A 26: Poster: Collisions, scattering and recombination

Time: Wednesday 17:00–19:00 Location: C/Foyer

A 26.1 Wed 17:00 C/Foyer

Energy-dependent electron impact induced fluorescence relative cross-sections of neon — •Catmarna Küstner-Wetekam, Philipp Schmidt, Andreas Hans, Christian Ozga, André Knie, and Arno Ehresmann — Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology, Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany

Electron impact induced ionization cross-sections of rare gases are needed in astrophysics and as benchmarks for theoretical calculations. Electron impact induced fluorescence spectroscopy (EIFS) has been used to determine relative partial fluorescence emission cross-sections of neon within the fluorescence wavelength range between 190 nm and 210 nm. The excitation energy was varied between 0.3 keV and 3.5 keV. The used experimental EIFS-setup [1] is shown and explained. Observed lines are assigned to transitions within NeII and NeIII and the results of the energy-dependent measurements are compared with published cross-sections [2,3] .

[1] A. Knie et al., J. Elec. Spec. Relat. Phenom., 185, 492-497 (2012)

[2] D. P. Almeida et al., J. Phys. B., 28, 3335-3345 (1995)

[3] B. L. Schram et al., Physica, 32, 185-196 (1966)

A 26.2 Wed 17:00 C/Foyer

Linear polarization of x-ray transitions due to dielectronic recombination in highly charged ions — •Holger Jörg[1], Zhimin Hu[1], Hendrik Bekker[2], Michael Andreas Blessenohl[2], Daniel Hollain[2], Stephan Fritzsche[3,4], Andrey Surzhykov[3], José Ramón Crespo López-Urrutia[2], and Stanislav Tashenov[1] — [1]Physikalisches Institut der Universität Heidelberg, 69120 Heidelberg, Germany — [2]Max-Plank-Institut für Kernphysik, Heidelberg, 69117 Heidelberg, Germany — [3]Helmholtz-Institut Jena, 07743 Jena, Germany — [4]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, 07743 Jena, Germany

Linear polarization of x-rays produced in the process of dielectronic recombination in highly charged xenon ions was studied at an electron beam ion trap by means of the Compton polarimetry technique. The experimental results are in all cases in good agreement with the theoretical predictions. In the specific case of the dielectronic recombination resonance exciting the [1s2s22p1/2]1 state, the Breit interaction between bound electrons strongly influences the polarization of the emitted x-rays. The results agree with the predictions which include the Breit interaction and by 5σ rule out the theory taking into account only the Coulomb electron-electron repulsion. Apart from the fundamental importance, the experimental results open numerous possibilities for polarization diagnostics of hot anisotropic plasmas. In particular the directions of the electrons in the plasmas, found e.g. in the accretion discs and jets of black holes, can be probed by measuring polarization of the satellite transitions in HCIs.

A 26.3 Wed 17:00 C/Foyer

PEGASUS: Building an intense spin-polarized electron gun - First test runs — Michael Lestinsky[1], •Daniel Schury[1,2], Siegbert Hagmann[1], Christophor Koshuharov[1], and Thomas Stoehlker[1,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt — [2]Institut für Atom- und Molekühlphysik, Universität Giessen, D-35392 Giessen — [3]Helmholtzinstitut Jena, Friedrich-Schiller-Universität Jena, D-07743 Jena

The PEGASUS project aims at building an intense and portable spin-polarized electron gun for experiments in crossed beams arrangements at various ion beam facilities. The electron beam will cover energies between 1 and 10 keV at electron currents up to 100 μA. As source material we will utilize laser-induced electron emission from GaAs photocathodes which will be prepared in a state of negative electron affinity. With a set of electrostatic lenses and benders, the electrons will be transported to the interaction zone and Wien-filters will be used for controlling the spin orientation.

Results from first test runs will be presented and foreseen experiments discussed.

A 26.4 Wed 17:00 C/Foyer

Diagnostics of the electron cyclotron motion in an electron beam ion trap — •Chintan Shah[1], Pedro Amaro[1], René Steinbrügge[2], Christian Beilmann[1,2], Sven Bernitt[2], Stephan Fritzsche[3,4], Andrey Surzhykov[3], José Ramón Crespo López-Urrutia[2], and Stanislav Tashenov[1] — [1]Physikalisches Institut, Heidelberg, Germany — [2]Max-Plank-Institut für Kernphysik, Heidelberg, Germany — [3]Helmholtz-Institut Jena, Jena, Germany — [4]Theoretisch-Physikalisches Institut, Jena, Germany

The electron cyclotron motion within an electron beam propagating through a strong magnetic field was studied at the electron beam ion trap FLASH-EBIT at the Max Planck Institute for Nuclear Physics in Heidelberg. It was probed by measuring the angular distribution of the x rays produced by resonant electron recombination in highly charged iron and krypton ions. For this purpose two germanium detectors registered x rays emitted along and perpendicularly to the beam propagation direction. A comparison of the measured x-ray emission asymmetries with those predicted using the Flexible Atomic Code revealed a small systematic discrepancy which we attribute to a non-vanishing component of the electron momentum transverse to the beam propagation direction. This cyclotron motion is enhanced as the beam propagates from the cathode into the much stronger magnetic field at the trap region. From the data we have deduced the cyclotron motion energy component at the trap center. This experiment demonstrates the suitability of resonant recombination angular distribution measurements for accurate diagnostics of plasma anisotropies.

A 26.5 Wed 17:00 C/Foyer

X-ray emission asymmetries in resonant recombination into highly charged iron ions — •Chintan Shah[1], Pedro Amaro[1], René Steinbrügge[2], Christian Beilmann[1,2], Sven Bernitt[2], Stephan Fritzsche[3,4], Andrey Surzhykov[3], José Ramón Crespo López-Urrutia[2], and Stanislav Tashenov[1] — [1]Physikalisches Institut, Heidelberg, Germany — [2]Max-Plank-Institut für Kernphysik, Heidelberg, Germany — [3]Helmholtz-Institut Jena, Jena, Germany — [4]Theoretisch-Physikalisches Institut, Jena, Germany

We report the first systematic measurement of the photon angular distribution in the inter-shell dielectronic, trielectronic and quadro-electronic recombination of free electrons into highly charged ions of iron. Ions in He-like through O-like charge states were produced in an electron beam ion trap, and the electron-ion collision energy was scanned over the recombination resonances exciting a K-shell electron. Two germanium detectors mounted head-on and side-on with respect to the electron beam propagation recorded X rays emitted in the decays of resonantly populated states. The measured x-ray emission asymmetries indicate the alignment of those states. The corresponding alignment parameters were extracted for 40 dominant KLL recombination resonances providing a comprehensive data for benchmarking advanced atomic codes, such as FAC and RATIP. This data can also be used for modelling and diagnostics of hot astrophysical plasmas.

A 26.6 Wed 17:00 C/Foyer

Strong correlation between the electron spin orientation and bremsstrahlung linear polarization observed in the relativistic regime — •Oleksiy Kovtun[1], Valeriy Tioukine[2], Andrey Surzhikov[3], Vladimir Yerokhin[4], Anton Khaplanov[5], Bo Cederwall[5], and Stanislav Tashenov[1] — [1]Physikalisches Institut der Universität Heidelberg, 69120 Heidelberg, Germany — [2]Institut für Kernphysik Johannes Gutenberg-Universität Mainz, Germany — [3]Helmholtz-Institut Jena, 07743 Jena, Germany — [4]Center for Advanced Studies, St. Petersburg State Polytechnical University, St. Petersburg 195251, Russia — [5]Royal Institute of Technology, SE-10691 Stockholm, Sweden

Polarization of bremsstrahlung produced in collisions of 2MeV electrons with a thin gold foil was studied using a polarized electron beam and the Compton polarimetry technique. A strong correlation between the spin orientation of the incoming electrons and the linear polarization of the emitted x-rays was observed at the high energy part of the x-ray spectrum. For longitudinally polarized electrons the plane of the x-ray linear polarization was tilted by several tens of degrees depending on the electron spin orientation. We attribute this effect to the precession of electron spin and orbital momentum in the magnetic field, which is induced in the rest frame of the electron by the moving nucleus. In comparison to an earlier experiment performed with

100 keV electrons, which observed a similar but much smaller effect, the significantly enhanced polarization correlation indicates a much stronger spin-orbit interaction at higher collision energies.

A 26.7 Wed 17:00 C/Foyer

Coincidence studies of K-LL dielectronic resonances and simultaneous vacuum ultraviolet transitions in highly charged iron — •Stepan Dobrodey[1], Sven Bernitt[2], Michael Blessenohl[1], and José Ramón Crespo López-Urrutia[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]IOQ, Friedrich-Schiller-Universität, Jena, Germany

We study dielectronic recombination (DR) in iron ions using an electron beam ion trap by observing the K_α X-ray photons and simultaneous transitions in the VUV range. The VUV spectra are obtained using a grating spectrometer equipped with a microchannel plate and a delay line anode. This allows for a time-resolved and wavelength-resolved detection of the VUV photons. The decay of the intermediate excited state to the ground state can occur by cascaded emission of a X-ray and a VUV photon. By recording the intensity of the spectral lines as a funtion of the electron beam energy, it becomes possible to distinguish different relaxation channels and to observe changes in the population of excited intermediate states. By simultaneously detecting a X-ray photon and a VUV photon we could separate decay channels resulting from different DR resonances which could not be resolved in previous measurements. This experimental setup will allow to study photonic relaxation after resonant recombination in more detail.

A 26.8 Wed 17:00 C/Foyer

Ionization cross sections of DNA constituents by light ions — •Mingjie Wang, Daniel Bennett, Ticia Buhr, Benedikt Rudek, Gerhard Hilgers, and Hans Rabus — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

Within the framework of the EMRP Joint Research Project "BioQuaRT" [1], a multiscale track structure simulation program based on interaction cross sections of DNA constituents is being developed. To this end, ionization cross sections for model molecules representing DNA constituents are being determined.

In the present work, double differential cross sections for the ionization of tetrahydrofuran (THF) by protons and helium ions with energies in the respective Bragg peak regions were measured. The experiments were carried out using the accelerator facilities at the PTB at energies from 70 keV to 3.3 MeV. The electrons emitted at angles between 30° and 90° relative to the ion beam direction were detected with an electrostatic hemispherical electron spectrometer. The measured spectra are converted into absolute cross sections using the transmission and detection efficiency of the analyzer. The latter are determined from measured spectra for the collision of 100 eV electrons with THF using electron cross section data for elastic scattering and ionization of THF reported by Baek et al. [2].

[1] Project web site: http://www.ptb.de/emrp/bioquart.html. The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

[2] W. Y. Baek et al., Phys. Rev. A 86, 032702 (2012)

A 26.9 Wed 17:00 C/Foyer

FAIR High Energy Storage Ring in the heavy-ion mode operation — •Oleksandr Kovalenko[1,2], Oleksiy Dolinskyy[2], Yuri A. Litvinov[2,3], Dieter Prasuhn[4], and Thomas Stöhlker[5] — [1]Heidelberg University — [2]GSI Helmholtz Centre for Heavy Ion Research — [3]Max Planck Institute for Nuclear Physics — [4]Jülich Research Centre — [5]Friedrich Schiller University and Helmholtz Institute Jena

The HESR (High Energy Storage Ring) is an essential part of the Facility for Antiproton and Ion Research (FAIR) at GSI in Darmstadt. It will be used in antiproton as well as in heavy ion operation modes. The latter is the main topic of the current study. The storage ring employs electron and stochastic cooling methods which helps to significantly reduce beam size, divergence and momentum spread. The energy of about 5 GeV per nucleon is foreseen for bare uranium. This all results in unprecedented conditions for high-precision internal target experiments with heavy ion beams. The experimental program will be carried out in the framework of the SPARC (Stored Particle Atomic Physics Collaboration) project.

In this study an ion optical layout designed specifically for the HESR operating with heavy ions is presented. The nonlinear beam dynamics simulations are carried out and the results are discussed.