

## Laboratory FIR Spectroscopy of $\text{OD}^-$ , $\text{N}_2\text{H}^+$ , $\text{H}_2\text{D}^+$

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Rotational spectra of molecular ions which are important in interstellar chemistry are studied with tunable far-infrared spectrometer. Frequency measurements of the rotational lines of  $\text{OD}^-$ ,  $\text{N}_2\text{H}^+$ , and  $\text{H}_2\text{D}^+$  in 1-5 THz region are reported.

As for  $\text{OD}^-$ , the fundamental band transitions were studied by Rehfuß et. al. in 1986 [1], and low- $J$  rotational lines  $R(J)$  ( $J=1,2$ ) were reported by Cazzoli et.al. [2,3]. We observed the lines  $R(J)$  ( $J=1-2,4,5,7$ ) (Fig.1). This work is an extension of our previous work of  $\text{OH}^-$  [4]. The molecular constants and the isotope-independent Dunham parameters were obtained.

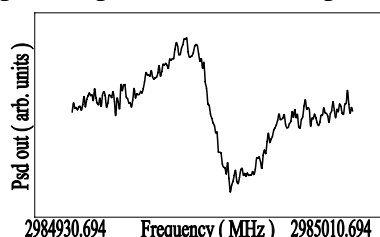


Figure 1: Typical trace of  $J = 5 \leftarrow 4$  transition of  $^{16}\text{OD}^-$ .

The molecular cation  $\text{H}_2\text{D}^+$  and  $\text{D}_2\text{H}^+$  are the isotopomers of  $\text{H}_3^+$ . Submillimeter-wave spectra of  $\text{H}_2\text{D}^+$  and  $\text{D}_2\text{H}^+$  were studied by Amano and Hirao in 2005 [5]. We have observed several lines of  $\text{H}_2\text{D}^+$  such as  $2_{11}-1_{10}$ ,  $3_{13}-2_{12}$ ,  $2_{02}-1_{01}$ , and  $2_{12}-1_{11}$  (Fig.2). Among them, the detection of  $2_{12}-1_{11}$  line in space has recently been reported. Our measured frequency will be useful to analyze this observation.

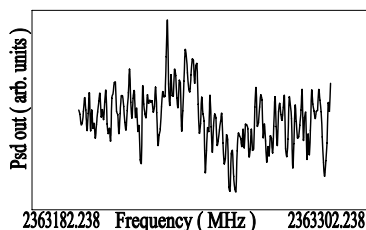


Figure 2:  $J = 2_{12} \leftarrow 1_{11}$  transition of  $\text{H}_2\text{D}^+$ .

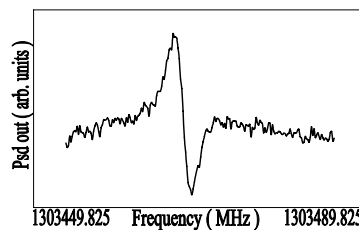


Figure 3:  $J = 14 \leftarrow 13$  transition of  $\text{N}_2\text{H}^+$ .

An extended-negative discharge glow discharge cell was applied to observe some of the molecular cations. Rotational lines of  $\text{N}_2\text{H}^+$ ,  $R(J)$  ( $J=13,15,20$ ) were measured to confirm the ability of this type of discharge cell (Fig.3).

### References

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