A 14: Interaction with VUV and X-ray light III

Time: Friday 10:30–12:45 Location: BAR 106

Invited Talk A 14.1 Fri 10:30 BAR 106

Synchrotron radiation spectroscopy of ions — •Alfred Müller — Institut für Atom- und Molekülphysik, Universität Giessen, Germany

Photoionization and -fragmentation of ions is studied by exposing suitable ionic targets to synchrotron radiation. The most common scenario for cross section measurements is the photon-ion merged-beam technique. Conventional mass and charge state analysis of accelerated ions provides well defined, clean targets for the monochromatized photons. All products of photon-ion interactions along the merge path of 0.3 to 1 m can be mass/charge separated with complete collection and almost 100 % detection efficieny. Accurate beam profile measurements allow for the determination of absolute cross sections. Scanning the photon energy in fine steps at resolving powers up to 40 000 delivers detailed spectroscopic information about excited states of the ions. Besides atomic ions also fullerene ions and endohedral fullerenes with encapsulated atomic ions have been studied. Time reversal symmetry relates photoionization to electron-ion recombination and provides new detailed insight into both processes. A particularly interesting subject of photon-ion studies is the response of endohedral fullerenes to photoabsorption by the atom encaged inside a carbon sphere. In comparison with a free ion, a significant redistribution of oscillator strengths is observed when the ion is encapsulated inside a fullerene cage. Also, evidence for containment resonances has been found. They arise from interference of photo-electron waves emitted by the central atom and then partially reflected back and forth by the fullerene sphere.

Invited Talk A 14.2 Fri 11:00 BAR 106

Doppler effect in fragment autoionization following core-to-valence excitation in molecular oxygen. — •Marc Simon[1], Renaud Guillemin[1], and Eiji Shigemasa[2] — [1]Laboratoire de Chimie Physique-Matière et Rayonnement, 11 rue Pierre et Marie Curie, 75005 Paris, France — [2]Ultraviolet Synchrotron Orbital Radiation Facility, Institute for Molecular Science, Okazaki 444-8585, Japan

Nuclear motion in ultrafast dissociation of core excited molecules can be probed by the Doppler effect in emitted Auger electrons as experimentally first evidenced at the core-to-valence excitation in molecular oxygen by Björneholm et al. [1].

We address the question of multiple Auger decay. Although cascade Auger decay has been known and studied for a long time in atoms, a detailed study of cascade Auger decay following resonant core excitation in a molecule, namely CO, was reported only recently [2].

We report the observation of a Doppler effect in secondary Auger electron emission from excited atomic oxygen fragments created after core 1s excitation in molecular oxygen [3].

References

[1] O. Björneholm et al., Phys. Rev. Lett. 84, 2826 (2000). [2] L. Journel et al., Phys. Rev. A 77, 042710 (2008). [3] R. Guillemin et al., Phys. Rev. A 82, 051401 (2008).

A 14.3 Fri 11:30 BAR 106

Non Sequential Double Ionization of Lithium — •Michael Schuricke, Gopisankararao Veeravalli, Christian Dornes, Katharina Joachimsmeyer, Moritz Kurka, Alexander Dorn, and Joachim Ullrich — Max Planck Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The most simple and fundamental non-linear multi-electron reaction is double ionization by the absorption of two photons. In a series of benchmark experiments on helium indirect but nonetheless clean information about the distinct reaction channels, in sequential and non sequential double ionization (SDI, NSDI), has been gained by studying the recoil ion momentum. In a new experiment two-photon double ionization of magneto-optically trapped lithium was investigated in a Reaction Microscope (MOT-REMI), again recording the recoil ion momentum with utmost resolution. Due to the structure of lithium with the two tightly bound inner shell and the loosely bound valence electrons, strongly different contributions of the various double ionization mechanisms as compared to helium are expected. While, for example, the NSDI amplitude of helium is partly due to the simultaneous absorption of one photon by each of the electrons, the analogous process is strongly suppressed in the $Li(1s^2 2s) + 2\gamma \rightarrow Li^{2+}(1s)$ reaction. Here the small binding energy of the outer electron reduces the absorption of vuv-light. Hence, the NSDI amplitude is governed by two-photon absorption of a K-shell electron and electron correlation.

A 14.4 Fri 11:45 BAR 106

Interaction of atoms with strong fields: Time propagation of electron wave packets with the Solov'iev-Fatunla method — •Johannes Eiglsperger[1,2], Aliou Hamido[3], Javier Madroñero[1], and Bernard Piraux[3] — [1]Physik Department, Technische Universität München, Germany — [2]Institut für Theoretische Physik, Universität Regensburg, Germany — [3]Institute of Condensed Matter and Nanosciences, Université catholique de Louvain, Belgium

The study of the quantum dynamics of driven complex atomic systems is a fundamental problem in atomic physics and a challenge for both experiments and theory. The recent development of new XUV laser sources have opened the route to the study of multiphoton multiple ionization or excitation of atoms at high frequency and intensity. This poses new challenges for both theoreticians and experimentalists. From the theoretical point of view the validity of strong field approximations is questionable. More accurate techniques for the solution of the time-dependent Schrödinger equation (TDSE) are necessary. We present a promising alternative for the treatment of the TDSE which combines an explicit method adapted to solve systems of stiff equations [1,2] and a time-dependent scaling transformation of the coordinates [3]. With this approach we have investigated the influence of the atomic structure on the low energy part of the Above-Threshold-Ionization spectrum for a model potential and the hydrogen atom.

[1] O. Fatunla, Math. Comput. 34, 373 (1980).
[2] J. Madroñero and B. Piraux, Phys. Rev. A 80, 033409 (2009).
[3] E. A. Soloviev and S. I. Vinitsky, J. Phys. B 18, L557 (1985).

A 14.5 Fri 12:00 BAR 106

Excitons, polaritons and entanglement with x-ray light — •Adriana Pálffy, Christoph H. Keitel, and Jörg Evers — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Resonant scattering of monochromatized synchrotron radiation off nuclei can lead to an excitation in the nuclear ensemble that is of excitonic nature such that collective effects determine the coherent reemission. It has been shown experimentally [1] that switching abruptly the direction of the magnetic hyperfine fields can control and even completely suppress the coherent decay channel due to destructive interference.

Based on this switching technique, we investigate more advanced coherent control schemes and show that the accelerated nuclear forward scattering allows for the generation of two correlated coherent decay pulses out of one excitation, providing single-photon entanglement in the keV regime [2]. With a proper choice of switching parameters, specific transitions between hyperfine levels can be restored thus controlling the polarization of the emitted x-ray light [3]. Furthermore, suppression of the coherent decay in resonant x-ray scattering can be used to control the cooperative branching ratio in nuclear systems, and thus the population of nuclear states [4]. Prospects for the population of metastable nuclear states are discussed.

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[2] A. Pálffy, C. H. Keitel and J. Evers, Phys. Rev. Lett. 103, 017401 (2009)
[3] A. Pálffy and J. Evers, J. Mod. Opt. 57, 1993 (2010)
[4] A. Pálffy, C. H. Keitel and J. Evers, arXiv:1010.5134

A 14.6 Fri 12:15 BAR 106

Photon-induced fluorescence spectroscopy (PIFS) — •Philipp Reiss, André Knie, and Arno Ehresmann — Universität Kassel, Institut für Physik und Center for Interdisciplinary Nanostructure Science and Technology, Heinrich Plett Str. 40, 34132 Kassel, Germany

Fluorescence spectroscopy and polarimetry of atoms and molecules is a versatile tool to investigate the final or intermediate decays of the ionic or neutral product. Over several years an apparatus has been built for this purpose.

This PIFS apparatus is designed to operate at synchrotron radiation beamlines, having synchrotron radiation as the excitation source of the atoms or molecules. The fluorescence light is dispersed by two 1m-normal-incidence monochromators and detected by position-sensitive single photon counting detectors. With interchangeable gratings and detectors, the observable range covers 45–800nm. It is possible to

extract in a certain spectral range the linear and circular degree of polarization.

Some examples for application of this device is shown, demonstrating the different application fields.

A 14.7 Fri 12:30 BAR 106

Kohärente Anregung von Neon durch XUV-Kurzpulsstrahlung — •Jürgen Plenge, Andreas Wirsing, Christopher Raschpichler und Eckart Rühl — Institut für Chemie und Biochemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin

Die kohärente Anregung von Atomen durch geformte Femtosekunden-Laserpulse kann aufgrund der Interferenz zwischen resonanten und nicht-resonanten Anregungspfaden zur Bildung von kohärenten Transienten führen. Es werden Experimente vorgestellt, in denen die kohärente Anregung von 3d-Rydbergzustände in Neon und die Bildung eines Wellenpakets durch phasenmodulierte XUV-Kurzpulstrahlung untersucht wurde. Die Zustände $2p^5(^2P_{3/2})3d[1/2]$ und $2p^5(^2P_{3/2})3d[3/2]$ wurden durch die 13. Harmonische ($h\nu = 20,04$ eV) eines Titan-Saphir Femtosekunden-Lasersystems angeregt und die Population der angeregten Zustände durch Ionisation mit einen zeitverzögerten 804-nm-Laserpuls nachgewiesen. Die zeitabhängige Photoelektronenausbeuten zeigen charakterische Oszillationen, die auf die Anregung von kohärenten Transienten und die Dynamik eines Wellenpakets zurückgeführt werden. Die Experimente zeigen, dass sich die kohärente transiente Anregung von Neon und die Dynamik des Wellenpakets durch die spektrale Phase der 13. Harmonischen kontrollieren lassen, wobei die Stärke der Modulation der spektralen Phase des XUV-Pulses durch die Wechselwirkung mit einem resonanten Gasfilter variabler Dichte erreicht wird. Damit ist die Möglichkeit der Kontrolle von Anregungsprozessen im XUV-Bereich durch phasenmodulierte höhere Harmonische gegeben.