SOLAR EXTINCTION RADIOMETRY

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I. During this period the work on the spectral line parameters of the OH $A^2\Sigma - X^2\Pi$ (0,0) band has been completed. A detailed paper describing this work has been published in J.Q.S.R.T. and a reprint is enclosed as an Appendix. Numerous reprints requests for this paper were received.

II. Using the methods developed for NO_2 quantification [1] during previous phases of this project, the uv-visible data obtained during the 1977 balloon flights have been used for O_3 quantification.

For atmospheric ozone amounts and the region covered by these spectra, the ozone absorption renders the atmosphere opaque at low sun agles in the 2800-3100Å region (Hartley bands). From about 3500 to 4000Å the ozone absorption coefficients are too small to give appreciable absorption even at the lowest sun angles scanned (~92°). From 4000 to 6000Å (Chappuis bands) the atmospheric absorption is quite weak and broad and does not have the contrast structure required for the three wavelengths method. The region from 3100Å to 3500Å appears to be the best region to use for determining ozone columns with the three-wavelength method.

Accurate determination of ozone columns and volume mixing ratios requires accurate ozone absorption coefficients measured at atmospheric temperatures (210 to 260K). The best presently available published absorption coefficients are those of Vigroux[2]. We have used these coefficients and five combinations of three wavelengths chosen from the features marked in Figure 1 to determine ozone columns and volume mixing ratios.

The ozone volume mixing ratios determined from the 9 February 1977 UV and 17 February 1977 UV data have been compared with standard middle-latitude ozone profiles[3]. The ozone profiles from both flights are in agreement with the standard profile mixing ratios, as shown in Figure 2.

The spectra in Fig. 1 have been smoothed to 2.5Å resolution. It should be noted that while the fine structure of the atmospheric O_3 absorption in Fig. 1 is not fully accounted for the Vigroux coefficients, it is in agreement with the recent high resolution (0.2Å) work being completed at the N.B.S.[4] The accuracy of the O_3 profiles should improve when this work, which is conducted at atmospheric temperatures, is completed.

III. Work has started on the new UV solar spectra obtained during the 3/19/81 balloon flight. Numerous high and low sun scans were obtained during ascent and from float altitude (~33 km) at 0.03Å resolution in the 3063-3099Å region. High and low sun scans from float altitude have been calibrated in wavelength. Representative scans are shown in Fig. 3 and Fig. 4 respectively for the 3070-3082Å region, which is considered best for OH measurements. The spectra are being studied for OH identification and quantification.

REFERENCES

1. A. Goldman, F.G. Fernald, W.J. Williams and D.G. Murcray, "Vertical Distribution of NO_2 in the Stratosphere as Determined from Balloon Measurements of Solar Spectra in the 4500Å Region," Geophys. Res. Lett. 5, 257 (1978).

2. E. Vigroux, Ann. Phys. 3, 709 (1953); Ann. Phys. 2, 209 (1967); Ann. Phys. 25, 169 (1969).

3. C.L. Mateer, J.J. DeLuisi and C.C. Porco, "The Short-Umkehr Method, Part 1: Standard Ozone Profiles for Use in the Estimation of Ozone Profiles by the Inversion of Short-Umkehr Observations," NOAA Technical Memorandum ERL ARL-86 (1980).

4. A.M. Bass and R.J. Paur, paper WP15, "Absorption Cross-Sections of Ozone as a Function of Temperature," Spectroscopy in Support of Atmospheric Measurements (November 10-12, 1980), Sarasota, Florida.

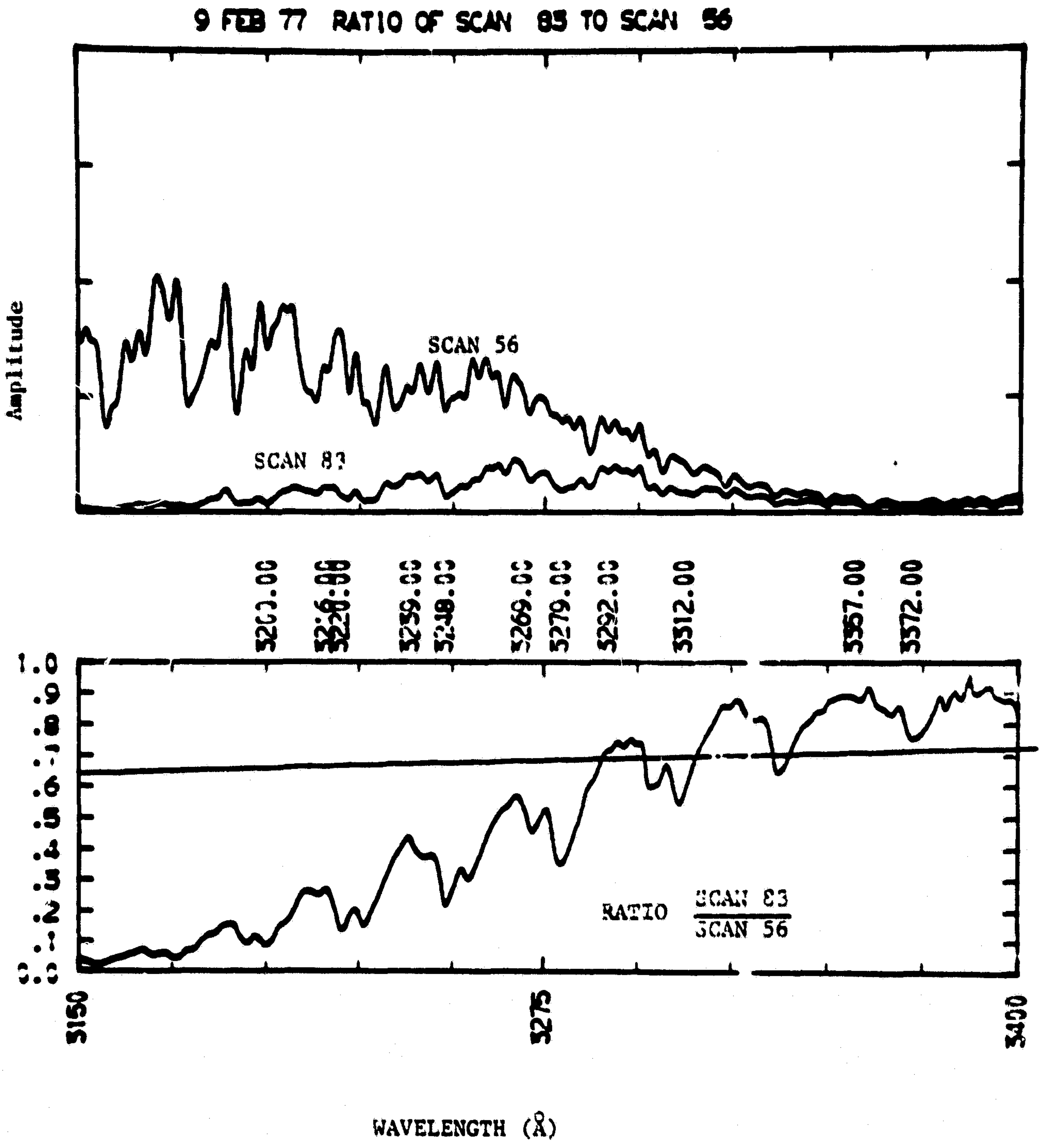


Fig. 1 Ratio of Scan 83 (low sun) to Scan 56 (high sun). The fine structure in the ratio spectrum is due to atmospheric O_3. Resolution is 2.5Å.

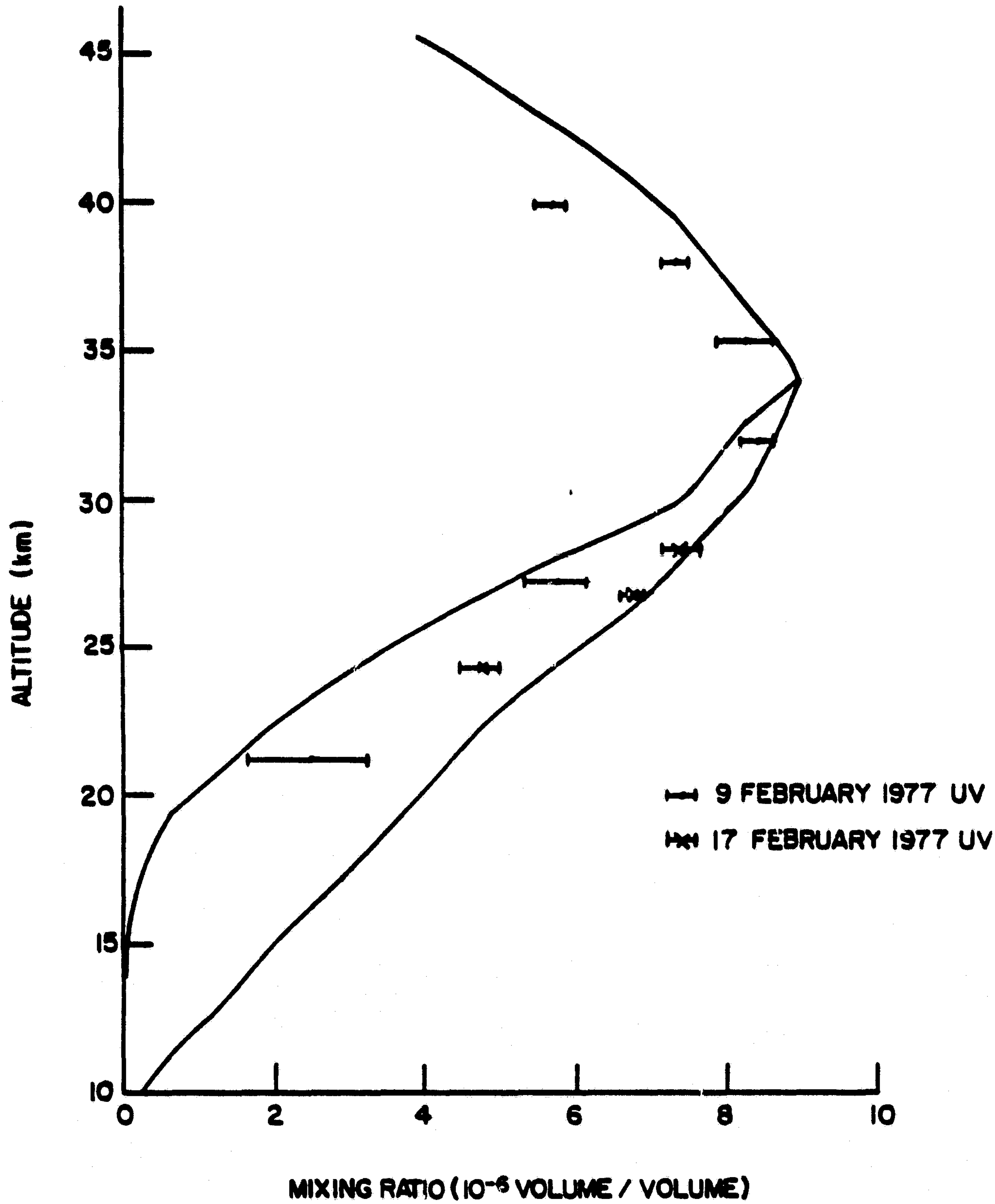


Figure 2 Preliminary ozone profiles superimposed on the standard midlatitude ozone profile of Mateer et al. (1980).

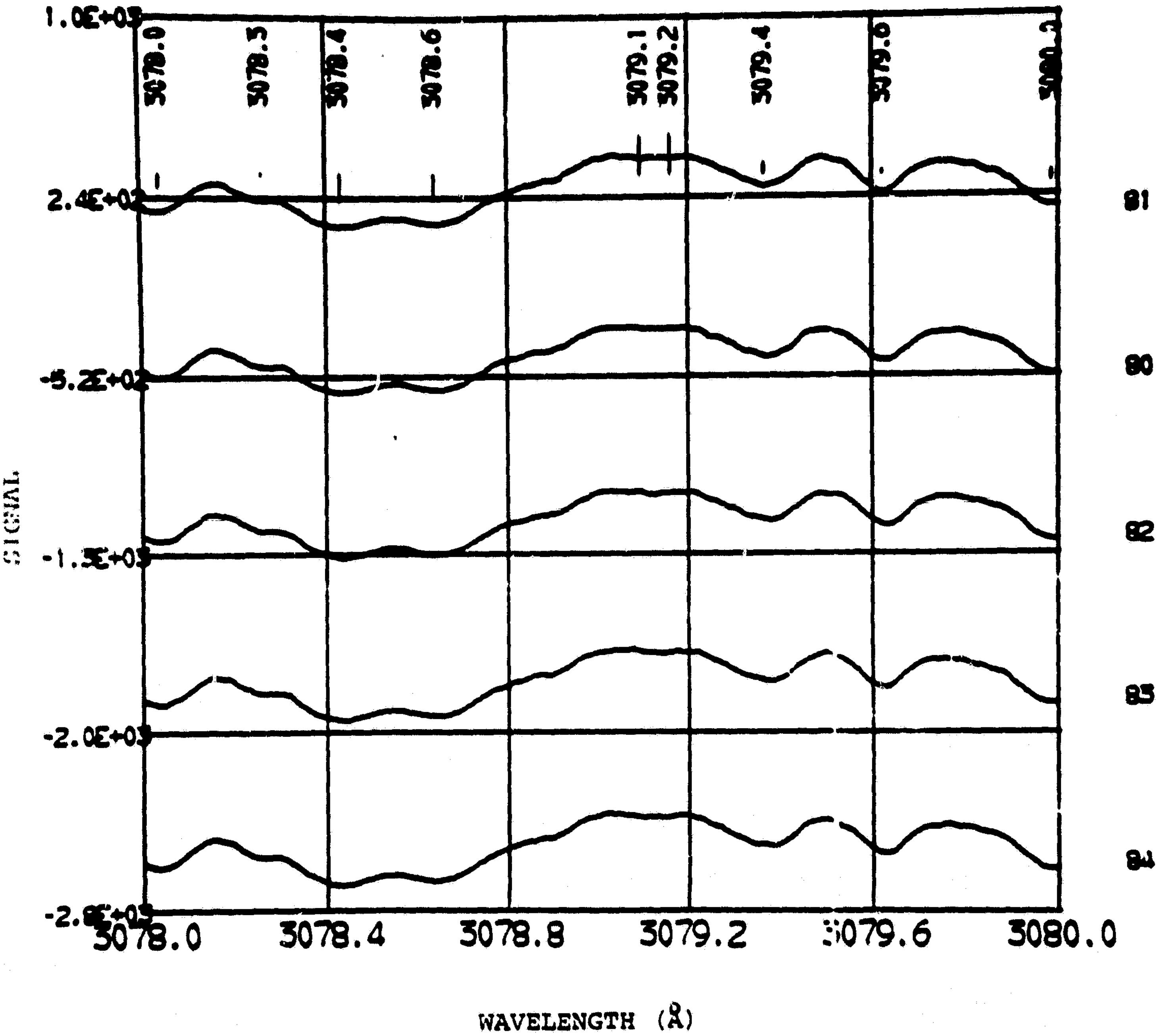
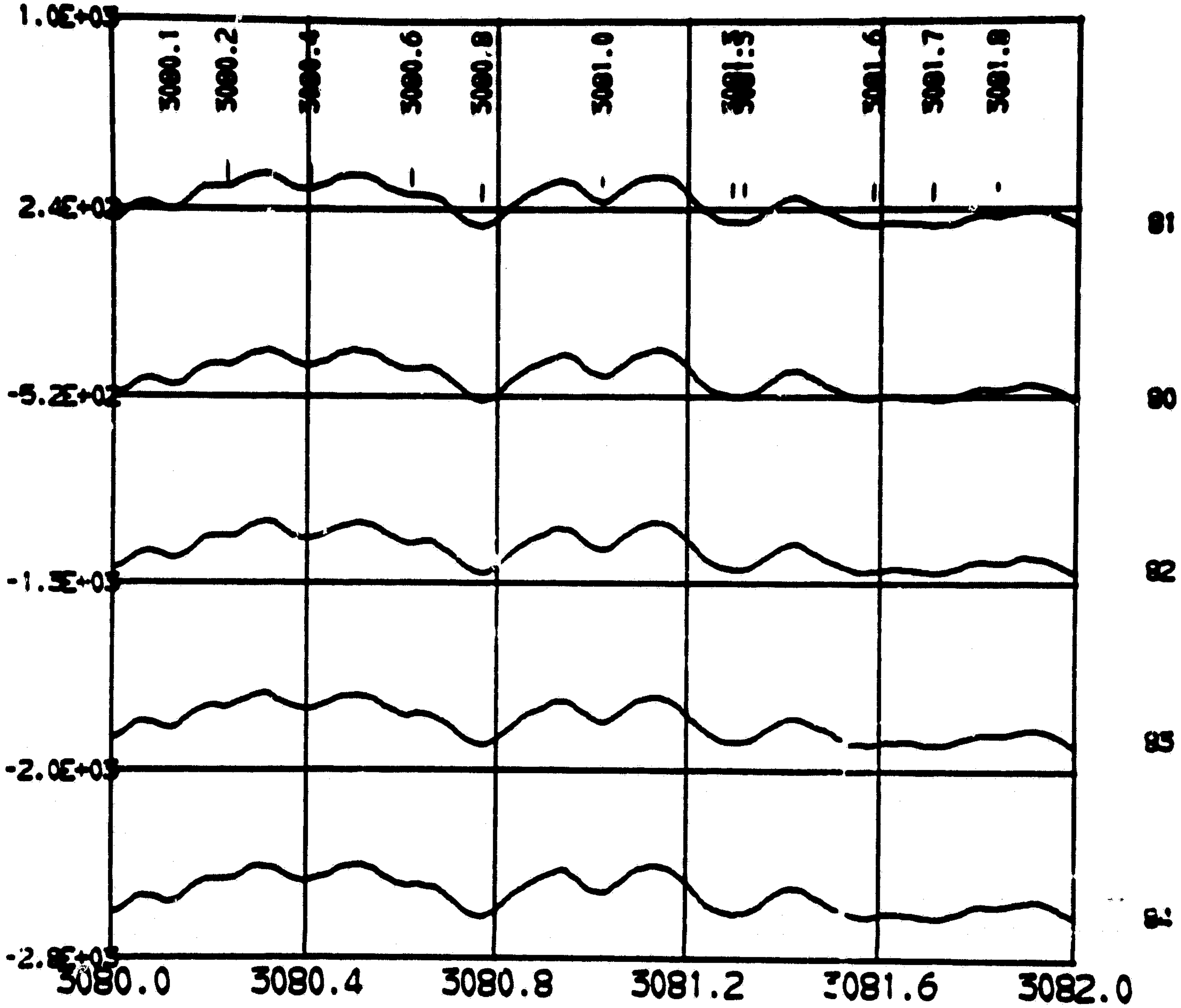


Fig. 3a Selected high sun scans obtained during the 3/19/81 balloon flight from float altitude (33 km). Resolution is 0.03Å.



1.0E+03
2.4E+02
-5.2E+02
-1.3E+03
-2.0E+03
-2.8E+03
3080.1
3080.2
3080.4
3080.6
3080.8
3081.0
3081.5
3081.6
3081.7
3081.8
81
80
82
83
3080.0
3080.4
3080.8
3081.2
3081.6
3082.0

Fig. 3b

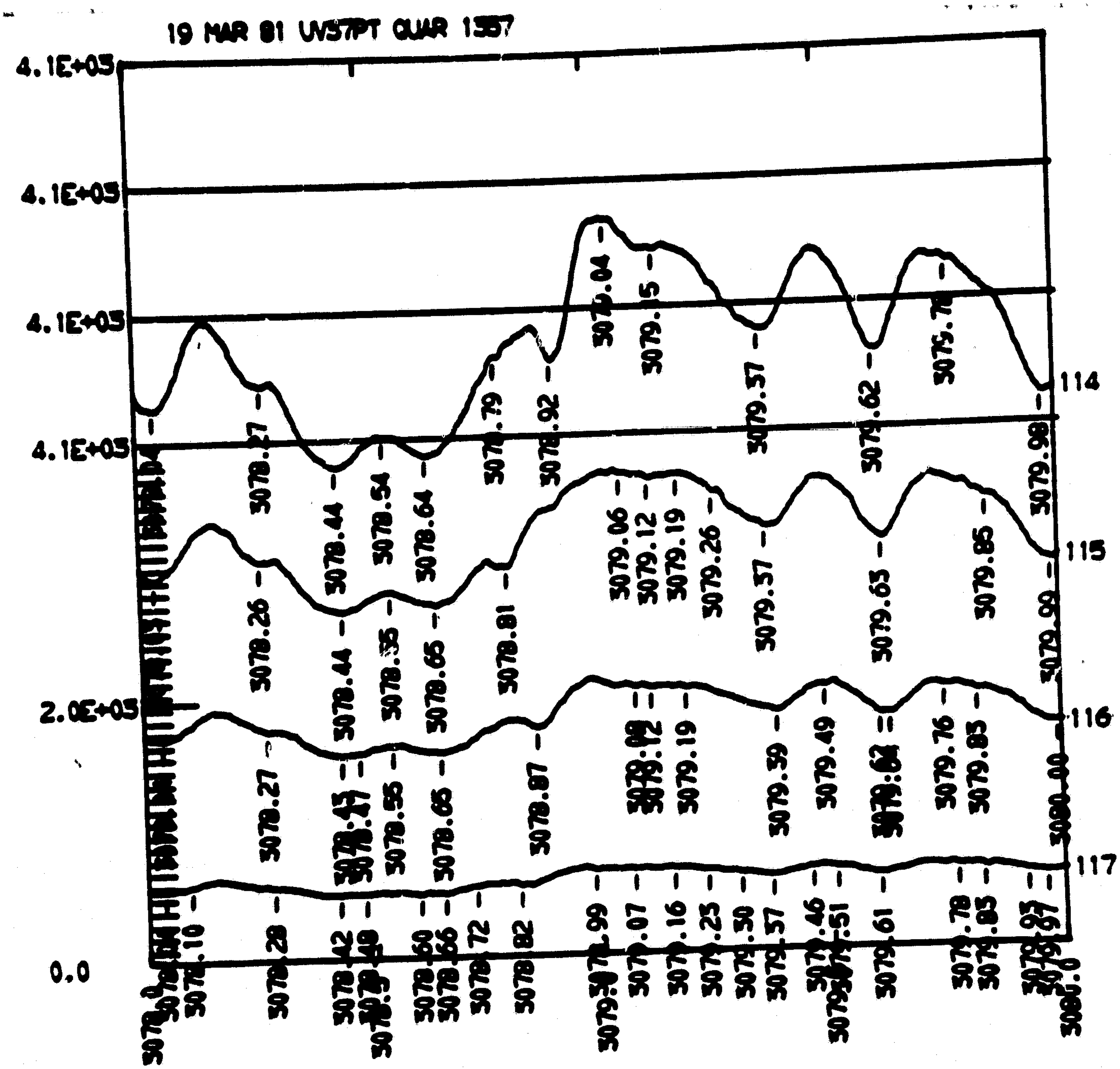
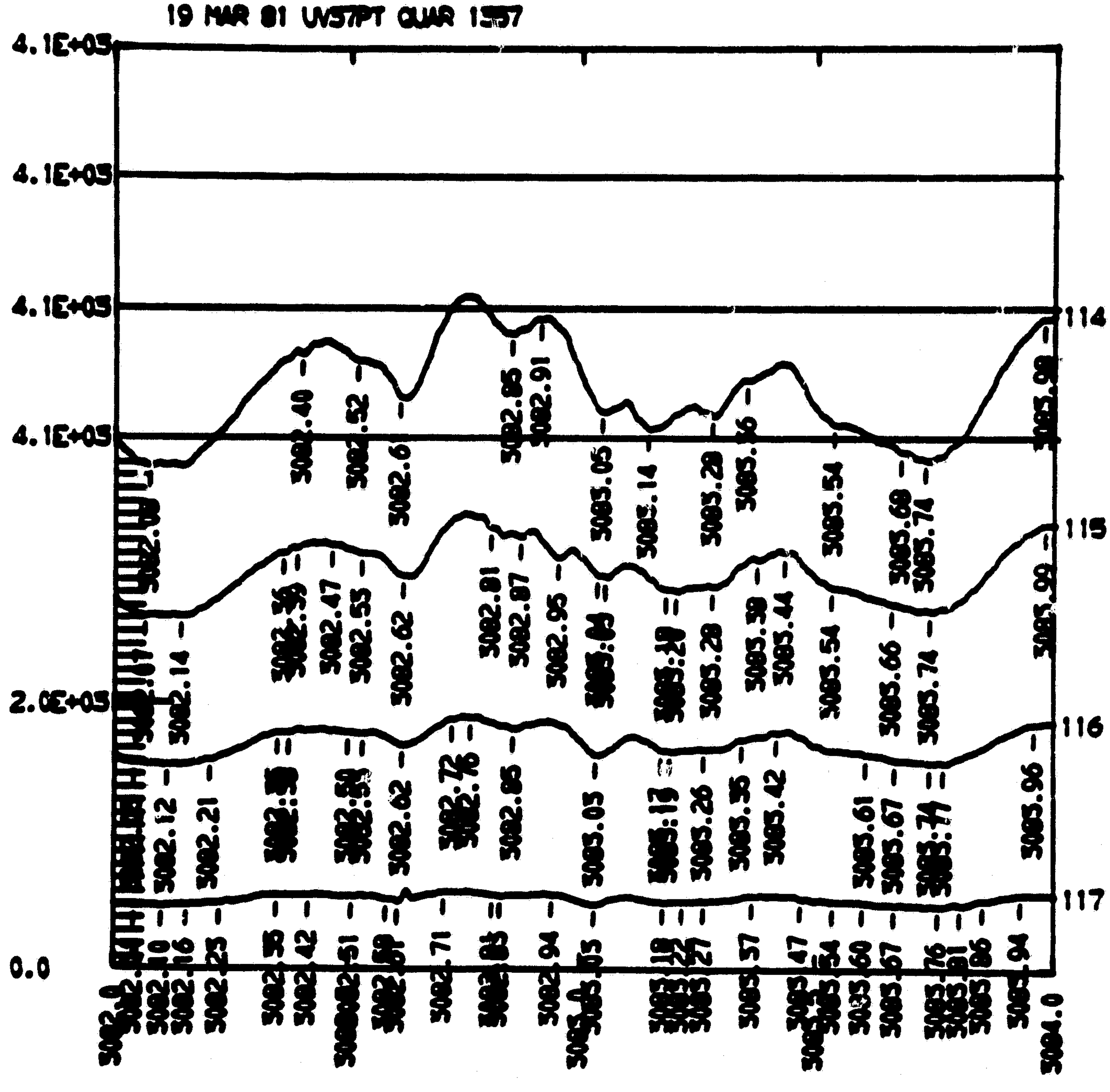


Fig. 4a Selected low sun scans obtained during the 3/19/81 balloon flight from float altitude (33 km). Resolution is 0.03Å.


19 MAR 81 UV57PT QUAR 1357
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4.1E+03
4.1E+03
4.1E+03
2.0E+03
0.0
114
115
116
117
5082.0
5084.0

Fig. 4b

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Pergamon Press Ltd., 1981. Printed in Great Britain [illegible]

SPECTRAL LINE PARAMETERS FOR THE $A^2\Sigma$–$X^2\Pi(0,0)$ BAND OF OH FOR ATMOSPHERIC AND HIGH TEMPERATURES

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Abstract—Individual spectral line parameters including line positions, strengths, and intensities, have been generated for the $A^2\Sigma$–$X^2\Pi(0,0)$ band of OH, applicable to atmospheric and high temperatures. Energy levels and transition frequencies are calculated by numerically diagonalizing the Hamiltonian. Line strengths are calculated using the dipole matrix and eigenvectors derived from energy matrix diagonalization. The line strengths are compared to those calculated from previously published algebraic line strength formulas. Tables of line parameters are presented for 240 and 4600°K.

1. INTRODUCTION

The $A^2\Sigma$–$X^2\Pi(0,0)$ band of OH in the 3085 Å region has been of interest to quantitative spectroscipists for many years because of its high absorption and emission intensity and convenient wavelength location for spectroscopic probes. The hydroxyl radical is a common by-product of most combustion processes, is present in atmospheric, solar and stellar spectra, and in recent years has been also recognized as an important trace constituent in atmospheric chemistry. Accurate determination of the amount of OH present during spectroscopic experiments depends on precise knowledge of line positions and intensities. Several analyses of spectral line positions for this band are available; among the more important of these are those of Dieke and Crosswhite,[1] who provided the first extensive analysis of the OH u.v. spectrum, and Destombes *et al.*,[2] who performed elaborate analysis of modern microwave, i.r. and u.v. OH data. Intensity (relative and absolute) studies of this band have been reviewed recently by Chidsey and Crosley,[3] who also performed extensive RKR calculations of rotational transition probabilities for the A–X system of OH.

The purpose of this work is to combine the best presently available data and theory to derive accurate quantitative line parameters for the $A^2\Sigma$–$X^2\Pi(0,0)$ band, applicable to atmospheric and high temperatures. The results are displayed in line parameter tables, and include improved values for the line strength, calculated in intermediate coupling from the energy matrix eigenvectors.

2. LINE PARAMETERS DERIVATION

The OH molecule has an unpaired electron with total electronic angular momentum $L = 1$ and $S = 1/2$. In the electronic ground state the projection of L along the internuclear axis is $\Lambda = \pm 1$. The projection of S along the internuclear axis is $\Sigma = \pm 1/2$, with a total electronic angular momentum projection $\Omega = \Lambda + \Sigma$. Here, Λ, Σ, Ω are considered as signed quantities, as in the notation of Hougen.[4] The electronic ground state is an inverted $^2\Pi$ state with the $^2\Pi_{1/2}(\Omega = \pm 1/2, F_2)$ levels at higher energy than the $^2\Pi_{3/2}$ levels ($\Omega = \pm 3/2$, F_1). The rotational levels for this state are intermediate between Hund's cases (a) and (b). In the $^2\Sigma$ upper state, which is Hund's case (b), $\Lambda = 0$ and $\Omega = \pm 1/2$ with $J = N \pm 1/2$. The $^2\Pi$ and $^2\Sigma$ states perturb one another and produce Λ doubling for each N ($^2\Sigma_{1/2}$) or J ($^2\Pi_{1/2,3/2}$).

We use the unique perturber approximation described by Destombes *et al.*[2] to calculate energy levels. This process is restricted to a single vibrational level v in the $A^2\Sigma$–$X^2\Pi$ subspace. The total angular momentum number F (not to be confused with the level designations F_1 and F_2) is a good quantum number. For a given F, the J and $J+1$ levels are weakly coupled by magnetic hyperfine interactions. These interactions are negligible in the calculation of electronic spectra and J may be considered a good quantum number. This procedure gives a 6×6 Hamiltonian matrix, the elements of which are listed in Table 1. The matrix elements are

Table 1. Nonzero Hamiltonian matrix elements [Hund's case (a) basis].

Matrix Element	Value
$\langle ^2\Pi_{3/2} \lvert H \rvert ^2\Pi_{3/2} \rangle$	$B_\Pi(x^2-2)+\frac{A}{2}-D_\Pi(x^4-3x^2+3)+A_D(x^2-2)+H_\Pi(x^6-3x^4+5x^2-4)$
$\langle ^2\Pi_{1/2} \lvert H \rvert ^2\Pi_{1/2} \rangle$	$B_\Pi x^2-\frac{A}{2}-D_\Pi(x^4+x^2-1)-A_D x^2+H_\Pi(x^6+3x^4-5x^2+2)$
$\langle ^2\Pi_{1/2} \lvert H \rvert ^2\Pi_{3/2} \rangle$	$B_\Pi y-2D_\Pi y(x^2-1)+H_\Pi y(3x^4-5x^2+3)$
$\langle ^2\Sigma_{1/2} \lvert H \rvert ^2\Sigma_{1/2} \rangle$	$B_\Sigma x^2+\frac{1}{2}\gamma_\Sigma+\nu_0-D_\Sigma(x^4+x^2)+H_\Sigma(x^6+3x^4)$
$\langle ^2\Sigma_{1/2} \lvert H \rvert ^2\Sigma_{-1/2} \rangle$	$B_\Sigma x-2D_\Sigma x^3+H_\Sigma(3x^5+x^3)$
$\langle ^2\Pi_{3/2} \lvert H \rvert ^2\Sigma_{1/2} \rangle$	$\langle BL_+\rangle y-\langle DL_+\rangle y(2x^2-1)+\langle A_D L_+\rangle y+\langle HL_+\rangle y(3x^4+1)$
$\langle ^2\Pi_{1/2} \lvert H \rvert ^2\Sigma_{-1/2} \rangle$	$\langle BL_+\rangle x-\langle DL_+\rangle x(2x^2+1)+\langle HL_+\rangle x(3x^4+6x^2-2)$
$\langle ^2\Pi_{3/2} \lvert H \rvert ^2\Sigma_{-1/2} \rangle$	$-2\langle DL_+\rangle xy+3\langle HL_+\rangle x(2x^2-1)y$
$\langle ^2\Pi_{1/2} \lvert H \rvert ^2\Sigma_{1/2} \rangle$	$\langle BL_+\rangle+\frac{1}{2}\langle AL_+\rangle-\langle DL_+\rangle(4x^2-1)+\frac{1}{2}\langle A_D L_+\rangle(2x^2-1)+\langle HL_+\rangle(9x^4-3x^2+1)$

Notes:

1. $x=J+1/2$; $y=((J-1/2)(J+3/2))^{1/2}$
2. Matrix elements are unchanged by exchange of initial and final states or by setting Ω to $-\Omega$ in both initial and final states.

written in Hund's case (a), with the wave functions represented by $|\Lambda S\Sigma\rangle|J\Omega\rangle = |\Lambda S\Sigma; J\Omega\rangle$, so that

$$
\begin{aligned}
{}^2\Sigma^{\pm}_{\pm 1/2}: &\quad |\Lambda S\Sigma; J\Omega\rangle = |0^{\pm}\, 1/2\, \pm 1/2; J\, \pm 1/2\rangle, \\
{}^2\Pi_{\pm 1/2}: &\quad |\Lambda S\Sigma; J\Omega\rangle = |\pm 1\, 1/2\, \mp 1/2; J\, \pm 1/2\rangle, \\
{}^2\Pi_{\pm 3/2}: &\quad |\Lambda S\Sigma; J\Omega\rangle = |\pm 1\, 1/2\, \pm 1/2; J\, \pm 3/2\rangle.
\end{aligned} \tag{1}
$$

The Hamiltonian constants used[5] are shown in Table 2 (these constants give a better fit to the

Table 2. Hamiltonian constants for $A^2\Sigma$–$X^2\Pi(0,0)$.

Constant	Value[a] (cm^{-1})
B_Σ	16.9258_{973}
D_Σ	$2.0396_{682} \times 10^{-3}$
H_Σ	$97.7_{612} \times 10^{-9}$
γ_Σ	$-7.8_{399} \times 10^{-3}$
ν_0	32402.056_{230}
A	-139.228_{325}
B_Π	18.3497_{356}
D_Π	$1.907_{952} \times 10^{-3}$
H_Π	$0.1239_{336} \times 10^{-6}$
A_D	$-0.72_{336} \times 10^{-3}$
$\langle AL_+\rangle$	-151.9226_{212}
$\langle BL_+\rangle$	25.0435_{440}
$\langle DL_+\rangle$	$2.6923_{336} \times 10^{-3}$
$\langle A_D L_+\rangle$	$8.051_{437} \times 10^{-3}$
$\langle HL_+\rangle$	$0.166_{603} \times 10^{-6}$

[a] Values are from Ref. 5 and are rounded to three figures beyond the standard errors indicated in Ref. 2.

observed spectrum than those of Ref. 2, which do not have a sufficient number of digits retained). The 6×6 Hamiltonian matrix may be reduced to two 3×3 blocks by the Kronig transformation,

$$|J\Omega\delta\rangle = \frac{1}{\sqrt{2}}(|\Lambda S\Sigma\rangle|J\Omega\rangle + \delta|-\Lambda S-\Sigma\rangle|J-\Omega\rangle), \tag{2}$$

where δ equals s = symmetric = + or a = antisymmetric = −. This notation should not be confused with the s, a and +, − notation for homonuclear diatomic molecules.† In this new basis, one of the 3×3 blocks contains only matrix elements of the type $\langle J'\Omega's|H|J\Omega s\rangle$ and the other contains only matrix elements of the type $\langle J'\Omega'a|H|J\Omega a\rangle$.

After numerical diagonalization of a 3×3 Kronig transformed block, the electronic state of each eigenvalue (energy level or, more properly, term value in cm^{-1}) may be determined by noting that the largest eigenvalue belongs to the $^2\Sigma_{1/2}$ state, the intermediate eigenvalue to the $^2\Pi_{1/2}$ state, and the smallest eigenvalue to the $^2\Pi_{3/2}$ state. The remaining quantum numbers and parities may be determined from Table 3.

The selection rules for the $A^2\Sigma$–$X^2\Pi(0,0)$ electric dipole allowed transitions are $\Delta J = 0, \pm 1$, $\Delta N = 0, \pm 1, \pm 2$. Parity selection rules require $+ \leftrightarrow -$, $+ \not\leftrightarrow +$, and $- \not\leftrightarrow -$, which give for the wavefunction the Kronig symmetry selection rules of $s \leftrightarrow s$ and $a \leftrightarrow a$ for $\Delta J = \pm 1$ (P and R branches) and $s \leftrightarrow a$ for $\Delta J = 0$ (Q branches). Transitions are designated by $^{\Delta N}\Delta J_{F'F''}(J'')$ where ′ refers to the upper state and ″ refers to the lower state and F is F_1 or F_2. These selection rules permit 12 branches, of which 6 are main branches ($^PP_{11}$, $^QQ_{11}$, $^RR_{11}$, $^PP_{22}$, $^QQ_{22}$, $^RR_{22}$) and 6 are (weaker) satellite branches $^QP_{21}$, $^RQ_{21}$, $^SR_{21}$, $^PQ_{12}$, $^QR_{12}$, $^OP_{12}$).

The line intensities $S_{lu}(T)$ (cm^{-1}/atm-cm) at temperature T(°K) are calculated from[6]

$$S_{lu}(T) = \frac{1}{8\pi c\nu^2}\left(\frac{N}{p}\right)\frac{e^{-1.4388E''/T}}{Q_{vR}}A_{J'J''}^{v'v''}(2J'+1)(1-e^{-1.4388\nu/T}), \tag{3}$$

where $\nu(= E' - E'')$ is the transition frequency in cm^{-1}, $c = 2.99792458 \times 10^{10}$ cm/sec, N is the total number of OH molecules/cm^3, p is the pressure in atm, $A_{J'J''}^{v'v''}$ is the Einstein A coefficient in sec^{-1}, E'' is the lower state energy ($= E_l$), and Q_{vR} is the vibration rotation partition function.

Line intensities may be converted from cm^{-1}/atm-cm at T to cm/molecule at T by

$$S_{lu}(T)(\text{cm/molecule}) = 3.721963 \times 10^{-20}\frac{T(°\text{K})}{273.16(°\text{K})}S_{lu}(T)(\text{cm}^{-1}/\text{cm-atm}). \tag{4}$$

The $S_{lu}(T)$ in cm/molecule are at the population temperature.

We assume that Q_{vR} is given by Q_vQ_R, where the vibrational partition function Q_v in the harmonic oscillator approximation is

$$Q_v = \frac{1}{1-e^{-1.4388\omega_e/T}} \tag{5}$$

Table 3. Assignment of quantum numbers to eigenvalues for given J.

State	$^2\Pi_{3/2}$	$^2\Pi_{1/2}$	$^2\Sigma_{1/2}$	
F	1	2	1	2
N	$J-1/2$	$J+1/2$	$J-1/2$	$J+1/2$
Parity: Eigenvalue from				
Symmetric block	$(-1)^{N+1}$	$(-1)^N$	—	$(-1)^N$
Antisymmetric block	$(-1)^N$	$(-1)^{N+1}$	$(-1)^N$	—

†We thank J. T. Hougen for pointing out that our notation s = symmetric = + is equivalent to the f levels and a = antisymmetric = − is equivalent to the e levels of J. M. Brown, J. T. Hougen, K.-P. Huber, J. W. C. Johns, I. Kopp, H. Lefebvre-Brion, A. J. Merer, D. A. Ramsay, J. Rostas, and R. N. Zare, *J. Molec. Spectrosc.* **55**, 500 (1975).

and ω_e is the vibrational harmonic oscillator frequency in cm^{-1}. Huber and Herzberg[7] give $\omega_e = 3737.76_1\ cm^{-1}$. A comparison of the values of Q_v calculated by Eq. (5) and by direct summation of $e^{-E_v/T}$ shows a difference of less than 0.2% at 4600°K. The rotational partition function Q_R is calculated from the actual energy levels as follows:

$$Q_R = \sum_{J''\Pi''} (2J''+1)\, e^{-1.43880F(J'')/T}. \tag{6}$$

Chidsey and Crosley[3] give the Einstein A coefficient as

$$A^{v'v''}_{J'J''} = \frac{64\pi^4}{3h} p^{v'v''}_{J'J''} S_{J'J''} \nu^3/(2J'+1)\ \text{sec}^{-1}, \tag{7}$$

where $p^{v'v''}_{J'J''}$ is the rovibrational transition probability and $S_{J'J''}$ is the rotational line strength. Chidsey and Crosley tabulate relative values of $A^{v'v''}_{J'J''}$ through $N''=32$ for the $A^2\Sigma - X^2\Pi(0,0)$ band in their Table 4. They state that they calculated the line strengths $S_{J'J''}$ based on Earls' formulas[8] with a J-dependent spin-orbit coupling parameter A and the rotational constants of Dieke and Crosswhite.[1] We have found that the use of Earls' formulas can lead to significant errors at high J in the satellite bands. (This problem is further discussed in the following section.) Therefore, we have calculated $S_{J'J''}$ by following the method described by Hougen.[4] Chidsey and Crosley[9] have kindly provided a table of relative values for $p^{v'v''}_{J'J''}$ through $J = 35.5$ prior to publication.

The $A^{v'v''}_{J'J''}$ may be put on an absolute basis by noting that the lifetime of a state is

$$\tau_{v'J'} = \left(\sum_{v''J''} A^{v'v''}_{J'J''}\right)^{-1} \text{sec}. \tag{8}$$

Because Chidsey and Crosley[3] give $A^0_1/A^0_0 \approx 0.0040$ (here the notation is $A^{v'}_{v''}$), we assume that for the $v'=0$ vibrational state all vibrational states other than $v''=0$ make negligible contributions to $\tau_{v'J'}$. The best available lifetime for the rotationless $(N'=0)v'=0$ state is probably that measured by German,[10] $\tau_{0,1/2} = (0.688 \pm 0.007)\times 10^{-6}$ sec. There are three transitions from the $v''=0$ state to the rotationless $v'=0$ state, namely, ${}^PP_{11}(1.5)$, ${}^OP_{12}(1.5)$, and ${}^PQ_{12}(0.5)$. We calculate relative $A^{v'v''}_{J'J''}$ for all J' and J'' of interest by ignoring all constant factors in Eq. (7) and normalize these by using Eq. (8).

We form the $S_{J'J''}$ by following the method given by Hougen.[4] In addition to the selection rules $\Delta J = 0, \pm 1$ and $+ \leftrightarrow -$ parity, electric dipole selection rules on Ω give nonzero matrix elements only for $\langle\Omega\pm 1|\mu_x \pm i\mu_y|\Omega\rangle$ for $\Delta\Omega = \pm 1$ and $\langle\Omega|\mu_z|\Omega\rangle$ for $\Delta\Omega = 0$, where μ_x, μ_y, and μ_z are electric dipole moment components in the molecule fixed axis system. In the laboratory fixed coordinate system

$$\mu_Z = \frac{1}{2}(\alpha_{Zx} - i\alpha_{Zy})(\mu_x + i\mu_y) + \frac{1}{2}(\alpha_{Zx} + i\alpha_{Zy})(\mu_x - i\mu_y) + \alpha_{Zz}\mu_z, \tag{9}$$

where α_{Zx}, α_{Zy}, and α_{Zz} are the direction cosines between the molecule-fixed and laboratory-

Table 4. Nonzero rotational direction cosine matrix elements in $\langle J'\Omega'|\mu_Z|J,\Omega\rangle$[Hund's case (a)].

	$J'=J+1$	$J'=J$	$J'=J-1$
$\langle J';\Omega\|\mu_Z\|J,\Omega\rangle$	$\left[\frac{(J+\Omega+1)(J-\Omega+1)}{2(J+1)}\right]^{1/2}$	$\cdot\,\Omega\left[\frac{2J+1}{2J(J+1)}\right]^{1/2}$	$\left[\frac{(J+\Omega)(J-\Omega)}{2J}\right]^{1/2}$
$\langle J';\Omega+1\|\mu_Z\|J,\Omega\rangle$	$-\left[\frac{(J+\Omega+1)(J+\Omega+2)}{2(J+1)}\right]^{1/2}$	$\left[\frac{(J-\Omega)(J+\Omega+1)(2J+1)}{2J(J+1)}\right]^{1/2}$	$\left[\frac{(J-\Omega)(J-\Omega-1)}{2J}\right]^{1/2}$
$\langle J';\Omega-1\|\mu_Z\|J,\Omega\rangle$	$\left[\frac{(J-\Omega+1)(J-\Omega+2)}{2(J+1)}\right]^{1/2}$	$\left[\frac{(J+\Omega)(J-\Omega+1)(2J+1)}{2J(J+1)}\right]^{1/2}$	$-\left[\frac{(J+\Omega)(J+\Omega-1)}{2J}\right]^{1/2}$

Note: The phases employed here are the same as those used in Refs. 2, 4, and 11.

fixed coordinates systems. The direction cosine matrix elements are given in Table 4. The μ_x, μ_y, and μ_z are taken to be experimentally determined parameters. For lack of better information, we take $\sqrt{(1/2)}|\mu_x + i\mu_y| = \sqrt{(1/2)}|\mu_x - i\mu_y| = \mu_- = 1$.

Because we assume that the electronic and rotational parts of the wavefunction are separable, the electric dipole matrix elements may be written as

$$\langle \Lambda' S \Sigma'; J'\Omega'|\mu_Z|\Lambda S\Sigma; J\Omega\rangle = \frac{1}{2}\langle \Lambda' S\Sigma'|\mu_x + i\mu_y|\Lambda S\Sigma\rangle\langle J'\Omega'|\alpha_{Zx} - i\alpha_{Zy}|J\Omega\rangle$$
$$+\frac{1}{2}\langle \Lambda' S\Sigma'|\mu_x - i\mu_y|\Lambda S\Sigma\rangle\langle J'\Omega'|\alpha_{Zx} + i\alpha_{Zy}|J\Omega\rangle + \langle \Lambda' S\Sigma'|\mu_z|\Lambda S\Sigma\rangle\langle J'\Omega'|\alpha_{Zz}|J\Omega\rangle, \tag{10}$$

where $''$ has been dropped on the lower state quantities. Only one of the three terms on the r.h.s. of Eq. (10) is nonzero for any allowed transition matrix element. The electric dipole transition matrix is formed in the same basis as was the Hamiltonian matrix, that is, the Hund's case (a) basis. Selection rules in this basis are $\Delta S = 0$, $\Delta\Sigma = 0$, $\Delta\Lambda = 0, \pm 1$, and $\Delta J = 0, \pm 1$. Because $\Delta\Sigma = 0$ and $\Omega = \Lambda + \Sigma$, the selection rule $\Delta\Omega = \Delta\Lambda$ is obtained.

For $^2\Sigma$–$^2\Pi$ transitions the last term in Eq. (10) is always zero. Because we are interested in $^2\Sigma$–$^2\Pi$ transitions, we set all matrix elements of the type $\langle ^2\Sigma|\mu_Z|^2\Sigma\rangle$ and $\langle ^2\Pi|\mu_Z|^2\Pi\rangle$ equal to zero. This approximation is valid because these matrix elements are much smaller in magnitude than the $\langle ^2\Sigma|\mu_Z|^2\Pi\rangle$ matrix elements and because they enter into the line strength only through weak mixing between the $^2\Pi$ and $^2\Sigma$ wavefunctions. The relative phases of the matrix elements are determined by following the prescription of Hougen[4] and Whiting and Nicholls.[11] Following the suggestions of Whiting and Nicholls, we have normalized the line strengths so that

$$\sum_{J'} S_{J'J''} = 2(2S+1)(2J''+1) = 4(2J''+1). \tag{11}$$

Table 4 reflects this choice of normalization.

The line strength $S_{J'J''}$ is formed in intermediate coupling by taking $|\langle u|\mu_Z|l\rangle|^2$, where $|u\rangle$ represents the eigenvector of the $^2\Sigma$ state, $|l\rangle$ represents the eigenvector of the $^2\Pi$ state, and μ_Z now represents the 6×6 transition matrix. However, the eigenvectors formed during diagonalization of the energy matrices are in the Kronig transformed basis; therefore, the dipole matrix must also be transformed into this basis. Using the Kronig transformed wavefunctions given by Eq. (1), the Kronig transformed dipole matrix elements have the form

$$\langle J'\Omega'\delta'|\mu_Z|J\Omega\delta\rangle = \frac{1}{2}(\langle J'\Omega'|\mu_Z|J\Omega\rangle + \delta\langle J'\Omega'|\mu_Z|J-\Omega\rangle$$
$$+\delta'\langle J'-\Omega'|\mu_Z|J\Omega\rangle + \delta\delta'\langle J'-\Omega'|\mu_Z|J-\Omega\rangle) \tag{12}$$

and, if we let μ_Z^K be the matrix of the $\langle J'\Omega'\delta'|\mu_Z|J\Omega\delta\rangle$,

$$S_{J'J''} = |\langle J'\Omega'\delta'|\mu_Z^K|J\Omega\delta\rangle|^2. \tag{13}$$

To our knowledge, the $^2\Sigma$–$^2\Pi$ transition matrices have not been published elsewhere. We show them for the P, Q, and R branches in Tables 5–7. The twelve branches correspond to the four 3×3 blocks in the Kronig basis as follows:

$$\left(\begin{array}{c|c} \begin{matrix} a \leftarrow a \\ {}^PP_{11}, {}^RR_{11}, {}^OP_{12}, {}^QR_{12} \end{matrix} & \begin{matrix} a \leftarrow s \\ {}^QQ_{11}, {}^PQ_{12} \end{matrix} \\ \hline \begin{matrix} s \leftarrow a \\ {}^QQ_{22}, {}^RQ_{21} \end{matrix} & \begin{matrix} s \leftarrow s \\ {}^PP_{22} {}^RR_{22}, {}^QP_{21} {}^SR_{21} \end{matrix} \end{array}\right) \tag{14}$$

For the Q-branch lines, the only nonzero 3×3 blocks are those for $a \leftarrow s$ and $s \leftarrow a$, while, for the R- and P-branch lines, the only nonzero 3×3 blocks are those for $a \leftarrow a$ and $s \leftarrow s$. When forming line strengths, the appropriate block must be substituted into Eq. (13) for μ_Z^K. For

Table 5. P-branch $^2\Sigma$-$^2\Pi$ transition matrix.

i) Hund's case (a) basis

$$
\begin{array}{c|cccccc}
 & ^2\Pi_{-3/2} & ^2\Pi_{-1/2} & ^2\Sigma_{-1/2} & ^2\Sigma_{1/2} & ^2\Pi_{1/2} & ^2\Pi_{3/2} \\
\hline
^2\Pi_{-3/2} & 0 & 0 & -w & 0 & 0 & 0 \\
^2\Pi_{-1/2} & 0 & 0 & 0 & -x & 0 & 0 \\
^2\Sigma_{-1/2} & -w & 0 & 0 & 0 & -x & 0 \\
^2\Sigma_{1/2} & 0 & -x & 0 & 0 & 0 & -w \\
^2\Pi_{1/2} & 0 & 0 & -x & 0 & 0 & 0 \\
^2\Pi_{3/2} & 0 & 0 & 0 & -w & 0 & 0
\end{array}
$$

ii) Kronig basis

$$
\begin{array}{c|cccccc}
 & ^2\Pi^e_{3/2} & ^2\Pi^e_{1/2} & ^2\Sigma^e_{1/2} & ^2\Sigma^f_{1/2} & ^2\Pi^f_{1/2} & ^2\Pi^f_{3/2} \\
\hline
^2\Pi^e_{3/2} & 0 & 0 & -w & & & \\
^2\Pi^e_{1/2} & 0 & 0 & x & & 0 & \\
^2\Sigma^e_{1/2} & -w & x & 0 & & & \\
^2\Sigma^f_{1/2} & & & & 0 & -x & -w \\
^2\Pi^f_{1/2} & & 0 & & -x & 0 & 0 \\
^2\Pi^f_{3/2} & & & & -w & 0 & 0
\end{array}
$$

$$w = \left[\frac{(J+3/2)(J+1/2)}{2J}\right]^{1/2}\mu_\perp$$

$$x = \left[\frac{(J-1/2)(J+3/2)}{2J}\right]^{1/2}\mu_\perp$$

where $\mu_\perp = \sqrt{\tfrac{1}{2}}\,|\mu_x \pm i\mu_y| = 1$

Table 6. Q-branch $^2\Sigma$–$^2\Pi$ transition matrix.

i) Hund's case (a) basis

$$
\begin{array}{c}
 \\ ^2\Pi_{-3/2} \\ ^2\Pi_{-1/2} \\ ^2\Sigma_{-1/2} \\ ^2\Sigma_{1/2} \\ ^2\Pi_{1/2} \\ ^2\Pi_{3/2}
\end{array}
\begin{array}{c}
\begin{array}{cccccc} ^2\Pi_{-3/2} & ^2\Pi_{-1/2} & ^2\Sigma_{-1/2} & ^2\Sigma_{1/2} & \Pi_{1/2} & ^2\Pi_{3/2} \end{array} \\
\left(\begin{array}{ccc|ccc}
0 & 0 & -t & 0 & 0 & 0 \\
0 & 0 & 0 & -v & 0 & 0 \\
-t & 0 & 0 & 0 & v & 0 \\
\hline
0 & -v & 0 & 0 & 0 & t \\
0 & 0 & v & 0 & 0 & 0 \\
0 & 0 & 0 & t & 0 & 0
\end{array}\right)
\end{array}
$$

ii) Kronig basis

$$
\begin{array}{c}
 \\ ^2\Pi^{e}_{3/2} \\ ^2\Pi^{e}_{1/2} \\ ^2\Sigma^{e}_{1/2} \\ ^2\Sigma^{e}_{1/2} \\ ^2\Pi^{e}_{1/2} \\ ^2\Pi^{e}_{3/2}
\end{array}
\begin{array}{c}
\begin{array}{cccccc} ^2\Pi^{e}_{3/2} & ^2\Pi^{e}_{1/2} & ^2\Sigma^{e}_{1/2} & ^2\Sigma^{e}_{1/2} & ^2\Pi^{e}_{1/2} & ^2\Pi^{e}_{3/2} \end{array} \\
\left(\begin{array}{ccc|ccc}
 & & & t & 0 & 0 \\
 & 0 & & v & 0 & 0 \\
 & & & 0 & -v & t \\
\hline
t & v & 0 & & & \\
0 & 0 & -v & & 0 & \\
0 & 0 & t & & &
\end{array}\right)
\end{array}
$$

$$t = \left[\frac{(J-{}^1/_2)(J+{}^3/_2)(2J+1)}{2J(J+1)}\right]^{1/2} \mu_\perp$$

$$v = \left[\frac{(J+{}^1/_2)^2(2J+1)}{2J(J+1)}\right]^{1/2} \mu_\perp$$

where $\mu_\perp = \sqrt{{}^1/_2}\,|\mu_x \pm i\mu_y| = 1$

Table 7. *R*-branch $^2\Sigma$–$^2\Pi$ transition matrix.

i) Hund's case (a) basis

	$^2\Pi_{-3/2}$	$^2\Pi_{-1/2}$	$^2\Sigma_{-1/2}$	$^2\Sigma_{1/2}$	$^2\Pi_{1/2}$	$^2\Pi_{3/2}$
$^2\Pi_{-3/2}$	0	0	y	0	0	0
$^2\Pi_{-1/2}$	0	0	0	z	0	0
$^2\Sigma_{-1/2}$	y	0	0	0	z	0
$^2\Sigma_{1/2}$	0	z	0	0	0	y
$^2\Pi_{1/2}$	0	0	z	0	0	0
$^2\Pi_{3/2}$	0	0	0	y	0	0

ii) Kronig basis

	$^2\Pi^e_{3/2}$	$^2\Pi^e_{1/2}$	$^2\Sigma^e_{1/2}$	$^2\Sigma^f_{1/2}$	$^2\Pi^f_{1/2}$	$^2\Pi^f_{3/2}$
$^2\Pi^e_{3/2}$	0	0	y			
$^2\Pi^e_{1/2}$	0	0	-z		0	
$^2\Sigma^e_{1/2}$	y	-z	0			
$^2\Sigma^f_{1/2}$				0	z	y
$^2\Pi^f_{1/2}$		0		z	0	0
$^2\Pi^f_{3/2}$				y	0	0

$$y = \left[\frac{(J-{}^1/_2)(J+{}^1/_2)}{2(J+1)}\right]^{1/2}\mu_\perp$$

$$z = \left[\frac{(J+{}^1/_2)(J+{}^3/_2)}{2(J+1)}\right]^{1/2}\mu_\perp$$

where $\mu_\perp = \sqrt{\tfrac{1}{2}}\,|\mu_x \pm i\mu_y| = 1$

example, to generate the Q_1 line strength we form

$$S^{Q_1}_{J'J''} = |\langle\psi^{s}_{\Sigma_{1/2}}|(a \leftarrow s)|\psi^{s}_{\Pi_{1/2}}\rangle|^2. \tag{15}$$

3. RESULTS AND DISCUSSION

Line strengths, Einstein A coefficients, intensities, and transition frequencies have been calculated for all branches of the $A^2\Sigma - X^2\Pi(0,0)$ OH spectrum through $J = 15.5$ at 240°K for atmospheric applications and through $J = 40.5$ at 4600°K for high temperature applications. These calculated values are shown in Tables 8 and 9, respectively. The total band intensities (by summation of the individual lines) are 2.7948×10^4 cm^{-1}/atm-cm at 240°K and 8.6863×10^2 cm^{-1}/atm-cm at 4600°K. Line intensities are plotted at these two temperatures in Fig. 1. Some caution must be exercised in using high J data from Table 9. The spectroscopic constants[5] used here were determined from data[2] which included transitions through $J = 25.5$. Although these constants allow prediction of that data to within 0.1 cm^{-1} maximum error and a standard deviation of ~ 0.03 cm^{-1} (the hyperfine structure is neglected here), such accuracy cannot be expected for all lines between $J = 25.5$ and 40.5. Uncertainties in the calculation of energy levels at these high J cause proportionally smaller uncertainties in the energy eigenvectors (wavefunctions) and in quantities calculated using the eigenvectors (line strengths, Einstein A coefficients, and intensities).

Chidsey and Crosley[9] list $p^{v'v''}_{J'J''}$ through $J = 35.5$. We have extrapolated $p^{v'v''}_{J'J''}$ for $J = 36.5$–40.5. Although the dependence of $p^{v'v''}_{J'J''}$ on J is quite linear for P, Q, and R transition probabilities between $J = 25.5$ and 35.5, extrapolated $p^{v'v''}_{J'J''}$ used to calculate Einstein A coefficients and intensities at higher J must be used with caution.

Although we list four digits for Einstein A coefficients and intensities in Tables 8 and 9, the absolute uncertainties of these quantities cannot be less than 1%, because German's[10] $\tau_{0,1/2}$ has a 1% quoted uncertainty and because Chidsey and Crosley's[9] $p^{v'v''}_{J'J''}$ are quoted to three significant digits. The relative uncertainties are limited by the relative accuracy of the $p^{v'v''}_{J'J''}$ and the line strengths. These relative uncertainties should be less than 0.5% for J less than 25.5 and are probably less than 1% for J less than 35.5.

Our calculated line strengths have been checked for accuracy by comparison with values calculated using Earls'[8] algebraic formulas (these formulas are equivalent to those of Kovacs[12] for $^2\Sigma$-$^2\Pi$ transitions). When centrifugal and higher order distortion and Σ-Π interactions are

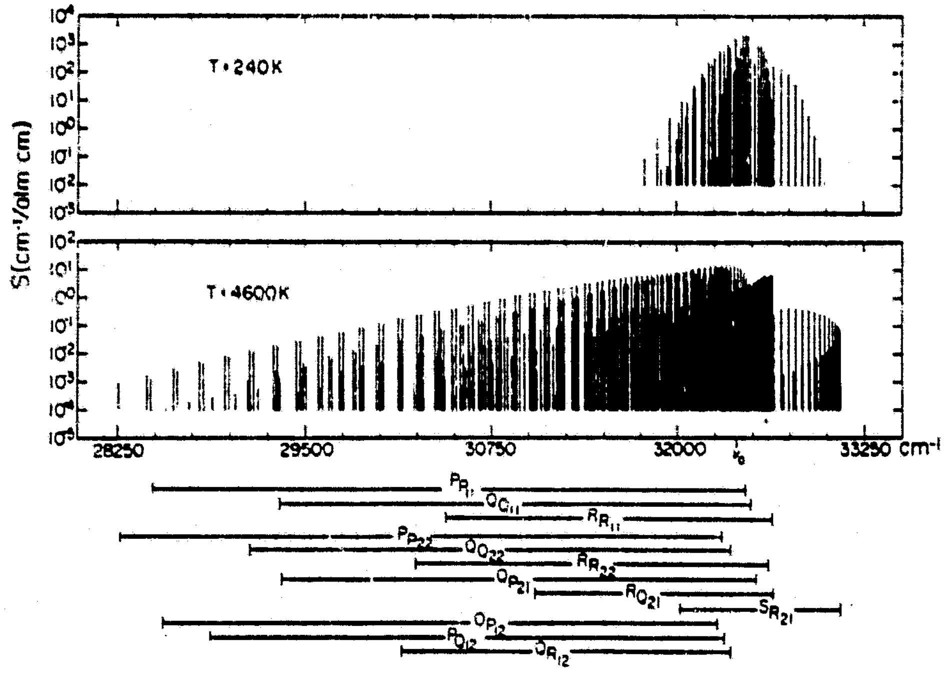

Fig. 1. Line intensities and positions for the $A^2\Sigma$-$X^2\Pi(0,0)$ band of OH. Only lines with intensity greater than 10^{-5} the intensity of the strongest line have been plotted.

Table 8. Line parameters for the $A^2\Sigma - X^2\Pi(0,0)$ OH band at 240°K.

J'	J"	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1}	Intensity cm/molecule	Einstein A sec^{-1}	Line strength	Number
						T = 240 K				
14.5	15.5	4939.982 -	O P 1 2(15.5)	30975.003	3227.4696	2.110E-11	6.929E-31	3.911E+03	2.20341E-01	1
13.5	14.5	4377.419 +	O P 1 2(14.5)	31084.683	3216.0896	6.649E-10	2.174E-29	4.547E+03	2.31060E-01	2
12.5	13.5	3846.059 -	O P 1 2(13.5)	31191.892	3205.0352	1.729E-08	5.659E-28	5.329E+03	2.43203E-01	3
11.5	12.5	3348.008 +	O P 1 2(12.5)	31296.666	3194.3051	3.784E-07	1.213E-26	6.280E+03	2.56976E-01	4
10.5	11.5	2884.110 -	O P 1 2(11.5)	31398.949	3183.8992	6.515E-06	2.133E-25	7.480E+03	2.72606E-01	5
14.5	15.5	4932.933 +	P P 2 2(15.5)	31460.396	3177.6803	1.623E-09	5.387E-29	2.969E+05	1.59436E+01	6
15.5	15.5	4932.933 +	P Q 1 2(15.5)	31463.010	3177.3355	7.479E-11	2.446E-30	1.281E+04	7.57344E-01	7
9.5	10.5	2453.149 +	O P 1 2(10.5)	31490.667	3173.8193	9.371E-05	3.064E-24	9.003E+03	2.90335E-01	8
13.5	14.5	4371.365 -	P P 2 2(14.5)	31540.460	3169.6197	4.517E-08	1.477E-27	3.067E+05	1.49196E+01	9
14.5	14.5	4371.365 -	P Q 1 2(14.5)	31543.628	3169.2961	2.333E-09	7.628E-29	1.470E+04	7.91566E-01	10
14.5	15.5	4341.846 -	P P 1 1(15.5)	31573.139	3166.3329	5.750E-08	1.880E-27	3.059E+05	1.62750E+01	11
8.5	9.5	2056.568 -	O P 1 2(9.5)	31595.731	3164.0607	1.099E-03	3.595E-23	1.096E+04	3.10306E-01	12
12.5	13.5	3841.676 +	P P 2 2(13.5)	31617.484	3161.8990	1.033E-06	3.378E-26	3.170E+05	1.38917E+01	13
13.5	13.5	3841.676 +	P Q 1 2(13.5)	31623.425	3161.5977	6.019E-08	1.968E-27	1.716E+04	8.30293E-01	14
13.5	14.5	3818.759 +	P P 1 1(14.5)	31651.343	3158.5892	1.337E-06	4.371E-26	3.172E+05	1.52695E+01	15
7.5	8.5	1694.914 +	O P 1 2(8.5)	31690.028	3154.6534	1.040E-02	3.420E-22	1.352E+04	3.32902E-01	16
11.5	12.5	3344.522 -	P P 2 2(12.5)	31691.411	3154.5157	1.926E-05	6.299E-25	3.267E+05	1.20593E+01	17
12.5	12.5	3344.522 -	P Q 1 2(12.5)	31694.220	3154.2353	1.280E-06	4.187E-26	2.005E+04	8.74207E-01	18
12.5	13.5	3311.982 -	P P 1 1(13.5)	31726.769	3151.0881	2.547E-05	8.330E-25	3.289E+05	1.42615E+01	19
10.5	11.5	2880.525 +	P P 2 2(11.5)	31762.412	3147.4639	2.920E-04	9.549E-24	3.362E+05	1.10217E+01	20
11.5	11.5	2880.525 +	P Q 1 2(11.5)	31765.021	3147.2054	2.235E-05	7.310E-25	2.359E+04	9.24097E-01	21
6.5	7.5	1360.720 -	O P 1 2(7.5)	31781.413	3145.5821	8.077E-02	2.641E-21	1.695E+04	3.57791E-01	22
11.5	12.5	2846.089 +	P P 1 1(12.5)	31799.456	3143.7972	3.954E-04	1.293E-23	3.402E+05	1.32510E+01	23
9.5	10.5	2450.279 -	P P 2 2(10.5)	31830.383	3140.7625	3.576E-03	1.170E-22	3.449E+05	1.07700E+01	24
10.5	10.5	2450.279 -	P Q 1 2(10.5)	31832.708	3140.5061	3.195E-04	1.045E-23	2.001E+04	9.00044E-01	25
10.5	11.5	2413.613 -	P P 1 1(11.5)	31869.446	3136.8927	4.986E-03	1.630E-22	3.516E+05	1.22402E+01	26
5.5	6.5	1078.509 +	O P 1 2(6.5)	31869.705	3136.8672	5.003E-01	1.636E-20	2.162E+04	3.84410E-01	27
8.5	9.5	2054.353 +	P P 2 2(9.5)	31895.283	3134.3516	3.525E-02	1.153E-21	3.532E+05	9.72727E+00	28
9.5	9.5	2054.353 +	P Q 1 2(9.5)	31897.463	3134.1373	3.724E-03	1.210E-22	3.359E+04	1.04530E+00	29
9.5	10.5	2015.036 +	P P 1 1(10.5)	31936.701	3130.2707	5.079E-02	1.661E-21	3.620E+05	1.12265E+01	30
4.5	5.5	824.013 -	O P 1 2(5.5)	31954.665	3128.5267	2.474E+00	8.092E-20	2.019E+04	4.10930E-01	31
7.5	8.5	1693.290 -	P P 2 2(8.5)	31957.040	3128.2934	2.779E-01	9.089E-21	3.611E+05	8.66826E+00	32
8.5	8.5	1693.290 -	P Q 1 2(8.5)	31959.008	3128.1015	3.530E-02	1.154E-21	4.077E+04	1.11058E+00	33
15.5	15.5	4939.982 -	Q Q 2 2(15.5)	31963.173	3127.6939	3.010E-09	9.842E-29	5.549E+05	3.12030E+01	34
8.5	9.5	1658.798 -	P P 1 1(9.5)	32001.569	3123.9478	4.172E-01	1.364E-20	3.745E+05	1.02106E+01	35
6.5	7.5	1367.617 +	P P 2 2(7.5)	32015.587	3122.5733	1.740E+00	5.689E-20	3.680E+05	7.59984E+00	36
14.5	14.5	4377.419 +	Q Q 2 2(14.5)	32015.910	3122.5417	8.436E-08	2.759E-27	5.712E+05	2.92491E+01	37
7.5	7.5	1367.617 +	P Q 1 2(7.5)	32017.324	3122.4038	2.712E-01	8.876E-21	5.020E+04	1.20092E+00	38
15.5	14.5	4377.419 +	Q R 1 2(14.5)	32019.325	3122.2087	1.434E-09	4.690E-29	9.105E+03	5.12512E-01	39
3.5	4.5	680.194 +	O P 1 2(4.5)	32035.976	3120.5958	9.645E+00	3.154E-19	3.767E+04	4.32924E-01	40
14.5	15.5	4351.310 +	Q P 2 1(15.5)	32042.018	3119.9973	1.080E-09	5.175E-29	1.895E+04	5.57413E-01	41
15.5	15.5	4351.310 +	Q Q 1 1(15.5)	32045.433	3119.6649	1.026E-07	3.354E-27	5.577E+05	3.12011E+01	42
7.5	8.5	1321.252 +	P P 1 1(8.5)	32063.690	3117.8805	2.751E+00	8.997E-20	3.860E+05	9.19253E+00	43
13.5	13.5	3846.059 -	Q Q 2 2(13.5)	32064.906	3117.7702	1.939E-06	6.341E-26	5.864E+05	2.72108E+01	44
14.5	13.5	3846.059 -	Q R 1 2(13.5)	32068.126	3117.4571	3.742E-08	1.224E-27	1.056E+04	5.40150E-01	45
5.5	6.5	1077.054 -	P P 2 2(6.5)	32070.760	3117.2004	8.575E+00	2.804E-19	3.737E+05	6.52103E+00	46
6.5	6.5	1077.054 -	P Q 1 2(6.5)	32072.279	3117.0534	1.680E+00	5.493E-20	6.276E+04	1.29194E+00	47

13.5	14.5	3019.156 -	O P 2 1(14.5)	32092.600	3115.0789	4.939E-08	1.615E-27	1.267E+04	5.85109E-01	48
14.5	14.5	3019.156 -	Q Q 1 1(14.5)	32095.829	3114.7663	2.396E-06	7.835E-26	5.739E+05	2.91665E+01	49
12.5	12.5	3340.000 +	Q Q 2 2(12.5)	32110.200	3113.3722	3.639E-05	1.190E-24	6.002E+05	2.51660E+01	50
2.5	3.5	429.275 -	O P 1 2(3.5)	32113.213	3113.0801	2.091E+01	9.453E-19	5.175E+04	4.40599E-01	51
13.5	12.5	3340.000 +	Q R 1 2(12.5)	32113.222	3113.0792	8.842E-07	2.630E-26	1.232E+04	5.71279E-01	52
4.5	5.5	424.525 +	P P 2 2(5.5)	32122.405	3112.1992	3.293E+01	1.077E-13	3.705E+05	5.63172E+00	53
6.5	7.5	1026.730 -	P P 1 1(7.5)	32123.403	3112.0925	1.449E+01	4.730E-19	3.997E+05	8.17260E+00	54
5.5	5.5	424.525 +	P Q 1 2(5.5)	32123.609	3112.0640	8.344E+00	2.729E-19	7.991E+04	1.30079E+00	55
12.5	13.5	3319.355 +	O P 2 1(13.5)	32139.725	3110.5120	1.060E-05	3.491E-26	1.470E+04	6.16716E-01	56
13.5	13.5	3319.355 +	Q Q 1 1(13.5)	32142.747	3110.2196	4.570E-05	1.497E-24	5.000E+05	2.71260E+01	57
11.5	11.5	2004.110 -	Q Q 2 2(11.5)	32151.022	3109.3416	5.539E-04	1.811E-23	6.120E+05	2.31170E+01	58
12.5	11.5	2004.110 -	Q R 1 2(11.5)	32154.640	3109.0691	1.419E-05	4.641E-25	1.447E+04	6.06410E-01	59
3.5	4.5	600.100 -	P P 2 2(4.5)	32170.237	3107.5617	9.696E+01	3.171E-18	3.019E+05	4.33399E+00	60
4.5	4.5	600.109 -	P Q 1 2(4.5)	32171.298	3107.4600	3.292E+01	1.077E-18	1.037E+05	1.40361E+00	61
5.5	6.5	767.450 +	P P 1 1(6.5)	32180.756	3106.5459	6.067E+01	1.904E-18	4.141E+05	7.15200E+00	62
11.5	12.5	2052.485 -	O P 2 1(12.5)	32183.440	3106.2860	1.896E-05	6.202E-25	1.737E+04	6.52643E-01	63
1.5	2.5	280.769 +	O P 1 2(2.5)	32185.089	3106.6542	6.333E+01	2.071E-18	7.357E+04	4.13554E-01	64
12.5	12.5	2052.485 -	Q Q 1 1(12.5)	32186.266	3106.0141	7.126E-04	2.330E-23	6.025E+05	2.50919E+01	65
10.5	10.5	2453.149 +	Q Q 2 2(10.5)	32189.707	3105.6743	6.819E-03	2.230E-22	6.220E+05	2.10604E+01	66
11.5	10.5	2453.149 +	Q R 1 2(10.5)	32192.397	3105.4225	2.046E-04	6.692E-24	1.711E+04	6.46185E-01	67
2.5	3.5	429.450 +	P P 2 2(3.5)	32213.092	3103.3503	2.127E+02	6.954E-18	3.035E+05	3.23470E+00	68
3.5	3.5	429.450 +	P Q 1 2(3.5)	32214.713	3103.2712	1.019E+02	3.336E-18	1.377E+05	1.55030E+00	69
10.5	11.5	2619.001 +	O P 2 1(11.5)	32223.855	3102.3960	2.764E-04	9.040E-24	2.066E+04	6.93759E-01	70
9.5	9.5	2056.560 -	Q Q 2 2(9.5)	32224.095	3102.3677	6.746E-02	2.206E-21	6.293E+05	1.89962E+01	71
11.5	11.5	2619.901 +	Q Q 1 1(11.5)	32226.464	3102.1396	8.906E-03	2.913E-22	6.139E+05	2.30295E+01	72
10.5	9.5	2096.560 -	Q R 1 2(9.5)	32226.492	3102.1369	2.406E-03	7.060E-23	2.061E+04	6.90930E-01	73
4.5	5.5	543.575 -	P P 1 1(5.5)	32235.923	3101.2312	2.611E+02	6.576E-18	4.319E+05	6.13324E+00	74
1.5	2.5	209.041 -	P P 2 2(2.5)	32252.060	3099.6087	3.293E+02	1.077E-17	3.040E+05	2.14901E+00	75
.5	1.5	187.491 -	O P 1 2(1.5)	32253.049	3099.5025	8.761E+01	2.065E-18	1.114E+05	3.10162E-01	76
2.5	2.5	209.341 -	P Q 1 2(2.5)	32253.447	3099.5443	2.407E+02	7.070E-18	1.075E+05	1.57735E+00	77
8.5	8.5	1694.914 +	Q Q 2 2(8.5)	32254.722	3099.4217	5.330E-01	1.746E-20	6.342E+05	1.69230E+01	78
9.5	8.5	1694.914 +	Q R 1 2(8.5)	32255.902	3099.2122	2.299E-02	7.5[illegible]E-22	2.450E+04	7.41400E-01	79
9.5	10.5	2019.633 -	O P 2 1(10.5)	32261.829	3098.8150	3.295E-03	1.077E-22	2.469E+04	7.41015E-01	80
10.5	10.5	2019.633 -	Q Q 1 1(10.5)	32263.426	3098.5856	9.153E-02	2.993E-21	6.236E+05	2.09700E+01	81
7.5	7.5	1368.720 -	Q Q 2 2(7.5)	32281.619	3096.8392	3.359E+00	1.098E-19	6.360E+05	1.49631E+01	82
8.5	7.5	1368.720 -	Q R 1 2(7.5)	32283.579	3096.6512	1.776E-01	5.800E-21	2.991E+04	7.97604E-01	83
.5	1.5	187.751 +	P P 2 2(1.5)	32286.475	3096.3734	3.111E+02	1.017E-17	3.970E+05	1.10199E+00	84
1.5	1.5	187.751 +	P Q 1 2(1.5)	32286.827	3096.3396	4.180E+02	1.367E-17	2.667E+05	1.49500E+00	85
3.5	4.5	355.185 +	P P 1 1(4.5)	32289.066	3096.1250	5.244E+02	1.715E-17	4.563E+05	5.12107E+00	86
8.5	9.5	1654.577 +	O P 2 1(9.5)	32295.059	3095.5503	3.207E-02	1.049E-21	2.999E+04	7.95546E-01	87
9.5	9.5	1654.577 +	Q Q 1 1(9.5)	32297.240	3095.3414	7.490E-01	2.449E-20	6.304E+05	1.89017E+01	88
6.5	6.5	1078.509 +	Q Q 2 2(6.5)	32304.695	3094.6269	1.664E+01	5.441E-19	6.332E+05	1.27554E+01	89
7.5	6.5	1078.509 +	Q R 1 2(6.5)	32306.433	3094.4605	1.106E+00	3.616E-20	3.602E+04	8.59222E-01	90
.5	.5	126.449 -	P Q 1 2(.5)	32314.091	3093.7271	5.435E+02	1.777E-17	4.010E+05	1.33333E+00	91
5.5	5.5	824.013 -	Q Q 2 2(5.5)	32323.0[illegible]0	3092.7970	6.436E+01	2.105E-18	6.252E+05	1.06647E+01	92
6.5	5.5	824.013 -	Q R 1 2(5.5)	32325.329	3092.6524	5.512E+00	1.802E-19	4.509E+04	9.23700E-01	93
7.5	8.5	1324.291 -	O P 2 1(8.5)	32326.847	3092.5020	2.544E-01	8.320E-21	3.702E+04	8.50667E-01	94
8.5	8.5	1324.291 -	Q Q 1 1(8.5)	32329.807	3092.3953	4.907E+00	1.605E-19	6.347E+05	1.68236E+01	95
4.5	4.5	600.194 +	Q Q 2 2(4.5)	32338.736	3091.3693	1.914E+02	6.260E-18	6.095E+05	8.50140E+00	96
5.5	4.5	600.194 +	Q R 1 2(4.5)	32343.020	3091.2466	2.177E+01	7.120E-19	5.777E+04	9.85130E-01	97
2.5	3.5	201.922 -	P P 1 1(3.5)	32343.567	3091.1943	1.066E+03	3.487E-17	4.955E+05	4.13042E+00	98
.5	.5	126.291 +	Q Q 2 2(.5)	32347.934	3090.4902	5.446E+02	1.781E-17	4.026E+05	1.33333E+00	99
1.5	.5	126.291 +	Q R 1 2(.5)	32348.207	3090.4565	2.717E+02	8.886E-18	1.284E+05	6.66645E-01	100

Table 8 (Contd).

J'	J"	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1}	Intensity cm/molecule	Einstein A sec^{-1}	Line strength	Number
						T = 240 K				
3.5	3.5	429.275 -	Q Q 2 2(3.5)	32349.158	3090.3741	4.289E+02	1.483E-17	5.843E+05	6.52912E+00	101
4.5	3.5	429.275 -	Q R 1 2(3.5)	32350.203	3090.2735	6.711E+01	2.195E-18	7.315E+04	1.02990E+00	102
6.5	7.5	1029.892 +	Q P 2 1(7.5)	32354.112	3089.9001	1.641E+00	5.369E-20	4.656E+04	9.31010E-01	103
1.5	1.5	187.491 -	Q Q 2 2(1.5)	32354.410	3089.8717	7.776E+02	2.543E-17	4.974E+05	2.75253E+00	104
2.5	2.5	208.769 +	Q Q 2 2(2.5)	32354.581	3089.8553	6.984E+02	2.284E-17	5.466E+05	4.55558E+00	105
2.5	1.5	187.491 -	Q R 1 2(1.5)	32354.997	3089.8156	2.637E+02	8.623E-18	1.125E+05	9.37233E-01	106
3.5	2.5	208.769 +	Q R 1 2(2.5)	32355.481	3089.7770	1.571E+02	5.137E-18	9.221E+04	1.03078E+00	107
7.5	7.5	1029.892 +	Q Q 1 1(7.5)	32355.858	3089.7342	2.559E+01	8.369E-19	6.357E+05	1.47348E+01	108
5.5	6.5	769.216 -	Q P 2 1(6.5)	32379.485	3087.4063	8.584E+00	2.807E-19	5.995E+04	1.01636E+00	109
6.5	6.5	769.216 -	Q Q 1 1(6.5)	32380.917	3087.3422	1.055E+02	3.450E-18	6.317E+05	1.26352E+01	110
1.5	2.5	83.719 +	P P 1 1(2.5)	32390.859	3086.3945	1.679E+03	5.489E-17	5.777E+05	3.10626E+00	111
4.5	5.5	544.889 +	Q P 2 1(5.5)	32402.122	3085.3217	3.642E+01	1.191E-18	7.960E+04	1.11311E+00	112
5.5	5.5	544.889 +	Q Q 1 1(5.5)	32403.405	3085.1995	3.412E+02	1.116E-17	6.216E+05	1.05266E+01	113
1.5	.5	126.449 -	R R 2 2(.5)	32415.452	3084.0528	2.721E+02	8.897E-18	1.212E+05	6.66669E-01	114
3.5	4.5	355.980 -	Q P 2 1(4.5)	32422.526	3083.3800	1.258E+02	4.086E-18	1.102E+05	1.22124E+00	115
4.5	4.5	355.980 -	Q Q 1 1(4.5)	32423.579	3083.2790	8.541E+02	2.793E-17	6.023E+05	8.41497E+00	116
.5	1.5	0.000 -	P P 1 1(1.5)	32440.540	3081.6677	2.060E+03	6.737E-17	8.611E+05	2.35645E+00	117
2.5	3.5	202.370 +	Q P 2 1(3.5)	32440.980	3081.6259	3.452E+02	1.129E-17	1.610E+05	1.33651E+00	118
3.5	3.5	202.370 +	Q Q 1 1(3.5)	32441.801	3081.5479	1.621E+03	5.302E-17	5.780E+05	6.31440E+00	119
2.5	1.5	187.751 +	R R 2 2(1.5)	32455.599	3080.2378	3.982E+02	1.302E-17	1.711E+05	1.41290E+00	120
1.5	2.5	83.928 -	Q P 2 1(2.5)	32457.981	3080.0117	7.647E+02	2.501E-17	2.646E+05	1.45015E+00	121
2.5	2.5	83.928 -	Q Q 1 1(2.5)	32458.568	3079.9560	2.233E+03	7.302E-17	5.150E+05	4.25111E+00	122
.5	1.5	.856 +	Q P 2 1(1.5)	32474.178	3078.4762	1.369E+03	4.476E-17	5.735E+05	1.56467E+00	123
1.5	1.5	.856 +	Q Q 1 1(1.5)	32474.523	3078.4420	1.961E+03	6.412E-17	4.108E+05	2.24821E+00	124
3.5	2.5	209.041 -	R R 2 2(2.5)	32489.384	3077.0346	3.472E+02	1.135E-17	2.650E+05	2.27273E+00	125
4.5	3.5	429.458 +	R R 2 2(3.5)	32517.473	3074.3765	2.098E+02	6.860E-18	2.313E+05	3.28653E+00	126
15.5	14.5	4371.365 -	R R 2 2(14.5)	32531.718	3073.0318	4.285E-08	1.375E-27	2.650E+05	1.42637E+01	127
5.5	4.5	688.188 -	R R 2 2(4.5)	32540.433	3072.2072	9.308E+01	3.041E-18	2.490E+05	4.10173E+00	128
1.5	1.5	0.000 -	R Q 2 1(1.5)	32541.981	3072.0606	8.575E+02	2.804E-17	1.803E+05	9.80002E-01	129
2.5	1.5	0.000 -	R R 1 1(1.5)	32542.480	3072.0131	5.771E+02	1.887E-17	8.891E+04	6.62669E-01	130
14.5	13.5	3841.676 +	R R 2 2(13.5)	32551.652	3071.1403	9.616E-07	3.145E-26	2.711E+05	1.32577E+01	131
6.5	5.5	824.525 +	R R 2 2(5.5)	32558.679	3070.4855	3.118E+01	1.019E-18	2.625E+05	5.17821E+00	132
2.5	2.5	83.719 +	R Q 2 1(2.5)	32559.631	3070.3956	6.715E+02	2.196E-17	1.557E+05	1.27305E+00	133
3.5	2.5	83.719 +	R R 1 1(2.5)	32560.452	3070.3182	8.076E+02	2.641E-17	1.404E+05	1.54848E+00	134
15.5	15.5	4341.846 -	R Q 2 1(15.5)	32561.229	3070.2450	2.396E-09	7.837E-29	1.271E+04	6.77938E-01	135
13.5	12.5	3344.522 -	R R 2 2(12.5)	32567.242	3069.6780	1.795E-05	5.871E-25	2.756E+05	1.22503E+01	136
7.5	6.5	1077.854 -	R R 2 2(6.5)	32572.485	3069.1840	8.056E+00	2.635E-19	2.717E+05	6.18487E+00	137
3.5	3.5	201.922 -	R Q 2 1(3.5)	32576.584	3068.8053	3.474E+02	1.136E-17	1.220E+05	1.34381E+00	138
4.5	3.5	201.922 -	R R 1 1(3.5)	32577.557	3068.7061	6.475E+02	2.117E-17	1.831E+05	2.52505E+00	139
12.5	11.5	2888.525 +	R R 2 2(11.5)	32578.555	3068.6120	2.723E-04	8.905E-24	2.791E+05	1.12416E+01	140

8.5	7.5	1367.617 +	R R 2 2(7.5)	32502.819	3068.2859	1.620E+60	5.323E-20	2.773E+05	7.19504E+00	141
14.5	14.5	3010.759 +	R Q 2 1(14.5)	32502.570	3068.2339	6.237E-60	2.039E-27	1.664E+04	7.11106E-01	142
11.5	10.5	2450.279 -	R Q 2 2(10.5)	32505.653	3067.9436	3.337E-63	1.091E-22	2.018E+05	1.02315E+01	143
15.5	14.5	3010.759 +	R R 1 1(14.5)	32505.985	3067.9124	1.190E-06	3.091E-26	2.619E+05	1.39060E+01	144
9.5	8.5	1693.290 -	R Q 2 2(8.5)	32507.372	3067.7810	2.596E-01	8.491E-21	2.006E+05	8.20815E+00	145
10.5	9.5	2054.353 +	R R 2 2(9.5)	32508.503	3067.6670	3.290E-02	1.076E-21	2.016E+05	9.22020E+00	146
4.5	4.5	355.105 +	R Q 2 1(4.5)	32591.026	3067.3626	1.350E+62	4.410E-18	9.577E+04	1.31733E+00	147
5.5	4.5	355.105 +	R R 1 1(4.5)	32593.109	3067.2410	3.615E+02	1.182E-17	2.137E+05	3.55940E+00	148
13.5	13.5	3311.982 -	R Q 2 1(13.5)	32599.703	3066.6138	1.339E-06	4.379E-26	1.695E+04	7.40441E-01	149
14.5	13.5	3311.982 -	R R 1 1(13.5)	32603.023	3066.3109	2.254E-05	7.372E-25	2.664E+05	1.29624E+01	150
5.5	5.5	543.575 -	R Q 2 1(5.5)	32605.046	3066.1100	4.111E+01	1.344E-18	7.527E+04	1.25109E+00	151
6.5	5.5	543.575 -	R R 1 1(5.5)	32606.557	3065.9766	1.499E+02	4.902E-18	2.392E+05	4.61326E+00	152
12.5	12.5	2946.009 +	R Q 2 1(12.5)	32612.991	3065.3710	2.365E-05	7.733E-25	1.979E+04	7.90527E-01	153
6.5	6.5	767.458 +	R Q 2 1(6.5)	32615.746	3065.1120	9.965E+00	3.259E-19	5.909E+04	1.17227E+00	154
13.5	12.5	2946.009 +	R R 1 1(12.5)	32616.812	3065.0879	3.477E-04	1.137E-23	2.697E+05	1.19353E+01	155
7.5	6.5	767.458 +	R R 1 1(6.5)	32617.484	3064.9693	4.756E+01	1.555E-18	2.508E+05	5.67107E+00	156
11.5	11.5	2413.613 -	R Q 2 1(11.5)	32622.320	3064.4952	3.420E-04	1.119E-23	2.317E+04	8.30010E-01	157
7.5	7.5	1026.730 -	R Q 2 1(7.5)	32623.669	3064.3741	1.942E+00	6.350E-20	4.835E+04	1.09322E+00	158
12.5	11.5	2413.613 -	R R 1 1(11.5)	32625.137	3064.2305	4.346E-03	1.421E-22	2.710E+05	1.09840E+01	159
8.5	7.5	1026.730 -	R R 1 1(7.5)	32625.569	3064.1900	1.176E+01	3.047E-19	2.604E+05	6.72852E+00	160
10.5	10.5	2015.036 +	R Q 2 1(10.5)	32627.901	3063.9710	4.646E-03	1.323E-22	2.762E+04	8.91565E-01	161
8.5	8.5	1321.252 +	R Q 2 1(8.5)	32629.304	3063.9256	3.055E-01	9.990E-21	3.953E+04	1.01913E+00	162
9.5	9.5	1650.790 -	R Q 2 1(9.5)	32629.872	3063.7859	3.899E-02	1.279E-21	3.274E+04	9.51013E-01	163
11.5	10.5	2015.036 +	R R 1 1(10.5)	32630.510	3063.7260	4.380E-02	1.432E-21	2.722E+05	9.86003E+00	164
9.5	8.5	1321.252 +	R R 1 1(8.5)	32633.565	3063.7280	2.293E+00	7.490E-20	2.671E+05	7.78859E+00	165
10.5	9.5	1650.795 -	R R 1 1(9.5)	32632.269	3063.5600	3.545E-01	1.159E-20	2.707E+05	8.82700E+00	166
2.5	1.5	.856 +	S R 2 1(1.5)	32643.295	3062.5260	1.634E+02	5.342E-18	2.305E+04	1.07807E-01	167
3.5	2.5	83.920 -	S R 2 1(2.5)	32694.505	3057.7289	1.570E+02	5.135E-18	2.756E+04	2.90634E-01	168
4.5	3.5	202.370 +	S R 2 1(3.5)	32744.561	3053.0544	8.967E+01	2.932E-18	2.569E+04	3.40830E-01	169
5.5	4.5	355.900 -	S R 2 1(4.5)	32792.722	3048.5704	3.695E+01	1.208E-18	2.228E+04	3.63319E-01	170
6.5	5.5	544.009 +	S R 2 1(5.5)	32838.395	3044.3101	1.160E+01	3.810E-19	1.873E+04	3.59496E-01	171
7.5	6.5	769.216 -	S R 2 1(6.5)	32881.122	3040.3740	2.985E+00	9.490E-20	1.569E+04	3.47219E-01	172
8.5	7.5	1029.892 +	S R 2 1(7.5)	32920.544	3036.7331	5.769E-01	1.886E-20	1.319E+04	3.31653E-01	173
9.5	8.5	1324.291 -	S R 2 1(8.5)	32956.371	3033.4317	9.217E-02	3.014E-21	1.115E+04	3.15300E-01	174
10.5	9.5	1654.577 +	S R 2 1(9.5)	32988.363	3030.4901	1.109E-02	3.887E-22	9.494E+03	2.99663E-01	175
11.5	10.5	2019.633 -	S R 2 1(10.5)	33016.273	3027.9254	1.245E-03	4.072E-23	8.143E+03	2.85026E-01	176
12.5	11.5	2419.881 +	S R 2 1(11.5)	33039.999	3025.7534	1.061E-04	3.470E-24	7.035E+03	2.71673E-01	177
13.5	12.5	2852.495 -	S R 2 1(12.5)	33059.280	3023.9887	7.377E-06	2.412E-25	6.118E+03	2.59626E-01	178
14.5	13.5	3319.355 +	S R 2 1(13.5)	33073.974	3022.6451	4.200E-07	1.373E-26	5.330E+03	2.48829E-01	179
15.5	14.5	3819.156 -	S R 2 1(14.5)	33083.919	3021.7365	1.965E-08	6.425E-28	4.687E+03	2.39107E-01	180

THE INTEGRATED INTENSITY FOR THE BAND IS 2.79400E+04 CM-2 ATM-1 AT T = 240.0 K OR 9.13939E-16 CM/MOLECULE

Table 9. Line parameters for the $A^2\Sigma$–$X^2\Pi(0,0)$ OH band at 4600°K.

J'	J"	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1} T = 4600 K	Intensity cm/molecule T = 4600 K	Einstein A sec^{-1}	Line strength	Number
39.5	40.5	26949.529 +	O P 1 2(40.5)	27339.521	3656.6660	3.209E-06	2.011E-24	6.673E+01	1.54670E-01	1
38.5	39.5	25860.074 -	O P 1 2(39.5)	27530.906	3631.2380	6.362E-06	3.979E-24	9.700E+01	1.53296E-01	2
37.5	38.5	24796.104 +	O P 1 2(38.5)	27716.057	3606.8030	1.145E-05	7.170E-24	1.314E+02	1.52320E-01	3
36.5	37.5	23734.737 -	O P 1 2(37.5)	27897.476	3583.5300	1.959E-05	1.220E-23	1.677E+02	1.51573E-01	4
35.5	36.5	22684.637 +	O P 1 2(36.5)	28073.156	3561.1047	3.230E-05	2.024E-23	2.072E+02	1.51036E-01	5
34.5	35.5	21646.000 -	O P 1 2(35.5)	28244.187	3539.5400	5.103E-05	3.249E-23	2.503E+02	1.50725E-01	6
39.5	40.5	26910.107 -	P P 2 2(40.5)	28257.590	3537.8601	8.005E-04	5.569E-22	1.954E+04	4.09727E+01	7
40.5	40.5	26910.107 -	P Q 1 2(40.5)	28263.694	3537.0970	7.110E-06	4.463E-24	1.520E+02	5.29096E-01	8
33.5	34.5	20622.193 +	O P 1 2(34.5)	28410.042	3518.7769	8.103E-05	5.079E-23	2.950E+02	1.50640E-01	9
38.5	39.5	25037.352 +	P P 2 2(39.5)	28445.626	3514.4741	1.726E-03	1.082E-21	2.013E+04	3.39824E+01	10
39.5	39.5	25037.352 +	P Q 1 2(39.5)	28451.698	3513.7239	1.653E-05	1.036E-23	2.629E+02	5.26730E-01	11
39.5	40.5	25818.569 +	P P 1 1(40.5)	28470.401	3511.4057	1.260E-03	7.967E-22	2.007E+04	4.11622E+01	12
32.5	33.5	19611.744 -	O P 1 2(33.5)	28573.369	3498.7612	1.255E-04	7.065E-23	3.408E+02	1.50014E-01	13
37.5	38.5	24766.199 -	P P 2 2(38.5)	28626.816	3492.2208	3.056E-03	1.916E-21	3.705E+04	3.09915E+01	14
38.5	38.5	24766.199 -	P Q 1 2(38.5)	28632.860	3491.4916	3.234E-05	2.027E-23	3.022E+02	5.24950E-01	15
38.5	39.5	24747.204 -	P P 1 1(39.5)	28651.775	3489.1856	2.455E-03	1.539E-21	2.007E+04	4.01540E+01	16
31.5	32.5	18616.429 +	O P 1 2(32.5)	28732.880	3479.4430	1.909E-04	1.196E-22	4.043E+02	1.51232E-01	17
36.5	37.5	23705.526 +	P P 2 2(37.5)	28801.537	3471.0466	5.117E-03	3.207E-21	4.627E+04	3.80801E+01	18
37.5	37.5	23705.526 +	P Q 1 2(37.5)	28807.515	3470.3227	5.085E-05	3.639E-23	5.114E+02	5.23001E-01	19
37.5	38.5	23686.472 +	P P 1 1(38.5)	28826.569	3468.0208	4.334E-03	2.716E-21	3.008E+04	3.91655E+01	20
30.5	31.5	17637.228 -	O P 1 2(31.5)	28886.947	3460.7799	2.075E-04	1.082E-22	4.670E+02	1.51915E-01	21
35.5	36.5	22656.237 -	P P 2 2(36.5)	28970.810	3450.8567	8.239E-03	5.164E-21	5.500E+04	3.70081E+01	22
36.5	36.5	22656.237 -	P Q 1 2(36.5)	28975.976	3450.1463	9.087E-05	6.197E-23	6.519E+02	5.23201E-01	23
36.5	37.5	22637.836 -	P P 1 1(37.5)	28995.177	3447.8615	7.229E-03	4.531E-21	4.743E+04	3.81756E+01	24
29.5	30.5	16675.895 +	O P 1 2(30.5)	29038.482	3442.7290	4.280E-04	2.682E-22	5.302E+02	1.52075E-01	25
40.5	40.5	26949.529 +	Q Q 2 2(40.5)	29120.465	3433.0269	1.110E-03	7.080E-22	2.573E+04	8.14577E+01	26
34.5	35.5	21619.256 +	P P 2 2(35.5)	29132.621	3431.5944	1.289E-02	8.076E-21	6.563E+04	3.60155E+01	27
35.5	35.5	21619.256 +	P Q 1 2(35.5)	29138.537	3430.8977	1.624E-04	1.018E-22	8.047E+02	5.23422E-01	28
35.5	36.5	21599.898 +	P P 1 1(36.5)	29157.894	3428.6199	1.160E-02	7.260E-21	5.717E+04	3.71074E+01	29
28.5	29.5	15731.031 -	O P 1 2(29.5)	29186.542	3425.2545	6.319E-04	3.960E-22	6.180E+02	1.54120E-01	30
33.5	34.5	20595.523 -	P P 2 2(34.5)	29289.614	3413.2084	1.958E-02	1.227E-20	7.535E+04	3.50222E+01	31
34.5	34.5	20595.523 -	P Q 1 2(34.5)	29295.473	3412.5177	2.587E-04	1.622E-22	9.674E+02	5.24252E-01	32
39.5	39.5	25860.074 -	Q Q 2 2(39.5)	29307.631	3411.1921	2.545E-03	1.599E-21	4.336E+04	7.94633E+01	33
40.5	39.5	25860.074 -	Q R 1 2(39.5)	29313.727	3410.3927	6.302E-06	3.950E-24	1.040E+02	2.95112E-01	34
34.5	35.5	20575.998 -	P P 1 1(35.5)	29314.998	3410.2440	1.806E-02	1.132E-20	6.721E+04	3.61970E+01	35
39.5	40.5	25455.390 -	Q P 2 1(40.5)	29323.316	3409.6263	1.107E-05	6.916E-24	1.079E+02	3.52704E-01	36
40.5	40.5	25895.390 -	Q Q 1 1(40.5)	29326.412	3408.9175	1.503E-03	9.925E-22	2.625E+04	8.13537E+01	37
27.5	28.5	14906.007 +	O P 1 2(28.5)	29331.526	3408.3231	9.213E-04	5.775E-22	7.059E+02	1.55692E-01	38
32.5	33.5	19585.991 +	P P 2 2(33.5)	29441.248	3395.6205	2.941E-02	1.843E-20	8.590E+04	3.40283E+01	39
33.5	33.5	19585.991 +	P Q 1 2(33.5)	29447.844	3394.9522	4.039E-04	2.531E-22	1.145E+03	5.25799E-01	40
33.5	34.5	19566.287 +	P P 1 1(34.5)	29466.747	3392.6828	2.733E-02	1.713E-20	7.713E+04	3.52077E+01	41
26.5	27.5	13980.997 -	O P 1 2(27.5)	29473.450	3391.9049	1.320E-03	8.326E-22	8.029E+02	1.57587E-01	42
38.5	38.5	24796.104 +	Q Q 2 2(38.5)	29486.793	3390.3755	4.069E-03	3.052E-21	6.159E+04	7.74683E+01	43
39.5	38.5	24796.104 +	Q R 1 2(38.5)	29492.066	3389.6774	1.399E-05	8.767E-24	1.726E+02	2.95702E-01	44
38.5	39.5	24783.345 +	Q P 2 1(39.5)	29499.632	3388.8939	2.195E-05	1.376E-23	2.767E+02	3.52570E-01	45
39.5	39.5	24783.345 +	Q Q 1 1(39.5)	29505.735	3388.2023	3.592E-03	2.252E-21	4.410E+04	7.93610E+01	46
31.5	32.5	18591.624 -	P P 2 2(32.5)	29587.766	3378.0858	4.327E-02	2.712E-20	9.645E+04	3.30336E+01	47

32.5	32.5	18591.624	-	P	Q	1	2(32.5)	29593.498	3378.1516	6.221E-04	3.099E-22	1.345E+03	5.28099E-01	48
25.5	26.5	13016.966	+	O	P	1	2(26.5)	29612.505	3375.9738	1.982E-03	1.192E-21	9.141E+02	1.59836E-01	49
32.5	33.5	18571.723	-	P	P	1	1(33.5)	29613.306	3375.8817	4.005E-02	2.961E-20	8.790E+04	4.62172E+01	50
37.5	37.5	23734.737	-	Q	Q	2	2(37.5)	29650.270	3370.7716	8.534E-03	5.369E-21	8.841E+04	7.54725E+01	51
38.5	37.5	23734.737	-	Q	R	1	2(37.5)	29664.322	3370.0049	2.605E-05	1.603E-23	2.467E+02	2.96817E-01	52
37.5	38.5	23721.729	-	Q	P	2	1(38.5)	29671.206	3369.2939	3.974E-05	2.491E-23	3.733E+02	3.52042E-01	53
38.5	38.5	23721.729	-	Q	Q	1	1(38.5)	29677.330	3368.6077	6.050E-03	4.293E-21	6.271E+04	7.75674E+01	54
30.5	31.5	17613.392	+	P	P	2	2(31.5)	29729.391	3362.7084	6.207E-02	3.940E-20	1.079E+05	3.20302E+01	55
31.5	31.5	17613.392	+	P	Q	1	2(31.5)	29735.030	3362.0699	9.467E-04	5.934E-22	1.569E+03	5.31109E-01	56
24.5	25.5	12154.873	-	O	P	1	2(25.5)	29740.902	3360.5030	2.691E-03	1.607E-21	1.036E+03	1.62469E-01	57
31.5	32.5	17593.290	+	P	P	1	1(32.5)	29755.140	3359.7905	5.981E-02	3.749E-20	9.066E+04	3.32263E+01	58
36.5	36.5	22604.637	+	Q	Q	2	2(36.5)	29822.396	3352.2211	1.416E-02	8.877E-21	9.970E+04	7.34762E+01	59
37.5	36.5	22604.637	+	Q	R	1	2(36.5)	29828.434	3351.5459	4.775E-05	2.993E-23	3.277E+02	2.99234E-01	60
36.5	37.5	22671.446	+	Q	P	2	1(37.5)	29835.507	3350.7198	6.814E-05	4.271E-23	4.789E+02	3.53513E-01	61
37.5	37.5	22671.446	+	Q	Q	1	1(37.5)	29841.595	3350.0644	1.196E-02	7.496E-21	8.100E+04	7.53735E+01	62
29.5	30.5	16692.271	-	P	P	2	2(30.5)	29866.335	3347.2091	9.002E-02	5.643E-20	1.109E+05	3.10420E+01	63
30.5	30.5	16652.271	-	P	Q	1	2(30.5)	29871.096	3346.6661	1.421E-03	8.908E-22	1.017E+03	5.35115E-01	64
23.5	24.5	11315.663	+	O	P	1	2(24.5)	29882.546	3345.4732	3.783E-03	2.371E-21	1.170E+03	1.65515E-01	65
30.5	31.5	16631.946	-	P	P	1	1(31.5)	29892.221	3344.3904	8.645E-02	5.419E-20	1.100E+05	3.22349E+01	66
35.5	35.5	21646.000	-	Q	Q	2	2(35.5)	29979.439	3334.6604	2.263E-02	1.418E-20	1.197E+05	7.14791E+01	67
36.5	35.5	21646.000	-	Q	R	1	2(35.5)	29985.404	3333.9970	8.091E-05	5.071E-23	4.165E+02	3.00054E-01	68
35.5	36.5	21633.410	-	Q	P	2	1(36.5)	29992.029	3333.1716	1.126E-04	7.055E-23	5.934E+02	3.54611E-01	69
28.5	29.5	15789.237	+	P	P	2	2(29.5)	29998.793	3332.5098	1.275E-01	7.989E-20	1.300E+05	3.08469E+01	70
36.5	36.5	21633.410	-	Q	Q	1	1(36.5)	29998.795	3332.5088	1.977E-02	1.239E-20	1.014E+05	7.33707E+01	71
29.5	29.5	15789.237	+	P	Q	1	2(29.5)	30004.260	3331.9817	2.100E-03	1.321E-21	2.092E+03	5.39929E-01	72
22.5	23.5	10500.267	-	O	P	1	2(23.5)	30013.664	3330.0644	5.250E-03	3.290E-21	1.335E+03	1.69813E-01	73
29.5	30.5	15600.670	+	P	P	1	1(30.5)	30024.026	3329.6194	1.231E-01	7.717E-20	1.216E+05	3.12430E+01	74
27.5	28.5	14785.263	-	P	P	2	2(28.5)	30126.944	3318.3330	1.777E-01	1.114E-19	1.427E+05	2.98469E+01	75
34.5	34.5	20622.193	+	Q	Q	2	2(34.5)	30129.604	3318.0312	3.497E-02	2.192E-20	1.395E+05	6.94013E+01	76
28.5	28.5	14785.263	-	P	Q	1	2(28.5)	30132.310	3317.7420	3.090E-03	1.937E-21	2.397E+03	5.45670E-01	77
35.5	34.5	20622.193	+	Q	R	1	2(34.5)	30135.600	3317.3790	1.313E-04	8.227E-23	5.092E+02	3.02297E-01	78
21.5	22.5	9789.682	+	O	P	1	2(22.5)	30142.147	3316.6592	7.252E-03	4.546E-21	1.517E+03	1.73006E-01	79
34.5	35.5	20680.586	+	Q	P	2	1(35.5)	30143.291	3316.5336	1.86[illegible]E-04	1.134E-22	7.109E+02	3.56159E-01	80
35.5	35.5	20680.586	+	Q	Q	1	1(35.5)	30149.207	3315.8826	3.144E-02	1.973E-20	1.216E+05	7.13830E+01	81
28.5	29.5	14764.434	-	P	P	1	1(29.5)	30153.139	3315.4502	1.733E-01	1.086E-19	1.330E+05	3.02505E+01	82
40.5	39.5	25937.352	+	R	P	2	2(39.5)	30232.641	3306.7313	8.786E-04	5.457E-22	1.529E+04	3.91496E+01	83
26.5	27.5	13801.320	+	P	P	2	2(27.5)	30250.955	3304.7293	2.442E-01	1.530E-19	1.549E+05	2.88679E+01	84
40.5	40.5	25010.569	+	R	Q	2	1(40.5)	30251.424	3304.6761	8.926E-06	5.595E-24	1.556E+02	4.39496E-01	85
27.5	27.5	13801.320	+	P	Q	1	2(27.5)	30256.213	3304.1558	4.484E-03	2.811E-21	2.737E+03	5.52439E-01	86
20.5	21.5	8944.563	-	O	P	1	2(21.5)	30260.236	3302.8425	9.898E-03	6.204E-21	1.721E+03	1.77544E-01	87
33.5	33.5	19611.744	-	Q	Q	2	2(33.5)	30273.392	3302.2080	5.286E-02	3.313E-20	1.597E+05	6.74027E+01	88
27.5	28.5	13060.205	+	P	P	1	1(28.5)	30277.329	3301.8506	2.402E-01	1.506E-19	1.459E+05	2.92574E+01	89
34.5	33.5	19611.744	-	Q	R	1	2(33.5)	30279.251	3301.6409	2.099E-04	1.315E-22	6.162E+02	3.04904E-01	90
33.5	34.5	19597.902	-	Q	P	2	1(34.5)	30287.234	3300.7707	2.830E-04	1.773E-22	8.521E+02	3.50169E-01	91
34.5	34.5	19597.902	-	Q	Q	1	1(34.5)	30293.346	3300.1322	4.830E-02	3.032E-20	1.416E+05	6.93066E+01	92
25.5	26.5	12990.371	-	P	P	2	2(26.5)	30370.991	3291.6698	3.321E-01	2.081E-19	1.669E+05	2.70470E+01	93
26.5	26.5	12990.371	-	P	Q	1	2(26.5)	30376.124	3291.1113	6.430E-03	4.030E-21	3.113E+03	5.60206E-01	94
19.5	20.5	8286.027	+	O	P	1	2(20.5)	30391.910	3289.4889	1.341E-02	8.409E-21	1.960E+03	1.92606E-01	95
26.5	27.5	12976.943	-	P	P	1	1(27.5)	30397.552	3288.7912	3.281E-01	2.056E-19	1.580E+05	2.82630E+01	96
39.5	38.5	24766.199	-	R	R	2	2(38.5)	30409.507	3287.4983	1.878E-03	1.177E-21	2.441E+04	3.81605E+01	97
32.5	32.5	18616.429	+	Q	Q	2	2(32.5)	30410.009	3287.3574	7.865E-02	4.930E-20	1.010E+05	6.54032E+01	98
33.5	32.5	18616.429	+	Q	R	1	2(32.5)	30416.665	3286.7310	3.207E-04	2.060E-22	7.343E+02	3.00147E-01	99
32.5	33.5	18602.331	+	Q	P	2	1(33.5)	30424.960	3285.8341	4.382E-04	2.747E-22	1.609E+03	3.60670E-01	100

Table 9 (Contd).

J'	J"	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1}	Intensity cm/molecule	Einstein A sec^{-1}	Line strength	Number
						T = 4600 K				
39.5	39.5	24747.284 -	Q Q 2 1(39.5)	30420.421	3205.4547	2.869E-05	1.297E-23	2.676E+02	6.30270E-01	101
33.5	33.5	18602.331 +	Q Q 1 1(33.5)	30430.703	3205.2003	7.276E-02	4.561E-20	1.620E+05	6.73094E+01	102
40.5	39.5	24747.284 -	R R 1 1(39.5)	30434.517	3204.7966	1.220E-03	7.690E-22	1.550E+04	3.90114E+01	103
24.5	25.5	12137.370 +	P P 2 2(25.5)	30487.162	3279.1262	4.445E-01	2.706E-19	1.700E+05	2.60466E+01	104
25.5	25.5	12137.370 +	P Q 1 2(25.5)	30492.182	3278.5844	9.134E-03	5.729E-21	3.539E+03	5.69307E-01	105
18.5	19.5	7494.048 -	Q P 1 2(19.5)	30513.229	3276.3229	1.081E-02	1.129E-20	2.237E+03	1.00581E-01	106
25.5	26.5	12115.598 +	P P 1 1(26.5)	30513.954	3276.2458	4.433E-01	2.779E-19	1.706E+05	2.72694E+01	107
31.5	31.5	17637.220 -	Q Q 2 2(31.5)	30542.169	3273.2183	1.154E-01	7.230E-20	2.031E+05	6.34029E+01	108
32.5	31.5	17637.220 -	Q R 1 2(31.5)	30547.893	3272.6049	5.077E-04	3.182E-22	8.670E+02	3.11010E-01	109
31.5	32.5	17622.844 -	Q P 2 1(32.5)	30556.545	3271.6783	6.662E-04	4.179E-22	1.170E+03	3.63711E-01	110
32.5	32.5	17622.844 -	Q Q 1 1(32.5)	30562.269	3271.0655	1.077E-01	6.751E-20	1.034E+05	6.53913E+01	111
38.5	37.5	23705.526 +	R Q 2 2(37.5)	30577.451	3269.4413	3.499E-03	2.193E-21	3.303E+04	3.71711E+01	112
38.5	38.5	23686.472 +	Q Q 2 1(38.5)	30596.505	3267.4052	4.030E-05	2.531E-23	3.007E+02	4.37505E-01	113
23.5	24.5	11299.258 -	P P 2 2(24.5)	30599.620	3267.0717	5.891E-01	3.693E-19	1.914E+05	2.50442E+01	114
39.5	38.5	23686.472 +	R Q 1 1(38.5)	30602.578	3266.7560	2.640E-03	1.659E-21	2.470E+04	3.08211E+01	115
24.5	24.5	11299.258 -	P Q 1 2(24.5)	30604.517	3266.5490	1.286E-02	8.061E-21	4.018E+03	5.79608E-01	116
24.5	25.5	11277.107 -	P P 1 1(25.5)	30626.660	3264.1872	5.896E-01	3.695E-19	1.029E+05	2.62765E+01	117
17.5	18.5	6811.855 +	Q P 1 2(18.5)	30632.193	3263.5984	2.390E-02	1.503E-20	2.557E+03	1.95070E-01	118
30.5	30.5	16675.095 +	Q Q 2 2(30.5)	30667.609	3259.8289	1.664E-01	1.043E-19	2.259E+05	6.14016E+01	119
31.5	30.5	16675.095 +	Q R 1 2(30.5)	30673.335	3259.2280	7.722E-04	4.840E-22	1.016E+03	3.16007E-01	120
30.5	31.5	16660.417 +	Q P 2 1(31.5)	30682.366	3258.2614	1.002E-03	6.281E-22	1.355E+03	3.67300E-01	121
31.5	31.5	16660.417 +	Q Q 1 1(31.5)	30688.012	3257.6619	1.571E-01	9.846E-20	2.859E+05	6.33922E+01	122
22.5	23.5	10484.962 +	P P 2 2(23.5)	30708.495	3255.4898	7.689E-01	4.819E-19	2.035E+05	2.40484E+01	123
23.5	23.5	10484.962 +	P Q 1 2(23.5)	30713.247	3254.9853	1.792E-02	1.123E-20	4.546E+03	5.91289E-01	124
23.5	24.5	10462 394 +	P P 1 1(24.5)	30735.816	3252.5951	7.768E-01	4.864E-19	1.957E+05	2.52707E+01	125
37.5	36.5	22656.237 -	R Q 2 2(36.5)	30736.778	3252.4933	6.023E-03	3.779E-21	4.350E+04	3.61013E+01	126
16.5	17.5	6157.854 -	Q P 1 2(17.5)	30748.824	3251.2191	3.162E-02	1.982E-20	2.932E+03	2.02489E-01	127
37.5	37.5	22637.836 -	R Q 2 1(37.5)	30755.979	3250.4627	7.231E-05	4.532E-23	5.190E+02	4.37461E-01	128
38.5	37.5	22637.836 -	R R 1 1(37.5)	30762.823	3249.8240	4.898E-03	3.070E-21	3.432E+04	3.70303E+01	129
29.5	29.5	15731.831 -	Q Q 2 2(29.5)	30787.575	3247.1267	2.366E-01	1.483E-19	2.489E+05	5.94794E+01	130
30.5	29.5	15731.831 -	Q R 1 2(29.5)	30793.136	3246.5403	1.162E-03	7.283E-22	1.194E+03	3.20775E-01	131
29.5	30.5	15716.826 -	Q P 2 1(30.5)	30802.580	3245.5449	1.489E-03	9.334E-22	1.561E+03	3.71402E-01	132
30.5	30.5	15716.826 -	Q Q 1 1(30.5)	30808.141	3244.9591	2.256E-01	1.413E-19	2.207E+05	6.13921E+01	133
21.5	22.5	9695.394 -	P P 2 2(22.5)	30813.869	3244.3550	9.916E-01	6.215E-19	2.157E+05	2.30351E+01	134
22.5	22.5	9695.394 -	P Q 1 2(22.5)	30818.477	3243.8707	2.472E-02	1.549E-20	5.146E+03	6.04507E-01	135
22.5	23.5	9672.362 -	P P 1 1(23.5)	30841.509	3241.4401	1.006E+00	6.303E-19	2.083E+05	2.42023E+01	136
15.5	16.5	5533.628 +	Q P 1 2(16.5)	30863.123	3239.1780	4.139E-02	2.594E-20	3.308E+03	2.10069E-01	137
36.5	35.5	21619.256 +	R R 2 2(35.5)	30887.77-	3236.5925	9.860E-03	6.180E-21	5.343E+04	3.51911E+01	138
28.5	28.5	14886.887 +	Q Q 2 2(28.5)	30902.022	3235.1805	3.317E-01	2.079E-19	2.723E+05	5.74761E+01	139
36.5	36.5	21599.898 +	R Q 2 1(36.5)	30907.135	3234.5653	1.220E-04	7.690E-23	6.620E+02	4.37923E-01	140
29.5	28.5	14886.887 +	Q R 1 2(28.5)	30907.409	3234.5202	1.722E-03	1.079E-21	1.367E+03	3.26157E-01	141
37.5	36.5	21599.898 +	R R 1 1(36.5)	30913.143	3233.9366	8.396E-03	5.263E-21	4.400E+04	3.60390E+01	142
20.5	21.5	8931.446 +	P P 2 2(21.5)	30915.846	3233.6530	1.260E+00	7.899E-19	2.276E+05	2.20203E+01	143
28.5	29.5	14790.647 +	Q P 2 1(29.5)	30917.383	3233.4931	2.193E-03	1.374E-21	1.794E+03	3.76297E-01	144
21.5	21.5	8931.446 +	P Q 1 2(21.5)	30920.383	3233.1877	3.382E-02	2.120E-20	5.835E+03	6.19413E-01	145
29.5	29.5	14790.647 +	Q Q 1 1(29.5)	30922.858	3232.9214	3.105E-01	1.996E-19	2.519E+05	5.93910E+01	146

21.5	22.5	8907.898	+	P	P	1	1(22.5)	30943.051	3230.7272	1.208E+00	8.073E-19	2.209E+05	2.32058E+01	147
14.5	15.5	4939.902	-	O	P	1	2(15.5)	30975.083	3227.4696	5.360E-02	3.364E-20	3.918E+03	2.20341E-01	148
27.5	27.5	13980.997	-	Q	Q	2	2(27.5)	31011.210	3223.7096	4.507E-01	2.079E-19	2.968E+05	5.54716E+01	149
19.5	20.5	8193.998	-	P	P	2	2(20.5)	31014.510	3223.3665	1.501E+00	9.966E-19	2.396E+05	2.18190E+01	150
28.5	27.5	13980.997	-	Q	R	1	2(27.5)	31016.576	3223.1510	2.530E-03	3.306E-21	1.577E+03	3.32208E-01	151
20.5	20.5	8193.998	-	P	Q	1	2(20.5)	31018.089	3222.9190	4.503E-02	2.073E-20	6.619E+03	6.36194E-01	152
27.5	28.5	13985.249	-	Q	P	2	1(28.5)	31026.957	3222.6733	3.108E-03	1.998E-21	2.049E+03	3.01794E-01	153
35.5	34.5	20595.523	-	R	R	2	2(34.5)	31030.725	3221.6921	1.542E-02	9.665E-21	6.209E+04	3.42009E-01	154
28.5	28.5	13985.249	-	Q	Q	1	1(28.5)	31032.324	3221.5161	4.435E-01	2.708E-19	2.751E+05	5.73080E+01	155
20.5	21.5	8169.866	-	P	P	1	1(21.5)	31042.933	3220.4151	1.624E+00	1.018E-18	2.331E+05	2.22868E+01	156
35.5	35.5	20575.998	-	R	Q	2	1(35.5)	31058.250	3219.6562	2.012E-04	1.261E-22	8.166E+02	4.30993E-01	157
36.5	35.5	20575.998	-	R	R	1	1(35.5)	31056.215	3219.0377	1.360E-02	8.574E-21	5.485E+04	3.50471E-01	158
13.5	14.5	4377.419	+	O	P	1	2(14.5)	31084.683	3216.0896	6.095E-02	4.322E-20	4.547E+03	2.31868E-01	159
18.5	19.5	7403.875	+	P	P	2	2(19.5)	31109.936	3213.4708	1.956E+00	1.220E-18	2.519E+05	2.08093E+01	160
19.5	19.5	7403.875	+	P	Q	1	2(19.5)	31114.078	3213.0519	6.153E-02	3.857E-20	7.510E+03	6.55860E-01	161
26.5	26.5	13016.966	+	Q	Q	2	2(26.5)	31115.349	3212.9239	6.249E-01	3.910E-19	3.138E+05	5.34660E+01	162
27.5	26.5	13016.966	+	Q	R	1	2(26.5)	31120.567	3212.3011	3.677E-03	2.305E-21	1.813E+03	3.30959E-01	163
26.5	27.5	13008.797	+	Q	P	2	1(27.5)	31131.478	3211.2551	4.578E-03	2.870E-21	2.330E+03	3.08027E-01	164
27.5	27.5	13008.797	+	Q	Q	1	1(27.5)	31136.736	3210.7120	6.093E-01	3.819E-19	2.991E+05	5.53054E+01	165
19.5	20.5	7659.105	+	P	P	1	1(20.5)	31138.039	3210.4960	2.022E+00	1.268E-18	2.456E+05	2.12077E+01	166
34.5	33.5	19565.991	+	R	R	2	2(33.5)	31165.986	3207.7097	2.371E-02	1.486E-20	7.317E+04	3.32094E-01	167
34.5	34.5	19566.287	+	R	Q	2	1(34.5)	31185.539	3205.6036	3.195E-04	2.068E-22	9.018E+02	4.40700E-01	168
35.5	34.5	19566.287	+	R	R	1	1(34.5)	31191.565	3205.0749	2.138E-02	1.339E-20	6.360E+04	3.40547E-01	169
12.5	13.5	3046.859	-	O	P	1	2(13.5)	31191.892	3205.0352	8.799E-02	5.519E-20	5.329E+03	2.43203E-01	170
17.5	18.5	6881.926	-	P	P	2	2(18.5)	31202.188	3203.9776	2.386E+00	1.495E-18	2.632E+05	1.89967E+01	171
18.5	18.5	6881.926	-	P	Q	1	2(18.5)	31206.151	3203.5707	8.174E-02	5.123E-20	8.544E+03	6.76291E-01	172
25.5	25.5	12154.973	-	Q	Q	2	2(25.5)	31214.479	3202.7159	8.406E-01	5.269E-19	3.420E+05	5.16590E+01	173
26.5	25.5	12154.973	-	Q	R	1	2(25.5)	31219.622	3202.1884	5.270E-03	3.308E-21	2.073E+03	3.46690E-01	174
25.5	26.5	12130.244	-	Q	P	2	1(26.5)	31231.188	3201.0186	6.527E-03	4.091E-21	2.650E+03	3.95050E-01	175
18.5	19.5	6776.431	-	P	P	1	1(19.5)	31231.646	3200.9555	2.486E+00	1.557E-18	2.500E+05	2.02076E+01	176
26.5	26.5	12130.244	-	Q	Q	1	1(26.5)	31236.251	3200.4836	8.244E-01	5.167E-19	3.225E+05	5.33007E+01	177
40.5	39.5	24783.145	+	S	R	2	1(39.5)	31286.649	3195.3279	5.912E-06	3.706E-24	7.976E+01	1.86740E-01	178
16.5	17.5	6148.962	+	P	P	2	2(17.5)	31291.328	3194.8509	2.865E+00	1.796E-18	2.744E+05	1.79818E+01	179
33.5	32.5	18591.624	-	R	R	2	2(32.5)	31293.513	3194.6278	3.563E-02	2.233E-20	8.361E+04	3.22108E-01	180
17.5	17.5	6148.962	+	P	Q	1	2(17.5)	31295.166	3194.4544	1.078E-01	6.756E-20	9.749E+03	7.08164E-01	181
11.5	12.5	3348.988	+	O	P	1	2(12.5)	31296.666	3194.3051	1.112E-01	6.973E-20	6.208E+03	2.56973E-01	182
24.5	24.5	11315.663	+	Q	Q	2	2(24.5)	31308.869	3193.0608	1.117E+00	7.003E-19	3.669E+05	4.94507E+01	183
33.5	33.5	18571.728	-	R	Q	2	1(33.5)	31313.488	3192.5972	4.970E-04	3.115E-22	1.161E+03	4.43073E-01	184
25.5	24.5	11315.663	+	Q	R	1	2(24.5)	31313.899	3192.5481	7.519E-03	4.713E-21	2.373E+03	3.56087E-01	185
34.5	33.5	18571.724	-	R	R	1	1(33.5)	31319.268	3191.9998	3.250E-02	2.042E-20	7.392E+04	3.30615E-01	186
17.5	18.5	6122.628	+	P	P	1	1(18.5)	31321.421	3191.7904	3.087E+00	1.805E-18	2.703E+05	1.92065E+01	187
24.5	25.5	11290.532	+	Q	P	2	1(25.5)	31326.808	3191.3138	9.187E-03	5.758E-21	3.082E+03	4.02960E-01	188
25.5	25.5	11290.532	+	Q	Q	1	1(25.5)	31331.028	3190.8925	1.101E+00	6.981E-19	3.460E+05	5.13764E+01	189
15.5	16.5	5525.697	-	P	P	2	2(16.5)	31377.379	3186.0081	3.394E+00	2.127E-18	2.857E+05	1.69642E+01	190
16.5	16.5	5525.697	-	P	Q	1	2(16.5)	31388.981	3185.7223	1.400E-01	8.826E-20	1.116E+04	7.27041E-01	191
23.5	23.5	10508.267	-	Q	Q	2	2(23.5)	31398.619	3183.9327	1.463E+00	9.169E-19	3.897E+05	4.74480E+01	192
10.5	11.5	2994.118	-	O	P	1	2(11.5)	31398.949	3183.8992	1.395E-01	8.745E-20	7.400E+03	2.72696E-01	193
24.5	23.5	10508.267	-	Q	R	1	2(23.5)	31403.588	3183.4378	1.057E-02	6.626E-21	2.704E+03	3.64211E-01	194
16.5	17.5	5498.452	-	P	P	1	1(17.5)	31408.225	3182.9588	3.586E+00	2.246E-18	2.821E+05	1.82842E+01	195
32.5	31.5	17613.392	+	R	R	2	2(31.5)	31413.847	3182.3892	5.267E-02	3.301E-20	9.458E+04	3.12268E-01	196
23.5	24.5	10482.588	-	Q	P	2	1(24.5)	31416.299	3182.1439	1.284E-02	8.048E-21	3.489E+03	4.11815E-01	197
24.5	24.5	10482.588	-	Q	Q	1	1(24.5)	31421.187	3181.6457	1.452E+00	9.181E-19	3.698E+05	4.93678E+01	198
32.5	32.5	17593.298	+	R	Q	2	1(32.5)	31433.949	3180.3548	7.620E-04	4.781E-22	1.362E+03	4.46147E-01	199
33.5	32.5	17593.298	+	R	R	1	1(32.5)	31439.744	3179.7677	4.869E-02	3.052E-20	8.439E+04	3.20670E-01	200

Table 9 (*Contd*).

J'	J''	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1}	Intensity cm/molecule	Einstein A sec^{-1}	Line strength	Number
					T = 4600 K					
39.5	38.5	23721.729 -	S R 2 1(38.5)	31453.976	3178.3289	1.292E-05	8.100E-24	1.296E+02	1.83893E-01	201
14.5	15.5	4932.933 +	P P 2 2(15.5)	31460.396	3177.6883	3.953E+00	2.470E-18	2.965E+05	1.59436E+01	202
15.5	15.5	4932.933 +	P Q 1 2(15.5)	31463.010	3177.3355	1.022E-01	1.142E-19	1.281E+04	7.57344E-01	203
22.5	22.5	9789.382 +	Q Q 2 2(22.5)	31483.056	3175.3124	1.089E+00	1.104E-18	4.122E+05	4.54292E+01	204
23.5	22.5	9789.682 +	Q R 1 2(22.5)	31488.688	3174.8332	1.473E-02	9.27[illegible]E-21	3.082E+03	3.74564E-01	205
15.5	16.5	4984.629 +	P P 1 1(16.5)	31492.115	3174.4796	4.214E+00	2.[illegible]1E-18	2.942E+05	1.72807E+01	206
9.5	10.5	2453.149 +	O P 1 2(10.5)	31498.667	3173.8193	1.734E-01	1.087E-19	9.883E+03	2.90339E-01	207
22.5	23.5	9691.321 +	Q P 2 1(23.5)	31502.136	3173.4697	1.774E-02	1.112E-20	3.853E+03	4.21728E-01	208
23.5	23.5	9691.321 +	Q Q 1 1(23.5)	31506.888	3172.9911	1.087E+00	1.183E-18	3.938E+05	4.73578E+01	209
31.5	30.5	16652.271 -	R R 2 2(30.5)	31527.118	3170.9558	7.648E-02	4.794E-20	1.855E+05	3.02336E+01	210
13.5	14.5	4371.365 -	P P 2 2(14.5)	31540.408	3169.6197	4.527E+00	2.837E-18	3.867E+05	1.49196E+01	211
14.5	14.5	4371.365 -	P Q 1 2(14.5)	31543.628	3169.2961	2.337E-01	1.469E-19	1.478E+04	7.91566E-01	212
31.5	31.5	16631.946 -	R Q 2 1(31.5)	31547.443	3168.9128	1.157E-03	7.249E-22	1.588E+03	4.49959E-01	213
32.5	31.5	16631.946 -	R R 1 1(31.5)	31553.168	3168.3371	7.156E-02	4.485E-20	9.538E+04	3.10733E+01	214
21.5	21.5	8944.563 -	Q Q 2 2(21.5)	31564.781	3167.1793	2.418E+00	1.511E-18	4.351E+05	4.34157E+01	215
22.5	21.5	8944.563 -	Q R 1 2(21.5)	31569.389	3166.7171	2.835E-02	1.276E-20	3.516E+03	3.86858E-01	216
14.5	15.5	4341.846 -	P P 1 1(15.5)	31573.139	3166.3329	4.873E+00	3.854E-18	3.859E+05	1.62758E+01	217
21.5	22.5	8925.622 -	Q P 2 1(22.5)	31583.642	3165.2799	2.429E-02	1.523E-20	4.365E+03	4.32788E-01	218
22.5	22.5	8925.622 -	Q Q 1 1(22.5)	31588.258	3164.8182	2.418E+00	1.516E-18	4.157E+05	4.57468E+01	219
8.5	9.5	2356.568 -	O P 1 2(9.5)	31595.731	3164.0687	2.137E-01	1.339E-19	1.096E+04	3.10386E-01	220
38.5	37.5	22671.446 +	S R 2 1(37.5)	31611.531	3162.4873	2.443E-05	1.531E-23	1.827E+02	1.01661E-01	221
12.5	13.5	3841.676 +	P P 2 2(13.5)	31617.484	3161.8998	5.183E+00	3.198E-18	3.178E+05	1.38917E+01	222
13.5	13.5	3841.676 +	P Q 1 2(13.5)	31620.425	3161.5977	2.974E-01	1.864E-19	1.716E+04	8.38293E-01	223
30.5	29.5	15789.237 +	R R 2 2(29.5)	31633.547	3160.2862	1.896E-01	6.867E-20	1.178E+05	2.92487E+01	224
20.5	20.5	8286.827 +	Q Q 2 2(20.5)	31641.266	3159.5152	3.831E+00	1.988E-18	4.572E+05	4.14802E+01	225
21.5	20.5	8286.827 +	Q R 1 2(20.5)	31645.722	3159.0782	2.779E-02	1.742E-20	4.883E+03	3.98821E-01	226
13.5	14.5	3818.759 +	P P 1 1(14.5)	31651.343	3158.5052	5.548E+00	3.472E-18	3.172E+05	1.52695E+01	227
30.5	30.5	15688.678 +	R Q 2 1(30.5)	31654.113	3158.2328	1.729E-03	1.084E-21	1.837E+03	4.54553E-01	228
31.5	30.5	15688.678 +	R R 1 1(30.5)	31659.768	3157.6695	1.833E-01	6.474E-20	1.863E+05	3.88708E+01	229
20.5	21.5	8186.358 +	Q P 2 1(21.5)	31660.935	3157.5523	3.291E-02	2.063E-20	4.940E+03	4.45149E-01	230
21.5	21.5	8186.358 +	Q Q 1 1(21.5)	31665.391	3157.1088	3.859E+00	1.917E-18	4.384E+05	4.33338E+01	231
7.5	8.5	1694.914 +	O P 1 2(8.5)	31690.828	3154.6534	2.689E-01	1.635E-19	1.352E+04	3.32982E-01	232
11.5	12.5	3344.522 -	P P 2 2(12.5)	31691.411	3154.5157	5.645E+00	3.538E-18	3.267E+05	1.28593E+01	233
12.5	12.5	3344.522 -	P Q 1 2(12.5)	31694.228	3154.2353	3.752E-01	2.352E-19	2.885E+04	8.74287E-01	234
19.5	19.5	7494.848 -	Q Q 2 2(19.5)	31713.653	3152.3033	3.758E+00	2.355E-18	4.786E+05	3.93825E+01	235
20.5	19.5	7494.848 -	Q R 1 2(19.5)	31717.951	3151.8761	3.764E-02	2.359E-20	4.567E+03	4.13804E-01	236
12.5	13.5	3311.982 -	P P 1 1(13.5)	31726.769	3151.0881	6.264E+00	3.889E-18	3.289E+05	1.42615E+01	237
29.5	28.5	14785.263 -	R R 2 2(28.5)	31733.344	3150.3472	1.541E-01	9.661E-20	1.282E+05	2.82472E+01	238
19.5	20.5	7474.376 -	Q P 2 1(20.5)	31734.125	3150.2696	4.422E-02	2.772E-20	5.684E+03	4.58959E-01	239
20.5	20.5	7474.376 -	Q Q 1 1(20.5)	31738.423	3149.8438	3.815E+00	2.391E-18	4.685E+05	4.13147E+01	240
29.5	29.5	14764.434 -	R Q 2 1(29.5)	31754.173	3148.2806	2.554E-03	1.681E-21	2.112E+03	4.59970E-01	241
37.5	36.5	21633.418 -	S R 2 1(36.5)	31759.597	3147.7429	4.274E-05	2.679E-23	2.394E+02	1.00457E-01	242
30.5	29.5	14764.434 -	R R 1 1(29.5)	31759.733	3147.7294	1.478E-01	9.215E-20	1.17[illegible]E+05	2.98828E+01	243
10.5	11.5	2888.525 +	P P 2 2(11.5)	31762.412	3147.4639	6.127E+00	3.841E-18	3.362E+05	1.18217E+01	244
11.5	11.5	2888.525 +	P Q 1 2(11.5)	31765.821	3147.2054	4.698E-01	2.948E-19	2.359E+04	9.24897E-01	245
6.5	7.5	1368.728 -	O P 1 2(7.5)	31781.413	3145.5921	3.151E-01	1.975E-19	1.695E+04	3.57791E-01	246
18.5	18.5	6811.855 +	Q Q 2 2(18.5)	31781.956	3145.5284	4.585E+00	2.874E-18	4.986E+05	3.73622E+01	247

19.5	18.5	6011.055 +	Q R 1 2(18.5)	31786.089	3145.1193	5.049E-02	3.164E-20	5.217E+03	4.20781E-01	248
11.5	12.5	2046.089 +	P P 1 1(12.5)	31799.456	3143.7972	6.822E+00	4.276E-18	3.402E+05	1.32510E+01	249
18.5	19.5	6790.493 +	Q P 2 1(19.5)	31803.318	3143.4154	5.808E-02	3.691E-20	6.370E+03	4.74397E-01	250
19.5	19.5	6790.493 +	Q Q 1 1(19.5)	31807.452	3143.0069	4.688E+00	2.930E-18	4.019E+05	3.93012E+01	251
28.5	27.5	13901.320 +	R R 2 2(27.5)	31826.769	3141.1051	2.143E-01	1.343E-19	1.390E+05	2.72532E+01	252
9.5	10.5	2450.279 -	P P 2 2(10.5)	31830.303	3140.7425	6.510E+00	4.000E-18	3.449E+05	1.07780E+01	253
10.5	10.5	2450.279 -	P Q 1 2(10.5)	31832.700	3140.5061	5.816E-01	3.646E-19	2.081E+04	9.00044E-01	254
17.5	17.5	6157.856 -	Q Q 2 2(17.5)	31846.260	3139.1767	5.520E+00	3.460E-18	5.109E+05	3.53391E+01	255
28.5	28.5	13060.205 +	R Q 2 1(28.5)	31847.024	3139.0224	3.729E-03	2.336E-21	2.410E+03	4.66291E-01	256
18.5	17.5	6157.856 -	Q R 1 2(17.5)	31852.222	3138.7061	6.708E-02	4.204E-20	5.971E+03	4.46359E-01	257
29.5	28.5	13060.205 +	R R 1 1(28.5)	31853.291	3138.4037	2.055E-01	1.280E-19	1.209E+05	2.00050E+01	258
17.5	18.5	6135.500 -	Q P 2 1(18.5)	31860.613	3136.9747	7.769E-02	4.870E-20	7.250E+03	4.91600E-01	259
10.5	11.5	2413.613 -	P P 1 1(11.5)	31869.446	3136.8927	7.367E+00	4.617E-18	3.516E+05	1.22402E+01	260
5.5	6.5	1070.509 +	O P 1 2(6.5)	31869.785	3136.8672	3.752E-01	2.351E-19	2.162E+04	3.04410E-01	261
18.5	18.5	6135.500 -	Q Q 1 1(18.5)	31872.576	3136.5846	5.669E+00	3.553E-18	5.010E+05	3.72811E+01	262
8.5	9.5	2054.353 +	P P 2 2(9.5)	31895.203	3134.3516	6.764E+00	4.240E-18	3.532E+05	9.72727E+00	263
9.5	9.5	2054.353 +	P Q 1 2(9.5)	31897.463	3134.1373	7.146E-01	4.479E-19	3.359E+04	1.04530E+00	264
36.5	35.5	20600.506 +	S R 2 1(35.5)	31898.447	3134.0486	7.124E-05	4.465E-23	3.000E+02	1.79406E-01	265
16.5	16.5	5533.620 +	Q Q 2 2(16.5)	31906.642	3133.2356	6.544E+00	4.102E-18	5.379E+05	3.33129E+01	266
17.5	16.5	5533.620 +	Q R 1 2(16.5)	31910.428	3132.8639	8.830E-02	5.535E-20	6.851E+03	4.65976E-01	267
27.5	26.5	12990.371 -	R R 2 2(26.5)	31913.835	3132.5294	2.930E-01	1.841E-19	1.514E+05	2.62506E+01	268
16.5	17.5	5510.159 +	Q P 2 1(17.5)	31930.184	3130.9333	1.015E-01	6.360E-20	8.205E+03	5.11063E-01	269
17.5	17.5	5510.159 +	Q Q 1 1(17.5)	31933.009	3130.5621	6.762E+00	4.238E-18	5.216E+05	3.52579E+01	270
27.5	27.5	12970.943 -	R Q 2 1(27.5)	31935.264	3130.4276	5.384E-03	3.374E-21	2.759E+03	4.73555E-01	271
9.5	10.5	2015.036 +	P P 1 1(10.5)	31936.781	3130.2787	7.796E+00	4.886E-18	3.620E+05	1.12265E+01	272
28.5	27.5	12970.943 -	R R 1 1(27.5)	31943.630	3129.9815	2.836E-01	1.778E-19	1.404E+05	2.70072E+01	273
4.5	5.5	824.013 -	O P 1 2(5.5)	31954.665	3128.5267	4.309E-01	2.751E-19	2.019E+04	4.18930E-01	274
7.5	8.5	1693.298 -	P P 2 2(8.5)	31957.049	3128.2934	6.855E+00	4.297E-18	3.611E+05	8.66026E+00	275
8.5	8.5	1693.298 -	P Q 1 2(8.5)	31959.008	3128.1015	8.707E-01	5.450E-19	4.077E+04	1.11050E+00	276
15.5	15.5	4939.902 -	Q Q 2 2(15.5)	31963.173	3127.6939	7.629E+00	4.782E-18	5.549E+05	3.12030E+01	277
16.5	15.5	4939.902 -	Q R 1 2(15.5)	31965.776	3127.3414	1.150E-01	7.211E-20	7.077E+03	4.87917E-01	278
15.5	16.5	4915.197 -	Q P 2 1(16.5)	31987.077	3125.2783	1.315E-01	8.245E-20	9.580E+03	5.32052E-01	279
16.5	16.5	4915.197 -	Q Q 1 1(16.5)	31991.408	3124.9262	7.943E+00	4.978E-18	5.405E+05	3.32319E+01	280
26.5	25.5	12137.370 +	R R 2 2(25.5)	31994.965	3124.5910	3.966E-01	2.485E-19	1.627E+05	2.52634E+01	281
8.5	9.5	1650.790 -	P P 1 1(9.5)	32001.509	3123.9470	8.083E+00	5.066E-18	3.745E+05	1.02106E+01	282
6.5	7.5	1367.617 +	P P 2 2(7.5)	32015.547	3122.5733	6.744E+00	4.227E-18	3.680E+05	7.59904E+00	283
14.5	14.5	4377.419 +	Q Q 2 2(14.5)	32015.910	3122.5417	8.750E+00	5.484E-18	5.712E+05	2.92491E+01	284
26.5	26.5	12115.598 +	R Q 2 1(26.5)	32016.677	3122.4669	7.682E-03	4.815E-21	3.134E+03	4.81846E-01	285
7.5	7.5	1367.617 +	P Q 1 2(7.5)	32017.324	3122.4038	1.051E+00	6.590E-19	5.020E+04	1.20092E+00	286
15.5	14.5	4377.419 +	Q R 1 2(14.5)	32019.325	3122.2087	1.487E-01	9.322E-20	9.105E+03	5.12512E-01	287
27.5	26.5	12115.598 +	R R 1 1(26.5)	32021.935	3121.9542	3.868E-01	2.426E-19	1.519E+05	2.60003E+01	288
35.5	34.5	19597.982 -	S R 2 1(34.5)	32024.345	3121.3293	1.136E-04	7.123E-23	3.614E+02	1.78754E-01	289
3.5	4.5	600.194 +	O P 1 2(4.5)	32035.976	3120.5958	4.996E-01	3.131E-19	3.767E+04	4.32924E-01	290
14.5	15.5	4351.310 +	Q P 2 1(15.5)	32042.019	3119.9973	1.689E-01	1.050E-19	1.095E+04	5.57613E-01	291
15.5	15.5	4351.310 +	Q Q 1 1(15.5)	32045.433	3119.6649	9.171E+00	5.748E-18	5.577E+05	3.12811E+01	292
7.5	8.5	1321.252 +	P P 1 1(8.5)	32063.690	3117.8885	8.194E+00	5.136E-18	3.860E+05	9.19252E+00	293
13.5	13.5	3846.059 -	Q Q 2 2(13.5)	32064.906	3117.7702	9.866E+00	6.184E-18	5.864E+05	2.72186E+01	294
14.5	13.5	3846.059 -	Q R 1 2(13.5)	32069.126	3117.4571	1.904E-01	1.193E-19	1.056E+04	5.40150E-01	295
25.5	24.5	11299.250 -	R R 2 2(24.5)	32070.095	3117.2658	5.293E-01	3.317E-19	1.743E+05	2.42675E+01	296
5.5	6.5	1077.856 -	P P 2 2(6.5)	32070.760	3117.2084	6.405E+00	4.819E-18	3.737E+05	6.52103E+00	297
6.5	6.5	1077.856 -	P Q 1 2(6.5)	32072.279	3117.0534	1.255E+00	7.865E-19	6.276E+04	1.29194E+00	298
25.5	25.5	11277.107 -	R Q 2 1(25.5)	32092.245	3115.1141	1.086E-02	6.805E-21	3.556E+03	4.91247E-01	299
13.5	14.5	3819.156 -	Q P 2 1(14.5)	32092.600	3115.0789	2.147E-01	1.346E-19	1.267E+04	5.85189E-01	300

Table 9 (*Contd*).

J'	J"	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1} T = 4600 K	Intensity cm/molecule T = 4600 K	Einstein A sec^{-1}	Line strength	Number
14.5	14.5	3819.156 -	Q Q 1 1(14.5)	32095.029	3114.7663	1.042E+01	6.520E-18	5.739E+05	2.91665E+01	301
26.5	25.5	11277.107 -	R R 1 1(25.5)	32097.380	3114.6150	5.170E-01	3.242E-19	1.631E+05	2.50004E+01	302
12.5	12.5	3340.000 +	Q Q 2 2(12.5)	32110.280	3113.3722	1.093E+01	6.050E-18	6.002E+05	2.51660E+01	303
2.5	3.5	429.275 -	Q P 1 2(3.5)	32113.213	3113.0801	5.417E-01	3.399E-19	5.179E+04	4.40599E-01	304
13.5	12.5	3340.000 +	Q R 1 2(12.5)	32113.222	3113.0792	2.416E-01	1.514E-19	1.232E+04	5.71279E-01	305
4.5	5.5	824.525 +	P P 2 2(5.5)	32122.405	3112.1892	5.032E+00	3.656E-18	3.705E+05	5.43172E+00	306
6.5	7.5	1026.730 -	P P 1 1(7.5)	32123.483	3112.0925	8.095E+00	5.074E-18	3.997E+05	8.17260E+00	307
5.5	5.5	824.525 +	P Q 1 2(5.5)	32123.689	3112.0640	1.478E+00	9.261E-19	7.991E+04	1.30079E+00	308
24.5	23.5	10404.962 +	R R 2 2(23.5)	32139.570	3110.5270	6.946E-01	4.354E-19	1.852E+05	2.32710E+01	309
12.5	13.5	3319.355 +	Q P 2 1(13.5)	32139.725	3110.5120	2.711E-01	1.700E-19	1.470E+04	6.16716E-01	310
13.5	13.5	3319.355 +	Q Q 1 1(13.5)	32142.747	3110.2196	1.163E+01	7.209E-18	5.000E+05	2.71260E+01	311
34.5	33.5	10602.331 +	S R 2 1(33.5)	32149.545	3109.5610	1.786E-04	1.119E-22	4.311E+02	1.70260E-01	312
11.5	11.5	2804.110 -	Q Q 2 2(11.5)	32151.022	3109.3416	1.186E+01	7.435E-18	6.120E+05	2.31170E+01	313
12.5	11.5	2804.110 -	Q R 1 2(11.5)	32154.640	3109.0691	3.039E-01	1.909E-19	1.447E+04	6.06410E-01	314
24.5	24.5	10462.394 +	R Q 2 1(24.5)	32162.139	3108.3442	1.520E-02	9.530E-21	4.031E+03	5.01057E-01	315
25.5	24.5	10462.394 +	R R 1 1(24.5)	32167.150	3107.8591	6.046E-01	4.291E-19	1.746E+05	2.40074E+01	316
3.5	4.5	680.100 -	P P 2 2(4.5)	32170.237	3107.5617	5.022E+00	3.140E-18	3.819E+05	4.33399E+00	317
4.5	4.5	680.100 -	P Q 1 2(4.5)	32171.290	3107.4600	1.785E+00	1.069E-18	1.837E+05	1.40361E+00	318
5.5	6.5	767.450 +	P P 1 1(6.5)	32180.756	3106.5459	7.760E+00	4.869E-18	4.141E+05	7.15200E+00	319
11.5	12.5	2852.405 -	Q P 2 1(12.5)	32183.440	3106.2866	3.393E-01	2.127E-19	1.737E+04	6.52643E-01	320
1.5	2.5	280.769 +	O P 1 2(2.5)	32185.069	3106.0502	5.341E-01	3.340E-19	7.357E+04	4.13554E-01	321
12.5	12.5	2852.405 -	Q Q 1 1(12.5)	32186.266	3106.0141	1.275E+01	7.992E-18	6.025E+05	2.50015E+01	322
10.5	10.5	2453.149 +	Q Q 2 2(10.5)	32189.787	3105.6743	1.262E+01	7.980E-18	6.220E+05	2.10604E+01	323
11.5	10.5	2453.149 +	Q R 1 2(10.5)	32192.397	3105.4225	3.786E-01	2.373E-19	1.711E+04	6.46105E-01	324
23.5	22.5	9695.394 -	R R 2 2(22.5)	32203.491	3104.3526	9.080E-01	5.641E-19	1.961E+05	2.22737E+01	325
2.5	3.5	429.450 +	P P 2 2(3.5)	32213.892	3103.3503	3.998E+00	2.501E-18	3.035E+05	3.23470E+00	326
3.5	3.5	429.450 +	P Q 1 2(3.5)	32214.713	3103.2712	1.910E+00	1.197E-18	1.377E+05	1.55030E+00	327
10.5	11.5	2419.001 +	Q P 2 1(11.5)	32223.855	3102.3900	4.215E-01	2.642E-19	2.060E+04	6.93759E-01	328
9.5	9.5	2056.560 -	Q Q 2 2(9.5)	32224.895	3102.3677	1.311E+01	8.217E-18	6.293E+05	1.09962E+01	329
11.5	11.5	2419.001 +	Q Q 1 1(11.5)	32226.464	3102.1396	1.378E+01	8.507E-18	6.139E+05	2.30295E+01	330
10.5	9.5	2056.560 -	Q R 1 2(9.5)	32226.492	3102.1369	4.676E-01	2.931E-19	2.041E+04	6.90930E-01	331
23.5	23.5	9672.362 -	R Q 2 1(23.5)	32226.524	3102.1339	2.107E-02	1.320E-20	4.563E+03	5.13700E-01	332
24.5	23.5	9672.362 -	R R 1 1(23.5)	32231.413	3101.6632	8.910E-01	5.585E-19	1.853E+05	2.30050E+01	333
4.5	5.5	543.575 -	P P 1 1(5.5)	32235.903	3101.2312	7.216E+00	4.523E-18	4.319E+05	6.13324E+00	334
1.5	2.5	289.041 -	P P 2 2(2.5)	32252.860	3099.6007	2.702E+00	1.744E-18	3.040E+05	2.14901E+00	335
.5	1.5	187.491 -	O P 1 2(1.5)	32253.649	3099.5825	4.156E-01	2.605E-19	1.114E+05	3.10162E-01	336
2.5	2.5	289.041 -	P Q 1 2(2.5)	32253.447	3099.5443	2.033E+00	1.274E-18	1.875E+05	1.57735E+00	337
8.5	8.5	1694.914 +	Q Q 2 2(8.5)	32254.722	3099.4217	1.329E+01	8.329E-18	6.342E+05	1.69230E+01	338
9.5	8.5	1694.914 +	Q R 1 2(8.5)	32256.982	3099.2122	5.723E-01	3.587E-19	2.450E+04	7.41400E-01	339
9.5	10.5	2019.633 -	Q P 2 1(10.5)	32261.029	3098.8150	5.191E-01	3.253E-19	2.469E+04	7.41015E-01	340
22.5	21.5	8931.446 +	R R 2 2(21.5)	32262.011	3098.7215	1.151E+00	7.215E-19	2.860E+05	2.12757E+01	341
33.5	32.5	17622.044 -	S R 2 1(32.5)	32262.292	3098.6945	2.740E-04	1.723E-22	5.063E+02	1.70036E-01	342
10.5	10.5	2019.633 -	Q Q 1 1(10.5)	32263.426	3098.5056	1.442E+01	9.039E-18	6.236E+05	2.09700E+01	343
7.5	7.5	1360.720 -	Q Q 2 2(7.5)	32281.619	3096.8392	1.318E+01	8.209E-18	6.360E+05	1.40431E+01	344
8.5	7.5	1360.720 -	Q R 1 2(7.5)	32283.579	3096.6512	6.920E-01	4.342E-19	2.991E+04	7.97604E-01	345
22.5	22.5	8987.898 +	R Q 2 1(22.5)	32285.559	3096.4612	2.009E-02	1.011E-20	5.160E+03	5.27171E-01	346
.5	1.5	187.751 +	P P 2 2(1.5)	32286.475	3096.3734	1.478E+00	9.264E-19	3.970E+05	1.10199E+00	347

1.5 1.5	107.751 +	P Q 1 2(1.5)	32286.827	3096.3396	1.906E+00	1.265E-18	2.667E+05	1.40500E+00	348
3.5 4.5	355.105 +	P P 1 1(4.5)	32289.066	3096.1250	6.440E+00	4.041E-18	4.563E+05	5.12107E+00	349
23.5 22.5	8907.898 +	R R 1 1(22.5)	32290.311	3096.0055	1.145E+00	7.174E-19	1.959E+05	2.20014E+01	350
8.5 9.5	1654.577 +	Q P 2 1(9.5)	32295.859	3095.5583	6.340E-01	3.979E-19	2.999E+04	7.95546E-01	351
9.5 9.5	1654.577 +	Q Q 1 1(9.5)	32297.248	3095.3414	1.403E+01	9.293E-18	6.304E+05	1.09017E+01	352
6.5 6.5	1078.509 +	Q Q 2 2(6.5)	32304.695	3094.6269	1.240E+01	7.019E-18	6.332E+05	1.27554E+01	353
7.5 6.5	1078.509 +	Q R 1 2(6.5)	32306.433	3094.4605	8.291E-01	5.196E-19	3.602E+04	8.59222E-01	354
.5 .5	126.449 -	P Q 1 2(.5)	32314.091	3093.7271	1.023E+00	1.142E-18	4.010E+05	1.33333E+00	355
21.5 20.5	8193.998 -	R R 2 2(20.5)	32315.274	3093.6139	1.440E+00	9.079E-19	2.167E+05	2.02760E+01	356
5.5 5.5	824.813 -	Q Q 2 2(5.5)	32323.888	3092.7976	1.142E+01	7.159E-18	6.252E+05	1.06667E+01	357
6.5 5.5	824.813 -	Q R 1 2(5.5)	32325.320	3092.6524	9.777E-01	6.120E-19	4.509E+04	9.23700E-01	358
7.5 8.5	1324.291 -	Q P 2 1(8.5)	32326.847	3092.5028	7.789E-01	4.832E-19	3.782E+04	8.50667E-01	359
8.5 8.5	1324.291 -	Q Q 1 1(8.5)	32328.887	3092.3953	1.487E+01	9.319E-18	6.347E+05	1.60236E+01	360
4.5 4.5	608.194 +	Q Q 2 2(4.5)	32338.736	3091.3693	9.916E+00	6.219E-18	6.095E+05	8.58148E+00	361
21.5 21.5	8169.866 -	R Q 2 1(21.5)	32339.398	3091.3068	3.929E-02	2.463E-20	5.043E+03	5.42150E-01	362
5.5 4.5	608.194 +	Q R 1 2(4.5)	32340.828	3091.2466	1.120E+00	7.069E-19	5.777E+04	9.85130E-01	363
2.5 3.5	201.922 -	P P 1 1(3.5)	32340.567	3091.1943	5.491E+00	3.442E-18	4.955E+05	4.13042E+00	364
22.5 21.5	8169.966 -	R R 1 1(21.5)	32344.885	3090.9657	1.451E+00	9.092E-19	2.064E+05	2.18763E+01	365
.5 .5	126.291 +	Q Q 2 2(.5)	32347.934	3090.4982	1.025E+00	1.144E-18	4.826E+05	1.33333E+00	366
1.5 .5	126.291 +	Q R 1 2(.5)	32348.287	3090.4565	9.105E-01	5.707E-19	1.264E+05	6.66645E-01	367
3.5 3.5	429.275 -	Q Q 2 2(3.5)	32349.158	3090.3741	8.830E+00	5.830E-18	5.843E+05	6.52912E+00	368
4.5 3.5	429.275 -	Q R 1 2(3.5)	32350.283	3090.2735	1.258E+00	7.883E-19	7.315E+04	1.02990E+00	369
6.5 7.5	1029.892 +	Q P 2 1(7.5)	32354.112	3089.9001	9.289E-01	5.822E-19	4.656E+04	9.31818E-01	370
1.5 1.5	107.491 -	Q Q 2 2(1.5)	32354.418	3089.8717	3.689E+00	2.312E-18	4.974E+05	2.75253E+00	371
2.5 2.5	288.769 +	Q Q 2 2(2.5)	32354.581	3089.8559	5.991E+00	3.692E-18	5.466E+05	4.55550E+00	372
2.5 1.5	107.491 -	Q R 1 2(1.5)	32354.997	3089.8156	1.251E+00	7.841E-19	1.125E+05	9.37233E-01	373
3.5 2.5	288.769 +	Q R 1 2(2.5)	32355.461	3089.7770	1.325E+00	8.304E-19	9.221E+04	1.03070E+00	374
7.5 7.5	1029.892 +	Q Q 1 1(7.5)	32355.858	3089.7342	1.449E+01	9.083E-18	6.357E+05	1.47340E+01	375
20.5 19.5	7403.875 +	R R 2 2(19.5)	32363.418	3089.0116	1.799E+00	1.127E-18	2.765E+05	1.92771E+01	376
32.5 31.5	16660.417 +	S R 2 1(31.5)	32366.821	3088.6858	4.169E-04	2.613E-22	5.094E+02	1.70065E-01	377
5.5 6.5	769.216 -	Q P 2 1(6.5)	32379.485	3087.4862	1.110E+00	6.958E-19	5.995E+04	1.01636E+00	378
6.5 6.5	769.216 -	Q Q 1 1(6.5)	32380.917	3087.3422	1.365E+01	8.553E-18	6.317E+05	1.26352E+01	379
29.5 20.5	7459.105 +	R Q 2 1(20.5)	32388.187	3086.6491	5.291E-02	3.316E-20	6.620E+03	5.59923E-01	380
1.5 2.5	83.719 +	P P 1 1(2.5)	32390.859	3086.3945	4.416E+00	2.760E-18	5.777E+05	3.19626E+00	381
21.5 20.5	7459.105 +	R R 1 1(20.5)	32392.643	3086.2245	1.808E+00	1.133E-18	2.168E+05	2.08696E+01	382
4.5 5.5	544.809 +	Q P 2 1(5.5)	32402.122	3085.3217	1.316E+00	8.247E-19	7.960E+04	1.11311E+00	383
5.5 5.5	544.809 +	Q Q 1 1(5.5)	32403.435	3085.1995	1.233E+01	7.728E-18	6.216E+05	1.05266E+01	384
19.5 18.5	6081.926 -	R R 2 2(18.5)	32406.575	3084.8977	2.281E+00	1.379E-18	2.357E+05	1.82765E+01	385
1.5 .5	126.449 -	R R 2 2(.5)	32415.452	3084.0520	9.124E-01	5.718E-19	1.212E+05	6.66665E-01	386
3.5 4.5	355.988 -	Q P 2 1(4.5)	32422.526	3083.3988	1.543E+00	9.674E-19	1.182E+05	1.22124E+00	387
4.5 4.5	355.988 -	Q Q 1 1(4.5)	32423.579	3083.2798	1.855E+01	6.612E-18	6.823E+05	8.41497E+00	388
19.5 19.5	6776.431 -	P Q 2 1(19.5)	32432.878	3082.4726	7.857E-02	4.423E-20	7.589E+03	5.77673E-01	389
20.5 19.5	6776.431 -	R R 1 1(19.5)	32436.368	3082.0641	2.224E+00	1.394E-18	2.254E+05	1.98611E+01	390
.5 1.5	0.000 -	P P 1 1(1.5)	32440.540	3081.6677	3.360E+00	2.111E-18	8.611E+05	2.35645E+00	391
2.5 3.5	202.370 +	Q P 2 1(3.5)	32440.988	3081.6259	1.782E+00	1.117E-18	1.610E+05	1.33651E+00	392
3.5 3.5	202.370 +	Q Q 1 1(3.5)	32441.891	3081.5479	8.369E+00	5.246E-18	5.780E+05	6.31440E+00	393
18.5 17.5	6140.942 +	R R 2 2(17.5)	32444.868	3081.2565	2.652E+00	1.662E-18	2.443E+05	1.72749E+01	394
2.5 1.5	107.751 +	R R 2 2(1.5)	32455.599	3080.2378	1.892E+00	1.186E-18	1.711E+05	1.41290E+00	395
1.5 2.5	83.928 -	Q P 2 1(2.5)	32457.981	3080.0117	2.014E+00	1.262E-18	2.646E+05	1.45015E+00	396
2.5 2.5	83.928 -	Q Q 1 1(2.5)	32458.568	3079.9568	5.888E+00	3.685E-18	5.159E+05	4.25111E+00	397
31.5 30.5	15716.826 -	S R 2 1(30.5)	32463.363	3079.5011	6.227E-04	3.903E-22	6.797E+02	1.79360E-01	398
18.5 18.5	6122.628 +	R Q 2 1(18.5)	32471.103	3078.7594	9.311E-02	5.836E-20	8.521E+03	5.98646E-01	399
.5 1.5	.056 +	Q P 2 1(1.5)	32474.178	3078.4762	2.238E+00	1.402E-18	5.735E+05	1.56467E+00	400

Table 9 (Contd).

J'	J''	Lower energy vacuum cm^{-1}	Transition	Frequency vacuum cm^{-1}	Wavelength STP angstroms	Intensity cm^{-2}-atm^{-1}	Intensity cm/molecule	Einstein A sec^{-1}	Line strength	Number
						T = 4600 K				
1.5	1.5	.056 +	Q Q 1 1(1.5)	32474.523	3078.4420	3.207E+00	2.010E-18	4.100E+05	2.24021E+00	401
19.5	18.5	6122.620 +	R R 1 1(18.5)	32475.317	3078.3675	2.694E+00	1.689E-18	2.34[illegible]E+05	1.00500E+01	402
17.5	16.5	5525.697 -	R R 2 2(16.5)	32478.417	3078.0737	3.146E+00	1.972E-18	2.523E+05	1.62723E+01	403
3.5	2.5	289.041 -	R R 2 2(2.5)	32489.384	3077.0346	2.933E+00	1.838E-18	2.050E+05	2.27273E+00	404
17.5	17.5	5498.452 -	R Q 2 1(17.5)	32505.661	3075.4937	1.219E-01	7.640E-20	9.707E+03	6.22121E-01	405
16.5	15.5	4932.933 +	R R 2 2(15.5)	32507.330	3075.3350	3.669E+00	2.300E-18	2.592E+05	1.52006E+01	406
18.5	17.5	5498.452 -	R R 1 1(17.5)	32509.624	3075.1180	3.212E+00	2.013E-18	2.424E+05	1.70304E+01	407
4.5	3.5	429.450 +	R R 2 2(3.5)	32517.473	3074.3765	3.936E+00	2.467E-18	2.313E+05	3.20653E+00	408
15.5	14.5	4371.365 -	R R 2 2(14.5)	32531.710	3073.0310	4.214E+00	2.641E-18	2.650E+05	1.4[illegible]37E+01	409
16.5	16.5	4904.629 +	R Q 2 1(16.5)	32535.634	3072.6603	1.581E-01	9.912E-20	1.109E+04	6.40424E-01	410
17.5	16.5	4904.629 +	R R 1 1(16.5)	32539.420	3072.3020	3.770E+00	2.363E-18	2.490E+05	1.60236E+01	411
5.5	4.5	608.188 -	R R 2 2(4.5)	32540.433	3072.2072	4.817E+00	3.019E-18	2.490E+05	4.10173E+00	412
1.5	1.5	0.000 -	R Q 2 1(1.5)	32541.981	3072.0606	1.402E+00	8.787E-19	1.003E+05	9.00002E-01	413
2.5	1.5	0.000 -	R R 1 1(1.5)	32542.484	3072.0131	9.434E-01	5.913E-19	8.091E+04	6.62669E-01	414
14.5	13.5	3841.676 +	R R 2 2(13.5)	32551.652	3071.1483	4.751E+00	2.978E-18	2.711E+05	1.32577E+01	415
30.5	29.5	14790.647 +	S R 2 1(29.5)	32552.137	3071.1026	9.197E-04	5.764E-22	7.063E+02	1.70954E-01	416
6.5	5.5	824.525 +	R R 2 2(5.5)	32558.679	3070.4855	5.521E+00	3.460E-18	2.629E+05	5.17021E+00	417
2.5	2.5	83.719 +	R Q 2 1(2.5)	32559.631	3070.3956	1.766E+00	1.107E-18	1.557E+05	1.27305E+00	418
3.5	2.5	83.719 +	R R 1 1(2.5)	32560.452	3070.3182	2.124E+00	1.332E-18	1.404E+05	1.54040E+00	419
15.5	15.5	4341.046 -	R Q 2 1(15.5)	32561.229	3070.2450	2.031E-01	1.273E-19	1.271E+04	6.77930E-01	420
16.5	15.5	4341.046 -	R R 1 1(15.5)	32564.831	3069.9053	4.346E+00	2.724E-18	2.561E+05	1.50062E+01	421
13.5	12.5	3344.522 -	R R 2 2(12.5)	32567.242	3069.6780	5.261E+00	3.297E-18	2.756E+05	1.22503E+01	422
7.5	6.5	1077.054 -	R R 2 2(6.5)	32572.485	3069.1840	6.019E+00	3.772E-18	2.717E+05	6.10407E+00	423
3.5	3.5	201.922 -	R Q 2 1(3.5)	32576.504	3068.8053	1.789E+00	1.121E-18	1.220E+05	1.34301E+00	424
4.5	3.5	201.922 -	R R 1 1(3.5)	32577.557	3068.7061	3.334E+00	2.090E-18	1.031E+05	2.52505E+00	425
12.5	11.5	2880.525 +	R R 2 2(11.5)	32578.555	3068.6120	5.714E+00	3.582E-18	2.791E+05	1.12416E+01	426
8.5	7.5	1367.617 +	R R 2 2(7.5)	32582.019	3068.2859	6.310E+00	3.955E-18	2.773E+05	7.19504E+00	427
14.5	14.5	3810.759 +	R Q 2 1(14.5)	32582.578	3068.2339	2.585E-01	1.620E-19	1.464E+04	7.11106E-01	428
11.5	10.5	2450.279 -	R R 2 2(10.5)	32585.653	3067.9436	6.074E+00	3.807E-18	2.010E+05	1.02315E+01	429
15.5	14.5	3810.759 +	R R 1 1(14.5)	32585.985	3067.9124	4.932E+00	3.091E-18	2.619E+05	1.39060E+01	430
9.5	8.5	1693.290 -	R R 2 2(8.5)	32587.372	3067.7818	6.404E+00	4.014E-18	2.006E+05	8.20815E+00	431
10.5	9.5	2054.353 +	R R 2 2(9.5)	32588.583	3067.6678	6.315E+00	3.958E-18	2.016E+05	9.22020E+00	432
4.5	4.5	355.105 +	R Q 2 1(4.5)	32591.826	3067.3626	1.660E+00	1.041E-18	9.577E+04	1.[illegible]1733E+00	433
5.5	4.5	355.105 +	R R 1 1(4.5)	32593.109	3067.2418	4.445E+00	2.786E-18	2.137E+05	3.55940E+00	434
13.5	13.5	3311.982 -	P Q 2 1(13.5)	32599.783	3066.6138	3.262E-01	2.044E-19	1.695E+04	7.40441E-01	435
14.5	13.5	3311.982 -	R R 1 1(13.5)	32603.003	3066.3109	5.491E+00	3.441E-18	2.664E+05	1.29624E+01	436
5.5	5.5	543.575 -	R Q 2 1(5.5)	32605.046	3066.1188	1.475E+00	9.246E-19	7.527E+04	1.25109E+00	437
6.5	5.5	543.575 -	R R 1 1(5.5)	32606.557	3065.9766	5.378E+00	3.371E-18	2.352E+05	4.61326E+00	438
12.5	12.5	2846.009 +	R Q 2 1(12.5)	32612.991	3065.3718	4.080E-01	2.557E-19	1.975E+04	7.90527E-01	439

6.5	6.5	767.458 +	R Q 2 1(6.5)	32615.746	3065.1129	1.276E+00	7.997E-19	5.909E+04	1.17227E+00	440
13.5	12.5	2046.009 +	R R 1 1(12.5)	32616.012	3065.0079	5.999E+00	3.760E-18	2.697E+05	1.19353E+01	441
7.5	6.5	767.458 +	R R 1 1(6.5)	32617.404	3064.9496	6.098E+00	3.017E-18	2.502E+05	5.67107E+00	442
11.5	11.5	2413.613 -	R Q 2 1(11.5)	32622.320	3064.4952	5.655E-01	3.160E-19	2.317E+04	8.30010E-01	443
7.5	7.5	1026.738 -	R Q 2 1(7.5)	32623.608	3064.3741	1.005E+00	6.000E-19	4.035E+04	1.09322E+00	444
12.5	11.5	2413.613 -	R R 1 1(11.5)	326[illegible].137	3064.2305	6.424E+00	4.026E-18	2.710E+05	1.09040E+01	445
8.5	7.5	1026.738 -	R R 1 1(7.5)	326[illegible].569	3064.1900	6.573E+00	4.119E-18	2.604E+05	6.72052E+00	446
10.5	10.5	2015.036 +	R Q 2 1(10.5)	[illegible].901	3063.9718	6.209E-01	3.092E-19	2.742E+04	8.91565E-01	447
8.5	8.5	1321.252 +	R Q 2 1(8.5)	326[illegible].304	3063.9256	9.099E-01	5.703E-19	3.953E+04	1.01913E+00	448
9.5	9.5	1650.796 -	R Q 2 1(9.5)	326[illegible].072	3063.7859	7.552E-01	4.733E-19	3.274E+04	9.52013E-01	449
11.5	10.5	2015.036 +	P R 1 1(10.5)	32630.518	3063.7260	6.722E+00	4.213E-18	2.722E+05	9.06003E+00	450
9.5	8.5	1321.252 +	R R 1 1(8.5)	32630.565	3063.7200	6.829E+00	4.208E-18	2.671E+05	7.70050E+00	451
10.5	9.5	1650.798 -	R R 1 1(9.5)	32632.269	3063.5608	6.869E+00	4.309E-18	2.707E+05	8.02708E+00	452
29.5	28.5	13005.249 -	S R 2 1(28.5)	32633.357	3063.4586	1.337E-03	8.382E-22	8.074E+02	1.79030E-01	453
2.5	1.5	.856 +	S R 2 1(1.5)	32643.295	3062.5260	2.672E-01	1.674E-19	2.305E+04	1.07007E-01	454
3.5	2.5	83.920 -	S R 2 1(2.5)	32694.505	3057.7289	4.135E-01	2.592E-19	2.756E+04	2.98634E-01	455
28.5	27.5	13008.797 +	S R 2 1(27.5)	32787.232	3056.5390	1.927E-03	1.208E-21	1.088E+03	1.81036E-01	456
4.5	3.5	282.378 +	S R 2 1(3.5)	32744.561	3053.0544	4.629E-01	2.981E-19	2.569E+04	3.48830E-01	457
27.5	26.5	12130.244 -	S R 2 1(26.5)	32773.962	3050.3154	2.745E-03	1.721E-21	1.140E+03	1.02567E-01	458
5.5	4.5	355.988 -	S R 2 1(4.5)	32792.722	3049.5794	4.564E-01	2.061E-19	2.221E+04	3.63319E-01	459
26.5	25.5	11298.532 +	S R 2 1(25.5)	32833.743	3044.7615	3.863E-03	2.421E-21	1.204E+03	1.84451E-01	460
6.5	5.5	544.809 +	S R 2 1(5.5)	32838.395	3044.3301	4.219E-01	2.644E-19	1.873E+04	3.59496E-01	461
7.5	6.5	769.216 -	S R 2 1(6.5)	32881.122	3040.3740	3.756E-01	2.354E-19	1.569E+04	3.47219E-01	462
25.5	24.5	10482.508 -	S R 2 1(24.5)	32886.764	3039.8524	5.391E-03	3.379E-21	1.446E+03	1.86713E-01	463
8.5	7.5	1029.892 +	S R 2 1(7.5)	32923.544	3036.7131	3.267E-01	2.047E-19	1.319E+04	3.31653E-01	464
24.5	23.5	9591.321 +	S R 2 1(23.5)	32933.211	3035.5656	7.425E-03	4.654E-21	1.622E+03	1.89302E-01	465
9.5	8.5	1324.291 -	S R 2 1(8.5)	32956.371	3033.4317	2.793E-01	1.751E-19	1.115E+04	3.15300E-01	466
23.5	22.5	8925.622 -	S R 2 1(22.5)	32973.264	3031.8775	1.013E-02	6.350E-21	1.819E+03	1.92491E-01	467
10.5	9.5	1654.577 +	S R 2 1(9.5)	32988.368	3030.4981	2.354E-01	1.476E-19	9.494E+03	2.99663E-01	468
22.5	21.5	8106.358 +	S R 2 1(21.5)	33007.099	3028.7695	1.378E-02	8.508E-21	2.041E+03	1.95677E-01	469
11.5	10.5	2019.633 -	S R 2 1(10.5)	33016.299	3027.9254	1.962E-01	1.236E-19	8.143E+03	2.85026E-01	470
21.5	20.5	7474.376 -	S R 2 1(20.5)	33034.088	3026.2215	1.831E-02	1.148E-20	2.286E+03	2.00105E-01	471
12.5	11.5	2419.081 +	S R 2 1(11.5)	33039.999	3025.7534	1.619E-01	1.814E-19	7.035E+03	2.71673E-01	472
20.5	19.5	6790.493 +	S R 2 1(19.5)	33056.068	3024.2155	2.426E-02	1.520E-20	2.565E+03	2.04065E-01	473
13.5	12.5	2852.485 -	S R 2 1(12.5)	33059.280	3023.9087	1.320E-01	8.274E-20	6.11[illegible]E+03	2.59626E-01	474
19.5	18.5	6135.588 -	S R 2 1(18.5)	33073.068	3022.7341	3.181E-02	1.994E-20	2.881E+03	2.10176E-01	475
14.5	13.5	3319.355 +	S R 2 1(13.5)	33073.974	3022.6451	1.067E-01	6.606E-20	5.338E+03	2.48029E-01	476
18.5	17.5	5518.159 +	S R 2 1(17.5)	33083.652	3021.7608	4.132E-02	2.590E-20	3.241E+03	2.16103E-01	477
15.5	14.5	3819.156 -	S R 2 1(14.5)	33083.919	3021.7365	8.541E-02	5.353E-20	4.607E+03	2.39107E-01	478
17.5	16.5	4915.197 -	S R 2 1(16.5)	33088.916	3021.2881	5.316E-02	3.332E-20	3.655E+03	2.22962E-01	479
16.5	15.5	4351.318 +	S R 2 1(15.5)	33088.952	3021.2768	6.766E-02	4.241E-20	4.129E+03	2.30590E-01	480

THE INTEGRATED INTENSITY FOR THE BAND IS 8.60624E+02 CM-2 ATM-1 AT T = 4600.0 K OR 5.44436E-16 CM/MOLECULE ignored, our line strengths are identical to those calculated using Earls' formulas. Ignoring these effects does not significantly alter the line strengths for main branch transitions but does lead to large errors at high J for the weaker satellite branch line strengths. Earls' forumlas (which ignore centrifugal and higher distortion and Σ–Π interactions) predict consistently smaller line strengths than those calculated by us (which include centrifugal and higher distortion and Σ–Π interactions). In the ${}^{Q}R_{12}$ branch, Earls' line strengths range from 93% of our line strength at $J'' = 20.5$ to 69% of our line strength at $J'' = 40.5$; in the ${}^{S}R_{21}$ branch they range from 78% of our line strength at $J'' = 20.5$ to 46% of our line strength at $J'' = 39.5$. Earls' formulas show intermediate error in this range for the other satellite branches.

Bennett's[13] line-strength formulas, which include P^4 centrifugal distortion, may be expected to give much more accurate results. Based on our check of Earls' formulas, the line strengths for the ${}^{S}R_{21}$ branch should have the largest deviation. Bennett's formula predicts line strengths for this branch which are 1% higher than ours at $J = 1.5$ and decrease to 6% lower at $J = 25.5$; they increase to 2% higher at $J = 39.5$. Examination of the eigenvectors shows that the P^6 term and, to a lesser extent, the ${}^2\Sigma$–${}^2\Pi$ mixing can contribute an effect of a few percent to the satellite bands line strengths. Thus, the dominant effect in the deviations from Earls' formulas is due to the centrifugal disortion, which is relatively large in a light molecule such as OH.

The conclusion to be drawn from these comparisons is that both the algebraic formulas or our method give accurate main branch line strengths at all experimentally observed J values. Earls' formulas lead to significant errors at high J in the satellite bands. Bennett's formulas give acceptable satellite branch line strengths for most work. However, when the highest accuracy is required, the line strengths from Table 9 should be used.

When our Einstein A coefficients are normalized to the same relative value as those of Chidsey and Crosley,[3] the two sets of values differ by at most ± 2 in the last decimal place. As with line strengths, these differences become inportant only at high J in the satellite branches where many of the relative Einstein A coefficients are quoted to only one significant digit by Chidsey and Crosley. An additional advantage of our Einstein A coefficients in Tables 8 and 9 for quantitative spectroscopy is that they are absolute rather than relative values.

Although we have chosen to present OH line parameters for temperatures of 240 and 4600°K, our computer program can generate $A^2\Sigma$–$X^2\Pi(0,0)$ band line parameters for any temperature. Table 10 may be used with Tables 8 or 9 and Eqs. (3) and (5) to convert line intensities from these temperatures to any temperature in the 200–6000°K range. Intensities so determined should have the same accuracy as those in Tables 8 and 9. Band intensities at temperatures other than 240 and 4600°K may be calculated by summing the individual line intensities at the desired temperature. Simpler approximate procedures which directly convert from a band intensity at one temperature to a band intensity at another temperature such as Eq. (7–126) in Penner,[6] give errors of approx. 15% when band intensities at 240 and 4600°K are compared.

Table 10. Rotational partition function Q_R vs temperature T.

T (K)	Q_R	T (K)	Q_R
200	26.71	2000	298.23
240	32.24	2500	375.87
296	40.17	3000	454.19
300	40.75	3500	533.18
500	70.00	4000	612.85
750	107.35	4500	693.14
1000	145.09	4600	709.26
1250	183.08	5000	773.98
1500	221.28	5500	855.28
1750	259.67	6000	936.88

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4. REFERENCES

1. G. H. Dieke and H. M. Crosswhite, *JQSRT* 2, 97 (1962).
2. J. L. Destombes, C. Marliere, and F. Rohart, *J. Molec. Spectrosc.* 67, 93 (1977).
3. I. L. Chidsey and D. R. Crosley, *JQSRT* 23, 187 (1980).
4. J. T. Hougen, *The Calculation of Rotational Energy Levels and Rotational Line Intensities in Diatomic Molecules*, NBS Monograph 115, U.S. Government Printing Office, Washington, D.C. (1970).
5. J. L. Destombes and C. Marliere-Demuynck, Private communication (1980).
6. S. S. Penner, *Quantitative Molecular Spectroscopy and Gas Emissivities*, Addison-Wesley, Reading, Mass. (1959).
7. K. P. Huber and G. Herzberg, *Molecular Spectra and Molecular Structure IV, Constants of Diatomic Molecules*, Van Nostrand Reinhold, New York (1979).
8. L. T. Earls, *Phys. Rev.* 48, 423 (1935).
9. I. L. Chidsey and D. R. Crosley, "Tables of Calculated Transition Probabilities for the A–X System of OH", Ballistic Research Laboratory Scientific Rep., to be published (1980).
10. K. R. German, *J. Chem. Phys.* 62, 2584 (1974).
11. E. E. Whiting and R. W. Nicholls, *Astrophys. J. Suppl. Series* 27, 1 (1974).
12. I. Kovacs, *Rotational Structure of Diatomic Molecules*, p. 130, Elsevier, New York (1969).
13. R. J. M. Bennett, *Mon. Not. R. Astr. Soc.* 147, 35 (1970).

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ERRATUM

The following corrections should be made to Goldman and Gillis[1]. In Eq. (3) and (7) the expression (2J'+1) should be 4(2J'+1). Consequently, all intensities in cm^{-1}/atm-cm and cm/molecule in Ref. 1 should be multiplied by 4. All other line parameters remain unchanged.

1. A. Goldman and J. R. Gillis, JQSRT 25, 111 (1981).