SUBMILLIMETER-WAVE SPECTRUM OF CH_2D^+

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In interstellar carbon chemistry, CH_3^+ is thought to be an important and abundant molecular ion. However, as it is a symmetric planar molecule and, as a result, it has no permanent dipole moment, it is almost impossible to detect this species by radio astronomical observations. Its deuterated species, CH_2D^+ and CHD_2^+, possess the dipole moment, so the rotational lines should be observable. Rösslein *et al.*[a] and Jagod *et al.*[b] observed the infrared spectra of these deuterated species. Demuynck and coworkers[c] tried to observe CH_2D^+ rotational lines in an extended negative glow discharge with no success. More recently Lis *et al.*[d] reported tentative identification of CH_2D^+ toward Ori IRc2.

The molecular constants and the predicted rotational transition frequencies given by Röslein *et al.*[a] were a good starting point in searching for the rotational lines. A very weak feature was found almost exactly at the calculated frequency for the $2_{12} - 1_{11}$ transition. Eventually the line appeared stronger enough for precise frequency measurements, after adjusting the reaction conditions. The optimum gas mixture was found to be CH_4 ($\sim$ 3 mTorr), CD_4 ($\sim$ 1 mTorr), H_2 ($\sim$ 2 mTorr), and He ($\sim$ 35 mTorr). It is interesting to note that helium is essential to produce CH_2D^+. No signals were detectable with Ar buffer. Although the signal was seen without H_2, it appears to play a subtle role in the formation, resulting in about a factor 2 increase in intensity. Adding D_2 instead of CD_4 resulted in no signal. The observations were made with about 16 mA discharge current with liquid nitrogen cooling. As this ion is a light molecule and the signal was only weakly observed, four transitions were detected so far in the 280-890 GHz region. All observed transition frequencies agree within 1MHz of the predicted frequencies. These laboratory transition frequencies strongly support the tentative astronomical identification by Lis *et al.*[d]

[a]M. Rösslein *et al.*, *Astrophys. J.* **382**, L51 (1991)
[b]M.-F. Jagod *et al.*, *J. Mol. Spectrosc.* **153**, 666 (1992)
[c]C. Demuynck, *J. Mol. Spectrosc.* **168**, 215 (1994)
[d]D. C. Lis *et al.*, in *Submillimeter Astrophysics and Technology, ASP Conference Series*, **417**, 23 (2009)