A 6: Interaction of matter with ions

Zeit: Dienstag 8:30–10:15 Raum: 3D

A 6.1 Di 8:30 3D

A MOTRIMS experiment on the energy dependence of double electron transfer — •Ina Blank[1], Simone Götz[1], Terry Mullins[1], Wenzel Salzmann[1], Roland Wester[1], Matthias Weidemüller[1], Valeriu Gabriel Hasan[2], Reinhard Morgenstern[2], and Ronnie Hoekstra[2] — [1]Physikalisches Institut, Universität Freiburg, Hermann-Herder Str. 3, 79104 Freiburg, Germany — [2]KVI - Atomic Physics, University of Groningen, Zernikelaan 25, NL-9747 AA Groningen, The Netherlands

We present the first results on the energy dependence of state-selective double-electron capture in ion-alkali collisions. Experiments are performed with an O^{6+} projectile beam, passing through a cloud of sodium atoms, stored in a magneto-optical trap. State resolved double electron transfer is observed by detecting Na^{2+} ions using Recoil-Ion-Momentum-Spectroscopy [1]. Laser cooling of target atoms ensures high momentum resolution due to low initial thermal momenta. Projectile ion energies are varied from 4.5 to 8.6 keV/amu. Recoil momenta of Na^{2+} ions reveal double transfer of outer and inner shell target electrons, principally into 3ln'l' states of the downcharged projectile [2]. Due to the short interaction times for transfer into 3l3l' states, double transfer into this channel is expected to occur simultaneously which suggests that coherent multi-particle correlations may be investigated via this process.

[1] J. W. Turkstra et al., Phys. Rev. Lett. 87, 123202 (2001).
[2] S. Knoop et al., Europhys. Lett., 74, 992, (2006)

A 6.2 Di 8:45 3D

Einfluss der Molekülorientierung von H_2^+-Projektilen auf die Dynamik der Stoßionisation von He — •Jan- Philipp Suske[1], Shao Feng Zhang[1,3], Daniel Fischer[4], Siegbert Hagmann[2], Andreas Krauss[1], Kai- Uwe Kühnel[1], Robert Moshammer[1] und Joachim Ullrich[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Gesellschaft für Schwerionenforschung, Planckstr. 1,64291 Darmstadt, Germany — [3]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, 730000, China — [4]Stockholm University, AlbaNova University Centre, 10 691 Stockholm, Sweden

Werden H_2^+-Molekülionen beschleunigt und zur Kollision mit kalten He-Atomen gebracht, kann das atomare Target bei gleichzeitiger Dissoziation des Projektilmoleküls ionisiert werden. Mit Hilfe eines Reaktionsmikroskops erhält man die vollständige kinematische Information über das ionisierte Target sowie die emittierten Elektronen. Ladung und Impulse der Projektilfragmente ergeben sich mit Hilfe eines Analysemagneten und zweier positionsempfindlicher Detektoren. Aus den Impulsen der Molekülfragmente lässt sich die Orientierung des Moleküls zum Zeitpunkt des Stoßes rekonstruieren. Insbesondere der Einfluss der Molekülorientierung des H_2^+ auf die Ionisation des Targets wurde untersucht.

A 6.3 Di 9:00 3D

Development of a Drift Time Spectrometer for Heavy Element Research — •Mustapha Laatiaoui[1], Michael Sewtz[1], Dieter Habs[1], Hartmut Backe[2], Werner Lauth[2], and Peter Kunz[2] — [1]Department für Physik, LMU München, Am Coulombwall 1, D-85748 Garching, Germany — [2]Institut für Kernphysik, Universität Mainz, D-55099 Mainz,Germany

Atomic and chemical properties of the heaviest elements are strongly influenced by relativistic effects. Theoretical calculations of ionic radii yield relativistic contractions of the valence orbitals, which show individual trends for different electronic configurations; an effect that may be exploited for element identification of superheavy ions.

Ion mobility spectrometry presents the most direct method to probe these calculations. This technique is well established for stable elements to determine the ionic mobility K by the drift time of ions along electric field lines inside a noble gas filled buffer gas cell. From collision cross sections, which are inverse proportional to K, ionic radii can be inferred.

Due to the low production rates and short half-lifes of the heaviest elements, ultra-sensitive experimental methods are needed. A suitable experimental setup is beeing developed, which will permit the determination of the ion mobility of short-lived nuclei with a precision of $\delta K/K < 10^{-2}$. A status report of this project will be given. This work is supported by the BMBF(06ML236I).

A 6.4 Di 9:15 3D

Energieverlust und Reichweitenstreuung relativistischer Uranionen — •B. Riese[1], H. Weick[2], H. Geissel[1,2], R. Knoebel[1,2], M. Maier[2], M. Matos[2], N. Nankov[2], W. Plass[1], M. Portillo[2], C. Scheidenberger[1,2] und M. Winkler[2] — [1]Justus Liebig Universität Giessen — [2]Gesellschaft für Schwerionenforschung Darmstadt

Die Abbremsung von Schwerionen im Energiebereich (100-1000) A MeV wurde mit dem Magnetspektrometer FRS der GSI untersucht. Der Energieverlust hängt vom mittleren Ladungszustand in der Materie ab. Uranionen sind in diesem Energiebereich noch nicht vollständig ionisiert, deshalb wurde die Ladungsverteilung in verschiedenen Targetmaterialien bestimmt. Wird der mittlere Ladungszustand korrekt berücksichtigt, sind die gemessenen Energieverluste in guter Übereinstimmung mit den theoretischen Vorhersagen. Die Energieverluststreuung in dicken Targets wurde zum einen mit Hilfe der Dispersion des Spektrometers und der Ortsverteilung aufgenommen. Zum anderen wurden die Ionen hinter dem Target vollständig abgebremst und deren Reichweitenstreuung bestimmt. Hierzu wurde hinter dem Target ein Abbremser variabler Dicke verwendet und die Zählrate vor und hinter dem Abbremser mit Hilfe von zwei Ionisationskammern gemessen. Der Einfluss verschiedener Ladungszustände führt zu einer deutlichen Vergrößerung der Energiebreiten. Die Reichweitenverteilungen sind wichtig beim gezielten Implantieren, wie z.B. von in Kernreaktionen bei hoher Energie produzierter Nuklide in einer gasgefüllten Stoppzelle. Aus dieser können dann Strahlen seltener Isotope bei niedriger Energie extrahiert werden.

A 6.5 Di 9:30 3D

Spectral shape of two-photon decay from 2s state in He-like Tin — •ajay kumar[1], sergiy trotsenko[1,2], andrei volotka[3], dariusz banas[4], heinrich beyer[1], harald bräuning[1], alexandre gumberidze[1], siegbert hagmann[1,2], sebastian hess[1,2], christophor kozhuharov[1], regina reuschl[1,2], uwe spillmann[1,2], martino trassinelli[1,5], günter weber[1,6], and thomas stöhlker[1,6] — [1]Atomic Physics Group, GSI, Darmstadt, Germany — [2]University of Frankfurt, Germany — [3]TU Dresden, Germany — [4]Swietokrzyska Academy, Kielce, Poland — [5]Institut des NanoSciences de Paris, France — [6]Universität Heidelberg, Germany

The (1s2s) 2^1S_0 state of He-like ions decays to the ground state via two-photon electric dipole (2E1) transitions. The study of the spectral shape of this 2E1 decay mode in He-like ions is of interest due to its sensitivity to electron-electron correlations and quantum electrodynamical effects. In the present investigation a novel experimental approach has been applied to study two-photon transitions in few-electron high-Z ions. Relativistic collisions of Li-like projectiles with a gaseous target were used to form the desired initial state, which allowed for a measurement of the undistorted two-photon spectral shape. The decay of the 2^1S_0 state in He-like tin was measured, following a successful earlier experiment with He-like uranium. The continuum shape of the two-photon energy distribution was compared with fully relativistic calculations, which are Z-dependent. With the present technique we could, for the first time, observe Z-dependent effects in the spectral shape.

A 6.6 Di 9:45 3D

A critical test for distorted wave theories: laser-assisted single ionization by ion impact — •Marcelo Ciappina[1] and Lars Bojer Madsen[2] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, D-01187 Dresden, Germany — [2]Department of Physics and Astronomy, Univ. of Aarhus, 8000 Aarhus C, Denmark

We study single ionization in laser-assisted high-energy non-relativistic ion-atom collisions and show that the low-energy angular differential electron spectrum may be enhanced significantly by a weak external field. With increasing the strength of the assisting field, the energy spectrum develops a plateau with a characteristic cut-off [1]. In the plateau region we predict distinct multiphoton peaks separated by the photon-energy of the laser field. In the present laser-assisted continuum-distorted-wave eikonal-initial-state (LA-CDW-EIS) theory, this effect may be related to the dynamics in the two-body electron-projectile subsystem. First-order type theories, e.g. the laser-assisted

distorted wave Born (LA-DWB) [2] and first Born approximation (LA-FBA) [3], do not account for the phase-distortion of the target electron by the incoming projectile and consequently the associated plateau, cut-off and multiphoton features are absent. The combined process where an electron is ionized by a heavy ion and subsequently moves in the laser field and under the influence of the Coulomb fields of the projectile and the target represents a stringent test for distorted wave theories. [1] M. F. Ciappina and L. B. Madsen, Phys. Rev. A, (submitted). [2] ibid, J. Phys. B 39 5057 (2006). [3] A. Voitkiv and J. Ullrich, J. Phys. B 34 1673 (2001); ibid, 34 4383 (2001).

A 6.7 Di 10:00 3D

Direct laser acceleration of ions for application in cancer radiotherapy — •Z. Harman[1], Y.I. Salamin[1,2], and C.H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]American University of Sharjah, POB 26666, Sharjah, United Arab Emirates

Linearly and radially polarized multi-terawatt and petawatt laser beams, focused to sub-wavelength waist radii, can directly accelerate protons and carbon nuclei, over micron-size distances, to the energies required for hadron cancer therapy. Radially polarized beams have better emittance than their linearly polarized counterparts. We put forward direct laser acceleration of ions as an appealing alternative for utilization in cancer therapy, once the refocusing of ion beams accelerated by linearly polarized lasers is experimentally solved or radially polarized pulses of sufficient power can be produced. Using a table-top laser system to accelerate the ions may results in a cut on the cost and physical space required by the construction of a conventional accelerator. This scheme may also be a better candidate than the ion production and acceleration by a laser-solid-target method.