A 29: Electron scattering and recombination

Zeit: Freitag 11:00–12:45 Raum: 3D

Hauptvortrag A 29.1 Fr 11:00 3D

Bridging atomic and nuclear physics in nuclear excitation by electron capture — •Adriana Pálffy, Jörg Evers, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Heidelberg

In the resonant process of nuclear excitation by electron capture (NEEC), the recombination of a continuum electron into a bound atomic shell leads to the excitation of the nucleus [1].

NEEC can act as an efficient nuclear excitation mechanism, in particular as triggering mechanism releasing on demand the energy stored in nuclear isomers - long-lived nuclear excited states [2]. The isomeric state can be excited via NEEC to a higher level which is associated with freely radiating states and therefore releases the energy of the metastable state. We present total cross sections for NEEC isomer triggering considering experimentally confirmed low-lying triggering levels and reaction rates based on realistic experimental parameters in ion storage rings. A comparison with other isomer triggering mechanisms shows that, among these, NEEC is the most efficient one [3].

An experimental verification of our findings at the borderline of atomic and nuclear physics may be provided by upcoming ion storage ring facilities and ion beam traps which will commence operation in the near future.

[1] A. Pálffy, W. Scheid, Z. Harman, Phys. Rev. A 73, 012715 (2006)
[2] P. M. Walker and G. D. Dracoulis, Nature 399, 35 (1999)
[3] A. Pálffy, J. Evers, C. H. Keitel, Phys. Rev. Lett. 99, 172502 (2007)

A 29.2 Fr 11:30 3D

Hochaufgelöste Elektronenspektroskopie an ionischen Targets — •Kristof Holste[1], Alfred Müller[1], Stefan Schippers[1] und Sandor Ricz[2] — [1]Institut für Atom- und Molekülphysik, Justus-Liebig-Universität Gießen — [2]Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, Hungary

Die Untersuchung von Elektron-Ion-Stößen ist auf Grund der um Größenordnungen kleineren Teilchendichten von ionischen Targets verglichen mit Gas- oder Festkörpertargets eine experimentelle Herausforderung. Totale Elektron-Ion-Wechselwirkungsquerschnitte werden heutzutage routinemäßig mit crossed- oder merged-beams-Anlagen gemessen. Dabei werden üblicherweise nur die umgeladenen Ionen als Reaktionsprodukte detektiert, nicht jedoch die emittierten Elektronen, die prinzipiell weitergehende Informationen über den Wechselwirkungsprozess liefern. Hier stellen wir eine crossed-beams-Anlage vor, in die ein zweistufiges Elektronenspektrometer integriert wurde. Das Spektrometer besteht aus einem sphärischen (1. Stufe) und einem zylindrischen (2. Stufe) Spiegelfeldanalysator mit azimutaler Symmetrie. In der ersten Stufe werden alle Elektronen, die vom Kreuzungspunkt des Ionen- und des Elektronenstrahls in die azimutale Streuebene emittiert werden, aufgesammelt und in die zweite Stufe transportiert. Dort wird sowohl die Energie als auch die Winkelverteilung der emittierten Elektronen mit einem positionsempfindlichen Mikrochannelplate-Detektor bestimmt. Erste Ergebnisse für die elastische Streuung an Cs^{+}-Ionen liegen vor.

A 29.3 Fr 11:45 3D

Exploring correlated high-field few-electron QED by means of dielectronic recombination in $W^{69+\ldots72+}$ ions — •Volkhard Mäckel, José Ramón Crespo López-Urrutia, Antonio Javier González Martínez, Zoltan Harman, Hiro Tawara, and Joachim Ullrich — MPI für Kernpysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The photorecombination of highly charged few-electron tungsten ions W^{69+} to W^{72+} has been investigated at the Heidelberg electron beam ion trap. By scanning the electron beam energy between 39 keV and 44 keV over the KLL dielectronic recombination region and monitoring the emitted x rays, the dielectronic resonance energies of the different charge states could be determined relative to the heliumlike resonances with an relative error as low as 3 eV at 40 keV. At this level of experimental accuracy quantum electrodynamic (QED) and finite nuclear size contributions can be probed. A comparison with different predictions shows strong discrepancies for certain Li- and Be-like ion states while general agreement with other charge states is found. This confirms earlier findings for mercury (Hg^{75+} to Hg^{78+}) DR measurements [1,2].

[1] A. J. González Martínez et al., Phys.Rev. A 73 (2006) 052710
[2] Z. Harman et al., Phys Rev. A 73 (2006) 052711

A 29.4 Fr 12:00 3D

Electron-impact ionization of xenon ions — •Alexander Borovik Jr[1], Mohammad Gharabeih[2], Carsten Brandau[1], Stefan Schippers[1], and Alfred Müller[1] — [1]Institut für Atom- und Moleküöphysik, Justus-Liebig Universität, Giessen, Germany — [2]Jordan University of Science and Technology, Irbid, Jordan

With their many subshells at comparatively low binding energies xenon ions offer rich opportunities to study many-electron processes such as excitation followed by autoionization and resonant electron capture with subsequent multiple electron emission. In high-temperature plasmas Xe ions emit strongly in the extreme ultraviolet spectral range. Recent interest in applying the EUV radiation of xenon or tin ions to lithography has led to the construction of light sources based on laser-produced plasmas or gas discharges. In the effort to optimize for maximum radiation output a detailed understanding of the origin of the radiation and the production of the radiating ions is necessary.

We report on measurements of cross sections for electron-impact single ionization of Xe^{q+} ions with q ranging from 1 to 15. Xe ions are produced in charge states up to 27 by using an 10-GHz-electron cyclotron resonance (ECR) ion source. The electron-ion crossed beams technique is used for the measurement of cross sections for single and multiple ionization. Beside the measurement of absolute cross sections an energy-scanning method is applied to uncover detailed structures in the ionization cross sections.

A 29.5 Fr 12:15 3D

Nuclear properties and strong-field electron dynamics explored by dielectronic recombination — •Z. Harman[1], U.D. Jentschura[1], C.H. Keitel[1], W. Scheid[2], C. Brandau[3], C. Kozhuharov[3], T. Stöhlker[3], D. Bernhard[2], S. Schippers[2], A. Müller[2], V. Mäckel[1], H. Tawara[1], J.R. Crespo López-Urrutia[1], and J. Ullrich[1] — [1]Max-Planck-Institut für Kernphysik — [2]Justus-Liebig-Universität Giessen — [3]GSI Darmstadt

Dynamical and structural properties of heavy highly charged ions have been investigated by means of dielectronic recombination. Isotope shift measurements of low-lying resonances, combined with our atomic structure calculations, allow one to extract information on the nuclear charge distribution of the isotopes involved. We analyze the dependence of electron interaction and QED contributions on the nuclear size and calculate mass shift terms to determine the change of nuclear radii corresponding to the isotope shift in Li-like Nd measured with the ESR storage ring of the GSI Darmstadt [1,2]. This approach constitutes a new technique to determine nuclear radii. Furthermore, we study relativistic electron interaction and QED effects in the strong binding fields of heavy nuclei in collaboration with experiments with the HD-EBIT [3] and the ESR [2]. Our investigation confirm the role of relativistic corrections to the electron interaction in a dynamical process. [1] C. Brandau, C. Kozhuharov, Z. Harman, *et al.*, submitted (2007) [2] C. Brandau, C. Kozhuharov, A. Müller, *et al.*, J. Phys.: Conf. Ser. 58, 81-86 (2007) [3] V. Mäckel, A.N. Artemyev, J.R. López Crespo-Urrutia, *et al.*, We102, XXV ICPEAC, Book of Abstracts (2007)

A 29.6 Fr 12:30 3D

Anomalous quasi-elastic electron scattering from single H2, D2 and HD molecules at large momentum transfer - Indications of nuclear spin effects — •C. Aris Chatzidimitriou-Dreismann[1], Glyn Cooper[2], and Adam P. Hitchcock[2] — [1]Intitute of Chemistry, Technical University of Berlin, D-10623 Berlin Germany — [2]Brockhouse Institute for Materials Research, McMaster University, Hamilton, ON, Canada L8S 4M1

Quasi-elastic electron scattering from gaseous H_2, D_2, a 50:50 mixture of H_2 and D_2 and HD is investigated with 2.25 keV impact energy and 100^o scattering angle, corresponding to a momentum transfer $\hbar q$ of 19.7 a.u. The energy transfer is less than the H-H, H-D or D-D bond dissociation energy. The spectral positions of the H and D recoil peaks are adequately explained by Rutherford scattering theory. Surprisingly, in the spectrum of the 50:50 H_2-D_2 mixture, the integrated intensity of the H peak is 31±4% lower (as compared to that of D) than predicted by Rutherford scattering, despite equal screening of

nuclear charges by the electrons in all molecules. In contrast, the ratio of scattering intensities from HD agrees with the predictions of Rutherford scattering. Comparison is made with previous neutron Compton scattering (NCS) experiments from the equimolar H_2-D_2 mixture and HD, at much higher energy transfer in the range which can cause H-H bond breaking. The NCS results showed the same deviation (about 30%) from theory in both the H_2-D_2 mixture and HD. Connection to existing theories (on scattering dynamics of entangled particles) is made.