PHD2018 - Title: **"Molecular anion reactivity in the gas phase at low temperature: application to the chemistry of astrophysical environments"**

Among the observed molecular species in the various cold astrophysical environments, such as molecular clouds, circumstellar envelops or planetary atmospheres, the recent detection of several anions has led to a radical rethink of the physical and chemical processes at play in these extreme environments. One of the challenges of modelling the reactional processes that prevail in these media is to reproduce the observed abundances of the detected species especially for the anions such as C_xH^- and C_xN^-. Essential to this modeling, laboratory data on the reactivity of negatively charged species are however sorely lacking: there are less than a dozen measurements on the kinetics in the gaseous phase of anions at low temperatures. In particular, the difficulties of producing and handling cold molecular anions explain this lack of data.

In this context, the "Laboratory Astrophysics" group of the Molecular Physics Department has engaged in the exploration of the gas phase reactivity at low temperature (down to 36K) of various small astrophysical molecular anions. Our expertise to perform kinetic measurements in cold gas flows (CRESU method) has led us to publish recently on the CN^-, C_3N^-, C_5N^- reactivity with HC_3N and HCOOH polar molecules [see some references below]. Encouraged by these results, we have upgraded the CRESU experimental set-up with a Mass Selective Ion Source prototype. This innovative and unique source makes possible the study of the reactivity of various molecular anions, such as C_x^- and $C_xH_y^-$, for which there is as yet very little experimental data, including at room temperature.

The future doctoral student will participate in the development of this new source, including optimization of the ion production mode, with the objective of studying reactions involving molecular anions of Cx^- and $CxHy^-$ type. This work will be carried out in close collaboration with all partners of the ANR program "Anion Cos Chem" in order to guarantee the completion of this ambitious project. Experimental developments will be made in connection with the Greek startup Fasmatech, expert in ion handling and guiding. Theoretical calculations accomplished by our colleagues from the LOMC-Le Havre, will support the experiments. These results will then be used to model the photochemistry of the Titan ionosphere (in collaboration with ISM-Bordeaux) and circumstellar envelopes (in collaboration with CSIC-Madrid).

The candidate must have a Master (or equivalent degree) in physics, physical chemistry or astrophysics. The future doctoral student must demonstrate abilities to work in a team. He will have to show a strong interest in experimentation. Knowledge in the field of mass spectrometry, plasmas, fluid mechanics is desirable. Data analysis skills using Matlab, Labview, C, Python or equivalent are essential.

References

- Joalland B., Jamal-Eddine N., Kłos J., Lique F., Trolez Y., Guillemin J.-C., Carles S., & Biennier L. "Low-Temperature Reactivity of C2n+1N− Anions with Polar Molecules", Journal of Physical Chemistry Letters, 7, 2957 (2016).
- Bourgalais J., Jamal-Eddine N., Joalland B, Capron M., Balaganesh M., Guillemin J.-C., Le Picard S.D., Faure A., Carles S., Biennier L., "Elusive anion growth in Titan's atmosphere: low temperature kinetics of the C3N− + HC3N reaction", Icarus 271, 194 (2016).

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