M2 NAC internship in CIMAP

Effect of the environment on the radiation damage

The emergence of radiotherapy, both conventional using photons than hadrontherapy using protons and heavier ions, triggered a large amount of work in order to understand the radiation damage in biological tissues. However this is a multiscale problem both in dimension and time and this requires a multiscale and interdisciplinary approach starting from the fundamental physical processes occurring at the fs time scale during the passage of radiation in matter to the biological effects.

In CIMAP, we are studying the radiation damage at the molecular level, i.e. performing experiments on isolated molecular systems. This allows to have access to the intrinsic properties of the system and to use highly sensitive spectroscopies such as multi-coincidence mass spectrometry. However this approach neglects the effects of the chemical environment surrounding the system. These indirect effects of the radiation are considered to have an important role in the radiation damage.

A step-by-step approach is thus necessary using clusters of molecules in order to mimic more and more complex chemical environment. With this method we have shown previously that the energy and the charge are redistributed among the constituents of a clusters of nucleobases or amino acids. Currently we are working on nanohydrated clusters, i.e. clusters of molecules such as nucleobases or amino acids with water molecules in order to better mimic the environment.

Ion collision experiments are performed at ARIBE the low-energy ion beam facility in GANIL. Complementary studies using UV and X-ray photoionisation are done in SOLEIL in collaboration with the scientific staff of the PLEIADES beamline. Moreover, a theoretical support is provided by colleagues in Madrid in the framework of an international laboratory.

The experimental method relies on the know-hows of the CIMAP team on the production of molecular clusters using a gas aggregation source and its expertise on the study of the ion interaction with complex molecular systems using coincidence detection of the products of the interaction analysed by time-of-flight mass spectrometry. In SOLEIL, electron and photoabsorption spectroscopies can be done giving access to the information of the chemical environment. Moreover, the study of the photofragmentation could be also done measuring in coincidence the (photo)electrons and the photoions.

This internship is intended for the experimental studies of the radiation damage of nanohydrted clusters of nucleobases. The analysis of the experiments performed during the first semester 2019 in GANIL and SOLEIL will be done by the student and she/he will perform additional experiments foreseen in GANIL during the internship in the second semester 2019. Moreover the student may also work on the design of a new device in project in SOLEIL aiming to couple an electrosray ion source to the PLEIADES beamline in order to perform experiments on larger molecular systems such as proteins.

Contact:
Alicja Domaracka domaracka@ganil.fr
Patrick Rousseau patrick.rousseau@unicaen.fr
Chiara Nicolafrancesco nicolafrancesco@ganil.fr