WEIGHTING (DRY AND CLEAN) ELEPHANTS

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : iLM

LEVEL : M2
TEAM(S) : SPECTROBIO

CONTACT(S) : ANTOINE Rodolphe
CHIROT Fabien

CONTACT(S) DETAILS: rodolphe.antoine[at]univ-lyon1.fr /
fabien.chirot[at]univ-lyon1.fr / Tel. 0472447975

KEYWORD(S) :

SCIENTIFIC CONTEXT :

In his Nobel prize lecture[1] for the invention of electrospray, J.B. Fenn prophesized that electrospray would allow to extend the field of mass spectrometry to unprecedently large molecular systems (molecular “elephants”). He was indeed proved right and electrospray ionization (ESI) has triggered the developments of new applications of mass spectrometry to analyze large molecular systems, such as intact non-covalently bound protein complexes. Recently, the development of charge detection mass spectrometry (especially by our group at iLM) has opened the way to detect even larger objects, including viruses,[2] or protein fibrils,[3] whose mass exceeds millions, or even billions of Daltons, thus much higher than the mass range accessible to conventional mass spectrometry.

For such large object, however, the electrospray process hardly leads to total desolvation and large amounts of water molecules can remain attached to (or captured inside) a viral particle or a protein fibril. Small ionic species from the salty buffer usually composing biological solvents are also often retained. Both effects can have important consequences on the accuracy of the measured masses and on the reproducibility of the results across different platforms or using different configurations.

MISSIONS :

A way to minimize the salt content consists in using electrospray tips with extremely small (sub-micron) apertures, which also results in the emission of very small droplets with sizes very close to that of the investigated objects. In order to minimize the influence of charge droplets on the measure, and to promote optimal desolvation of the objects of interest after ESI, we will also explore a new direction consisting in irradiating the droplets in the ESI plume using different infrared wavelength either matching the absorption of organic moieties constituting the objects, or the water itself.

The proposed work program for the internship will consist in optimizing the ESI process with very small (20-100 nm) ESI tips and in characterizing the effect of laser irradiation on the mass, size, and charge distribution of the droplets using different irradiation strategies, and with different types of analytes (synthetic polymers or protein fibrils).

The candidate is expected to have a minimum background in mass spectrometry and physical chemistry, and an interest for experimental works would be appreciated.

OUTLOOKS :

Application possible for a follow up PhD

BIBLIOGRAPHY :

1. Fenn, J. B. Electrospray Wings for Molecular Elephants (Nobel Lecture). Angewandte Chemie International Edition 42, 3871–3894 (2003).

2. Miller, L. M. & Jarrold, M. F. Charge detection mass spectrometry for the analysis of viruses and virus-like particles. Essays Biochem 67, 315–323 (2023).

3. Pansieri, J. et al. Mass and charge distributions of amyloid fibers Chem Sci 9, 2791–2796 (2018).

published on 07/09/2026