A 19: Photoionization

Time: Tuesday 14:00–16:00 Location: BEBEL E42

Invited Talk A 19.1 Tue 14:00 BEBEL E42

The molecular double slit: transition from random to oriented target properties — •Gregor Hartmann[1,2], Markus Braune[3], Jens Viefhaus[3], André Meissner[1], Toralf Lischke[1,2], Axel Reinköster[1], Burkhard Langer[4], Sascha Deinert[3], Leif Glaser[3], Frank Scholz[3], Jörn Seltmann[3], Markus Ilchen[3], André Knie[5], Philipp Schmidt[5], Arno Ehresmann[5], Omar Al-Dossary[6], and Uwe Becker[1,2,6] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin — [2]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle — [3]DESY, Notkestraße 85, 22067 Hamburg — [4]Physikalische Chemie, FU Berlin, Takustr. 3, 14195 Berlin — [5]Institut für Physik, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel — [6]Physics Department, King Saud University, Riyadh 11451, Saudi Arabia

The analogy of homonuclear diatomic molecules to the Young type double slit experiment such as Cohen-Fano cross section oscillations has been topic of a large amount of photoionization investigations. Here, the hydrogen molecule's cross section oscillations are analyzed over a large photon energy range (29eV-1200eV) distinguishing between the randomly in space distributed molecule and the 'oriented sample', in which the orientation of the molecular axis to the light polarization vector is detected. Furthermore, a transition effect from random to oriented target properties is detected, when the de Broglie wave length of the photoelectron resolves the internuclear distance. The ion fragment angular distribution is analyzed and found as a reason for the transition.

A 19.2 Tue 14:30 BEBEL E42

Radiative and Auger widths of X-ray K-shell excited few-electron iron ions — •René Steinbrügge[1], Sven Bernitt[1], Sascha W. Epp[2], Jan K. Rudolph[1,3], Christian Beilmann[5], Hendrik Bekker[1], Sita Eberle[1], Alfred Müller[3], Joachim Ullrich[6], Oscar O. Versolato[1], Hasan Yavaş[4], Hans-Christian Wille[4], and José R. Crespo López-Urrutia[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Max-Planck-Institut für Struktur und Dynamik der Materie, Hamburg — [3]Institut für Atom- und Molekülphysik, Gießen — [4]DESY, Hamburg — [5]Physikalisches Institut, Heidelberg — [6]PTB, Braunschweig

The spectrum of highly charged iron ions gives rich information of the dynamics of outflows in X-ray binary stars and active galactic nuclei. Very high X-ray fluxes in the vicinity of such objects produce and drive mainly photoionized plasmas, but up to now it was not possible to investigate the underlying photoionisation processes in the laboratory. We present the first measurement of radiative and Auger rates for K-shell transitions in Li-like, Be-like, and C-like iron ions. These were produced and trapped in the transportable electron beam ion trap FLASH-EBIT and resonantly excited with X-ray photons at PETRA III. We observe photoionization by detecting the changes in the ionic charge state. By taking ratios of the photoionization yield and the simultaneous recorded fluorescence, we suppress setup-dependent uncertainties. Together with the total linewidths [1], this allows us to determine absolute values for the radiative and Auger widths.

[1] J. K. Rudolph et al., Phys. Rev. Lett. **111**, 103002 (2013)

A 19.3 Tue 14:45 BEBEL E42

Angular distribution of photoelectrons emitted from a laser-cooled and polarised lithium target — •Renate Hubele, Johannes Goullon, Elisabeth Brühl, Michael Schuricke, Hannes Lindenblatt, and Daniel Fischer — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

With a magneto optical trap (MOT) a polarised atomic target for ionisation experiments can be realised. In the MOT the atoms are cooled to very low temperatures exploiting the principle of Doppler cooling, where the continuous absorption of photons from three pairs of counter-propagating red detuned laser beams is used to slow down the atoms. In our setup, the cooling takes place in a homogeneous magnetic field that leads to an energetic splitting of the atomic states into different Zeeman-sublevels according to their quantum number m. Due to the red-detuning of the cooling laser beams, a predominant population of the $2P_{3/2}, m_L = -1$ (i.e. $m_j = -3/2$) excited state is achieved.

In the experiments presented here, laser light in the UV wavelength range with linear polarisation both parallel and perpendicular to the direction of the external magnetic field is used to ionise the excited lithium atoms and the angular emission pattern of the photoelectrons is recorded with a Reaction Microscope. The emission pattern corresponds to the angular probability densities of the wave function of the final state of the reaction. Due to selection rules, the different polarisations of the UV laser lead to different final states and therefore to distinct electron angular emission patterns.

A 19.4 Tue 15:00 BEBEL E42

Non-monotonic behavior of the ionization probability of model negative ions by high-frequency laser pulses — •Koudai Toyota, Ulf Saalmann, and Jan Michael Rost — Max-Planck-Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187, Dresden, Germany

We report on the non-monotonic behavior of the ionization probability of a model negative ion in strong high-frequency laser pulses as a function of pulse durations. Three distinct ionization processes contribute to the behavior and show characteristic features in the photo-electron spectrum. The first mechanism is single-photon absorption which dominates the ionization dynamics for long pulse durations. The second one is non-adiabatic transitions in the adiabatic picture induced by the slow deformation of the electron's effective potential as a function of time. The third mechanism is also a non-adiabatic process, similarly to the shake-off ionization, and can be understood in a sudden picture. This process strongly depends on the carrier-envelope phase of the pulse. The latter two dominate the ionization dynamics for short pulse durations.

A 19.5 Tue 15:15 BEBEL E42

Partial Decay Rates of Driven 1D eZe Helium — •Nicolai Heitz, Klaus Zimmermann, Felix Jörder, Alberto Rodriguez, and Andreas Buchleitner — Physikalisches Institut der Albert-Ludwigs-Universität, Hermann-Herder-Straße 3, D-79104 Freiburg

We study the photoionization process of doubly excited states of 1D helium in the eZe configuration, with full account of the Coulomb singularities as well as of the atomic continuum structure. In order to distinguish pronounced autoionization processes induced by the electron-electron interaction from bona fide photoionization, we implement a variant of complex dilation, which is capable of assessing partial decay channels.

A 19.6 Tue 15:30 BEBEL E42

Molecular hydrogen in strong laser fields: breakdown(s) of the fixed-nuclei approximation — •Johann Förster and Alejandro Saenz — AG Moderne Optik, Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin, Germany

We investigate the effect of nuclear vibration on the ionization behaviour of molecular hydrogen by a direct solution of the time-dependent Schrödinger equation. For this purpose, our six-dimensional configuration-interaction method to solve the electronic Schrödinger equation of molecular hydrogen in strong laser fields [1, 2] is extended to include molecular vibration. The results obtained within the correlated treatment of electronic and vibrational motion are compared to those stemming from the fixed-nuclei approximation (FNA; i.e. the solution of the electronic Schrödinger equation only for the equilibrium geometry). We show that the FNA breaks down for certain laser parameters in the multiphoton and quasistatic regimes. For example, the total ionization yield can differ from the "full" treatment by several orders of magnitude. The reasons for these complete breakdowns of the FNA are explained and it is shown that other very simple (and "useful") approximations still agree surprisingly well with the "full" treatment.

References

[1] M. Awasthi, Y. V. Vanne and A. Saenz, *J. Phys. B* **38**, 3973 (2005).
[2] Y. V. Vanne and A. Saenz, *Phys. Rev. A* **82**, 011403(R) (2010).

A 19.7 Tue 15:45 BEBEL E42

Optically Excited Graphene - Non - Equilibrium Many Body Theory — •Regine Frank — Institute for Theoretical Physics, Eberhard-Karls University Tübingen, Germany Center for Light-

Matter-Interaction, Sensors and Analytics (LISA+) and Center for Complex Quantum Phenomena (CQ)

A generalized non-equilibrium dynamical mean field theory (DMFT) for graphene is presented. The non-equilibrium DMFT derives properties such as electronic density of states (LDOS) and occupation numbers of the optically driven system. It fully characterizes the system in it's time dependent state. It is demonstrated, how such a setup may be employed in order to realize all-optical switching processes. Results for relevant time scales in setups as well as wave-mixing influences are presented.