HIGH-ACCURACY LINE LISTS OF METHANE AND FORMALDEHYDE BETWEEN 1240 AND 1380 cm^{-1} FROM FOURIER-TRANSFORM OPTICAL FREQUENCY COMB SPECTROSCOPY

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Many small molecules have strong vibrational bands between 1000 to 1500 cm^{-1}. This spectral range overlaps with the atmospheric water window and lies within the sensitivity range of space observatories such as the James Webb Space Telescope. Therefore, it is well suited for detecting such molecules in the Earth's atmosphere or on celestial bodies. However, the current line lists in this range are still largely based on conventional FTIR measurements. Optical frequency comb spectroscopy offers superior frequency accuracy and precision but was hindered by the lack of comb sources in that spectral range. We recently developed a Fourier-transform spectrometer [a] based on an 8-μm difference-frequency-generation comb source[b]. Here, we present low-pressure spectra of methane ($\mathrm{CH_4}$), a potent greenhouse gas and constituent of (exo-) planetary atmospheres, and formaldehyde ($\mathrm{H_2CO}$), an atmospheric pollutant and constituent of the interstellar medium, measured with this spectrometer using the sub-nominal resolution sampling-interleaving method[c]. From these spectra, we retrieved line positions and intensities of several hundred rovibrational transitions of the $^{12}\mathrm{CH_4}$ and $^{13}\mathrm{CH_4}$ ν_4 fundamental bands and two $^{12}\mathrm{CH_4}$ hot bands, as well as of the $\mathrm{H_2CO}$ ν_4 and ν_6 bands, achieving uncertainties of line positions and line intensities of a few hundred kilohertz and a few percent, respectively. The line positions and intensities of $^{12}\mathrm{CH_4}$ were used to improve the global fit of the effective Hamiltonian and dipole-operator parameters, leading to a reduction of the line-position fit residuals by over one order of magnitude relative to the previously used data[d].

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