Electron and Nuclear Dynamics in the Hard X-ray Domain

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The 'tender' x-ray domain, from 2 to 13 keV, has recently become available for atomic and molecular studies at the French synchrotron SOLEIL on the GALAXIES beam line with state-of-the-art photon and electron energy resolution. The GALAXIES beamline is dedicated to inelastic x-ray scattering (IXS) and high-energy x-ray photoemission (HAXPES) in the hard x-ray range. The beamline is designed to provide a monochromatic and microfocused beam with the highest flux possible in the 2.3-13 keV spectral range and an adaptable energy bandwidth between 50 meV and 1 eV.

We have investigated there a wealth of new phenomena by means of photoelectron and Auger spectroscopy. The list includes recoil due to the photoelectron's momentum [1,2], ultrafast nuclear motion on the femto- and sub-femtosecond time scale [3], double-core-hole studies [4-8], novel interference phenomena [9-12], ultrafast photodissociation in the Auger cascade following deep-core ionization [13,14], direct derivation of potential energy surfaces [15] (see also [16] for a recent review).

Another key experiment has been performed at SPring-8, Japan, where even higher photon energy is available, which has allowed us to measure for the first time the Xe 1s photoelectron spectrum [17].

We demonstrate that the newly accessible extended photon energy range does not simply allow studying more systems with deeper core edges, but opens a totally new horizon in what concerns electron and nuclear dynamics of deep-core-excited and core-ionized isolated species.

References

[1] M. Simon *et al*, Nat. Commun. **5**, 4069 (2014)
[2] E.Kukk *et al*, Phys.Rev.A **95,** 042509 (2017)
[3] M.N. Piancastelli et al, J. Phys. B: At. Mol. Opt. Phys. **47,** 124031 (2014)
[4] R. Püttner *et al*, Phys.Rev.Lett. **114**, 093001 (2015)
[5] S. Carniato *et al*, Phys.Rev. A **94**, 013416 (2016)
[6] G. Goldsztejn *et al*, Phys.Rev.Lett. **117**, 133001 (2016)
[7] R. Feifel *et al*, Sci.Rep. **7**, (2017) 13317
[8] D. Koulentianos *et al*, Phys.Chem.Chem.Phys. **20**, (2018) 2724
[9] D.Céolin *et al*, Phys.Rev.A **91**, 022502 (2015)
[10] R.K.Kushawaha *et al*, Phys.Rev.A **92**, 013427 (2015)
[11] G. Goldsztejn *et al*, Phys.Rev.A **95**, 012509 (2017)
[12] G. Goldsztejn *et al*, Phys.Chem.Chem.Phys. **18**, 15133 (2016)
[13] O.Travnikova *et al*, Phys.Rev.Lett. **116**, 213001 (2016)
[14] O.Travnikova *et al,* Phys.Rev.Lett. **118**, 213001 (2017)
[15] T.Marchenko *et al*, Phys.Rev.Lett. **119**, 133001 (2017)
[16] M.N.Piancastelli *et al*, J.Phys.B: At. Mol. Opt. Phys. **50,** 042001 (2017)
[17] M.N.Piancastelli *et al*, Phys.Rev.A **95**, 061402(R) (2017)

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