EXPERIMENTAL STUDIES OF DISSOCIATIVE RECOMBINATION OF H_3^+, KRH$^+$ AND XEH$^+$

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The exact value of the rate coefficient α for dissociative recombination of H_3^+ ground state ions has been and is still a subject of controversy (1),(2),(3). Following our previous work in helium afterglow, we have measured using a FALP-MS apparatus $\alpha(H_3^+)$, $\alpha(KrH^+)$ and $\alpha(XeH^+)$ in an argon-helium buffer. Argon flows through the discharge (Gate G_1: Q_{Ar} = 30 $l\ min^{-1} atm$) and the electrons are thermalized downstream by large helium injection (G_2: Q_{He} = 5 $l\ min^{-1} atm$). It is therefore possible to obtain at low pressure (P ~ 0.5 $Torr$) a plasma where Ar^+ is the dominant ion. Addition of hydrogen alone results in H_3^+ production through the following reactions $Ar^+ + H_2 \rightarrow ArH^+ + H$ and $ArH^+ + H_2 \rightarrow H_3^+ + Ar$. The latter reaction is known to form H_3^+ up to $v = 2$. In this case $\alpha(H_3^+)$ has been determined to be 1.0 x 10^{-7} $cm^3 s^{-1}$.

When Kr or Xe (Gate G_3) is injected in excess of H_2 (Gate G_4), the plasma is dominated by KrH$^+$ or XeH$^+$, these two gazes having proton affinities larger than H_2. The measured values of the rate coefficients for these ions are respectively $\alpha(KrH^+) < 1.0$ x 10^{-8} cm^3s^{-1} and $\alpha(XeH^+) = 1.1$ x 10^{-7} cm^3s^{-1}, in good agreement with the previous work of Geoghegan (4) and co-workers only for KrH$^+$.

By adding a large quantity of H_2 further downstream (Gate G_5) in a flowing afterglow plasma dominated by KrH$^+$, it is possible to obtain H_3^+ as a dominant ion through the reaction $KrH^+ + H_2 \rightarrow H_3^+ + Kr$ with $[H_2] >> [Kr]$ due to the very close proton affinity of Kr and H_2. Since KrH$^+$ does not recombine, this can be done with a fairly high density. It is therefore possible to measure $\alpha(H_3^+)$ for ions that are almost certainly in their ground state $\alpha(H_3^+) = 0.8$ x 10^{-7} cm^3s^{-1}, see figure 2.

Considering the uncertainties in the various experiments, this result is, in our opinion, still in agreement with the measurements of Larsson and co-workers (5). However it can be taken as showing that the α value for ground state is slightly lower than for excited state.

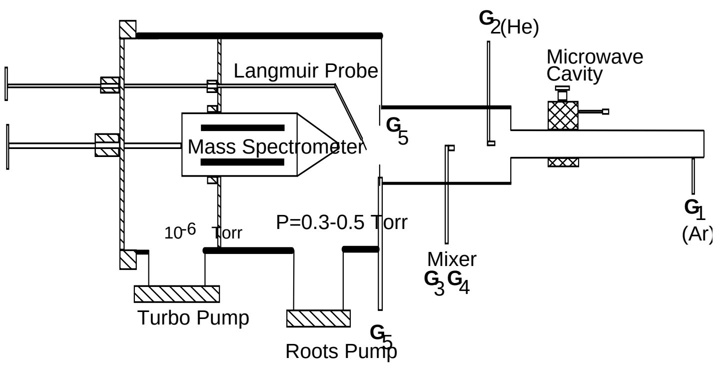

Fig.1: MS-FALP experimental set-up

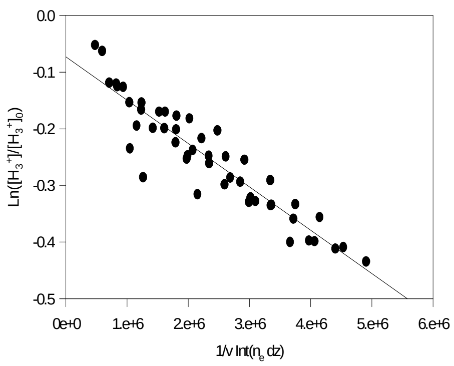

Fig. 2: Typical plot yielding $\alpha = 0.8\ 10^{-7}\ cm^3s^{-1}$

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