CH_3^+: A NEW TOOL FOR STUDYING THE ENIGMA OF INTERSTELLAR CH^+?

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Although CH^+ was one of the very first interstellar molecules to be identified (in the early 1940s), its ubiquitous presence in the diffuse interstellar medium remains an enigma. CH^+ is thought to be rapidly destroyed by the abundant species H, H_2, and e^-, but there is no known efficient formation mechanism at low temperatures. In steady state, one would therefore expect a very low abundance of CH^+, but yet strong CH^+ lines are seen in nearly all diffuse cloud sightlines. Various solutions to this paradox have been proposed, and most of them invoke shocks (especially magnetohydrodynamic shocks) to drive the endothermic reaction $C^+ + H_2 \rightarrow CH^+ + H$.

Regardless of the mechanism by which it is produced, CH^+ will undergo fast hydrogen abstraction reactions to form CH_2^+ and then CH_3^+, if it is in an environment with a large fraction of the hydrogen in molecular form. Since CH_3^+ reacts only very slowly with H_2, by radiative association to form CH_5^+, it is destroyed primarily by dissociative recombination with electrons. A simple steady state analysis suggests that CH_3^+ may be over 10 times more abundant than CH^+, although this factor depends on the molecular fraction and the electron temperature.

In order to provide observational constraints on the environment in which CH^+ is observed, we have searched for the infrared ν_3 band of CH_3^+ at 3.2 μm in diffuse cloud sources. We will present our upper limits on the equivalent width of the CH_3^+ lines, discuss the inferred limits on the CH_3^+ column density, and offer some speculations about the conditions in the regions where CH^+ exists.