EXPERIMENTAL STUDIES OF DISSOCIATIVE RECOMBIINATION OF H_3^+ AND KrH^+

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Dissociative recombination of molecular ions (such H_3^+, HCO^+ …) with electrons plays a key role in the chemistry of interstellar clouds, planetary ionospheres. Given the importance of H_3^+ ion, many experiments have been done to measure its recombination rate coefficient $\alpha(H_3^+)$. Actually, the value of l-2 x $l0^{-7}$ cm^3s^{-1} at 300 K for ground vibrational state ions is always controversial [1-2]. Considering this perplexing situation, we have performed new studies using our FALP-MS apparatus.

This one has been extensively described elsewhere [3]. The major difference with other flowing afterglow apparatuses is that the reaction zone is located in a subsonic jet expanding in a large stainless steel chamber (25 cm in diameter) directly outside of the low tube (8 cm diameter). This design allows us to move a quadrupole mass spectrometer along the flow axis as well as a Langmuir probe. It is therefore possible to measure the densities of both ions and electrons as a function of distance z along the flow in the reaction zone.

A plasma is created by a microwave discharge (2450 .Mhz) in a argon buffer gas flowing through a glass tube (5 cm in diameter) connected upstream of the stainless steel flow tube. Helium is injected through an upstream inlet. Three rotating flat disks were inserted inside the tubes allowing the initial electron densities to be varied from 2×10^{10} to 10^9 cm^{-3}.

With these conditions, an afterglow of Ar^+ and electrons at 300 K is obtained at the end of the flow tube, just before the reaction zone. Hydrogen is then added through an eight needle entry port to form H_3^+ ions. The dissociative rate coefficient $\alpha(H_3^+)$ of 1.l x 10^{-7} cm^3s^{-1} for H_3^+ (v=0, 1) is obtained by analysing the decrease of the ion and the electron density along the flow axis in agreement with previous works [3].

To confirm this value for the ground vibrational state, experiments with krypton have been planed. The idea: the proton affinity of hydrogen is in the same order of krypton. In this case, the process quenching $H_3^+(v)$ should be very efficient to give H_3^+ in ground state, but it is impossible to obtain in the afterglow H_3^+ without KrH^+. From measurements in a plasma dominated KrH^+ ion, it is possible to give an upper value of the recombination rate coefficient for KrH^+, it is found that $\alpha(KrH^+) <= 1.4 \times 10^{-8}$ cm^3s^{-1}. No accurate value of $\alpha(H_3^+)$ is available at present: when KrH^+ and H_3^+ densities are in the same order, we have obtained an experimental value of $\alpha(H_3^+)$ about 5 x 10^{-8} cm^3s^{-1} but this result is consistent with our previous value of $\alpha(H_3^+) = 1.1 \times 10^{-7}$ cm^3s^-1.

In our poster, we hope to give a more accurate value of $\alpha(H_3^+)$ and $\alpha(ArH^+)$ using experiments with krypton and preliminary results on XeH^+ dissociative recombination

[1] D. Smith and P. Spanel, Int. J. Mass Spectrometry and Ion processes, 129 (1993) 163

[2] J. Jonhsen *et al*, invited paper in Third International Symposium on « Dissociative Recombination: Theory, Experiment and Application ». Ein Gedi Israel (May 29-June 2, 1995).

[3] Canosa *et al* J. Chem. Phys. 97 (1992) 1028.