Coupling an Electron Time-of-flight Spectrometer and an under Vacuum Liquid Jet for Coincidence Measurements on Solvated Biomolecules

L. Huart, A. Kumar, F. Penent, I. Ismail, P. Lablanquie, J.P. Renault, M.-A. Hervé Du Penhoat, C. Nicolas, J. Palaudoux

Coupling an Electron Time-of-flight Spectrometer and an under Vacuum Liquid Jet for Coincidence Measurements on Solvated Biomolecules

L.Huart[1;2;3], A.Kumar[3,] F.Penent[1], I.Ismail[4], P.Lablanquie[4], J-P.Renault[1], M-A.Hervé du Penhoat[3], C.Nicolas[2], J. Palaudoux[4]

[1]NIMBE UMR CEA-CNRS 3685, Saclay, France,
[2]Synchrotron SOLEIL, Saint Aubin, France,
[3]IMPMC, Sorbonne Université - UPMC, UMR CNRS 7590, Paris, France
[4]LCPMR, Sorbonne Université - UPMC, UMR CNRS 7614, Paris, France

ABSTRACT

Radiation damage of biological systems is a complex multi-scale problem, not only in the spatial domain but also in the temporal domain. While interactions start at the atomic level (from atto- to femto-second), they can impact the molecular level (femto- to pico-second) and ultimately affect a cell's behavior over hours or days, culminating, in the worst case, in a full breakdown of a living organism over months to years. Photoelectron spectroscopy constitutes one of the basic experimental methods to study processes initiated by interaction of light with matter. It is widely applied in experiments or photoionization of gaseous, solid, and more recently, in liquid media [1].

The Magnetic Bottle Time-Of-Flight (MB-TOF) is specially designed to study multi-electron processes [2]. Indeed, due to its almost 4π electron collection efficiency, it is well suited to studying the early stages of an inner-shell photoionization, via coincidence techniques between the photoelectron and the resulting Auger electrons. Thus, coupled with an under vacuum liquid jet, it allows to investigate the different relaxation pathways of biomolecules in an aqueous media, after being irradiated by soft X-ray radiation [3].

We will present the first results obtained on different solutes and highlight how it is possible to clearly disentangle the liquid phase signal from the signal arising from the surrounding gas phase water [4]. Particular attention will be drawn to non-local energy transfers (between the solute and water molecules) such as interatomic coulombic decay or electron transfer mediated decay [5].

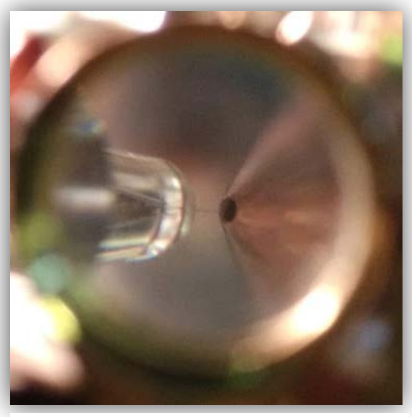

Fig 1 : Photography of the liquid jet

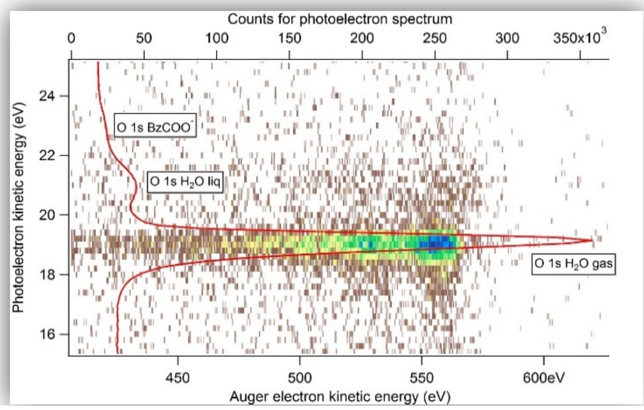

Fig. 2: 2D map representing coincidence between two electrons. O1s photoelectron spectrum (in red) recorded at 580 eV.

REFERENCES

1. G. Kumar et al., Faraday Discuss., 212, 359–381 (2018).
2. P. Lablanquie et al., J. Phys. B: At. Mol. Opt. Phys., 49, 182002 (2016).
3. H. L. Williams et al., J. Phys. Chem., 148, 194303 (2018).
4. S. Thürmer et al., Physical Review Letter, 111, 173005 (2013).
5. I. Unger et al., Nature Chemistry, 9(7), 708–714 (2017).