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

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Recent observations of highly deuterated molecules such as ND_3 and D_2CO in prestellar cores and their explanation as due to the extraordinarily high deuterium fractionation of H_3^+ to H_2D^+, HD_2^+ and D_3^+,[a] have revealed the importance of observing other deuterated variants of fundamental molecular ions that also play pivotal roles in interstellar chemistry. We have launched an infrared project to study such ions systematically in order to provide their approximate rotational constants for millimeter wave spectroscopists.

We are presenting our work on the near-infrared spectroscopy of CHD^+ and CD_2^+. While our search for interstellar CH_2^+ based on our infrared[b] and near-infrared[c] laboratory spectra has not been successful due to its extremely high reactivity, its detection in the future is expected in diffuse clouds since it is the intermediate between the abundant CH^+ and yet to be observed but very important CH_3^+. CH_2^+ and its deuterated species are also of special interest for theoretical study 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 CH_4, CH_2D_2, CD_4 and their mixtures, we are searching for the spectra of CD_2^+ and CHD^+ in the near-infrared from 10,500 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. Our search is based on the *ab initio* calculation by Bunker, Jensen and colleagues[d] which predicts the $\tilde{A}(0,5,0)^1$ and $\tilde{A}(0,4,0)^1 \leftarrow \tilde{X}(0,0,0)^0$ bands of CD_2^+, and the $\tilde{A}(0,4,0)^1 \leftarrow \tilde{X}(0,0,0)^0$ band of CHD^+ as the most intense in the region.

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[d] G. Osmann, P.R. Bunker, P. Jensen, W.P. Kraemer, *Chem. Phys.* **225**, 33 (1997).