

THz high-resolution TuFIR spectroscopy of pure rotational transitions of molecular ions H_2D^+

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Light molecules or ions composed of small number of light atoms such as hydrogen play key roles in the history of chemical evolution of interstellar species. Precise frequency measurement of rotational lines of such light species is important to improve rotational constants of the species and to give precise prediction of the rotational lines for future search of the species.

So far, we have investigated rotational lines of molecules and ions in the far-infrared region (in the range from 0.8 to more than 5 THz) by using tunable far-infrared spectrometer (TuFIR) at University of Toyama. The spectrometer is based on the difference frequency generation from the selectable stabilized two CO_2 laser lines. And He-liquid cooled Si-composite bolometer.

Fig.1 shows the $2_{12} - 1_{11}$ line of H_2D^+ observed at 2.363 THz with TuFIR spectrometer. This line was previously detected toward Sgr B2 by Cernicharo et al [1]. Four lines of H_2D^+ were observed with our spectrometer.

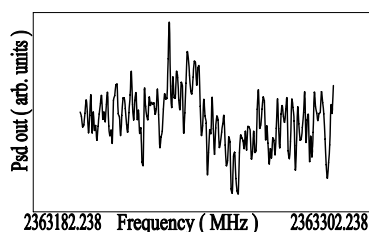


Figure 1: $J = 2_{12} \leftarrow 1_{11}$ transition of H_2D^+ .

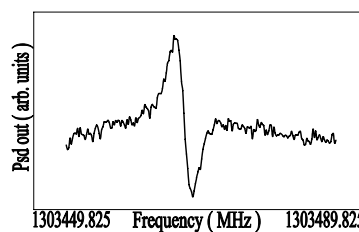


Figure 2: $J = 14 \leftarrow 13$ transition of N_2H^+ .

As for the lower frequency data, Asvany et al. [2] observed the $1_{01} - 0_{00}$ line (1370085.3 MHz) by using laser induced chemical reaction detection method. Our observed THz lines ($2_{11}-1_{10}$, $3_{13}-2_{12}$, $2_{02}-1_{01}$, $2_{12}-1_{11}$) recorded in the shape of first derivative curve were analysed together with known millimeter- and sub-millimeter-wave lines, and the combination differences derived from the infrared lines to obtain the parameters in Watson's effective Hamiltonian. A set of improved molecular constants are obtained [3].

The spectrometer is now modified to introduce a discharge sample cell using extended negative glow discharge technique. Fig.2 shows the test data of N_2H^+ observed by using the extended negative glow discharge. The spectral line was enhanced by one order of magnitude by using the new discharge cell.

References

- [1] J. Cernicharo, E. Polehampton, J.R. Goicoechea, 2007, *Astrophys. J.* 657, L21-L24.
- [2] O. Asvany, O. Ricken, H.S.P. Muller, M.C. Wiedner, T.F. Giesen, S. Schlemmer, 2008, *Phys. Rev. Lett.* 100, 233004.
- [3] T. Yonezu, F. Matsushima, Y. Moriwaki, K. Takagi, T. Amano, 2009 *J. Mol. Spectrosc.* 256, 238-241.