# $CH^+$ AND CH EMISSION FROM THE RED RECTANGLE

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Using the 3.5 meter telescope at the Apache Point Observatory, we have observed the 0 - 0, 1 - 0, 0 - 1, 1 - 2, and 2 - 1 bands of the $\tilde{A}^1\Pi \rightarrow \tilde{X}^1\Sigma^+$ transition (origin at 4238 Å) of $CH^+$ and the 0 - 0 band of the $\tilde{A}^2\Delta \rightarrow \tilde{X}^2\Pi$ transition (4307 Å) of CH in emission from HD 44179, the central star of the Red Rectangle. The 0 - 0 band emission of $CH^+$ was reported earlier,[a] but all other emission bands are new.

The $CH^+$ emission lines are observed up to the $Q(7)$ and the $P(6)$ lines demonstrating population of $CH^+$ up to at least $J = 6$ in the ground state. Since $CH^+$ has a large dipole moment (1.656 D,[b] 1.804 D[c]) the spontaneous emission of the $J = 6 \rightarrow 5$ rotational transition at 165.96 $cm^{-1}$ is fast (the Einstein coefficient A = 1.81 $s^{-1}$, 2.15 $s^{-1}$). In order to populate up to the $J = 6$ level, $CH^+$ must be in an environment with a high density on the order of $10^9$ $cm^{-3}$. It has to be a cloud of H atoms since $H_2$ will immediately react with $CH^+$ to produce $CH_2^+$. Existence of such a high density H I cloud is remarkable.

The observed CH emission, on the other hand, is limited to the $R_2(1/2)$, $R_1(3/2)$ and $R_1(5/2)$ lines all of which can be reached from the lowest two levels in the ground state that are separated by only 17.9 $cm^{-1}$ and spontaneous emission between them is slow. This clearly demonstrates that $CH^+$ and CH exist in entirely different regions of the cloud surrounding HD 44179. A more detailed analysis will be given.

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[a] S. P. Balm and M. Jura, *A&A* **261** L25 (1992)

[b] F. R. Ornellas and F. B. C. Machado, *J. Chem. Phys.* **84** 1296 (1986)

[c] H. Sun and K. F. Freed, *J. Chem. Phys.* **88** 2659 (1988)