THZ SPECTROSCOPY OF $^{12}CH^+$, $^{13}CH^+$, AND $^{12}CD^+$

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In 1937, Dunham[a] detected a couple of unidentified lines in near-UV, and later Douglas and Herzberg[b] identified them based on their laboratory observations to be low-J electronic transitions of CH^+. The electronic spectra, in particular the $A^1\Pi - X^1\Sigma^+$ band, have been investigated extensively. On the other hand, the pure rotational transitions have not been studied so extensively. Only the lowest rotational transition, $J = 1 - 0$, was observed in the laboratory for the normal species, $^{13}CH^+$, and CD^+.[c,d]

Based on the laboratory frequency, CH^+ was detected in star forming regions with the Hershel space observatory. Cernicharo et al identified pure rotational transitions from $J = 2 - 1$ to $J = 6 - 5$ in the far-infrared region in the ISO spectrum of the planetary nebula NGC 7027[e]. The ISO spectra, however, were of low-resolution, so high-resolution spectroscopic observation is highly desirable.

In this presentation, we have extended the measurements to higher-J lines up to 2 THz. For production of CH^+, an extended negative glow discharge in a gas mixture of CH_4 ($\sim$ 0.5 mTorr) diluted in He ($\sim$ 60 mTorr) was used. The optimum discharge current was about 15 mA and the axial magnetic filed to 160 Gauss was applied up. The discharge cell was cooled down to liquid nitrogen temperature. Several frequency multiplier chains, developed at JPL and purchased from Virginia Diodes, were used as THz radiation sources.

New THz measurements are not only useful for providing better characterization of spectroscopic properties but also will serve as starting point for astronomical observations.

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[b] A. E. Douglas and G. Herzberg, *Ap. J.* **94**, 381 (1941)
[c] T. Amano, *Ap.J.Lett.*, **716**, L1 (2010)
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[e] J. Cernicharo et al., *Ap. J. Lett.*, **483**, L65 (1997)