

## HIGH- $J$ ROTATIONAL LINES OF $\text{HCO}^+$ AND ITS ISOTOPOLOGUES MEASURED BY USING EVENSON-TYPE TUNABLE FIR SPECTROMETER

RYO OISHI, TATSUYA MIYAMOTO, MARI SUZUKI, YOSHIKI MORIWAKI, FUSAKAZU MATSUSHIMA, *Department of Physics, University of Toyama, Toyama, Japan*; TAKAYOSHI AMANO, *Department of Chemistry, University of Waterloo, Waterloo, ON, Canada*.

Frequencies of high- $J$  rotational lines of  $\text{HCO}^+$  and  $\text{DCO}^+$  have been measured precisely by using an Evenson-type tunable far-infrared spectrometer in Toyama. The spectrometer (sometimes called TuFIR in short) is based on synthesizing terahertz radiation from two mid-infrared  $\text{CO}_2$  laser lines and one microwave source. The  $\text{HCO}^+$  ions are produced by discharging a  $\text{CO}$ ,  $\text{H}_2$  (or  $\text{D}_2$ ), and Ar mixture in an extended negative glow discharge cell cooled with liquid nitrogen. The low- $J$  rotational lines have been extensively studied. Information on the higher- $J$  levels have been obtained by observing the vibration-rotation bands. More recently high precision infrared measurements have been made by observing the Lamb dips.<sup>a</sup> We focus our efforts to measuring the high- $J$  rotational lines. Currently we have observed the lines  $J + 1 \leftarrow J$  ( $J=7-19, 21$ ) for  $\text{HCO}^+$ , and  $J + 1 \leftarrow J$  ( $J=11, 13-14, 16-24$ ) for  $\text{DCO}^+$ . An additional isotopologue,  $\text{H}^{13}\text{CO}^+$  is now under investigation. From the analysis of the intensity of each rotational line, we estimate the rotational temperature to be as low as 120K. Apparently, due to this low temperature, it seems to be difficult to extend the measurements to yet higher- $J$  lines.

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<sup>a</sup>B. M. Siller, J. N. Hodges, A. J. Perry, and B. J. McCall, *J. Phys. Chem. A*, **117**, 10034(2013)