A 16: Photoionization

Time: Tuesday 11:00–12:30 Location: F 428

A 16.1 Tue 11:00 F 428

The effect of dimensionality in the photoionization of inversion symmetric systems — •Markus Ilchen[1,2], Uwe Becker[3,7], Piero Decleva[4], Marshaal AlKhaldi[7], Markus Braune[2], Sascha Deinert[2], Leif Glaser[2], Gregor Hartmann[3], André Knie[5], Burkhard Langer[6], André Meissner[3], Frank Scholz[2], Jörn Seltmann[2], Peter Walter[2], Omar Al-Dossary[7], and Jens Viefhaus[2] — [1]European XFEL GmbH — [2]Deutsches Elektronen Synchrotron DESY — [3]MPI für Mikrostrukturphysik Halle — [4]Universita di Trieste — [5]Universität Kassel — [6]Freie Universität Berlin — [7]King Saud University

Quantum coherence and resulting interferences are widely studied fields of atomic and molecular physics highlighting quantum mechanics in an impressive way. One of the most famous experiments in this respect is the molecular double slit experiment which was predicted to reveal fingerprints of coherent electron emission from the valence of inversion symmetric systems. We will show results for partial ionization cross sections as well as angular distributions of N_2, O_2 and also C_{60} providing first experimental proofs of the Cohen-Fano oscillations. For N_2 and O_2 the σ and β-oscillations are phase shifted by π for the valence gerade states and parallel for the ungerade states. For C_{60} our results show that the three-dimensionality of this system leads to an anti-parallel behavior. The important role of dimensionality in studies of inversion symmetric systems will be discussed.

A 16.2 Tue 11:15 F 428

Coronium & friends: High-precision calculation of the structure of astrophysically relevant Fe ions — •Natalia S. Oreshkina[1], Zoltán Harman[1,2], and Christoph H. Keitel[1] — [1]Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]ExtreMe Matter Institute (EMMI), Planckstrasse 1, 64291 Darmstadt, Germany

The dynamics of astrophysical objects, such as coronal plasmas, stellar winds, outflows, and accretion disks can be studied using the Doppler shifts and widths of emission lines of highly charged Fe ions, recorded by space observatories. High-precision calculations of these systems may be important for astrophysical research: as an example, velocities of astrophysical objects relative to the observer may be determined once the frequency in the emitter (ionic) frame is well known from theoretical calculations or from photoionization (or photoexcitation) experiments.

In the talk, accurate calculations of the visible and x-ray transition energies in highly charged ${}^{56}_{26}\mathrm{Fe}^{13+}$ to ${}^{56}_{26}\mathrm{Fe}^{16+}$ ions are presented. Relativistic electron correlation calculations are performed within the framework of the configuration interaction method with Dirac-Fock-Sturmian basis functions. For the $3p_{3/2} \rightarrow 3p_{1/2}$ green magnetic dipole transition in ${}^{56}_{26}\mathrm{Fe}^{13+}$, we take into account quantum electrodynamic effects by employing an effective screening potential. The results are compared to electron beam ion trap measurements.

A 16.3 Tue 11:30 F 428

Recoil induced transition from coherent to randomly oriented target properties — •Gregor Hartmann[1,2], Markus Braune[3], Axel Reinköster[1], Sanja Korica[1], Toralf Lischke[1,2], André Meissner[1], Burkhard Langer[4], André Knie[5], Arno Ehresmann[5], Markus Ilchen[3], Max Stammer[1,2], Omar Al-Dossary[6,7], and Uwe Becker[1,2,6] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany — [2]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle, Germany — [3]DESY Notkestraße 85, 22067 Hamburg, Germany — [4]Physikalische Chemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin, Germany — [5]Institut für Physik and CINSaT, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [6]Physics Department, College of Science, King Saud University, Riyadh 11451, Saudi Arabia — [7]National Center for Mathematics and Physics, KACST, Saudi Arabia

The electronic states of homonuclear diatomic molecules give rise to double slit like oscillations in the photoabsorption cross section of these molecules, depending whether the electrons are emitted from a randomly distributed or an oriented target. We show this phase shift effect and a transition phenomenon from coherent to randomly oriented target properties unambiguously for the first time for the photoionization of molecular hydrogen.

A 16.4 Tue 11:45 F 428

The transition from coherent behavior to random order — •Rainer Hentges[1], Toralf Lischke[2], Gregor Hartmann[2], Burkhard Langer[3], Arno Ehresmann[1], and Uwe Becker[2] — [1]Institut für Physik, Universität Kassel Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [3]Institut für Chemie und Biochemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin, Germany

One of the basic discoveries of quantum physics regarding the properties of nature was the duality of wave like and particle like behavior. Wave like behavior is determined by coherent superpositions of wave like quantum objects, whereas particle like behavior follows the rules of classical mechanics rather than the rules of quantum mechanics. Following quantum mechanics the outcome of measurements in this regime would be random. One of the most beautiful example in this respect is Wheelers "delayed choice experiment" realized for the first time only some years ago by the group of Alain Aspect.

We studied a similar problem in the context of photoionization. The transition from coherent behavior to random order is the transition from coherent determinism in form of interference pattern to non-coherent but "which way" carrying pattern, the regime of random order. In between these two regimes is another regime, the "coherent order" regime which will be discussed in more detail in the talk.

A 16.5 Tue 12:00 F 428

Angular distribution of electrons emitted in photoionization with twisted photons — •Oliver Matula[1,2], Armen Hayrapetyan[1], Stephan Fritzsche[2,3], and Andrey Surzhykov[1,2] — [1]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]FIAS Frankfurt Institute for Advanced Studies, D-60438 Frankfurt am Main, Germany

Photoionization of atoms and ions has been studied intensively in the last decades for various different charge states and photon energies, both in experiment and theory [1]. Apart from total ionization cross sections, much attention has been paid to the angular distribution of the emitted photoelectrons. So far, however, these angle-differential investigations dealt only with the spin degree of freedom of the incoming photons and outgoing photoelectrons. Recent advances in photo-optics allow nowadays to control not only the spin (polarization) of photon beams but also their orbital angular momentum (so-called twisted photons) [2]. In this contribution we perform a theoretical analysis of the angular distribution of electrons emitted in photoionization of hydrogen-like ions with (twisted) Bessel beams. Special attention is paid to the dependence of the electron distribution on the photon-ion impact parameter. Detailed computations and results are presented for photoionization of atomic hydrogen and hydrogen-like carbon and argon for a range of different impact parameters.

[1] J. Eichler et al., Phys. Rep. 439, 1 (2009).
[2] G. Molina-Terriza et al., Nature Phys. 3, 305 (2007).

A 16.6 Tue 12:15 F 428

Stopping power measurements with Calorimetric Low Temperature Detectors — •Patrick Grabitz[1,2], Artur Echler[1,2,3], Saskia Kraft-Bermuth[3], Wladyslaw Trzaska[4], Heikki Kettunen[4], Mikko Rossi[4], Katrin Müller[3], and Ari Virtanen[4] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [2]Johannes Gutenberg Universität, Mainz, Germany — [3]Justus-Liebig-Universität, Gießen, Germany — [4]University of Jyväskylä, Finland

Compared to conventional ionization detectors calorimetric low temperature detectors (CLTD's) provide, due to their detection principle, substantial advantages in detector performance, such as energy resolution, linearity and the absence of any pulse hight defect [1].
One potential application of such detectors is the determination of electronic stopping powers for slow heavy ions which are important for our understanding of the interaction of heavy ions with matter. Recently a combined setup of a CLTD-array and a time-of-flight detector (E-TOF) has been used to perform transition type energy loss measurements at the accelerator facility of the University of Jyväskylä.

The new experimental technique allowed to determine precise data on electronic stopping powers for 0.05-1 MeV/u ^{131}Xe-Ions in Carbon, Nickel and Gold. The results will be presented in comparison with theoretical predictions and data from the literature.

[1] P. Egelhof and S. Kraft-Bermuth, Topics Appl. Phys. 99 (2005) 469-500