Absorption Spectra and Absorption Coefficients for the 790 nm and 889 nm bands of Methane obtained using Intracavity Laser Spectroscopy

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Methane spectral features are prominent in the reflected sunlight spectra from the outer planets and some of their major satellites (e.g., Titan) and can provide detailed information on the atmospheres of those bodies. Methane bands in the visible to near-IR are particularly important because for many of these planetary bodies, the methane bands occurring in the IR are found to be saturated. Laboratory data acquired at appropriate low temperature conditions are required to interpret the observational data. Because methane bands in the visible to near-IR region consists of high overtone and/or combination transitions, the spectra are intrinsically weak. Consequently, sensitive techniques such as intracavity laser spectroscopy (ILS) are required to perform the laboratory measurements. In this paper, the ILS technique with an argon-ion laser pumped Ti:sapphire laser is used to record spectra in the 790 nm band (from 12,125 cm^{-1} to 13,235 cm^{-1}) and the central portion of the 889 nm band (from 10,975 cm^{-1} to 11,345 cm^{-1}), for room (298 K) and liquid nitrogen temperature (77 K) methane. Spectra for the more strongly absorbing sections of these bands will be presented. These spectra are acquired at a resolution of approximately 500,000. From the spectra, absorption coefficients are determined and these are presented as averages over 1 $\AA$ and 1 cm^{-1} intervals. The results are compared with low resolution measurements on methane at room temperature and with absorption coefficients derived from methane features observed in spectra of the outer planets and Titan. To obtain our results, spectra are deconvolved for the instrument function using a Fourier transform technique. The validity of the approach is verified from studies of isolated water absorption lines occurring in the same spectral region. Good agreement is observed between the intensity values determined from the FT deconvolution and integration method and those derived by fitting the observed line profiles to Voigt lineshapes convoluted with the instrument function.

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