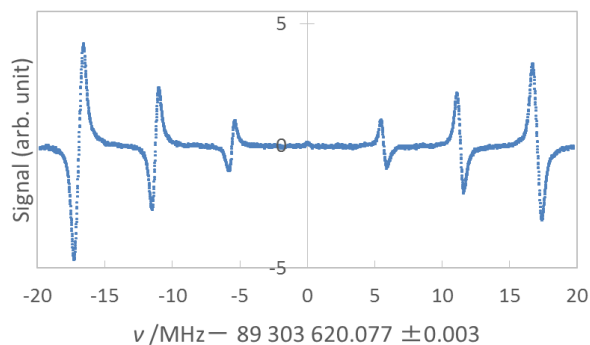


EXTENSIVE MEASUREMENTS OF VIBRATION-INDUCED PERMANENT ELECTRIC DIPOLE MOMENTS OF METHANE

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A methane molecule (CH_4) has a permanent electric dipole moment (PEDM) in the excited state of the triply-degenerate vibrational modes^{a,b}. The rotational dependence of the PEDM was reported in the $2\nu_3$ band^c. However, in the ν_3 band, it was only determined on the $P(7)E$ transition which fortunately lies in the tunable range of a $3.4\ \mu\text{m}$ He-Ne laser.

We have developed a mid-infrared broadband sub-Doppler resolution spectrometer consisting of a difference-frequency-generation source and an optical frequency comb linked to International Atomic Time. This spectrometer enables us to measure the Stark effects of 20 transitions in the ν_3 band of methane from 87.7 to 92.8 THz ($2927\sim 3095\ \text{cm}^{-1}$). The observed linewidth is 0.5 MHz, and the frequency scale is absolutely calibrated. The figure depicts the Stark modulation spectrum of the $P(4)E$ transition. The applied DC electric field was 3.5 kV/cm. We determined Stark coefficients with a relative uncertainty of 1 %. Our goal is to reveal the rotational dependence of the PEDM. For this end, we yield molecular constants which reproduce the transition frequencies by a least-square method and determine the mixing of the wave functions.



^aM. Mizushima and P. Venkateswarlu, *J. Chem. Phys.* **21**, 705 (1953).

^bK. Uehara, K. Sakurai and K. Shimoda, *J. Phys. Soc. Jpn.* **26**, 1018 (1969).

^cH. Sasada, K. Suzumura and C. Ishibashi, *J. Chem. Phys.* **105**, 9027 (1996).