A 23: Poster: Electron scattering and recombination

Time: Tuesday 16:30–19:00 Location: Poster.V

A 23.1 Tue 16:30 Poster.V

Dielectronic recombination of highly charged iron measured by extracting ions from an EBIT — •René Steinbrügge, Sven Bernitt, Christian Beilmann, José R. Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Dielectronic recombination (DR) is the resonant capture of an electron into a highly charged ion with the kinetic energy transferred to a bound electron, resulting in a doubly excited state. Due to large cross sections compared with non-resonant processes, it is highly important in hot plasmas. Electron beam ion traps (EBIT) are suitable tools for investigating this process. We present DR measurements of He-, Li- and Be-like iron carried out at the FLASH-EBIT. In addition to X-rays emitted during the relaxation of the excited state, DR was detected by the change in the charge state distribution. For this purpose the ions were extracted from the EBIT, charge separated by a Wien-type velocity filter and detected on a position sensitive detector. This allows to distinguish the contributions of different charge states. During the measurement new methods based on analysis of the extracted ions and space charge compensation were successful tested, promising further improvements in future experiments.

A 23.2 Tue 16:30 Poster.V

Multiple scattering in electron impact ionization of aligned H_2 molecules — Xueguang Ren, Thomas Pflüger, Arne Senftleben, •Alexander Dorn, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, 69117 Heidelberg

Ionization of molecular hydrogen (H_2) by 54 eV electron impact is investigated with an advanced reaction microscope. The alignment of the H_2 molecular axis during the collision is determined by the post-collision dissociation process of the H_2^+ ion. By triple-coincidence detection of the proton and both final state electrons the complete collision kinematics is determined. Therefore, fully differential cross sections for fixed in space molecular axis were measured. The ejected electron is observed to be emitted into two preferential directions: firstly, along the momentum transfered by the projectile and, secondly, along the molecular axis which involves another scattering process for the ejected electron. A first numerically demanding state-of-the-art theory shows satisfactory agreement with the experimental data.

A 23.3 Tue 16:30 Poster.V

Unexpected high strength of intershell trielectronic recombination — •C. Beilmann[1], P.H. Mokler[1], S. Bernitt[1], C.H. Keitel[1], J. Ullrich[1], J.R. Crespo López-Urrutia[1], and Z. Harman[1,2] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]ExtreMe Matter Institute (EMMI), Darmnstadt, Germany

Intershell KL-LLL trielectronic recombination (TR) in highly charged ions, where a K-shell and a L-shell electron are simultaneously excited by the capture of a free one, was supposed to occure in neglectible strength due to the large excitation energy and a weak electron-electron interaction in inter-shell processes. In our experiments and accompanying *ab initio* MCDF calculations, we show that these higher order contributions to the total recombination yield grow to an unexpected strength in light and mid-heavy ions. The experimental results of TR measurements in Ar, Fe and Kr allow for the deduction of a scaling law for the TR strength in dependence of Z. In C-like ions with $Z \leq 20$, TR even dominates over the first order dielectronic process [1]. These surprising findings should be taken into account in the detailed modelling of astrophysical and fusion plasmas. This is important in view of the problem of missing opacities in calculations of the solar matter and can also help improving plasma diagnostics of laboratory plasmas. Furthermore, the strong sensitivity of the TR process to eletron-electron interaction gives new experimental access to the study of inner-atomic electron correlation effects.

[1] C. Beilmann et al., Phys. Rev. Lett. 107, 143201 (2011)

A 23.4 Tue 16:30 Poster.V

Nuclear Excitation by Electron Capture in Stellar Environments — •Stephan Helmrich, Katja Beckerle, and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

In the resonant process of nuclear excitation by electron capture (NEEC), the recombination of a continuum electron leads to the excitation of the nucleus [1]. NEEC becomes increasingly efficient with rising electron density and degree of ionization of the atoms involved. These are the predominant conditions in the interior of stars and supernovae. In the context of isomer depletion, NEEC populating low-lying nuclear excited states under dense stellar plasma conditions has been investigated [2].

In the present work we consider for the first time NEEC built on highly excited states close to the neutron threshold prior to their decay. Neutron capture and successive gamma decay followed by beta decay of the thus formed neutron-rich daughter nucleus constitutes the basic reaction leading to the synthesis of heavy isotopes. We show that even low-energetic NEEC on the order of tens of keV following neutron capture may significantly change the net decay rates of the formed compound nucleus. Thus, neutron re-emission becomes predominant at the expense of gamma decay, significantly suppressing the production of the daughter isotope.

[1] A. Pálffy, W. Scheid and Z. Harman, Phys. Rev. A 73, 012715 (2006).
[2] G. Gosselin, P. Morel and P. Mohr, Phys. Rev. C 81, 055808 (2010).

A 23.5 Tue 16:30 Poster.V

Investigation into anomalies in electron scattering cross sections of H_2 and D_2 molecules — •Adrian Menssen[1], Florian Trinter[1], Markus Waitz[1], Markus Schöffler[1,3], Daniel Fischer[2], Horst Schmidt-Böcking[1], and Reinhard Dörner[1] — [1]Goethe Universität, Frankfurt, Germany — [2]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [3]Institut für Photonik, TU Wien, Gusshausstraße 27, Wien, Austria

For scattering of electrons or neutrons at a molecule at sufficiently high momentum transfers intramolecular dynamics and coherence effects are typically neglected: One only considers a binary scattering process between the incident electron and one constituent of the molecule. However recent experiments suggested an unexpected breakdown of this binary scattering approximation. Cooper et al. observed differences of up to 30 % in the total electron scattering cross-sections of H_2 and D_2: H_2 appeared to be "smaller "than expected.

We have been aiming to observe this same effect, however in a different experimental approach at momentum transfers between 2 and 4 a.u. Hydrogen-like O^{7+} and Magnesium Mg^{11+} were accelerated to energies between 30 and 90 MeV and then crossed with a supersonic gas-jet (50:50 mixture of H_2 and D_2) at 298 K. The projectile can be ionised by interaction of its electron with the target-molecule nucleus (n-e) or with one of the molecular electrons (e-e). Both processes (n-e and e-e) can be distinguished in momentum space.

A 23.6 Tue 16:30 Poster.V

Electron induced double and triple fragmentation of CH_4 — •Xueguang Ren, Thomas Pflueger, Shenyue Xu, Arne Senftleben, Alexander Dorn, and Joachim Ullrich — Max-Planck-Institut fuer Kernphysik , 69117 Heidelberg, Germany

Collisions of energetic electrons with molecules that induce chemical and physical reactions are of fundamental importance for a range of areas from plasma physics to radiation damage in living tissue. The study of dissociative ionization of molecules where the molecular ion is fragmenting can provide detailed insight into the molecular reaction dynamics. The fragmentation process of small polyatomic molecules has been extensively investigated for which one electron of the target molecule is ionized resulting in some dissociating states, see e.g. [1]. In this work, the fragmentation cross sections of doubly or triply charged methane induced by 130 eV electron impact has been measured using the reaction microscope, in which the momentum vectors of all charged particles emerging from the collision are measured in coincidence and detected in 4π solid angle. Therefore, the information of the kinetic energy of fragments is determined to get insight into its breakup mechanism. The sensitivity of the experimental method enable us to extend the study of the fragmentation pattern of CH_4^{2+} to include small breakup channels such as $H_3^+ + CH^+$. Furthermore, some breakup channels of the triply charged CH_4^{3+} have been detected as triple coincidence. [1] S. Xu, et al., Phys. Rev. A 83, 052702 (2011).