A 50: Interaction of matter with ions

Time: Friday 14:00–15:30 Location: V57.05

A 50.1 Fri 14:00 V57.05

Starke Rueckwaerts-Fokussierung von in Transfer-Ionisation Emittierten Elektronen — •Michael Schulz[1,2], Xingcheng Wang[3], Magnus Gundmundsson[4], Katharina Schneider[3,5], Aditya Kelkar[3,5], Alexander Voitkiv[3], Bennaceur Najjari[3], Markus Schoeffler[2], Lothar Schmidt[2], Reinhard Doerner[2], Joachim Ullrich[3], Robert Moshammer[3] und Daniel Fischer[3] — [1]Missouri University of Science & Technology — [2]Institut f. Kernphysik Universitaet Frankfurt — [3]Max-Planck-Institut f. Kernphysik Heidelberg — [4]Atomic Physics Institute, Stockholm University — [5]Extreme Matter Institute EMMI GSI Darmstadt

Kinematisch vollständige Experimente zu Stössen zwischen Ionen und Helium Atomen wurden durch geführt. Dabei wurden umgeladene Projektile in Koinzidenz mit den Impuls-analysierten Elektronen und doppelt geladenen Rückstossionen gemessen. Es wurden 3-dimensionale Winkelverteilungen der Elektronen extrahiert, die in Transfer-Ionisations Prozessen (TI) emittiert wurden. Wir beobachten eine starke Fokussierung des Elektronenflusses in Rückwärtsrichtung [1]. Dieses Verhalten ist in starkem Kontrast zu Einfachionisation und lässt sich somit auch nicht durch einen TI - Mechanismus erklären, bei dem der Einfang und die Ionisation unabhängig sind. Dagegen sind die Daten konsistent mit einem korrelierten Prozess, der erst kürzlich vorrausgesagt wurde [2] und der mit den hier präsentierten Resultaten erstmals experimentell bestätigt ist.

[1] M. Schulz et al., accepted in Phys. Rev. Lett. (2011) [2] A. Voitkiv, Phys. Rev. Lett. 101, 223201 (2008)

A 50.2 Fri 14:15 V57.05

Laser Cooling and Optical Diagnostics for Relativistic Ion Beams — Michael Bussmann[1], Uwe Stuhr[1], Matthias Siebold[1], Ulrich Schramm[1,2], Danyal Winters[3], Thomas Kühl[3], Christophor Kozhuharov[3], Christina Dimopoulou[3], Fritz Nolden[3], Markus Steck[3], •Christopher Geppert[3,4], Rodolfo Marcelo Sanchez Alarcon[3,4], Wilfried Nörstershäuser[3,4], Thomas Stöhlker[3,5], Tobias Beck[6], Thomas Walther[6], Sascha Tichelmann[6], Gerhard Birkl[6], Weiqiang Wen[7], and Xinwen Ma[7] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]TU Dresden — [3]GSI Helmholtzzentrum für Schwerionenforschung — [4]Universität Mainz — [5]Universität Heidelberg — [6]TU Darmstadt — [7]IMPCAS Lanzhou

Cooling of ion beams is essential for precision experiments at future storage rings. Laser cooling is one of the most promising techniques to reach high phase space densities at relativistic ion energies for all ion species which provide suitable atomic cooling transitions.

Establishing laser cooling as a standard technique at future storage rings requires laser sources that can address ion beams with large initial velocity spreads.

Without optical diagnostics however, the dynamics of ions at very low temperatures cannot be resolved, as conventional beam diagnostics reach their resolution limits.

We discuss concepts and techniques that pave the way for making laser cooling a reliable tool at future storage rings, some of which can already be tested at the ESR at GSI.

A 50.3 Fri 14:30 V57.05

Inner and outer shell single ionization of laser-cooled lithium by ion impact — •Aaron LaForge[1], Renate Hubele[1], Xincheng Wang[1], Johannes Goullon[1], Michael Schulz[2,3], and Daniel Fischer[1] — [1]Max Planck Institut fuer Kernphysik, Heidelberg, DE — [2]Misouri University of Science & Technology, Rolla, USA — [3]Institut fuer Kernphysik, Goethe Universitaet, Frankfurt, DE

We have performed a kinematically complete experiment of single ionization of optically trapped and cooled lithium by 1.5 MeV/amu O^{8+}. In comparison to prior work, the overall experimental resolution was drastically improved. As a result, it is possible to resolve ionization from the different energey shells (n=1 & n=2). Furthermore, from the higher order differential data, one can see clear difference between the emitted electron energy, momentum transfer, and other quantities depending on the initial state. Double and fully differential cross sections will be presented. This represents the first direct and simultaneous comparison between such data for inner and outer shell ionization.

A 50.4 Fri 14:45 V57.05

Combined Radiation Effects of Protons and Electrons in Silicon Bipolar Junction Transistor — Chaoming Liu, •Xingji Li, Erming Rui, and Hongbin Geng — Harbin Institute of Technology, Harbin, China

This investigation compares individual radiation effects of 110keV electrons and 170keV protons with combined ones, including simultaneous and sequential radiation effects, caused by 110keV electrons together with 170keV protons, on the forward current gain of bipolar junction transistor. The experimental procedure for the simultaneous irradiation is that the 170keV protons and 110keV electrons irradiation are performed in the same time, while the procedure for the sequential irradiation is the protons and electrons irradiation are performed on same alternate exposure time. The combined exposures will produce both the ionization in the oxide layer (due to the 110keV electrons) and the displacement effect in Si bulk (due to the 170keV protons), resulting in the synergistic radiation effects on bipolar junction transistor. It is instructive to characterize the combined radiation damage caused by electrons and protons with lower energies based on analyzing the damage effects both in the oxide layer and the Si bulk. From the experimental data, the interaction between ionizing damage and displacement damage of bipolar junction transistor is discussed.

A 50.5 Fri 15:00 V57.05

Dense monoenergetic proton beams from chirped laser-plasma interaction — •Benjamin J. Galow[1], Yousef I. Salamin[1,2], Tatyana V. Liseykina[3], Zoltán Harman[1,4], and Christoph H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69029 Heidelberg, Germany — [2]Department of Physics, American University of Sharjah, POB 26666, Sharjah, United Arab Emirates — [3]Institut für Physik, Universität Rostock, 18051 Rostock, Germany — [4]ExtreMe Matter Institute EMMI, Planckstrasse 1, 64291 Darmstadt, Germany

Interaction of a frequency-chirped laser pulse with single protons and a hydrogen gas target is studied analytically and by means of particle-in-cell simulations, respectively. Feasibility of generating ultra-intense (10^7 particles per bunch) and phase-space collimated beams of protons (energy spread of about 1%) is demonstrated. Phase synchronization of the protons and the laser field, guaranteed by the appropriate chirping of the laser pulse, allows the particles to gain sufficient kinetic energy (around 250 MeV) required for such applications as hadron cancer therapy, from state-of-the-art laser systems of intensities of the order of 10^{21} W/cm^2 [1].

[1] B. J. Galow, Y. I. Salamin, T. V. Liseykina, Z. Harman, and C. H. Keitel, Phys. Rev. Lett. **107**, 185002 (2011)

A 50.6 Fri 15:15 V57.05

Electron transfer and ionization in collisions of highly charged ions with Na(3s) and Na*(3p) — •Ina Blank[1], Sebastian Otranto[2], Ronald E. Olson[3], and Ronnie Hoekstra[1] — [1]KVI Atomic and Molecular Physics, University of Groningen, The Netherlands — [2]Departamento de Fisica, Universidad Nacional del Sur, Bahia Blanca, Argentina — [3]Physics Department, Missouri University of Science and Technology, Rolla, USA

We present an experimental and theoretical study of single electron transfer and ionization in collisions of highly charged ions (N^{5+}, O^{6+} and Ne^{8+}) with ground state Na(3s) and excited state Na*(3p). The investigated collision energy ranges from 1 to 10 keV/amu which includes the classical orbital velocity of the target's valence electron.

In order to test theory on the most basic level multiply differential cross sections are required. Experimental differential cross sections are obtained by combining recoil-ion momentum spectroscopy with a magneto-optically cooled Na atom target. The results are compared with three-body classical-trajectory Monte Carlo calculations which also provide impact parameter dependences of the processes under study. Differential cross for highly excited projectile final states feature an oscillatory structure for each presented collision system, which is also predicted by the theory.