HIGH-RESOLUTION NEAR-INFRARED SPECTROSCOPY OF DEUTERATED CH_2^+

HAIMING WANG, CHRISTOPHER P. MORONG, and TAKESHI OKA, *Department of Chemistry, Department of Astronomy & Astrophysics, and the Enrico Fermi Institute, University of Chicago, Chicago, IL 60637*.

Observations of highly deuterated molecules in prestellar cores and protostars in recent years have aroused new interest in deuterium ion chemistry. The widely accepted interpretation of this phenomenon as due to extraordinarily high deuterium fractionation of H_3^+ to H_2D^+, HD_2^+ and D_3^+[a] implies that deuterated variants of other fundamental molecular ions also play pivotal roles in the deuterium fractionation. Aiming at providing approximate rotational constants for millimeter wave spectroscopists to identify these deuterated species, we are continuing our project to study the laboratory spectra of the deuterated CH_2^+ molecular ions. CH_2^+ has been chosen as our first target ion because it is the intermediate between the abundant CH^+ and yet to be observed but very important CH_3^+ in the "tree" of interstellar chemistry. Its abundance is expected in diffuse clouds although our search for interstellar CH_2^+ based on our infrared[b] and near-infrared[c] laboratory spectra has not been successful. CH_2^+ and its deuterated species are also of special interest for theoretical studies because of their unique intramolecular dynamics, i.e., the Renner-Teller interaction and quasi-linearity.

Using He-dominated liquid-N_2 cooled plasmas ($\sim$10 Torr) containing a small amount ($\sim$0.1 Torr) of CD_4, we have measured the spectra of CD_2^+ in the near-infrared from 11,000 cm^{-1} to 12,500 cm^{-1} with our Ti:sapphire laser spectrometer that combines velocity modulation and phase modulation with heterodyne detection for near shot-noise-limited sensitivity. In this talk, we will review our analysis of the $\tilde{A}(0,5,0)^1 \leftarrow \tilde{X}(0,0,0)^0$ band, presented last year[d] and examine the $\tilde{A}(0,5,0)^0 \leftarrow \tilde{X}(0,0,0)^1$ and $\tilde{A}(0,4,0)^2 \leftarrow \tilde{X}(0,0,0)^1$ bands of CD_2^+ based on the *ab initio* calculations by Bunker and colleagues[e]. A scan for CHD^+ is in preparation.

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[e] P.R. Bunker, private communications.