Ionen für den Test des Zeitdilatationsfaktors an der GSI — •C. Novotny[1], G. Huber[1], S. Karpuk[1], W. Nörtershäuser[1], S. Reinhardt[2], G. Saathoff[2], D Schwalm[2], A. Wolf[2], G. Gwinner[3], F. Bosch[4], G. Ewald[4], C. Geppert[4], H.J. Kluge[4], T. Kühl[4], M. Steck[4], T. Stöhlker[4], T.W. Hänsch[5], R. Holzwarth[5], T. Udem[5] und M. Zimmermann[5] — [1]Johannes Gutenberg Universität Mainz — [2]MPI für Kernphysik, Heidelberg — [3]University of Manitoba, Winnipeg, Canada — [4]Gesellschaft für Schwerionenforschung, Darmstadt — [5]MPI für Quantenoptik, Garching

Im Rahmen von ersten spektroskopischen Untersuchungen an relativistischen ^{7}Li^{+*}-Ionen am Experimentier-Speicherring (ESR) der GSI konnte gezeigt werden, dass einfach positiv geladenes Lithium bei einer Geschwindigkeit von 33,4% der Lichtgeschwindigkeit mit sehr guter Ionenstrahlqualität gespeichert werden kann. Hierbei wurde durch antiparallele Laseranregung des elektronen-gekühlten Ionenstrahls die Lebensdauer der metastabilen Fraktion im ESR auf $\tau = 45s \pm 3s$, sowie die relative Impulsverteilung auf einen Wert von $\frac{\Delta p}{p} \approx 5 \times 10^{-6}$ bestimmt. Bei den im nächsten Schritt geplanten Experimenten soll die Präzision gegenüber dem Vorgängerexperiment am Testspeicherring des MPI für Kernphysik, das bei einer niedrigeren Ionengeschwindigkeit von 6,4% der Lichtgeschwindigkeit durchgeführt wurde und die bisher genauste Messung der Zeitdilatation liefert [1], um mehr als eine Größenordnung erhöht werden.

[1]. G. Saathoff et al., Phys. Rev. Lett. 91, 190403 (2003)

A 8.4 Di 16:30 Labsaal

Two color polarization spectroscopy in indium vapor cell — •Jae-Ihn Kim and Dieter Meschede — Institute for applied physics, University of Bonn, Wegelerstr.8, 53115 Bonn

Polarization spectroscopy in a multi level Λ system is demonstrated. The In Λ transition, $5^2P_{1/2}$ - $6^2S_{1/2}$ - $5^2P_{3/2}$, is driven with a violet 410 nm and a blue 451 nm lasers. On contrast to typical polarization spectroscopy where one laser frequency is used, violet light with circular polarization was used as pump beam and blue light with linear polarization was only used as probe beam. We find dispersive resonance line with another sharp dispersive line at the center. The expected line-shape was calculated by a simplified 3 level model including velocity changing collisions.

A 8.5 Di 16:30 Labsaal

Experiments with an ultracold gas of Rydberg atoms — •J. Denskat[1], M. Reetz-Lamour[1], T. Amthor[1], A.L. de Oliveira[2,3], S. Westermann[1], J. Deiglmayr[1], and M. Weidemüller[1] — [1]Physikalisches Institut Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg — [2]Universidade do Estado de Santa Catarina, Departamento de Física, Joinville, SC 89223-100, Brazil — [3]Universidade de São Paulo, Instituto de Física, São Carlos, SP 13560-970, Brazil

Atoms in highly excited states (Rydberg atoms) are far more strongly influenced by external fields than ground state atoms: The electric polarizability scales with the principal quantum number n as n^7, the van-der-Waals interaction as n^{11} and the size of the electronic wavefunction as n^2. Rydberg atoms in an ultracold gas (*i.e.* the initial motion can be ignored on the relevant timescales given by the Rydberg lifetime, typically a few 10μs), therefore constitute a unique tool to study controlled (many-body) interactions.
In our experiment we cool ^{87}Rb atoms in a magneto-optical trap and excite the atomic cloud into Rydberg states with two photons (780nm, 480nm) from continuous wave lasers. Recent measurements focussed on the coherent excitation (efficiency up to 90%) [1] and the dynamics of resonant energy transfer processes [2]. The experimental details and results will be presented.

[1] Deiglmayr *et al.*, OptComm subm.
[2] Westermann *et al.*, EPJD subm.

A 8.6 Di 16:30 Labsaal

Fine- and hyperfine structure analysis of the odd configuration system tantalum atom — •Bronislaw Arcimowicz[1], Jerzy Dembczynski[1], and Laurentius Windholz[2] — [1]Chair of Atomic Physics, Poznan University of Technology, Nieszawska 13, PL-60-965 Poznan, Poland — [2]Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria

For the atomic and ionic tantalum, above 5000 spectral lines are observed. But, the classification of these lines is still incomplete. The previous attempts of the fine- and hyperfine structure analysis for the odd configurations of tantalum atom were unsatisfactory.

The new experimental results of the fine- and hyperfine structure investigations of L.Windholz and co-workers stimulated us to perform parametric reanalysis in the extended basis of 27 configurations :

$5d^4n'f$ (n'=5-7) + $5d^4n''p$ (n"=6-10) + $5d^36sn'f$ (n'=5-7) + $5d^36sn''p$ (n"=6-10) + $5d^36p7s$ + $5d^36p6d$ + $5d^25f6s^2$ + $5d^26s^2n''p$ (n"=6-10) + $5d^26s^27p$ + $5d^26s6p7s$ + $5d^26s6p6d$ + $5d^26p^3$.

Magnetic-dipole hyperfine interaction constants A were calculated using the fine structure eigenvectors and adjusting radial integrals in a least-squares procedure which compare the calculated A constants with the experimental values. Moreover, the values of energy for the levels up to now unidentified and hyperfine structure A constants were predicted.

A 8.7 Di 16:30 Labsaal

Fine- and hyperfine structure analysis of the even configuration system of tantalum atom — •Jerzy Dembczynski[1], Magdalena Elantkowska[1], Jaroslaw Ruczkowski[1], and Laurentius Windholz[2] — [1]Chair of Atomic Physics, Poznan University of Technology, Nieszawska 13, PL-60-965 Poznan, Poland — [2]Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria

The experimental work of L.Windholz and co-workers, concerning observation of the tantalum spectrum, yield many informations about new energy levels and hyperfine structure splittings. In this report the new findings are presented on the systematic studies of the tantalum atom and ion performed last years. We contribute the results of the complex parametric studies of the fine- and hyperfine structure of the mentioned element up to second-order of perturbation theory. The work has been performed for the systems including at least 23 configurations. The values of the radial parameters describing the one- and many-body interactions effects on atomic structure are given. We predicted values of energy levels and their A- and B- hyperfine structure constants, also for experimentally levels not observed up to now.

A 8.8 Di 16:30 Labsaal

Fine- and hyperfine structure analysis of the odd configuration system of Ta II — •Jerzy Dembczynski[1], Jaroslaw Ruczkowski[1], Magdalena Elantkowska[1], and Laurentius Windholz[2] — [1]Chair of Atomic Physics, Poznan University of Technology, Nieszawska 13, PL-60-965 Poznan, Poland — [2]Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria

The fine structure of the odd levels of the single ionised tantalum has been analyzed by simultaneous parametrization of one- and two-body interactions for the system of 23 configurations:

$5d^3n'f$ (n'=5-7) + $5d^3n''p$ (n"=6-10) + $5d^26sn'f$ (n'=5-7) + $5d^26sn''p$ (n"=6-10) + $5d^26p7s$ + $5d5f6s^2$ + $5d6s^26p$ + $5d6s^27p$ + $5d6s6p7s$ + $5d6s6p6d$ + $5d6p^3$.

The analysis was stimulated by the new experimental data obtained by L.Windholz and co-workers. Magnetic-dipole hyperfine interaction constants A were calculated using the fine structure eigenvectors and adjusting radial integrals in a least-squares procedure which compare the calculated A constants with the experimental values. Moreover, the values of energy for the levels up to now unidentified and hyperfine structure A constants were predicted.

A 8.9 Di 16:30 Labsaal

Detection of nonlinear resonances for trapped Pr^+ ions — •Adam Buczek, Gustaw Szawiola, Adrian Walaszyk, Wojciech Koczorowski, Danuta Stefanska, and Ewa Stachowska — Chair of Atomic Physics, Poznan University of Technology, Nieszawska 13, PL-60-965 Poznan, Poland

A Paul trap allows selection of trapped ions according to ionization stage and mass. Following [1,2,3], the deviation of the trap potential from ideal quadruple form leads to nonlinear resonances. The observation of this effects are presented for Pr^+ ions confined in a Paul trap with a ring electrode diameter of 2 cm.

The presented work has been supported by the project of Poznan University of Technology BW 63-028/06.

[1] F.G. Major, V.N. Gheorghe, G. Werth, Charged Particle Traps, Springer - Atomic, Optical and Plasma Physics 37, Berlin 2005
[2] R. Alheit, K. Enders, G. Werth, Appl. Phys. B 62, 511-513 (1996)
[3] R. Alheit, C. Hennig, R. Morgenstern, F. Vedel, G. Werth, Appl. Phys. B 61, 277-283 (1995)

A 8.10 Di 16:30 Labsaal

Optical diagnostic of nonneutral plasma of Pr^+ ions confined in a rf trap — •Wojciech Koczorowski, Gustaw Szawiola, Adrian Walaszyk, Adam Buczek, Danuta Stefanska, and Ewa Stachowska — Chair of Atomic Physics, Poznan University of Technology, Nieszawska 13, PL-60-965 Poznan, Poland

The ion cloud in a quadrupole rf trap constitutes simply a confined plasma. There exist a few theoretical models, which describes such systems [1,2,3]. However, discrepancies between theory and experiment are still being observed. This contribution shows also evidence of such differences concerning the trapped rare earth element, e.g. Pr^+. The experimental method used for plasma diagnostics is based on a standard laser induced fluorescence technique.

The presented work has been supported by the project of Poznan University of Technology BW 63-028/06.

[1] F.G. Major, V.N. Gheorghe, G. Werth, Charged Particle Traps, Springer - Atomic, Optical and Plasma Physics 37, Berlin 2005
[2] R. Alheit, K. Enders, G. Werth, Appl. Phys. B 62, 511-513 (1996)
[3] R. Alheit, C. Hennig, R. Morgenstern, F. Vedel, G. Werth, Appl. Phys. B 61, 277-283 (1995)

A 8.11 Di 16:30 Labsaal

Fine- and hyperfine structure analysis of the even configuration of Ta II — •Ewa Stachowska[1], Jerzy Dembczynski[1], and Laurentius Windholz[2] — [1]Chair of Atomic Physics, Poznan University of Technology, Nieszawska 13, PL-60-965 Poznan, Poland — [2]Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria

This work contributes to the analysis of the complex atomic structure of tantalum atom and ion. The analysis was stimulated by the new experimental data obtained by the last author. Semi-empirical calculations of fine- and hyperfine structure of the system of 25 configurations have been performed;

$5d^4$ + $5d^3n'g$ (n'=5-6) + $5d^36s$ + $5d^36d$ + $5d^26s^2$ + $5d^26sn'g$ (n'=5-6) + $5d^26sn''d$ (n"=6-10) + $5d^26sn'''s$ (n"'=7-10) +$5d^25f6p$ + $5d^26p^2$ + $5d6s^27s$ + $5d6s^2n''d$ (n"=6-7) + $5d6s6p^2$ + $5d5f6s6p$ + $5d5f6s7p$ + $5d6s6d7s$.

A 8.12 Di 16:30 Labsaal

Challenges for Atomic Physics with Highly-Charged Ions — •Thomas Stöhlker[1], Angela Bräuning-Demian[1], Wolfgang Quint[1], Reinhold Schuch[2], and Eberhard Widmann[3] — [1]GSI, 64291 Darmstadt, Germany — [2]Manne Siegbahn Laboratory, 10405 Stockholm, Sweden — [3]Stefan Meyer Institute for Subatomic Physics, 1090 Vienna, Austria

The future international accelerator Facility for Antiproton and Ion Research (FAIR) has key features that offer a range of new and challenging opportunities for atomic physics and related fields. The proposed facility will provide the highest intensities for relativistic beams of both stable and unstable heavy nuclei, in combination with the strongest possible electromagnetic fields, thus allowing to extend atomic spectroscopy virtually up to the limits of atomic matter. Due to a tremendous improvement concerning intensity and energy, new fields will be opened in addition by the strongly enhanced production yields for unstable nuclei. Moreover, the new facility will produce the highest flux of antiprotons in the world and will opening up the possibility to create low-energy antiprotons at high intensities and high brilliance. Here, the atomic physics program comprises a broad range of experiments such as atomic collision studies using ultra-slow, cooled antiproton beams in storage rings and precision spectroscopy of antiprotonic atoms and of antihydrogen.

A 8.13 Di 16:30 Labsaal

Neue Energieniveaus im Termschema des Praseodym-Atoms — •L. Windholz[1], U. Zaheer[1], D. El Bakkali[2] und G.H. Guthöhrlein[2] — [1]Institut für Experimentalphysik, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Österreich, windholz@tugraz.at — [2]Labor für Experimentalphysik, Univ. d. Bundeswehr Hamburg, Holstenhofweg 85, D-22043 Hamburg

Für Atome mit offenen Elektronenschalen ist die Kenntnis der Energieniveaus der Elektronenhülle noch immer mangelhaft. Daher sind viele der Spektrallinien nicht als Übergänge zwischen bestimmten Niveaus erklärbar. Ein Beispiel für ein derartiges Atom ist Praseodym. Die Vielzahl der Emissionslinien des Praseodym-Spektrums bringt es mit sich, daß bei der Laser-Anregung eines Übergangs in der Regel eine große zahl von Linien beobachtet wird, die laser-induzierte Fluoreszenz zeigen. Nimmt man zu den Wellenzahlen der Anregungs- und Fluoreszenzlinien als Zusatzinformation die Hyperfeinstrukturkonstanten dazu, könne die beteiligten Energieniveaus zweifelsfrei identifiziert werden. Dies führt zur Einführung neuer, bislang unbekannter Energieniveaus. Anhand der vorliegenden experimentellen Ergebnisse konnten etwa 50 neue Niveaus aufgefunden werden.

A 8.14 Di 16:30 Labsaal

Kalibrierbares wellenlängendispersives Spektrometer für die absolute Bestimmung atomarer Fundamentalparameter im Energiebereich von 0.27 keV bis 1.85 keV — •Matthias Müller[1], Rolf Fliegauf[1], Burkhard Beckhoff[1], Birgit Kanngiesser[2] und Gerhard Ulm[1] — [1]Physikalisch-Technische Bundesanstalt, Abbestraße 2-12, 10587 Berlin — [2]Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

Ein kalibrierbares wellenlängendispersives Spektrometer wurde aufgebaut, das im PTB-Laboratorium bei BESSY II am Plangittermonochromatorstrahlrohr für Undulatorstrahlung eingesetzt werden wird. Es soll ermöglichen, atomare Fundamentalparameter wie Coster-Kronig-Koeffizienten, Übergangswahrscheinlichkeiten von Fluoreszenz- und Satellitenlinien sowie Streuquerschnitte der resonanten Ramanstreuung im Energiebereich von 0.27 keV bis 1.85 keV absolut zu bestimmen. Der gewählte Energiebereich deckt die K-Linien leichter Elemente (C bis Si), L-Linien von Übergangsmetallen sowie M-Linien seltener Erden ab.

Das Spektrometer ist auf Kalibrierbarkeit, hohes Energieauflösungsvermögen (500), gute Effizienz und sehr gute Stabilität ausgelegt. Es besteht aus einem Eintrittspalt, einem sphärischem Reflexionsgitter und einem CCD-Detektor, angeordnet auf einem Rowlandkreis.

Der aktuelle Stand der Charakterisierung des Gerätes sowie Ergebnisse erster Experimente werden vorgestellt.

A 8.15 Di 16:30 Labsaal

Projectile x-ray emission in relativistic collisions of Be-like uranium ions with gaseous target. — •S. Trotsenko[1,2], D. Banas[3], A. Gojska[4], A. Gumberidze[1,2], S. Hagmann[1,2], S. Hess[1,2], Ch. Kozhuharov[1], D. Liesen[1], M. Nofal[1], R. Reuschl[1,2], J. Rzadkiewicz[1,4], U. Spillmann[1,2], and Th. Stöhlker[1,2] — [1]GSI, Darmstadt, Germany — [2]IKF, Universitat Frankfurt, Germany — [3]Institute of Physics, Swietokrzyska Academy, Kielce,Poland — [4]The Soltan Institute for Nuclear Studies, Swierk, Poland

During recent years the process of K-shell ionization of Li-like high-Z ions in relativistic collisions with gaseous targets was studied at the ESR storage ring at GSI. This process has proven to be a highly-selective mechanism for the population of excited (n=2) s-states. In the present study, the state selective investigation was extended to the study of initially Be-like ions allowing us to produce almost exclusively an excited state in Li-like uranium which is expected to undergo predominantly an exotic two electron-one photon decay. The experiment was performed with cooled Be-like uranium ions colliding with N2 gas target at the energy of 90 MeV/u at the storage ring ESR. The x-rays produced in this process were measured under different angles with respect to the propagation direction of the ion beam. In particular the radiative transitions in the Li-like uranium ions caused by K-shell ionization of the initial projectile were studied. The spectral data and preliminary analysis results will be presented.

A 8.16 Di 16:30 Labsaal

VUV spectroscopy from TESLA-EBIT — •G. Başak Balli, Sascha Epp, José R. Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik Saupfercheckweg 1, D-69117 Heidelberg, Germany

An electron beam ion trap (TESLA-EBIT) will be installed in the new free electron laser (FEL) beam line at the TESLA facility in Hamburg. A soft x-ray flat-field grazing-incidence grating spectrometer has been recently implemented to the EBIT. This spectrometer is equipped with a cryogenically cooled back-illuminated charge-coupled device (CCD) camera. It has a 2400 grooves/mm grating which spectral region varies from 1 to 5 nm (VUV). Preliminary results of K-shell lines in hydrogenlike and heliumlike O, N, and C ions are presented here. The differences between a monoenergetic and a Maxwellian-like electron beam will also be studied for the L-shell transitions in highly charged Ar ions.