THE $4\nu_3$ SPECTRAL REGION OF METHANE

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The near infrared bands of methane were first observed in the outer planets and Titan where atmospheric ray paths are long. The spectrum is complex, and long absorption paths in the laboratory are difficult to cool to outer solar system temperatures. At room temperature, many significant spectral lines appear per Doppler width. The band models generally used in the 890 nm spectral region of methane do not provide transmissions that are multiplicative, so scattering and inhomogeneous atmospheres cannot be properly treated using this approach.

The intracavity laser spectrometer at the University of Missouri-St. Louis was used to obtain low temperature (99-161K), low pressure (0.12-7.13 Torr), long path (3.14-5.65 km) and high resolution (0.01 cm^{-1} HWHM) spectra of methane covering the entire 890nm feature (10925-11500 cm^{-1}), the deepest band in the CCD spectral region. At these temperatures, the spectral lines originating from higher energy levels are not visible, and the Doppler width is substantially smaller than at room temperature. The result is a dense, but manageable spectrum from which line positions, intensities and lower state energies are derived on a line by line basis by the College of William and Mary multispectrum nonlinear least squares fitting program.[a] Simulations of the methane spectrum for outer planet atmospheres using our positions, intensities and lower state energies reveal a surprising amount of spectral structure at high resolution. This structure carries a great deal of atmospheric information.[b]

[a] D. Chris Benner, C. P. Rinsland, V. M. Devi, M. A. H. Smith, and D. A. Atkins, JQSRT 1995;53:705-21.

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