THE $4\nu_3$ SPECTRAL REGION OF METHANE

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The near infrared bands of methane were the first observed in the outer planets and Titan. In this spectral region very long paths within the atmospheres of these objects make scattering and pressure and temperature inhomogeneities important. 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, so the absorption is usually modeled statistically using unrealistic assumptions. These models generally do not provide transmissions that are multiplicative, so scattering and inhomogeneous atmospheres cannot be properly modeled.

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]. The results allow the simulation of the methane spectrum at infinite resolution at temperatures less than $\sim$160K, even for complex atmospheric paths.[b]

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[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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