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Kick-starting aerosol formation on Titan with ion chemistry

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Abstract

The Cassini Huygens probe has revealed the presence of abundant and heavy ions in the upper atmosphere of Titan [1, 2]. These so-called macromolecules are now considered to be key intermediates in the production of aerosols observed at lower altitudes [3]. Under this scenario, macromolecules are formed and grow by gas phase ion-neutral reactions in the ionosphere. There they attach efficiently free electrons and recombine with positive ions leading to a rapid gain in mass. As they settle down in the cold atmosphere, they continue to grow until they reach a size where coagulation takes over. However, the composition of these macromolecules and their precise formation mechanisms are still largely unknown. It includes the first steps leading to the production of the macromolecules, which govern the growth rate.

In particular, negative ion cold chemistry has not been explored systematically. Although there have been a number of experimental studies conducted to determine the kinetics of anion-neutral reactions, a fraction only has simultaneously led to the determination of the nature of products and even less to the branching ratio into the different exit channels.

In the laboratory, we recently engaged in kinetics studies of anion-molecule reactions starting with the reaction of CN^- and C_3N^- with cyanoacetylene HC_3N over the 50-300 K temperature range using the CRESU technique (French acronym standing for Reaction Kinetics in Uniform Supersonic Flow). The results show that the CN^- + HC_3N reaction contributes directly to the growth of larger anions [4] whereas C_3N^- + HC_3N does not [5].

The investigation is now extended in the laboratory to other anions (such as C_xH^-) through the synthesis of adapted molecular precursors. The development of a versatile selected anion source, which will be combined with the CRESU apparatus, will be also presented.

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