A 5: Photoionization I

Time: Monday 14:00–16:00 Location: BAR 106

Invited Talk A 5.1 Mon 14:00 BAR 106

New insights in molecular photoionization physics - Coherence properties of the valence photoionization of N_2 and O_2 — •Jens Viefhaus[1], Markus Ilchen[1], Sascha Deinert[1], Leif Glaser[1], Frank Scholz[1], Peter Walter[1], Markus Braune[2], André Meissner[2], Lokesh Tribedi[2,3], and Uwe Becker[2] — [1]DESY, Hamburg, Germany — [2]Fritz-Haber-Institut, Berlin, Germany — [3]Tata Institute of Fundamental Research, Mumbai, India

New Synchrotron Radiation sources such as the "Variable Polarization XUV beamline P04" at PETRA III (DESY, Hamburg) which is presently under construction enable new classes of photoionization experiments. The main characteristics of these beamlines are exceptionally high resolution which well exceeds a resolving power of 10,000 combined with high photon flux "up to 1012 photons per second" and variable polarization properties over a very wide energy range (200-3000 eV in the case of P04 at PETRA III). This allows both to address long standing discussions in photoionization physics such as the two-center interferences in N_2 and O_2 [1] with high precision over a broad energy range as well as to perform systematic low signal coincidence studies of e.g. the coherence properties of small molecules [2]. Results of exploratory experiments performed at BESSY (HZB, Berlin) and DORIS (DESY, Hamburg) on the valence photoionization of N_2 and O_2 will be presented and compared with theory [1,3]. In addition an overview on recent experimental developments at different synchrotron radiation centers will be given.

[1] H. D. Cohen and U. Fano, Phys. Rev. **150**, 30 (1966).
[2] B. Zimmermann et al., Nature Phys. **4**, 649 (2008).
[3] D. Toffoli, P. Decleva, J. Phys. B **39**, 2681 (2006).

Invited Talk A 5.2 Mon 14:30 BAR 106

Appearance of coherent localization due to the Auger Doppler effect — •Burkhard Langer[1], Rainer Hentges[2], Oliver Kugeler[3], Markus Braune[2], Sanja Korica[2], Jens Viefhaus[2], Daniel Rolles[2], Uwe Hergenhahn[3], Hironobu Fukuzawa[4], Xiaojing Liu[4], Yusuke Tamenori[5], Masamitsu Hoshino[6], Hiroshi Tanaka[6], Christophe Nicolas[7], Catalin Miron[7], Omar Al-Dossary[8], Kiyoshi Ueda[4], and Uwe Becker[2,8] — [1]Freie Universität Berlin — [2]Fritz-Haber-Institut, Berlin — [3]Institut für Plasma Physik, Garching — [4]Tohoku University, Sendai — [5]Japan Synchrotron Radiation Research Institute, Hyogo — [6]Sophia University, Tokyo — [7]Synchrotron SOLEIL, France — [8]King Saud University, Riyadh

Homouclear diatomic molecules are inversion symmetric systems which form eigenstates of the parity operator known as *gerade* and *ungerade* states. These states are non-local superpositions of charge distributions on both nuclear sites of the molecule with a phase shift of 0 and π, respectively. Due to this intrinsic character a coherent superposition of these states generates a localized state either on the left or on the right side. Such a coherent superposition of two parity eigenstates with different symmetries occurs on top of the broad $3\sigma_u$ shape resonance of O_2 because the narrow $3s\sigma_g$ Rydberg excitation is sitting just near its maximum. This gives rise to interference causing coherent localization of the emitter position of the autoionizing electron. As a result of this localization the two Doppler components of the corresponding electron have unequal intensities, the so called wrong component has half of the right component only. This unexpected experimental result could be confirmed by a numerical simulation which takes known values of the decay life time, the splitting of the excited symmetry states and the conical intersection of the corresponding potential curves into account. The result is in perfect agreement with the measurements.

A 5.3 Mon 15:00 BAR 106

X-ray Photoelectron Spectroscopy of Free Silicon Dioxide Nanoparticles near the Si 2p Absorption Edge — •Egill Antonsson[1], Burkhard Langer[1], Johan Söderström[2], Christophe Nicolas[2], Olivier Sublemontier[3], Xiojing Liu[2], Christina Graf[1], Peter Schmiel[1], Ghassen Saidani[4], Jean-Luc Le Garrec[4], Emmanuel Robert[2], James Brian Mitchell[4], Paul Morin[2], Cécile Reynaud[3], Catalin Miron[2], and Eckart Rühl[1] — [1]Institut für Chemie und Biochemie, Freie Universität Berlin, Germany — [2]Synchrotron SOLEIL, Gif-sur-Yvette, France — [3]Laboratoire Francis Perrin, Gif-sur-Yvette, France — [4]University of Rennes, Rennes, France

The physical and chemical properties of nanoparticles are a subject of great interest. Their unique properties are often related to their high surface-to-bulk ratio. In order to study the intrinsic properties of nanoparticles free from interactions with any surrounding medium, we have used aerodynamic focusing to form a beam of nanoparticles in high vacuum. We have studied the photoemission from silicon dioxide nanoparticles (diameter: 50-200 nm) after excitation near the Si 2p absorption edge over a wide electron-kinetic-energy range. This reveals contributions from direct photoelectrons, Auger electrons, inelastically scattered electrons, and Auger electron channels as well as slow secondary electrons. Specific attention is given to electron-electron coincidence events involving emission of two electrons. The emission of two secondary electrons is the most common process involving emission of two electrons.

A 5.4 Mon 15:15 BAR 106

Origin of Low Energy Structures in Photoelectron Spectra Induced by Mid-Infrared Strong Laser Fields — •Liu Chengpu and Hatsagortsyan Karen Z. — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Based on a semiclassical model incorporating tunneling and Coulomb field effects, the origin of the low-energy structures (LES) in above-threshold ionization spectrum observed in recent experiments [1] is identified. Following a systematic investigation how the LES depend on laser polarization, pulse duration and the atomic potential range, we classified and quantified the Coulomb effects. We proved that the non-perturbative contribution of the multiple forward scattering into Coulomb focusing is responsible for the appearance of LES [2]. The shape of the LES is due to the interplay between multiple forward scattering of an ionized electron and the electron momentum disturbance by the Coulomb field immediately after the ionization determine. The former determines the appearance of the LES, while the latter does the positions of the LES peaks. The dependence of the LES height and width on the laser intensity or wavelength is also investigated and a simple scaling law is derived.

[1] C. I. Blaga et al., Nature Phys. 5, 335 (2009); W. Quan et al., Phys. Rev. Lett. 103, 093001 (2009).
[2] C. Liu and K. Z. Hatsagortsyan, Phys. Rev. Lett. 105, 113003 (2010).

A 5.5 Mon 15:30 BAR 106

NO^+ fluorescence in the visible spectral range after excitation of the $1s^{-1}2\pi^2$ resonances with synchrotron radiation — •Benjamin Kambs, 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 spectra after deexcitation of different vibrational levels of the NO^+ $A^1\Pi$-term have been measured with photon induced fluorescence spectroscopy (PIFS) in the spectral range of 420-480 nm.

The excitation was performed with synchrotron radiation from the UE56/2 PGM2 beamline at BESSY II in the energy range of 397-400 eV.

Intensities of fluorescence radiation have been measured horizontally and vertically with respect to the polarization vector of the exciting radiation. Therefore the angular distribution parameter β can be calculated. Its energy dependency was used to verify the influence of symmetry forbidden electronic state interference (ESI) on the population of the NO^+ $A^1\Pi$-term via symmetry different, resonant intermediate electronic states.

A 5.6 Mon 15:45 BAR 106

Photoelectron Time-of-Flight Spectroscopy in a hard X-ray Regime — •Markus Ilchen[1], Sascha Deinert[1], Leif Glaser[1], Frank Scholz[1], Jörn Seltmann[1], Peter Walter[1], and Jan Grünert[2] — [1]Deutsches Elektronen Synchrotron, Notkestraße 85, 22609 Hamburg — [2]European XFEL, Albert-Einstein-Ring 19, 22761 Hamburg

Using photoelectron time-of-flight spectroscopy for the determination of several Synchrotron and FEL beam properties is a well characterized method for the soft X-ray regime. Upcoming and already working XFEL facilities as well as hard X-ray photon beamlines at Synchrotron

Radiation facilities like PETRA III at DESY are also highly interested in online beam diagnostics in terms of beam positioning, energy, flux and the degree of photon polarization. The energy range in which this method is successfully tested was increased from the soft X-ray regime up to 15 keV. Not only diagnosis but also angle resolved photoelectron spectroscopy of rare gases like Argon, Krypton and Xenon were performed in that energy range at the P09 beamline at PETRA III. The actual status of the developed spectrometer, the latest measurements for polarization determination as well as the angular distribution of Xe 2p electrons from threshold up to 7 keV will be presented. Adaptability to XFELs in terms of shot to shot polarization analysis and relevant technical issues will be discussed.