13.3 Rotational Assignments in the 6200Å Band of Methane


The 6200Å band of methane is present in spectra of all the outer planets and Titan. It has been used, in combination with other bands of methane in the visible, as a probe for CH₃ abundances and vertical atmospheric structures. Many of the analyses have been done with band model techniques because of the very high density of CH₃ lines in the visible and because of a total lack of spectroscopic assignments.

We report here probable rotational J assignments of CH₃ transitions in the 6200Å band obtained from comparison of line intensities at 295, 200, and 77K in nearly Doppler-limited laboratory spectra recorded with high-sensitivity long-path and photoacoustic techniques. The 295K spectrum was recorded with a high-resolution F.T.R. at a path length of 4.5m for pressures down to 80 Torr. Low temperature spectra were obtained over the complete band (16000-16200 cm⁻¹) with tunable dye laser excitation of CH₃ in an intracavity photoacoustic cell. Absolute intensity calibration of the low temperature measurements was accomplished using dye laser transmission in a coolable White cell (path length: 128m) at selected wavelengths. More than 80 of the strongest lines have been assigned in this manner for J between 1 and 5. Such assignments will be extremely useful to improve modeling of planetary spectra in the visible.

* Visiting scientist, Kitt Peak National Observatory (N.O.A.A.), operated by A.U.A.

13.4 The Collision-Induced Translational/ Rotational Absorption Spectra of Hydrogen and Hydrogen-Helium Mixtures

Lothar Fromhold (U. of Texas), Wilfried Meyer (U. Kaiserslautern, F.R.G.), and George Birnbaum (N.B.S., Washington, D.C.)

The translational/rotational collision induced absorption (CIA) spectra of H₂-He and H₂-He complexes are obtained from first principles using a rigorous quantum formalism. Induced dipole moments computed with highly correlated wavefunctions and believed to be accurate to about 2%, are input together with anisotropic semi-empirical interaction potential. The resulting theoretical spectra are compared with the existing measurements on an absolute intensity scale. Agreement within -5% for H₂-He₂ and -10% for H₂-He which correspond to the estimated experimental uncertainties, is observed at frequencies from 0 to 1,500 cm⁻¹, and temperatures between 77 and 298 K. Simple analytical expressions computable with pocket calculators are specified which approximate the exact quantum profiles with rms deviations of the 1% range, at temperatures of 40K and higher where no measurements exist, for accurate modeling of planetary atmospheres. Small structures seen in the Voyager spectra near the centers of the S(0) and S(1) rotational lines of H₂ are shown to be due to bound-free transitions involving hydrogen dimers. The CIA spectra of H₂-He on the other bands, are nearly free from such structures which may be of interest for the determination of para-H₂/ortho-H₂ and He/H₂ abundance ratios. Similar computations of the fundamental band, and of other systems of interest for the modeling of Titan's atmosphere, are in preparation.

*Work at the U. of Texas supported by the NSF, grant AST 8310786. Work at the U. Kaiserslautern was supported by the DFG - SFB 91.

13.5 Improved Molecular Constants for HD

M.E. Nickelson, B.A. Bare (Denison U.), J.T. Trauger (Cal. Inst. of Tech.)

The interpretation of the spectra of the atmospheres of the outer planets requires accurate knowledge of molecular parameters for both H₂ and HD. Only a few of the observable transitions of these molecules have been characterized to the degree presently needed by workers in the field of planetary atmospheres. In this paper we describe the analysis of high resolution spectra of the 2-0 through 6-0 vibrational-rotational bands of the hydrogen deuteride molecule obtained using the Kitt Peak Solar Far UV at a resolving power in excess of 600,000. These measurements were made on a high purity gas sample contained in a 2-meter White cell adjusted for a total optical pathlength of 56.25 meters. Absorption spectra were taken at room temperature and at pressures ranging from 200 to 1400 torr. Results on the determination of line strengths, self-broadening coefficients, pressure shifts and line profiles have been reported for a few of the 4-0, 5-0 and 6-0 lines by Trauger and Nickelson (1983 Icarus 56, 176). Here we report an analysis of 2-0 and 3-0 band spectra and present a new set of equilibrium molecular constants useful in predicting line positions.

13.6 Radiative Transfer in Horizontally Inhomogeneous Media

K. Lumme (U. Helsinki), H. Karttunen and W.M. Irvine (U. Mass.)

We have been studying the transfer of radiation in rough and porous media whose upper surface height deviations from the mean plane follow a gaussian distribution. The horizontal structure is given by an autocorrelation function. The probability that a photon can pass a certain distance r in this medium depends not only on r, but also both on the height of the starting point z and the direction of propagation θ. This probability is shown to be of the form R(z, θ) where R and R₂ are certain functions of r, z, and θ. In addition to the single scattering albedo and single particle phase function which enter in the classical plane-parallel radiative transfer theory, there are three extra parameters which describe the structure of the medium. The function R includes two of these parameters: the volume density D and the rms roughness σ of the gaussian surface; and R₂ depends on D and the ratio of σ to the mean free path inside the porous medium. The theory is shown to be complete in the sense that all the special cases (e.g. plane parallel approximation) are obtained from the theory by a proper choice of the free parameters. Our preliminary Monte Carlo computations show that the numerical results are consistent with theoretical predictions for the case of a smooth surface.

13.7 Radiative Transfer in a Homogeneous Sphere Illuminated by a Parallel Beam

R.-L. Shia and Y.L. Yung (Caltech)

Radiative transfer in a homogeneous sphere with isotropic scattering is investigated in detail. It is shown that the solution can be expanded in a multipole series such that the general spherical problem is reduced to solving a set of decoupled integral equations in one dimension. Computations have been performed for a range of parameters of interest and illustrative examples of