SUBMILLIMETER-WAVE SPECTROSCOPY OF "INTERSTELLAR MOLECULAR-IONS":CH_3CNH^+, HN_2^+, AND DN_2^+

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The laboratory data for exotic molecules such as free radicals and ions for radio astronomical observations in the submillimeter-wave region are still not quite complete as they should be. In this talk, we present some of recent results of our such efforts.
Interstellar CH_3CNH^+ was searched for based on the transition frequencies calculated from the infrared data[a]. More recently three rotational transitions, $J = 1 - 0, K = 0$, and $J = 2 - 1, K = 0, 1$ were observed in the laboratory using Fourier Transform Microwave technique[b], and three molecular constants, B, D_J, and D_{JK}, were determined. Therefore, predictions of the transition frequencies should be viewed with some caution. So it is highly desirable to observe higher-J rotational lines directly. We have measured the rotational transitions ranging from $J = 19 - 18$ to $J = 29 - 28$, $K = 0, 1, 2, 3$ by using an extended negative low discharge in a gas mixture of CH_3CNH^+(1 mTorr) and Ar(14 mTorr), and a set of improved molecular constants have been determined.
Protonated nitrogen HN_2^+ is one of the most extensively studied ions. However, the rotational spectra in its excited vibrational states have not been measured to our knowledge so far. Despite lower vibrational temperature compared with that for the case in HCO^+, we have detected the rotational lines in the submillimeter-wave region in all the three fundamental vibrational states both for HN_2^+ and DN_2^+. The observed data have yielded much improved spectroscopic constants and equilibrium molecular structure.

[a] B. E. Turner, T. Amano, P. A. Feldman, *Astrophys. J.* **349**, 376-387(1990)
[b] C. A. Gottlieb, A. J. Apponi, M. McCarthy, and P. Thaddeus, *J. Chem. Phys.* **113**, 1910-1915(2000)