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: ζ (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 ζ 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 ζ 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 ζ 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)