A 7: Collisions, Scattering and Correlation Phenomena II (joint session A/MO)

Time: Monday 17:00–19:00 Location: N 2

A 7.1 Mon 17:00 N 2

Theory of Electronic Transitions — •Hubert Klar — retired from University Freiburg, Institut für Physik — 79000 Freiburg, Hermann-Herder-Strasse 3

Starting from the Hamilton-Jacobi frame we present a novel parabolic partial difference equation for s-wave electron atom scattering.This equation serves for initial value problems.Thanks to an unexpected separation of coordinates we calculate easily the classical action which we use later to derive a quantum wave function in the semiclassical limit including correlation. There is no way for direct excitation. That lack is filled by a correlated multielectron wave propagation along a potential ridge. The final destination of that wave is a multielectron concentration point, i. e. all correlated electrons arrive near the nucleus. In the special case of single excitation two electrons form a pair comparable to a Cooper pair.These pairs fill a lake whose elements are represented by converging and diverging Fresnel distributions. The concentration point is highly unstable, the decay leads to an excited target state plus an escaping electron.Our results are in conflict with the old Born model for several reasons. (i) We describe the electrons by matrial waves rather by mass-points. (ii) Correlation has been properly takn in account. (iii) The target electron is not kicked up but pulled up due to electron-electron attraction.

A 7.2 Mon 17:15 N 2

Asymmetries observed in vibrational dissociation of HD by proton impact — •Michael Schulz[1,2], Shruti Majumdar[1], Sujan Bastola[1], Basu Lamicchane[1], Daniel Fischer[1], Ahmad Hasan[3], and Ramaz Lomsadze[4] — [1]Missouri University of Science & Technology, Rolla, USA — [2]Max-Planck Institut für Kernphysik, Heidelberg, Germany — [3]UAE University, Al Ain, UAE — [4]Tbilisi State University, Tbilisi, Georgia

We have measured momentum-analyzed H+ and D+ molecular fragments produced in p + HD collisions in coincidence with neutralized scattering-angle resolved projectiles. From the data we extracted multiple (including fully) differential cross sections for dissociative capture. In various spectra we observed a pronounced asymmetry favoring the H+ + D0 over the H0 +D+ fragmentation channel. A qualitatively similar, but weaker asymmetry was previously found for dissociative ionization and well reproduced by theory [1]. It was explained by an isotope shift in the asymptotic molecular energy curves favoring the electron to be localized closer to the deuteron. We conclude that the same explanation holds for our results on dissociative capture. The larger magnitude of the asymmetry is probably due to the significantly smaller projectile energy.

[1] I. Ben-Itzhak et al., Phys. Rev. Lett. 85, 58 (2000)

A 7.3 Mon 17:30 N 2

Coherent Ionization of Atoms by Dense and Compact Beams of Extremely Relativistic Electrons — •Sami Kim, Carsten Müller, and Alexander B. Voitkiv — Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf

Coherent ionization of atoms by very dense and compact beams of highly relativistic electrons is studied [1]. We consider and compare two coherent electron-induced ionization mechanisms, tunnel/over-barrier ionization and coherent impact ionization. In both mechanisms, a significant fraction of the beam electrons acts coherently, leading to a substantial ionization enhancement. The low-frequency components of the total beam field can coherently induce tunneling in target atoms, while the high-frequency components enable coherent impact ionization. The processes are shown to depend very sensitively on the spatiotemporal structure of these novel electron beams, which offers a means for their characterization.

[1] S. Kim, C. Müller and A. B. Voitkiv; arXiv:2508.17192v2

A 7.4 Mon 17:45 N 2

Detachment with target ionization in collisions of slow D- ions with He and Ar — •Michael Schulz[1], Felix Hermann[1], Weiyu Zhang[1], Alexander Voitkiv[2], Bennaceur Najjari[3], Maka Siddiki[1], Alexander Dorn[1], Manfred Grieser[1], Florian Grussie[1], Holger Kreckel[1], Olda Novotny[1], Andreas Wolf[1], Thomas Pfeifer[1], Claus Dieter Schröter[1], and Robert Moshammer[1] — [1]Max Planck Institut für Kernphysik, Heidelberg, Germany — [2]Heinrich Heine University, Düsseldorf, Germany — [3]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China

We have measured momentum-analyzed recoil-ions and ejected electrons in triple coincidence with projectiles neutralized in collisions of D- ions with He and Ar at projectile energies between 20 and 120 keV. From the data we extracted multiple-differential momentum distributions of electrons ejected in detachment accompanied by single target ionization. For the Ar target the results confirm a strong role played by a first-order correlated channel proceeding by a mutual interaction between the active projectile- and target- electrons which we observed earlier for Si- projectiles. Surprisingly, this is the case even well below the threshold energy for this mechanism pointing to the significance of the interaction between the two active electrons in this fundamental scattering process. The first-order process is important for the He target as well, however, there signatures of higher-order channels are more pronounced than for Ar. The data are qualitatively well reproduced by our higher-order calculations.

A 7.5 Mon 18:00 N 2

Rate coefficients for dielectronic recombination of the astrophysically relevant N-like Ne ion at CRYRING@ESR — •Elena-Oana Hanu[1,2,3], Michael Lestinsky[1], Carsten Brandau[1], Michael Fogle[5], Pierre-Michel Hillenbrand[1], Mirko Looshorn[6,7], Esther Menz[1,4], Stefan Schippers[6,7], Reinhold Schuch[8], Maria Tatsch[6,7], Ken Ueberholtz[9], Shu-Xing Wang[6,7], and Thomas Stoehlker[1] — [1]GSI GmbH, Darmstadt — [2]HI Jena — [3]GU Frankfurt am Main — [4]Universität zu Köln — [5]Dep. of Physics, Auburn University, USA — [6]I. Physikalisches Institut, Uni Giessen — [7]HFHF, Giessen — [8]Dep. of Physics, Stockholm University, Sweden — [9]IKP, Uni Muenster

Dielectronic recombination of N-like Ne was studied using a merged-beams setup at CRYRING@ESR for collision energies from 0 to 25 eV. The measured energy-dependent recombination rate coefficient includes all ΔN=0 DR resonances from 2s to 2p core excitations was compared with results from theoretical calculations. The ion beam contained roughly equal fractions of ions in the ground-state and in metastable states, therefore the theoretical rates were weighted accordingly. From the measurements we derived a DR plasma rate coefficient α(T). The results agree well with previous theory for high temperatures where N-like Ne is abundant, but yield slightly higher rates at the lower temperatures typical of photoionized plasmas and collisionally ionized plasmas. Parametrized fits of the experimental DR plasma rates are provided for use in astrophysical models.

A 7.6 Mon 18:15 N 2

Electron gun optimization for electron-ion crossed-beams experiments — •B. Michel Döhring[1,2], Kurt Huber[1], Mirko Looshorn[1,2], and Stefan Schippers[1,2] — [1]Justus-Liebig-Universität Gießen — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

Electron-impact ionization is a fundamental atomic collision process, which is of importance for a wide range of scientific and technical applications such as astrophysics, EUV lithography and fusion research [1]. Recent cross-section measurements with moderately charged xenon ions [2] and singly charged lanthanum ions [3] have demonstrated the excellent performance of our high-current electron gun, which we have designed and built in Giessen [4,5]. This gun has also served as a prototype of the transverse free electron target for CRYRING at GSI/FAIR [6]. Here, we report on our latest achievements in electron beam resolution, on measurements particularly in the low-energy region, and on future plans for optimizing the flexible electron gun.

[1] A. Müller, Adv. At. Mol. Opt. Phys. **55**, 293 (2008).
[2] F. Jin et al., Eur. Phys. J. D **78**, 68 (2024).
[3] B. M. Döhring et al., Atoms **13**, 2 (2025).
[4] W. Shi et al., Nucl. Instrum. Meth. B **205**, 201 (2003).
[5] B. Ebinger et al., Nucl. Instrum. Meth. B **408**, 317 (2017).
[6] M. Lestinsky et al., Eur. Phys. J. ST **225**, 797 (2016).

A 7.7 Mon 18:30 N 2

A Novel Compton Telescope for Polarimetry in the MeV Range: Towards Delbrück Scattering — •Tobias Over-Winter[1,2,3], Anton Kononov[1], Thomas Krings[4], Wilko Middents[1,2,3], Uwe Spillmann[1], Günter Weber[1,2], and Thomas Stöhlker[1,2,3] — [1]Helmholtz Institute Jena, Jena, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]Friedrich Schiller University Jena, Jena, Germany — [4]Forschungs Zentrum Jülich, Jülich, Germany

For photon energies from several tens of keV up to a few MeV, Compton polarimetry provides insight into subtle details of fundamental radiative processes in atomic physics. Within the SPARC collaboration [1] several segmented semiconductor detectors have been developed that are well suited for application as efficient Compton polarimeters. For scattering and photon emission processes in the hard x-ray regime this kind of detector enable revealing photon polarization effects in great detail [2]. Recently, a new polarimeter has been constructed within the SPARC collaboration based on an arrangement of two segmented semiconductor crystals in a telescope structure. This design allows us to employ the Compton polarimeter in a broad energy range of photon energies from 50 keV up to 1 MeV. In my contribution I will present this detector. Additionally, I will discuss first planned experiments utilizing this detector at high photon energies up to 1 MeV.

[1] Th. Stöhlker et al. Nucl. Instrum. Methods Phys. Res. B 365 (2015) 680.

[2] K.H. Blumenhagen et al. New J. Phys. 18 (2016) 119601.

A 7.8 Mon 18:45 N 2

Single-Electron Detection at Room Temperature Using Background-Gas Ion Signals in a Penning Trap — •Arindam Kumar Sikdar[1,2], Joydip Nandi[1,2], M. Chatterjee[3], Vyshnav C.H.[4], A Ray[1], K. T. Satyajith[4], and P. Das[1,2] — [1]Variable Energy Cyclotron Centre, 1/AF Bidhannagar, Kolkata, INDIA — [2]Homi Bhabha National Institute, Anushaktinagar, Mumbai, Maharashtra, INDIA — [3]Jadavpur University, Raja Subodh Chandra Mallick Road, Jadavpur, Kolkata, INDIA — [4]Delta Q, IMJ Institute of Research, Moodlakatte, Karnataka, INDIA

We present a simple, room-temperature method for detecting a single trapped electron without relying on cryogenic electronics or image-current readout. A single electron confined in a Penning trap naturally ionizes residual background molecules, producing low-energy ions that are guided to a microchannel plate (MCP) and counted individually. These ion bursts provide a clear, indirect signature of the electron*s presence and confinement dynamics.

This ionization-based readout is highly sensitive, non-invasive, and directly compatible with hybrid trap architectures such as dual-frequency Paul traps and Penning*Paul combinations, where conventional detection is limited by weak image currents and RF noise. The technique offers a practical path toward single-lepton detection in room-temperature electron, positron, and antimatter experiments, and opens new opportunities for compact precision sensors and single-particle studies.