A 26: Poster: Interaction of matter and collisions with ions

Time: Tuesday 16:30–18:30 Location: Spree-Palais

A 26.1 Tue 16:30 Spree-Palais

Momentum transfer to a free floating double slit: Realization of a thought experiment from the Einstein-Bohr debates — •Lothar Ph. H. Schmidt, Till Jahnke, Sven Schössler, Markus Schöffler, Adrian Messen, Horst Schmidt-Böcking, and Reinhard Dörner — Goethe-Universität Frankfurt am Main, Germany

In one of the most famous physics debates ever Einstein challenged Bohr and the then new quantum mechanics in 1927 with a thought experiment. He proposed that measuring the momentum transfer to a double slit would unveil through which of the two slits the quantum particle had passed. We translate this experiment finally to experimental reality using an isotope labeled free floating diatomic molecular ion as the double pinhole. The reaction $HD^+ + He \rightarrow H + D + He^+$ was measured in a kinematically complete experiment by using COLTRIMS. We find that the Helium does not only travel delocalized through both slits, but even more counter intuitive and completely opposite to Einstein's assumption, it transfers momentum to both slits simultaneously.

A 26.2 Tue 16:30 Spree-Palais

Mean-field description of bare- and dressed-ion collisions with neon atoms — •Gerald Schenk and Tom Kirchner — Department of Physics and Astronomy, York University, Toronto, Ontario, M3J 1P3, Canada

Motivated by the availability of new experimental data [1] we study multiple ionization and charge transfer processes in collisions of neon atoms with doubly- and triply-charged bare and dressed ions at intermediate energies (25 keV/u to 1 MeV/u). In the case of dressed-ion impact, electrons are present on both centres in the initial state. We address this in an independent-particle-model approach, the many-electron system is represented by a single mean field. Electrons of both the target and the projectile are propagated in a common potential using the same basis set to ensure the orbitals remain orthogonal throughout. This allows to represent the combined system in terms of a standard single Slater determinant and to obtain exclusive transition probabilities for all final configurations in a consistent fashion.

The present study expands on recent work for B^{2+}-Ne [2], in which we examined the role of active projectile electrons for projectile charge state coincident multiple target ionization, in several respects: (i) additional collision channels are considered; (ii) time-dependent response is taken into account; (iii) comparisons with equicharged bare ions are carried out in order to shed more light on the role of the (active and passive) projectile electrons.

[1] W. Wolff et al, Phys. Rev. A **84**, 42704; Ihani et al, J. Phys. B **46**, 115208. [2] G. Schenk et al, Phys. Rev. A **88** 012712.

A 26.3 Tue 16:30 Spree-Palais

Vortices associated with the wavefunction of a single electron emitted in slow ion-atom collisions — •Lothar Ph. H. Schmidt[1], Christoph Goihl[1], Daniel Metz[1], Horst Schmidt-Böcking[1], Reinhard Dörner[1], Serge Yu. Ovchinnikov[2,3], Joseph H. Macek[3], and David R. Schultz[2] — [1]Goethe-Universität Frankfurt am Main — [2]University of North Texas, Denton — [3]University of Tennessee, Knoxville

Using COLTRIMS we measured the momentum distribution of electrons emitted during slow ion-atom collisions $He^{2+} + He \rightarrow He^+ + He^{2+} + e^-$. At large scattering angles above 2 mrad it shows rich structures which have not been seen in earlier experiments. They arise from two-electron states absent in an independent electron picture of the transfer ionization process. Our calculations reveal that minima in the measured distributions are zeroes in the electronic probability density resulting from vortices in the electronic current.

A 26.4 Tue 16:30 Spree-Palais

Ion Optics of the HESR Storage Ring at FAIR for Operation with Heavy Ions — •Oleksandr Kovalenko, Oleksiy Dolinskyy, Yuri Litvinov, and Thomas Stoehlker — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

High Energy Storage Ring (HESR) of the FAIR project is primarily designed for internal target experiments with stored and cooled antiprotons, which is the main objective of the PANDA collaboration. However, the HESR storage ring also appears to have remarkable properties to carry out physics experiments with heavy ions. This paper proposes a new ion optical design allowing for the heavy ion operation mode of the HESR. The main goal was to provide an optics which meets the requirements of the future experiments with heavy ion beams. In connection, issues like closed orbit correction, dynamic aperture as well as other characteristics of beam dynamics of the new ion optical setup are under analysis in this study.

A 26.5 Tue 16:30 Spree-Palais

Single differential projectile ionization cross sections for 50 AMeV U28+ in the ESR storage ring — •Siegbert Hagmann[1,2], Pierre-Michel Hillenbrand[1,3], Carsten Brandau[2,4], Alexander Gumberidze[4], Dalong Guo[5,6], Michael Lestinsky[1], Yuri Litvinov[1,7], Alfred Müller[3], Stefan Schippers[3], Uwe Spillmann[1], Sergey Trotsenko[1,8], Thomas Stöhlker[1,8,9], Shahab Sanjari[4], Nicolas Winckler[1], and Weidong Chen[1] — [1]GSI Darmstadt — [2]Inst. f. Kernphysik, Uni Frankfurt — [3]Univ. Giessen — [4]EMMI-GSI-Darmstadt — [5]IMP Lanzhou, China — [6]Univ. Beijing, China — [7]Univ. Heidelberg — [8]Helmholtz Inst. Jena — [9]Univ. Jena

For a thorough understanding of beam loss for low q high Z beams with 2.6AGeV in SIS100 it is imperative that the mechanisms active in projectile ionization be understood quantitatively to provide benchmarks for advanced ab initio theories beyond first order. We have embarked on an experimental investigation of single differential projectile ionization cross sections SDCS $d\sigma/dE_e$ for single and multiple ionization of U28+ in the ESR storage ring by measuring the electron loss to continuum (ELC) cusp at 0 degree with respect to the beam axis employing our imaging forward electron spectrometer. This was motivated by the high relative fraction of multiple ionization estimated by theory to exceed 40%. We report first results for absolute projectile ionization SDCS for U28+. We find a remarkably high asymmetry for the ELC cusp. This is at strong variance with the line shape expected for validity of first order theories.

A 26.6 Tue 16:30 Spree-Palais

Refinement of the Basis for the Solution of the Two-Centre Dirac Equation Employing the Finite Basis Set Approach — •Walter Hahn — Institut für theoretische Physik, Universität Heidelberg, Germany

The solution of the Dirac equation for an electron in the presence of two spatially fixed nuclei is a necessary step for understanding the formation of quasi-molecules in collisions of highly-charged heavy ions and the accompanying creation of lepton pairs. In a previous work, we have shown a numerical solution of this Dirac equation by employing the finite basis set approach together with a basis constructed from B-splines. In this work, we propose two issues for the improvement of the previous results. First, we enlarge the basis by functions found to be essential, which go beyond the B-spline ansatz. We achieve an increase of accuracy, which holds for almost all low-energy bound states and all distances between the two centres, and in some specific cases amounts to several orders of magnitude. Arguments aiming to explain this increase of accuracy are presented. Second, we employ the dual kinetic-balance basis in order to avoid non-physical spurious states. An accurate solution of the problem presented constitutes a cornerstone on the road towards tests of QED in super-critical fields.