# VIBRATIONAL AND ROTATIONAL ACTION SPECTROSCOPY OF $H_2C_3H^+$

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The high-resolution rovibrational and pure rotational spectra of $H_2C_3H^+$ are reported here for the first time. The spectra were collected in a 4K 22-pole cryogenic ion trap (COLTRAP) instrument using the novel leak-out spectroscopy (LOS) method.[a] Rovibrational signatures within the fundamental $\nu_1$ (C-H stretch) and the combination $\nu_3$+$\nu_5$ (C-C stretches) bands were detected in the 3 $\mu$m spectral region using a continuous wave optical parametric oscillator and were successfully assigned, aided by previous theoretical calculations.[b] These observations allowed accurate spectroscopic constants for the ground and vibrationally excited states to be determined. Significant differences were observed in the values of the rotational constant *A*, which decreases by about 2.7% and 5.0% in the $\nu_1$ and $\nu_3$+$\nu_5$ bands, respectively, in comparison to $\nu_0$. By analyzing the changes in *A*, information about the molecular structure of $H_2C_3H^+$ upon excitation of the C-H and C-C stretches was obtained, which indicates that the HCH angle may have an increase of approximately 3° in $\nu_1$ and 6° in $\nu_3$+$\nu_5$. Guided by the ground state constants obtained from the infrared (IR) measurements, 14 pure rotational lines were observed in the 90-200 GHz frequency range using a double resonance scheme, in which the ions are excited simultaneously by the IR and a mm-wave radiation. These rotational measurements allowed even more accurate ground state spectroscopic parameters to be determined and open up the possibility for the first (radio)astronomical search of $H_2C_3H^+$ in the interstellar medium. Finally, the capability of the novel LOS method in isolating isomers in the ion trap will be discussed with a focus on the abundances of $H_2C_3H^+$ and its cyclic sibling, c-$C_3H_3{}^+$.

[a] Schmid, P. C., Asvany, O., Salomon, T., Thorwirth, S., and Schlemmer, S. 2022, J. Phys. Chem. A, 126, 8111.

[b] Huang, X., Taylor, P. R., and Lee, T. J. 2011, The Journal of Physical Chemistry A, 115, 5005.