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Anion Chemistry on Titan: A possible route to large N-bearing hydrocarbons

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HIGHLIGHTS
- Phase gas reaction of CN- with HC3N is studied in a multiple collision regime
- Formation of large anions identified as (HC3N)x.C2p+1N- and (HC3N)x.C2pN- is observed
- Mechanism and energetics are discussed for an extrapolation to Titan's ionosphere
- Similarities found between laboratory data and Cassini CAPS-ELS observations
- First time a growth pathway for anions in Titan's ionosphere is proposed

The CN- + HC3N reaction has been studied in a tandem mass spectrometer as a function of the HC3N target molecule going from a single to a multiple collision regime. The primary and secondary reactions with HC3N were found to be extremely efficient, resulting in anionic products of rapidly growing size through a simple mechanism [1]. Comparison of the experimental mass spectra with the spectrum observed on board of CASSINI with the CAPS-ELS instrument by Coates et al [2,3] suggests that the proposed mechanism may be of interest to describe the growth of negatively charged hydrocarbons in Titan's ionosphere [1].
The kinetic of the CN- + HC3N reaction has recently been experimentally investigated by Carles et al. [4] under single collision conditions. The rate constant is k = 4.8 x 10-9 cm3/s and C3N- could be identified as the main reaction product following the proton transfer CN- + HC3N → C3N- + HCN.
In this study, CN- ion was formed by means of a APCI (Atmospheric Pressure Chemical Ionisation) source from acetonitrile (CH3CN). The reaction itself was studied using a Waters Quattro Premier TM tandem quadruple mass spectrometer operating in negative ion mode. With increasing HC3N pressure, the mass spectra reveal the fast decrease of the CN- parent and apparition of larger anions of rapidly growing size. Most of the masses observed were found to belong only to two series of products: (HC3N)x.C2p+1N- and (HC3N)x.C2pN- resulting from the sequential additions of HC3N molecules and loss of HCN or HCCN molecules. The intensity of each product has been followed as a function of the HC3N pressure [1].
It is first time that ion-molecule reactions are proposed to account for the growth of anions in Titan's ionosphere through successive collisions.

References
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