SUBMILLIMETER OBSERVATION OF HCO^+ AND DCO^+ IN THE EXCITED VIBRATIONAL STATES

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Hirota and Endo reported observations of the rotational transitions of HCO^+ and DCO^+ in excited vibrational states.[a] The lowest three rotational transitions of (02^20) 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[b] 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_3CNH^+ [c] and SD_3^+ [d] were observed with no difficulty. Also no anomalies were observed for similar lines for HCN [e] and HNC [f] produced in an extended negative glow discharge.

In the present investigation, we extended the measurements up to 800 GHz. The HCO^+ and DCO^+ ions were produced in an extended negative glow discharge in a gas mixture of H_2 or D_2 and CO (a couple of mTorr each) in Ar buffer (12 mTorr). The measurements were done mostly at liquid nitrogen temperature. For HCO^+, the rotational lines in the excited vibrational levels up to (040) and (002) which are located at about 4300 cm^{-1} above the ground state have been measured. The measurements for DCO^+ are not as extensive so far. Our observations confirmed that (02^20) lines and, in general, larger ℓ 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 (02^20) have been detected as induced emission for both HCO^+ and DCO^+. This observation clearly leads to a conclusion that the previous non-observation of low-J lines in (02^20) is not due to the Stark effect, but due to specificity of the reaction mechanism and subsequent collisional relaxation processes.

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[e] Z. Zelinger et al, J. Mol. Spectrosc. 220, 223 (2003)
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