# OBSERVATIONS OF $H_3^+$ IN THE DIFFUSE INTERSTELLAR MEDIUM

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The unexpectedly high column density of $H_3^+$ observed[a,b] in the diffuse interstellar medium towards Cygnus OB2 12 presented quite an enigma for interstellar chemistry. Since $H_3^+$ has now been detected in many sightlines[c], it is clear that there is a general problem with the chemical models.

The standard model of $H_3^+$ chemistry in diffuse clouds contains only three parameters: $\zeta$ (the $H_2$ ionization rate), $k_e$ (the $H_3^+$ dissociative recombination rate constant), and $[e]/[H_2]$ (the electron fraction) — evidently, at least one of the assumed values for these parameters is in error by one to two orders of magnitude. There are only three options: (1) the electron fraction is lower than expected from complete conversion of $C \rightarrow C^+$, (2) the value of $k_e$ for $J = 1$ $H_3^+$ (and cold electrons) is lower than that reported in the laboratory for rotationally hot $H_3^+$, and/or (3) the value of $\zeta$ is higher in diffuse clouds than in dense clouds due to the presence of low-energy cosmic rays.

We report new observations of $H_3^+$ in the diffuse interstellar medium using CGS4 at UKIRT and IRCS at Subaru, which seem to rule out option (1). In particular, we have tentatively detected $H_3^+$ in the classical diffuse cloud towards $\zeta$ Per, toward which both $C^+$ and $H_2$ have been spectroscopically measured.

It now seems that it is up to the dissociative recombination community to unambiguously determine the appropriate value of $k_e$ through both experiment and theoretical calculation. With a definitive value of $k_e$ in hand, observations of $H_3^+$ will then serve as a direct probe of the cosmic-ray ionization rate $\zeta$ in diffuse clouds.

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[a] B. J. McCall, T. R. Geballe, K. H. Hinkle, and T. Oka, *Science* **279**, 1910 (1998)

[b] T. R. Geballe, B. J. McCall, K. H. Hinkle, and T. Oka, *Astrophysical Journal* **522**, 338 (1999)

[c] B. J. McCall et al. *Astrophysical Journal* **567**, 391 (2002)