LABORATORY OBSERVATION OF A SUBMILLIMETER-WAVE LINE of D_2H^+

T. HIRAO and T. AMANO, *Institute for Astrophysics and Planetary Sciences, Ibaraki University, 2-1-1 Bunkyo, Mito 310-8512, Japan*.

The first spectroscopic detection of D_2H^+ was made in the infrared region at National Research Council of Canada[a], followed by observations of two rotational transitions ($2_{20} - 2_{11}$ and $1_{11} - 0_{00}$) in the THz region[b]. Polyansky and McKellar derived more accurate molecular constants and term values by combining all the available data[c]. However, since the molecule is very light, even such revised molecular constants should be subject to critical tests.

The line position of the $1_{10} - 1_{01}$ transition was predicted to be 691.705 GHz by using previous IR data. A backward-wave oscillator based submillimeter-wave system was used for the observation of the spectra. The D_2H^+ molecules were generated in an extended negative glow discharge in gas mixture of H_2 and D_2 with Ar as buffer gas near liquid nitrogen temperature (77 K). Following numerous efforts, in the range of the expected spectral region, we discovered only one signal at 691.660440 GHz that was highly sensitive to magnetic field that was applied to the discharge to achieve the extended negative glow condition. This absorption line vanished by cutting off H_2 or D_2 gas, by inducing tiny air leak, or by raising cell temperature. In contrast to H_2D^+, the mixing ratio of H_2 / D_2 was found to be less sensitive in producing D_2H^+. This behavior was similar to the findings in previous IR spectroscopy at NRC[a,d]. The optimum mixing ratio of gases was found to be H_2 / D_2 / Ar = 4 / 2 / 17 mTorr and discharge current was about 8 mA. The observed line width (FWHM = 1.7 MHz) was comparable with the Doppler line width of the molecule (FWHM = 1.9 MHz), assuming that the temperature of the cell was 77 K. A set of the improved molecular constants was obtained by combining all available IR data.

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