DETECTION OF $CCCH^+$ TOWARD W49N: ELUCIDATING THE MOLECULAR COMPLEXITY OF THE DIFFUSE INTERSTELLAR GAS

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The simple hydrocarbons CCH, $CCCH$, c-C_3H, H_2CCC, and c-C_3H_2 are common in the interstellar gas and are thought to be important in the production of larger molecules, yet their abundances are poorly understood. Observations of the carbon chain ion $CCCH^+$, a key intermediate in the chemistry of these species, have begun to shed some light on their abundances: (i) maps of $CCCH^+$ in the Horsehead nebula photodissociation region (PDR) suggest that besides ion-molecule chemistry, the fragmentation of large molecules or very small interstellar grains contributes to the production of small hydrocarbons;[a] and (ii) there is important but limited evidence that the $CCCH^+$ abundance is uniform in diffuse clouds in the Galactic disk, and is remarkably similar to $CCCH^+$ abundances inferred in PDRs.[b] Furthermore, there is clear evidence for a very large molecule—the fullerene ion C_{60}^+—in the diffuse gas,[c] so studies of $CCCH^+$ and similar ions in diffuse clouds should allow robust constraints on chemistry over a very large scale in molecular size.

Using the 100-m Green Bank Telescope, we recently detected the two lowest rotational transitions of $CCCH^+$ along with transitions of several related hydrocarbons in absorption from diffuse clouds toward the luminous H II region W49N. Our observations demonstrate that absorption spectroscopy is a highly sensitive means to detect trace polyatomic species such as $CCCH^+$, owing to the large pathlengths through the Spiral Arms and the availability of bright centimeter continuum sources. We will discuss our results toward W49N within the context of elucidating the abundances of small hydrocarbons in diffuse clouds. We will also discuss the prospects of detecting $CCCH^+$ toward several other Galactic continuum regions, and detecting larger polyatomic molecules in diffuse clouds through dedicated spectral line surveys.

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[a] Guzmán, V., Pety, J., Goicoechea, J. R., et al. 2015, ApJL, 800, L33

[b] Gerin, M., Liszt, H., Neufeld, D., et al. 2019, A&A, 622, A26; *and references therein.*

[c] Maier, J. P. & Campbell, E. K. 2016, Phil. Trans. R. Soc. A, 374, (issue 2076), 1