New beam line of biomolecular ions at ARIBE facility: Experimental setup, first results and prospects

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New Beam Line of Biomolecular Ions at ARIBE Facility:  
Experimental Setup, First Results and Prospects  

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Synopsis  
An electrospray ion source coupled with a quadrupole mass spectrometer has been installed at the  
ARIBE facility. Molecular beams of biological interest with an efficient control of the degree of the solvation  
become available. Preliminary results have been obtained concerning the mass resolution and the ion beam  
energy dispersion. In parallel, a collision chamber coupled with a singly charged atomic ion source is developed  
with the to produce very high current ion beams. This system allows to study the ion-induced fragmentation of  
biomolecules with the aim to better understand the solvatation effects.

The study of radiation damage of biological systems at a molecular scale needs to consider  
the effect of the water environment. Therefore, it is necessary to compare fragmentation results  
obtained for a molecule of biological interest in gas phase, either isolated or embedded in a water  
environment. Indeed, such comparison may allow us to distinguish primary and secondary  
processes causing radiation damages.

As it is difficult to produce large neutral intact biomolecules in the gas phase by evaporating  
processes, the use of an Electrospray Ion Source (ESI) is an advantageous alternative. It allows  
to bring very fragile molecules from the liquid to the gas phase and to produce many different  
species attached with more or less solvent (water) molecules (see Fig.1). The temperature of  
the heated capillary (used in the ESI) influences the relative intensity of each species.  

By this method, we can measure the kinetic energy of the molecular ion beam as a derivative  
function of the transmitted beam current (see Fig.2).

We also studied the gentle deposition of antibiotic biomolecular systems on clean surfaces  
by a ‘soft landing’ technique, in collaboration with the group of R.W. McCullough at QUB  
(Belfast). We aim to study the behaviour of deposited biomolecular systems on surfaces.

In parallel, we develop a collision chamber where the biomolecular beam interacts with an  
intense beam of singly charged atomic ions. With such an intense ion source, the low density of the  
biomolecular targets can be compensated. It will allow to study the different ion-induced dissociation  
channels of the solvated biomolecules.

This experimental setup will be operational before the end of this year at the ARIBE facility  
(Caen, France), part of the distributed LEIF infrastructure. The support received by the European  
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Fig. 1. Typical spectrum of a solution of Thymine for a temperature of 90 °C in the heated capillary.

Fig. 2. Energy dispersion for a beam of protonated Adenine with a mean kinetic energy of 8.4 eV.