

## A 8: Photoionization II

Time: Monday 16:30–18:30

Location: BAR 106

## Invited Talk

A 8.1 Mon 16:30 BAR 106

**Ultrafast Electron and Nuclear Dynamics in Dissociative Ionization of H<sub>2</sub>/D<sub>2</sub> probed by Molecular Frame Photoemission.**

— •DANIELLE DOWEK — Institut des Sciences Moléculaires d'Orsay, UMR8214, Université Paris-Sud and CNRS, 91405, Orsay, France

Dissociative photoionization of the H<sub>2</sub>/D<sub>2</sub> molecules, involving resonant excitation of the Q1 and Q2 doubly excited states, provides prototypes for the study of ultrafast electronic and nuclear dynamics. Single photon absorption in the 28–35 eV VUV range induces electronic correlation, coupling between electron and nuclear motion, and intricate interference patterns, taking place on the femtosecond (fs) scale. A state of the art theoretical description of these processes is currently performed, using stationary [1] or time-dependent [2] calculations.

We will discuss DPI of H<sub>2</sub>/D<sub>2</sub> obtained using the electron-ion vector-correlation (VC) method [3,4] and two excitation modes: the synchrotron radiation SOLEIL, providing linearly and circularly polarized VUV pulses and high-order harmonic generation at CEA-SLIC, where the H21 line was selected using multilayer optics.

The VC method gives access to the molecular frame photoelectron angular distributions (MFPADs) as a function of the Kinetic Energy Release (KER) of the fragments. Ultrafast dynamics including delayed photoemission can be probed at the fs level by comparing measured and computed KER-resolved MFPADs.

[1] F. Martín *et al.*, *Science*, 315, 629 (2007) [2] J. F. Perez-Torres *et al.*, *PRA* 80, 011402 (2009) [3] M. Lebech *et al.*, *RSI*, 73, 1866 (2002) [4] D. Doweck *et al.*, *PRL*, 104, 233003 (2010)

## Invited Talk

A 8.2 Mon 17:00 BAR 106

**High-resolution soft X-ray spectroscopies of isolated species**

— VICTOR KIMBERG, ANDREAS LINDBLAD, XIAO-JING LIU, CHRISTOPHE NICOLAS, EMMANUEL ROBERT, JOHAN SÖDRESTRÖM, OKSANA TRAVNIKOVA, and •CATALIN MIRON — Synchrotron SOLEIL, L'Orme des Merisiers, Saint-Aubin, BP 48, 91192 - Gif-sur-Yvette Cedex, France

Ultra-high resolution X-ray spectroscopies allow probing in great detail femtosecond decay dynamics of inner-shell excited species in both solid state and gas phase. New possibilities have been recently opened owing to bright and highly monochromatic photon beams and state-of-the-art instrumentation available at the newest facilities for dilute matter spectroscopies, such as the PLEIADES beamline in operation since March 2010 at SOLEIL. Doppler types of broadening are nowadays the main limitations of electron spectroscopies at room temperature.

Following the first experimental evidence of Vibrational Scattering Anisotropy (**VSA**) in the resonant Auger decay of core-excited C<sub>2</sub>H<sub>2</sub> [Miron *et al.*, *PRL* 2010], we have recently observed **VSA** in O<sub>2</sub>, where the interference between direct photoionization and resonant Auger scattering channels represent the only origin of the **VSA**. We predict **VSA** to be a completely general phenomenon, which is possible to observe as soon as experimental resolution is high enough. The fully variable polarization and high flux at PLEIADES have been also used to study the Auger electron emission anisotropy from dissociating core-excited SF<sub>6</sub> molecules using circularly polarized light, allowing observation of Auger-Doppler profiles [Travnikova *et al.*, *PRL* 2010].

## Invited Talk

A 8.3 Mon 17:30 BAR 106

**Double Photoionization of Aromatic Hydrocarbons** — •RALF WEHLITZ — SRC, UW-Madison, Stoughton, WI-53589, USA

Recently we have studied the double-ionization process in various aromatic hydrocarbons using synchrotron radiation. The double-to-single photoionization ratio was recorded over a large photon energy range in order to compare that ratio for different molecules and atoms. Questions that will be addressed in this talk are: How does the structure of a molecule affect the double photoionization process? Is there an isomer effect? And, how similar is the general photon-energy dependence of the ratio among different hydrocarbons?

Previous investigations on C<sub>60</sub> [1] showed that the double-to-single photoionization ratio as a function of photon energy can be used to determine geometrical distances of the cluster such as the carbon-carbon distance. Although aromatic hydrocarbons (with benzene being the prototype molecule) do not have localized valence electrons as C<sub>60</sub> has, we did find a similar effect that leads to an enhanced ratio based on the structure of the benzene ring.

The SRC is supported by US-NSF Grant No. DMR-0537588

[1] P.N. Juranic *et al.*, *Phys. Rev. Lett.* **96**, 023001 (2006)

A 8.4 Mon 18:00 BAR 106

**Are there interference effects of differently localized electrons?**

— •ANDRÉ KNIE, PHILIPP REISS, BENJAMIN KAMBS, and ARNO EHRESMANN — Universität Kassel, Institut für Physik und Center for Interdisciplinary Nanostructure Science and Technology, Heinrich Plett Str. 40, 34132 Kassel, Germany

For many processes occurring in nature quantum mechanical interference causes dramatic counterintuitive observations, requiring detailed understanding of this effect. As a prototypical linear three-atomic molecule N<sub>2</sub>O was investigated with almost any known experimental technique. Here we investigate the decay of N 1s-3p resonances of the central N-atom overlapping with resonances of the terminal N-atom. Decays into the N<sub>2</sub>O<sup>+</sup> A state will be measured by the N<sub>2</sub>O<sup>+</sup> A-X fluorescence. If interference effects are observed, this will be interference of electrons originally localised at different sites.

A 8.5 Mon 18:15 BAR 106

**Theory of resonant photoionization of highly charged ions at keV photon energies**— •ZOLTÁN HARMAN<sup>1,2</sup>, MARIUS SCHÜTZ<sup>1</sup>, CHRISTOPH H. KEITEL<sup>1</sup>, MARTIN C. SIMON<sup>1</sup>, JOSÉ R. CRESPO LÓPEZ-URRUTIA<sup>1</sup>, CHRISTIAN BEILMANN<sup>1</sup>, and JOACHIM ULLRICH<sup>1</sup> — <sup>1</sup>Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany — <sup>2</sup>ExtreMe Matter Institute EMMI, Planckstrasse 1, 64291 Darmstadt, Germany

Highly charged ions may be further ionized by x-ray radiation, as it happens in, e.g., the warm-hot intergalactic medium. Photoexcitation to an autoionizing state and the subsequent Auger decay gives rise to resonance peaks in photoion or -electron spectra. We calculate cross sections for this process for a variety of ionic systems up to highly charged Fe by means of a fully relativistic distorted wave theory, and compare them to measurements employing an electron beam ion trap and x rays from a synchrotron source (see, e.g., [1]). Understanding photoionization is a prerequisite for the interpretation of a range of astrophysical observations.

[1] M. C. Simon *et al.*, *Phys. Rev. Lett.* **105**, 183001 (2010).