

## SUBMILLIMETER OBSERVATION OF HCO<sup>+</sup> AND DCO<sup>+</sup> IN THE EXCITED VIBRATIONAL STATES

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Hirota and Endo reported observations of the rotational transitions of HCO<sup>+</sup> and DCO<sup>+</sup> in excited vibrational states.<sup>a</sup> The lowest three rotational transitions of (02<sup>2</sup>0) could not be detected in their experiment. They ascribed this non-observation to the Stark broadening caused by the electric field in a hollow cathode discharge. More recently Dore and coworkers<sup>b</sup> also did not see the  $\ell = 2$  lines in an extended negative glow discharge and interpreted this result in terms of the Stark effect. However, symmetric top ions such as CH<sub>3</sub>CNH<sup>+</sup><sup>c</sup> and SD<sub>3</sub><sup>+</sup><sup>d</sup> were observed with no difficulty. Also no anomalies were observed for similar lines for HCN<sup>e</sup> and HNC<sup>f</sup> produced in an extended negative glow discharge.

In the present investigation, we extended the measurements up to 800 GHz. The HCO<sup>+</sup> and DCO<sup>+</sup> ions were produced in an extended negative glow discharge in a gas mixture of H<sub>2</sub> or D<sub>2</sub> and CO ( a couple of mTorr each ) in Ar buffer ( 12 mTorr ). The measurements were done mostly at liquid nitrogen temperature. For HCO<sup>+</sup>, the rotational lines in the excited vibrational levels up to (040) and (002) which are located at about 4300 cm<sup>-1</sup> above the ground state have been measured. The measurements for DCO<sup>+</sup> are not as extensive so far. Our observations confirmed that (02<sup>2</sup>0) lines and, in general, larger  $\ell$  lines in the (030) and (040) states were weaker than expected. However, a most notable result obtained in the present investigation is that some low- $J$  lines of (02<sup>2</sup>0) have been detected as induced emission for both HCO<sup>+</sup> and DCO<sup>+</sup>. This observation clearly leads to a conclusion that the previous non-observation of low- $J$  lines in (02<sup>2</sup>0) is not due to the Stark effect, but due to specificity of the reaction mechanism and subsequent collisional relaxation processes.

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<sup>a</sup>E. Hirota and Y. Endo, *J. Mol. Spectrosc.* 127, 527 (1988).

<sup>b</sup>L. Dore, S. Beninati, C. Puzzarini, and G. Cazzoli, *J. Chem. Phys.* 118, 7857 (2003).

<sup>c</sup>T. Amano, K. Hashimoto, and T. Hirao, *J. Mol. Structure*, 795, 190 (2006)

<sup>d</sup>F. Tinti et al, *J. Mol. Spectrosc.* 240, 202 (2006)

<sup>e</sup>Z. Zelinger et al, *J. Mol. Spectrosc.* 220, 223 (2003)

<sup>f</sup>T. Amano and Z. Zelinger, *J. Mol. Spectrosc.* 211, 273 (2002)