A 27: Posters: Electron scattering and recombination

Zeit: Donnerstag 16:30–18:30 Raum: Poster C3

A 27.1 Do 16:30 Poster C3

Characteristic x–ray emission following the radiative capture and projectile excitation in relativistic ion–atom collisions — •Stephan Fritzsche[1,2], Andrey Surzhykov[1,3], and Thomas Stöhlker[2,4] — [1]Max–Planck–Institut für Kernphysik, Heidelberg — [2]Gesellschaft für Schwerionenforschung (GSI), Darmstadt — [3]École Normale Supérieure, Paris — [4]Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg

During the last decade, the radiative electron capture of target electrons by high–Z ions and the projectile excitation have been studied in great detail at the GSI storage ring in Darmstadt. Typically, both of these processes lead to an alignment of the excited states of the ions with regard to the incident beam direction and, hence, to an anisotropic emission and polarization of the decay x–ray photons [1]. From the angular and polarization analysis of this emission, however, one can learn a lot about the structural properties as well as the dynamical behaviour of few–electron heavy ions in very strong electromagnetic fields.

In this contributions, we shall consider especially the Lyman–α_1 ($2p_{3/2} \rightarrow 1s_{1/2}$) and K$\alpha_1$ ($1s2p_{3/2} \rightarrow 1s^2_{1/2}$) radiative transitions in hydrogen– and helium–like uranium ions and compared the emitted characteristic radiation for an initial electron capture *versus* the Coulomb excitation of the projectiles [2].

[1] S. Fritzsche *et al.*, J. Phys. B **38** (2005) S707.
[2] A. Surzhykov *et al.*, Phys. Rev. A **74** (2006) 052710.

A 27.2 Do 16:30 Poster C3

The high efficiency spin-resolved electron detection in a mini-Mott analyzer — •Rustam Berezov and Joachim Jacoby — Institut für Angewandte Physik, Max von Laue-Str. 1, D-60438 Frankfurt / Main

The investigation of spin-dependent measurements with electron polarimeters gives a lot of additional information concerning many physical processes. The main problem in polarized electron studies at keV-particle energy is now not longer the source intensity, but rather the low efficiency of usual electron polarimeters, like Mott scattering polarimeter. We present here the design and performance of a compact mini-Mott spin analyzer of electron polarization. Due to the compact small size the cylindrical-electrode Mott polarimeter has a higher efficiency which is defined as ratio I/Io of intensity for scattered electrons divided by the initial current. In turn the increasing efficiency improves the figure of merit.

A 27.3 Do 16:30 Poster C3

Dielektronische Rekombination wasserstoffähnlicher Uranionen — •Dietrich Bernhardt[1], Carsten Brandau[2], Zoltan Harman[3], Christophor Kozhuharov[2], Alfred Müller[1], Werner Scheid[4], Stefan Schippers[1], Eike W. Schmidt[1], Deyang Yu[5], Karl Beckert[2], Anton N. Artemyev[8], Peter Beller[2], Sebastian Böhm[1], Fritz Bosch[2], Fred Currell[6], Bernhard Franzke[2], Alexandre Gumberidze[2], Jörg Jacobi[1], Paul Mokler[1,3], Fritz Nolden[2], Uwe Spillmann[2], Zbigniew Stachura[7], Markus Steck[2], Thomas Stöhlker[2] und Ilya I. Tupitsyn[8] — [1]Institut für Atom- und Molekülphysik, JLU Gießen — [2]GSI, Darmstadt — [3]MPI für Kernphysik, Heidelberg — [4]Institut für Theoretische Physik, JLU Gießen — [5]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, P. R. China — [6]Physics Department, Queens University, Belfast, UK — [7]Instytut Fizyki Jądrowej, Kraków, Poland — [8]Department of Physics, St. Petersburg State University, Russia

Im Rahmen eines am GSI Experimentierspeicherring mit überlagerten Ionen- und Elektronenstrahlen durchgeführten Experiments wurden erstmals absolute Ratenkoeffizienten der dielektronischen Rekombination DR von U^{91+} gemessen. Diese Untersuchung der e-e-Wechselwirkung in den stärksten möglichen atomaren Feldern erfolgte bei Kollisionsenergien von 63 bis 90 keV. Individuelle Gruppen von KLL-Resonanzen konnten aufgelöst werden. Die Ergebnisse werden mit QED-Effekte berücksichtigenden Atomstrukturrechnungen verglichen. Der starke Einfluss der Breitwechselwirkung auf den DR-Prozess wird belegt.

A 27.4 Do 16:30 Poster C3

Photoionization of excited states in kinematically complete experiments — •Thomas Pflueger, Xueguang Ren, Arne Senftleben, Alexander Dorn, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Reaction microscopes (RM) deliver kinematically complete information on atomic and molecular ionization processes. We want to extend this method to the investigation of excitation, e.g. by charged particle impact. By means of a laser pulse the excited states are photoionized and the released electron and the ion are detected. From the energies and angular distributions of these particles we gain detailed information on the primary collision process. Examples for electron impact excitation of atoms will be presented.

A 27.5 Do 16:30 Poster C3

Systematic effects on the absolute energy determination of dielectronic recombination resonances — •Christian Beilmann, José R. Crespo López-Urrutia, Volkhard Mäckel, Hiro Tawara, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The dielectronic recombination (DR) is a resonant electron capture process by a highly charged ion, where the kinetic energy of the captured electron is transfered to a bound electron thus exciting it. By measuring DR, the electronic energy levels can be determined with high precision. The ions are produced and trapped in an electron beam ion trap (EBIT) using an intense electron beam. Varying the electron energy allows measuring the electron capture resonances. In these experiments the space charge potential of the electron beam (partially compensated by the ions) has to be inferred. In previous experiments it was observed that the trapping potential depth had an influence on the space charge potential as well as on its linearity with respect to the current of the electron beam. The precise determination of the space charge potential is an issue of ongoing experiments. The resonance energies of the DR at several trapping potentials are studied and compared with each other. Applying the corrections obtained in these investigations leads to an higher accuracy for the absolute resonance energies.

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A Photoemission Electron Source Based on GaAs Semiconductor Crystal Used in a Reaction Microscope — •Vladimir Borovik, Steffen Lüdemann, Toshiyasu Ichioka, Claus Dieter Schröter, Alexander Dorn, and Joachim Ullrich — Max-Planck Institute of Nuclear Physics, Saupfercheckweg 1, D-69117 Heidelberg, Germany

The dynamics of fundamental few-body quantum systems can be investigated by observing single and multiple ionization of atoms and molecules in the near-threshold region. We employ recoil-ion and electron momentum spectroscopy which allows us to measure the momentum vectors of several ions and electrons created in such reactions. For electron-impact ionization, the momentum resolution critically depends on the incident electron beam quality. For our experiments an electron source with a narrow energy distribution at small energies of the beam is required. Recent measurements were limited by the characteristics of the thermocathode electron source used (see, e.g., [1]). We have built a new pulsed photoemission electron source based on a GaAs semiconductor crystal activated to a state of negative electron affinity. Since the electron beam is produced by irradiating the crystal surface with a picosecond laser beam, its time structure is essentially defined by the characteristics of the laser. The current status of the photoelectron source and main technical issues related to its implementation in the collision experiments using the so-called reaction microscope [2] will be discussed. [1] M. Durr et al., Phys. Rev. Lett. 96, 243202 (2006). [2] J. Ullrich et al., Rep. Prog. Phys. 66, 1463 (2003).

A 27.7 Do 16:30 Poster C3

Spin-resolved electron scattering on lead (Pb) and bismuth (Bi) atoms — •Volker Hamelbeck, Philipp Brüner, and G. Friedrich Hanne — Physikalisches Institut, 48149 Münster, Germany

The physics of interactions between low-energetic spin-polarised electron beams and atomic as well as molecular targets have comprehensively been studied in our group. An interesting aspect of this field are collision experiments on heavy metal atoms such as Pb and Bi where spin-orbit and exchange effects occur simultaneously. This is still a difficult task for theory.

For a description of these processes, the scattering parameters S_P, S_A, $\vec{T}$ and $\vec{U}$ are introduced. Through the polarisation function S_A the spin-dependence of the DCS is quantified. The other parameters are determined by measurement of $\vec{P}$ and $\vec{P}'$, the electron polarisation before and after scattering respectively.
In such an experiment, the spin-polarised electron beam is guided from a GaAs source to the collision centre where it hits the heavy metal vapour emanating from an oven. A rotatable spectrometer is used to collect the scattered electrons whose spin polarisation is subsequently determined in a Mott-detector.
At the conference, details of the apparatus and current results will be presented. Through further investigations, we will gain a deeper insight into the physics of collisions between spin-polarised electrons and atoms.

A 27.8 Do 16:30 Poster C3

Isotopieverschiebung in der dielektronischen Rekombination von Li-artigen $^{A}Nd^{57+}$ Ionen — •C. Brandau[1], C. Kozhuharov[1], Z. Harman[2], A. Müller[3], S. Schippers[3], Y.S. Kozhedub[4], D. Bernhardt[3], S. Böhm[3], J. Jacobi[3], E.W. Schmidt[3], P.M. Mokler[2,3], F. Bosch[1], H.-J. Kluge[1], Th. Stöhlker[1], K. Beckert[1], P. Beller[1], F. Nolden[1], M. Steck[1], A. Gumberidze[1], R. Reuschl[1], U. Spillmann[1], F.J. Currell[5], I.I. Tupitsyn[4], V.M. Shabaev[4], U.D. Jentschura[2], C.H. Keitel[2], A. Wolf[2] und Z. Stachura[6] — [1]Gesellschaft für Schwerionenforschung, 64291 Darmstadt, Germany — [2]Max-Planck Institut für Kernphysik, 69117 Heidelberg, Germany — [3]Justus-Liebig-Universität, 35392 Gießen, Germany — [4]St. Petersburg State University, 198504 St. Petersburg, Russia — [5]Queen's University, Belfast BT7 1NN, UK — [6]Instytut Fizyki Jądrowej, 31-342 Kraków, Poland

Die Messung von Isotopieverschiebungen (IS) im Resonanzspektrum der dielektronischen Rekombination ist eine neuartige, hochpräzise und sensitive Methode, um Parameter von Kernladungsverteilungen experimentell zu bestimmen. Dies gilt insbesondere für schwere Wenig-Eletronensysteme, wie das in dieser Arbeit untersuchte Li-artige $^{A}Nd^{57+}$. Ergebnisse eines ersten Experiments am Speicherring ESR der GSI mit den beiden stabilen Nd-Isotopen A=142 und A=150 werden vorgestellt und diskutiert. Die Ableitung der Radiusänderung $^{142,150}\delta\langle r^2\rangle$ aus der IS erfolgte im Rahmen eines voll relativistischen Ansatzes unter Berücksichtigung von QED Korrekturen.

A 27.9 Do 16:30 Poster C3

The Coulomb four-body problem: double ionization of helium by electron impact close to threshold — •Xueguang Ren, Alexander Dorn, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg

The dynamics of many-particle quantum systems is still one of the most important unsolved problems in quantum physics. For three-electron escape from an ionic potential close to the fragmentation threshold theories predict a symmetric electron emission with 120° relative angles [1] as well as a T-shape emission with two electrons emitted back-to-back and the third one emitted perpendicular [2]. We have realized such a strongly correlated three electron continuum in electron impact double ionization of helium atoms. Kinematical complete experiments were performed for impact energies 27 eV and 5 eV above the break-up threshold. For the higher energy (27 eV) symmetric as well as T-shape configurations are observed [3]. For 5 eV excess energy only symmetric electron emission is found strongly supporting the Wannier-like saddle point dynamics on which Klar and Schlecht base their work [1].

[1] H. Klar and W. Schlecht, J. Phys. B 9, 1699 (1976)
[2] A. Emmanouilidou and J. M. Rost, J. Phys. B 39, 4037 (2006)
[3] M. Dürr et al., Phys. Rev. Lett. 98, 193201 (2007).

A 27.10 Do 16:30 Poster C3

Nuclear lifetime prolongation in resonant electron recombination processes — •Adriana Pálffy[1], Zoltan Harman[1], Christophor Kozhuharov[2], Carsten Brandau[2], Christoph H. Keitel[1], Werner Scheid[3], and Thomas Stöhlker[2] — [1]MPI für Kernphysik, Heidelberg — [2]Gesellschaft für Schwerionenforschung, Darmstadt — [3]Institut für Theoretische Physik, Giessen

Processes at the borderline between atomic and nuclear physics open the possibility to explore properties of exotic nuclei via experiments involving highly-charged ions. The coupling of nuclei to atomic shells in the process of nuclear excitation by electron capture (NEEC) can lead to a number of nuclear effects.

In the resonant process of NEEC, the recombination of a continuum electron into a bound atomic shell leads to the excitation of the nucleus [1]. When occuring into an excited electronic bound state, NEEC is followed by fast x-ray emission, changing the electronic configuration of the ion. For some heavy highly-charged ions, the electronic decay suppresses the internal conversion decay channel and leads therefore to lifetime prolongation of the excited nuclear state and an increase of the NEEC resonance strengths of up to two orders of magnitude. Applications of these effects to the measurement of the not yet experimentally observed NEEC and their possible relevance to dense astrophysical plasmas are discussed.

[1] A. Pálffy, W. Scheid, Z. Harman, Phys. Rev. A 73, 012715 (2006)

A 27.11 Do 16:30 Poster C3

Low energy electron cooler for the Heidelberg CSR — •andrey shornikov, dmitry orlov, manfred grieser, and andreas wolf — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The Cryogenic Storage Ring (CSR) is currently under development at MPI-K in Heidelberg. The CSR is an electrostatic ring intended for storing ions in the 20-300 keV energy range (E/Q) in cryogenic environment at temperature down to 2K. CSR will be equipped with an electron cooler which has to combine cooler and electron target functions. For cooling operation at given ion energies corresponding electron energies are in the range from 160 down to a few eV. Main problems in such operation mode are the decrease of electron beam intensity, the degradation of the electron longitudinal energy spread[1] and the distortion of stored low energy ion trajectories during beams merging. For the CSR a new merging beam section layout[2] together with a photocathode based cold electron source[3] (tested at the Heidelberg TSR) have been proposed. In this paper we present the design of CSR electron cooler including the cryogenic implementation together with numerical calculations of the electron beam longitudinal and transverse energy spread in merged beam section.

[1] D. Orlov et al. Proc COOL05 (2005) pp 478-487
[2] H. Fadil et al. Proc EPAC2006 pp 1630-1632
[3] D. Orlov et al , J. Phys.:Conf.Ser., 4,pp 290-295(2005)

A 27.12 Do 16:30 Poster C3

Dielectronic recombination of highly charged ions for optimization of charge breeding — •Lodewijk Arntzen, José R. Crespo López-Urrutia, Volkhard Mäckel, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, 69256 Heidelberg, Germany

The dielectronic recombination (DR) resonances for highly charged ions have been investigated through measurements of ions extracted from the Heidelberg electron beam ion trap (EBIT) while slowly scanning the electron energy. At strong DR resonances, the yield of the He-like krypton ions was substantially reduced, whereas that of the Li-like krypton ions was correspondingly increased. At slightly higher electron energies similar features were observed for the Li- and Be-like krypton ions. The DR process can be therefore used to modify significantly the ion charge state distribution, and by judicious choice of the excitation and recombination energies and timing, to concentrate the extracted ion current into particularly interesting charge states while depleting the undesired ones. This is particularly important for future charge breading experiments with short-lived radioactive isotopes, in order to improve the total charge breeding efficiency and to reduce the radioactive ion beam losses in the accelerator system. The convenient control of this parameters in an EBIT makes them well suited for this purpose.