Laboratory investigation of negative ion cold chemistry: application to Titan's upper atmosphere

Ludovic Biennier[1], Sophie Carles[1], and Jean-Claude Guillemin[2]
[1] Institut de Physique de Rennes UMR 6251 CNRS, France
[2] Sciences Chimiques de Rennes. UMR 6226 CNRS -. Ecole Nationale Supérieure de Chimie de Rennes, France

The measurements performed by the Cassini-Huygens probe in the upper atmosphere of Titan (~950 km) have revealed negatively charged molecular species over a wide range of masses (from 10 to 10 000 amu/q). The unexpected presence of large amount of anions (up to 200 ions/cm^3) means that chemical reactions and photophysics of these species have to be accounted for in the modeling of the chemistry of the atmosphere. In the work of Vuitton (1), three low mass peaks observed by the spectrometer are attributed to CN^-, C_3N^-, and C_5N^- . These nitrogen containing species could be the building blocks of the larger negative ions observed, which may be the precursors to the aerosols identified at lower altitudes. A recent modeling study suggests that the density of negatively charged aerosols could be higher than the density of the positively charged ones (2). The investigation of the negative ion chemistry is key to the modeling of Titan's atmosphere. Experimental studies of the kinetics, products and branching ratios of reactions involving these species are required to refine the production and destruction chemical pathways. In our laboratory, we have explored the reaction of CN^- with cyanoacetylene (HC_3N) over the 20-300 K temperature range in uniform supersonic flows using the CRESU technique (3). The results show that the kinetics is independent of the temperature and that C_3N^- + HCN represents the dominant exit channel. The investigation is currently extended to reactions involving larger anions such as C_3N^- .

References

(1) Vuitton, V.; Lavvas, P.; Yelle, R. V.; Galand, M.; Wellbrock, A.; Lewis, G. R.; Coates, A. J.; Wahlund, J. E. *Planetary and Space Science* **2009**, *57*, 1558-1572.
(2) Michael, M.; Tripathi, S. N.; Arya, P.; Coates, A.; Wellbrock, A.; Young, D. T. *Planetary and Space Science* **2011**, *59*, 880-885.
(3) Le Garrec, J. L.; Carles, S.; Speck, T.; Mitchell, J. B. A.; Rowe, B. R.; Ferguson, E. E. *Chemical Physics Letters* **2003**, *372*, 485-488.