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The Distribution, Excitation, and Abundance Of C^+, CH^+, and CH in Orion KL

Harshal Gupta[1], Patrick W. Morris[1], Zsofia Nagy[2], Volker Ossenkopf[3] and John C. Pearson[4]

[1] Infrared Processing and Analysis Center, California Institute of Technology, 770 S. Wilson Ave., Pasadena, CA 91125, USA

[2] Department of Physics and Astronomy, University of Toledo, Toledo, OH 43606, USA

[3] I. Physikalisches Institut der Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

[4] Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA

e-mail: hgupta@caltech.edu

The CH^+ ion was one of the first molecules identified in the interstellar gas over 75 years ago, and is postulated to be a key species in the initial steps of interstellar carbon chemistry. The high observed abundances of CH^+ in the interstellar gas remain a puzzle, because the main production pathway of CH^+, *viz.*, $C^+ + H_2 \rightarrow CH^+ + H$, is so endothermic (4640 K), that it is unlikely to proceed at the typical temperatures of molecular clouds. One way in which the high endothermicity may be overcome, is if a significant fraction of the H_2 is vibrationally excited, as is the case in molecular gas exposed to intense far-ultraviolet radiation fields. Elucidating the formation of CH^+ in molecular clouds requires characterization of its spatial distribution, as well as that of the key participants in the chemical pathways yielding CH^+. Here we present high-resolution spectral maps of the two lowest rotational transitions of CH^+, the fine structure transition of C^+, and the hyperfine-split fine structure transitions of CH in a $\sim 3' \times 3'$ region around the Orion Kleinmann-Low (KL) nebula, obtained with the *Herschel Space Observatory's* Heterodyne Instrument for the Far-Infrared (HIFI).[1] We compare these maps to those of CH^+ and C^+ in the Orion Bar photodissociation region (PDR), and discuss the excitation and abundance of CH^+ toward Orion KL in the context of chemical and radiative transfer models, which have recently been successfully applied to the Orion Bar PDR (Nagy et al. 2013).

REFERENCES

Nagy, Z., van der Tak, F. F. S., Ossenkopf, V. et al. 2013, A&A, 550, A96

[1] These observations were done as part of the Herschel observations of EXtraordinary sources: the Orion and Sagittarius star-forming regions (HEXOS) Key Programme, led by E. A. Bergin at the University of Michigan, Ann Arbor, MI.