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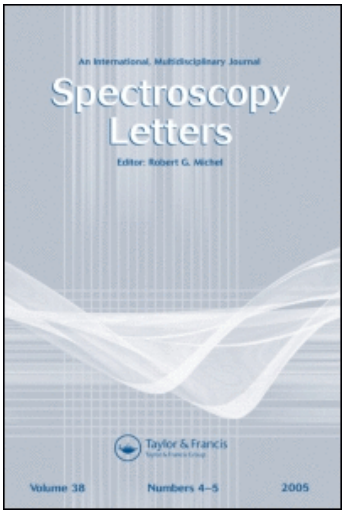

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Transition Probability Data for Seven Band Systems of C_2

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TRANSITION PROBABILITY DATA FOR SEVEN BAND SYSTEMS OF C_2

KEY WORDS: Transition Probability, C_2 Molecule

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Abstract — Absolute transition probability parameters $S_{v'v''}$, $A_{v'v''}$, and $f_{v'v''}$ for seven band systems of the C_2 molecule are reported. These parameters are based on absolute measurements of the electronic transition moments.

INTRODUCTION

The C_2-band systems appear in absorption and emission in a wide variety of terrestrial and astrophysical sources. Reliable spectroscopic diagnostics of these sources depend crucially on the absolute values of transition probability data of the band systems involved. In this paper new transition probability data

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determined by shock tube spectroscopy are presented for seven band systems of C_2.

There are eight known C_2-band systems in the 0.2- to 1.2-micron spectral region. These transitions are represented on the energy level diagram of Figure 1 where the singlet and triplet transitions have been separated, and some electronic states omitted for simplicity. The spectroscopic notation of the electronic states in Figure 1 is adopted from the systematic relabeling of C_2-electronic states recommended by Herzberg et al.[1]

Of the eight systems represented on Figure 1, the electronic transition moment of only the dominant Swan System has been relatively

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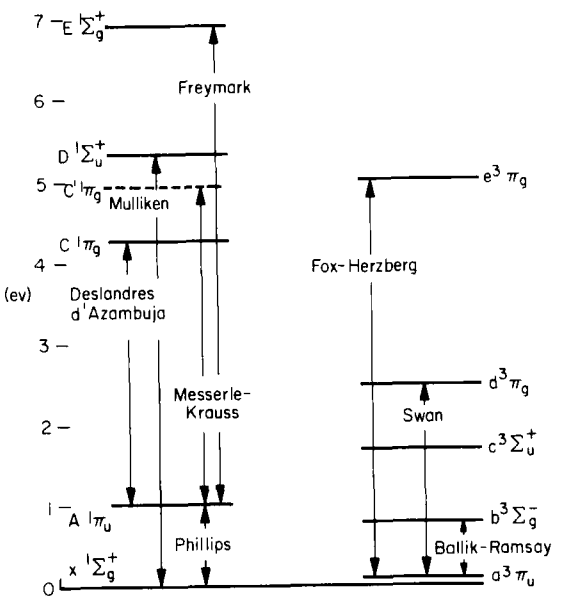

FIG. 1
Energy level diagram for C_2, showing the important electronic transitions.

well determined.[2] This paper presents new measurements of electronic transition moments of seven of these band systems obtained by the synthetic spectrum analysis of absolute intensity data from shock-excited C_2. The Messerle-Krauss system[3] was not excited strongly enough in the shock tube for intensity measurements to be obtained. The electronic transition moments are used below to determine extensive tables of the transition probability parameters $S_{v'v''}$, $A_{v'v''}$, and $f_{v'v''}$ for each of the band systems measured. The complete details of these measurements are given in References 4 and 5.

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THEORY

The integrated intensity of a rotational line due to spontaneous emission is given by

$$E_{J'J''} = \frac{16\Pi c\nu^4 N_u \, 10^{-7}}{(2 - \delta_{o,\Lambda'})(2S' + 1)(2J' + 1)} \Sigma|R_e(\bar{r}_{v'v''})|^2 \times q_{v'v''} S^{J'\Lambda'}_{J''\Lambda''} , \frac{W}{cm^3 SR} \quad (1)$$

where

$\Sigma|R_e(\bar{r}_{v'v''})|^2$ = sum of the square of the electronic transition moment. In this study it is normalized to the quantity $(ea_o)^2$.

$q_{v'v''}$ = Franck-Condon factor.

$S^{J'\Lambda'}_{J''\Lambda''}$ = Hönl-London factor.

N_u = number density of particles in the upper state.

All other symbols are conventional.

In the experimental work, a shock tube was used to excite C_2 band systems thermally in A-C_2H_2 mixtures. The thermodynamic properties of the shock-heated gas, including the equilibrium species concentration N_u, were accurately calculated from thermochemical theory. Thus, absolute measurements of $E_{J'J''}$ summed over all contributing lines in a radiometer pass-band were used to determine $\Sigma|\frac{R_e}{ea_o}|^2$. For this work, the Franck-Condon factors ($q_{v'v''}$) and Hönl-London factors ($S^{J'\Lambda'}_{J''\Lambda''}$) were those of McCallum et al.[6] and Schadee,[7] respectively. A complete compilation of these numbers is given in Reference 4.

Formal summation of Equation (1) over all lines in a vibrational band leads to

$$E_{v'v''} = \frac{16\Pi c(\bar{\nu})^4 N_u 10^{-7}}{(2 - \delta_{o,\Lambda'})(2S' + 1)} \cdot \Sigma|\frac{R_e}{ea_o}|^2 \cdot q_{v'v''} \qquad (2)$$

which represents the total integrated intensity in a vibrational (v',v") band. The term $\bar{\nu}$ in Equation (2), is the band origin frequency. At fixed thermal conditions, the relative strength of $E_{v'v''}$ is controlled primarily by the Franck-Condon factors, whose magnitudes predict the relative intensities of all vibrational bands in an electronic transition.

Figures 2-8 display Deslandres arrays of normalized Franck-Condon factors for the seven band systems on which the occurrence of relatively strong bands is clear. For each band system the Franck-Condon factors have been normalized to unity for the strongest band of the system, and only those normalized values greater than 0.1 are displayed.

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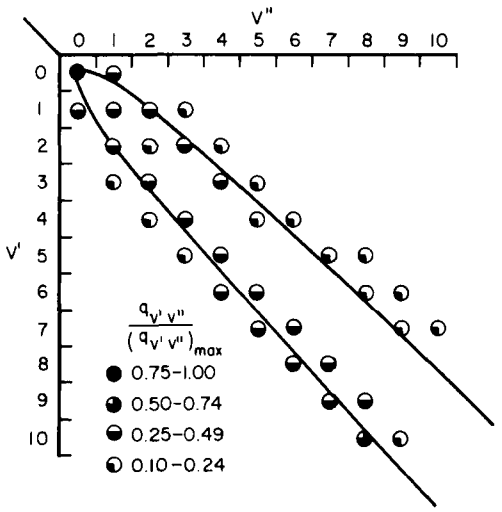

FIG. 2
Deslandres diagram of normalized Franck-Condon factors for the Swan system.

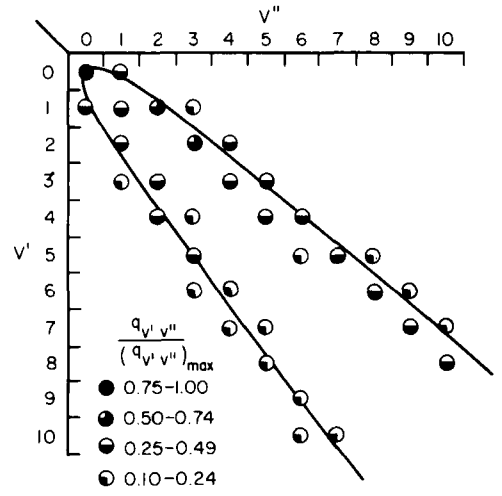

FIG. 3
Deslandres diagram of normalized Franck-Condon factors for the Ballik-Ramsay system.

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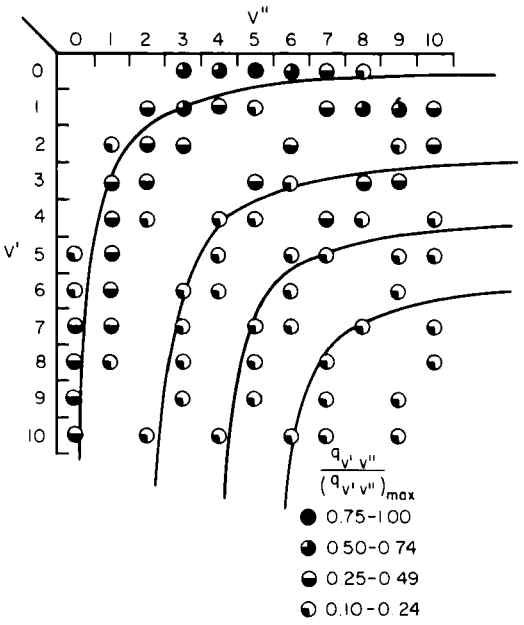

FIG. 4
Deslandres diagram of normalized Franck-Condon factors for the Fox-Herzberg system.

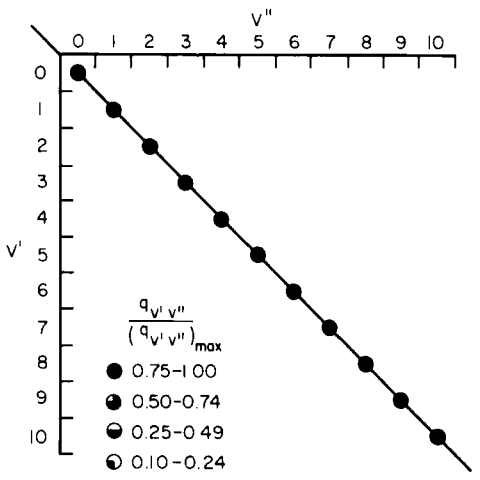

FIG. 5
Deslandres diagram of normalized Franck-Condon factors for the Mulliken system.

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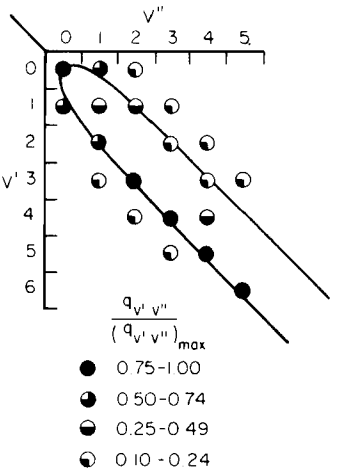

FIG. 6
Deslandres diagram of normalized Franck-Condon factors for the Freymark system.

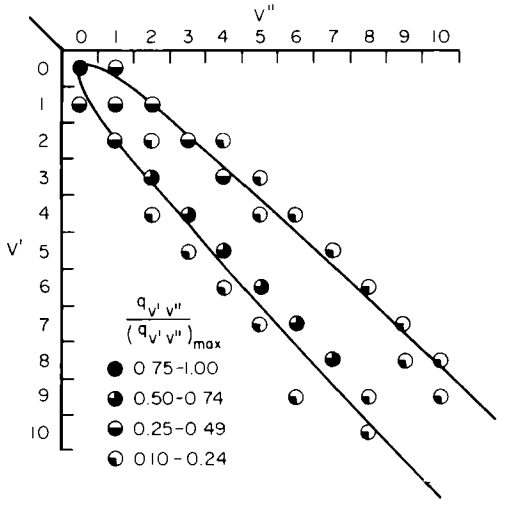

FIG. 7
Deslandres diagram of normalized Franck-Condon factors for the Deslandres-d'Azambuja system.

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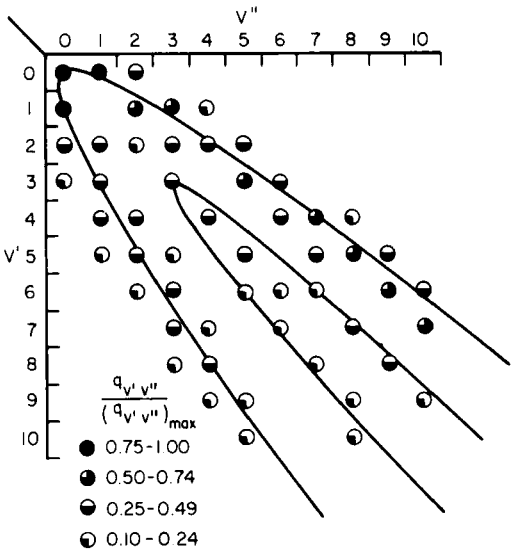

FIG. 8
Deslandres diagram of normalized Franck-Condon factors for the Phillips system.

The locus of the most intense bands is the principal Condon locus, which is quasi-parabolic with an axis near the principal diagonal. The width of this curve, the distance of its apex from (0,0), and the existence within it of subsidiary loci depend upon the magnitude of the difference of equilibrium internuclear separations (Δr_e).[8] Examples of cases of small Δr_e, medium Δr_e, and large Δr_e are seen, respectively, in Figures 5, 8, and 4.

EXPERIMENTAL METHODS

The experimental measurements were made in a stainless steel combustion-driven shock tube. The test gas was nominally 85% A and 15% C_2H_2. Postshock temperature and C_2 concentration were approximately 6000°K and 10^{17} particles/cm^3, respectively.

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Absolute intensities of selected spectral regions of the radiation were measured behind the incident shock wave as a funtion of time by absolutely and spectrally calibrated narrow band-pass radiometers. These measurements were converted to electronic transition moments by a synthetic spectrum analysis which accounts for the contribution from each line in the radiometer band-pass by using Equation (1) augmented by a line profile factor of Voigt form. Complete details of the shock tube operation, instrumentation, and data analysis procedures are given in Reference 4.

RESULTS AND DISCUSSION

The final results of our measurements on electronic transition moments are displayed in Table 1. The $\Sigma|\frac{R_e}{ea_o}|^2$ values are respectively averaged over a given Δv sequence in each case. This is because the band pass often includes contributions from two or more vibrational transitions of a particular band. Column 3 of Table 1 gives the number of data points from which the final result in column 4 was obtained. As estimate of the accuracy to which the $\Sigma|\frac{R_e}{ea_o}|^2$ values have been determined has also been included. These values of electronic transition moments for C_2 band systems thus represent, for the first time, a firm basis for the establishment of arrays of absolute transition probability data for all bands of the systems.

Each $\Sigma|\frac{R_e}{ea_o}|^2$ value of Table 1 is specific to the wavelength at which it was measured. The measurements at two Δv sequences for each of the Phillips and Deslandres-d'Azambuja systems on Table 1, and an earlier scanned spectrum study[2] of the C_2 Swan system

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TABLE 1.

Measured values of the electronic transition moments squared

C -band system	Δv	λ (Å)	Number of data points	$\Sigma\left\|\frac{R_e}{ea_o}\right\|^2$ (atomic units)
SWAN, $d^3\Pi_g - a^3\Pi_u$	0	5,165	16	3.52 ± 0.50
PHILLIPS, $A^1\Pi_u - X^1\Sigma_g^+$	0	12,140	28	0.36 ± 0.08
	+2	8,750	9	0.40 ± 0.10
DESLANDRES-d'AZAMBUJA, $C^1\Pi_g - A^1\Pi_u$	-1	4,090	7	0.93 ± 0.18
	+2	3,400	11	0.91 ± 0.18
FOX-HERZBERG, $e^3\Pi_g - a^3\Pi_u$	-2	2,775	14	0.40 ± 0.10
MULLIKEN, $D^1\Sigma_u^+ - X^1\Sigma_g^+$	0	2,315	8	0.13 ± 0.05
FREYMARK, $E^1\Sigma_g^+ - A^1\Pi_u$	-1	2,218	8	2.26 ± 1.13
BALLIK-RAMSAY, $b^3\Sigma_g^- - a^3\Pi_u$	+2	11,970	28	0.65 ± 0.15

indicate that the electronic transition moments do not appear to vary significantly over any of the C_2 systems, particularly for those of relatively small spectral extent. Therefore, by assuming $\Sigma|\frac{R_e}{ea_o}|^2$ = const, the absolute arrays of band strengths ($S_{v'v''}$), band

TABLE 2.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Swan System

($\Sigma|\frac{R_e}{ea_o}|^2 = 3.52$)

v' \ v''	0	1	2	3	4	5	6	7	8	9	10
	2.55	7.74-1	1.62-1	2.97-2	5.32-3	9.82-4[a]					
0	2.50-2	6.96-3	1.33-3	2.20-4	3.52-5	5.76-6					
	6.27+6	1.47+6	2.31+5	3.12+4	3.99+3	5.07+2					
	8.66-1	1.16	1.01	3.59-1	9.40-2	2.20-2	5.07-3				
1	9.27-3	1.15-2	9.17-3	2.97-3	7.05-4	1.48-4	3.02-5				
	2.76+6	2.91+6	1.96+6	5.30+5	1.03+5	1.74+4	2.80+3				
	1.02-1	1.30	4.12-1	9.33-1	5.14-1	1.82-1	5.39-2	1.50-2			
2	1.18-3	1.40-2	4.10-3	8.54-3	4.30-3	1.38-3	3.68-4	9.13-5			
	4.11+5	4.20+6	1.05+6	1.86+6	7.82+5	2.07+5	4.47+4	8.78+3			
	4.75-3	2.63-1	1.45	7.85-2	7.11-1	5.88-1	2.73-1	1.00-1	3.33-2		
3	5.90-5	3.05-3	1.57-2	7.85-4	6.55-3	4.22-3	2.10-3	6.93-4	2.06-4		
	2.37+4	1.07+6	4.74+6	2.04+5	1.45+6	9.20+5	3.22+5	8.66+4	2.06+4		
	4.54-5	1.65-2	4.51-1	1.42	6.16-5	4.54-1	5.81-1	3.48-1	1.55-1	6.09-2	
4	6.01-7	2.05-4	5.24-3	1.54-2	6.19-7	4.21-3	4.94-3	2.70-3	1.09-3	3.84-4	
	2.74+2	8.24+4	1.84+6	4.68+6	1.60+2	9.40+5	9.30+5	4.23+5	1.40+5	3.40+4	
	1.11-6	1.40-4	3.52-2	6.44-1	1.28	5.21-2	2.37-1	5.00-1	3.87-1	2.09-1	9.61-2
5	1.56-8	1.85-6	4.37-4	7.49-3	1.39-2	5.25-4	2.21-3	4.28-3	3.03-3	1.48-3	6.14-4
	8.00	8.43+2	1.75+5	2.63+6	4.24+6	1.38+5	4.98+5	8.16+5	4.82+5	1.95+5	6.51+4
		1.15-5	2.15-4	5.98-2	8.27-1	1.11	1.50-1	8.69-2	3.84-1	3.87-1	2.52-1
6		1.61-7	2.84-6	7.42-4	9.61-3	1.20-2	1.51-3	8.12-4	3.30-3	3.05-3	1.81-3
		8.22+1	1.29+3	2.97+5	3.38+6	3.69+6	4.01+5	1.84+5	6.36+5	4.92+5	2.41+5
			6.27-5	1.63-4	8.66-2	1.00	9.33-1	2.39-1	1.26-2	2.53-1	3.46-1
7			8.75-7	2.14-6	1.07-3	1.16-2	1.01-2	2.41-3	1.18-4	2.18-3	2.74-3
			4.43+2	9.66+2	4.27+5	4.06+6	3.09+6	6.39+5	2.68+5	4.23+5	4.46+5
				2.37-4	1.32-5	1.12-1	1.15	7.81-1	2.94-1	2.65-3	1.39-1
8				3.29-6	1.73-7	1.38-3	1.33-2	8.44-3	2.96-3	2.48-5	1.20-3
	LEGEND			1.65+3	7.71+1	5.45+5	4.62+6	2.57+6	7.83+5	5.64+3	2.33+5
	$S_{v'v''}$				6.90-4	2.56-4	1.30-1	1.30	6.72-1	3.03-1	3.63-2
9					9.51-6	3.33-6	1.59-3	1.50-2	7.24-3	3.04-3	3.39-4
	$f_{v'v''}$				4.70+3	1.47+3	6.23+5	5.15+6	2.18+6	7.99+5	7.68+4
	$A_{v'v''}$					1.64-3	2.48-3	1.33-1	1.43	6.09-1	2.73-1
10						2.24-5	3.20-5	1.62-3	1.63-2	6.52-3	2.73-3
						1.07+4	1.39+4	6.23+5	5.56+6	1.94+6	7.09+5

[a]The fourth digit of an entry is the power of ten by which it is multiplied.

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oscillator strengths ($f_{v'v''}$), and band Einstein A coefficients ($A_{v'v''}$) for the systems can be calculated as described below.

The band strength defined in Equation (3) is the quantity which controls band oscillator strengths and band Einstein A

TABLE 3.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Phillips System

$$(\Sigma|\frac{R_e}{ea_o}|^2 = 0.38)$$

v' \ v''	0	1	2	3	4	5	6	7	8	9
	1.57-1	1.51-1	5.89-2[a]							
0	3.94-3	2.96-3	8.31-4							
	8.90+4	4.09+4	5.97+3							
	1.26-1	2.10-3	1.10-1	1.03-1						
1	3.77-3	5.12-5	2.08-3	1.39-3						
	1.22+5	1.10+3	2.69+4	9.23+3						
	6.16-2	6.54-2	2.21-2	4.37-2	1.15-1					
2	2.14-3	1.91-3	5.23-4	1.99-4	1.49-3					
	9.28+4	5.84+4	1.06+4	9.64+3	9.11+3					
	2.40-2	7.56-2	1.20-2	5.43-2	6.35-3					
3	9.44-4	2.55-3	3.40-4	1.25-3	1.12-4					
	5.28+4	1.05+5	9.85+3	2.37+4	1.26+3					
	8.21-3	4.79-2	5.24-2	4.67-4	5.93-2	1.06-3				
4	3.61-4	1.84-3	1.72-3	1.29-5	1.32-3	1.81-5				
	2.52+3	9.78+4	6.75+4	3.52+2	2.36+4	1.90+2				
	2.61-3	2.92-2	5.51-2	2.19-2	1.40-2	4.33-2				
5	1.26-4	9.83-4	2.06-3	7.02-4	3.75-4	9.34-4				
	1.07+4	6.53+4	1.04+5	2.61+4	9.70+3	1.57+4				
	7.94-4	9.35-3	3.65-2	4.56-2	3.36-3	3.10-2				
6	4.20-5	4.42-4	1.53-3	1.66-3	1.05-4	8.07-4				
	4.25+3	3.58+4	9.68+4	8.01+4	3.69+3	1.97+4				
	2.34-4	3.48-3	1.90-2	4.26-2	2.78-2	6.42-4	3.91-2			
7	1.34-5	1.80-4	8.79-4	1.74-3	9.89-4	1.95-5	9.89-4			
	1.59+3	1.74+4	6.79+4	1.05+5	4.52+4	6.51+2	2.29+4			
	6.76-5	1.22-3	8.55-3	2.82-2	3.95-2	1.11-2	8.59-3	3.65-2		
8	4.16-6	6.83-5	4.32-4	1.27-3	1.58-3	3.85-4	2.54-4	8.98-4		
	5.07+2	7.74+3	3.99+4	9.38+4	9.05+4	1.67+4	8.04+3	1.96+4		
	1.95-5	4.10-4	3.51-3	1.53-2	3.37-2	2.95-2	1.57-3	1.95-2	2.64-2	
9	1.28-6	2.47-5	1.92-4	7.56-4	1.49-3	1.15-3	5.31-5	5.62-4	6.32-4	
	2.00+2	3.24+3	2.08+4	6.66+4	1.04+5	6.27+4	2.19+3	1.69+4	1.31+4	
	5.66-6	1.35-4	1.36-3	7.33-3	2.20-2	3.36-2	1.69-2	5.21-4	2.72-2	1.44-2
10	3.96-7	8.69-6	8.01-5	3.92-4	1.06-3	1.45-3	6.42-4	1.72-5	7.64-4	3.36-4
	6.99+1	1.30+3	1.00+4	4.06+4	8.92+4	9.68+4	3.34+4	6.74+2	2.17+4	6.58+3

LEGEND
$S_{v'v''}$
$f_{v'v''}$
$A_{v'v''}$

[a]The fourth digit of an entry is the power of ten by which it is multiplied.

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coefficients defined in Equations (4) and (5). Absolute arrays of these quantities represent very important transition probability data for band systems.

TABLE 4.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Ballik-Ramsey System

$$(\Sigma|\frac{R_e}{ea_o}|^2 = 0.65)$$

v' \ v''	0	1	2	3	4	5	6	7
0	4.12-1 1.18-3 4.98+4	1.99-1[a] 4.05-4 8.70+3						
1	1.75-1 6.28-4 4.20+4					LEGEND $S_{v'v''}$ $f_{v'v''}$ $A_{v'v''}$		
2	4.83-2 2.08-4 2.01+4							
3	1.13-2 5.67-5 7.43+3	9.43-2 3.96-4 3.63+4						
4	2.46-3 1.41-5 2.39+3	3.17-2 1.55-4 1.94+4	1.18-1 4.83-4 4.21+4					
5	5.19-4 3.33-6 7.10+2	8.97-3 5.01-5 8.14+3	5.46-2 2.61-4 3.10+4	1.17-1 4.66-4 3.85+4				
6	1.05-4 7.44-7 1.94+2	2.31-3 1.45-5 2.96+3	1.95-2 1.06-4 1.65+4	7.35-2 3.43-4 3.88+4	9.82-2 3.81-4 2.98+4			
7				3.25-2 1.73-4 2.56+4	8.39-2 3.81-4 4.10+4			
8					4.57-4 2.38-6 3.35+2	8.45-2 3.74-4 3.82+4		
9						5.66-2 2.87-4 3.85+4	7.61-2 3.28-4 3.18+4	
10							6.32-2 3.13-4 3.98+4	6.16-2 2.59-4 2.37+4

[a] The fourth digit of an entry is the power of ten by which it is multiplied.

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TABLE 5.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Freymark System

$$(\Sigma|\frac{R_e}{ea_o}|^2 = 2.26)$$

v' \ v''	0	1	2	3	4	5
	1.31	6.12-1	2.31-1	7.41-2	2.25-2	6.03-3[a]
0	4.64-2	2.10-2	7.64-3	2.36-3	6.92-4	1.79-4
	2.70+8	1.14+8	3.86+7	1.11+7	3.02+6	7.25+5
	8.38-1	3.66-1	5.02-1	3.25-1	1.46-1	5.49-2
1	3.07-2	1.30-3	1.72-2	1.08-1	4.67-3	1.69-3
	1.91+8	7.55+7	9.34+7	5.45+7	2.20+7	7.44+6
	1.06-1	1.09-1	1.06-1	3.16-1	3.23-1	1.85-1
2	4.01-3	3.99-3	3.76-3	1.08-2	1.07-2	5.92-3
	2.65+7	2.47+7	2.18+7	5.87+7	5.42+7	2.80+7
	3.44-5	1.90-1	1.19	4.41-2	1.80-1	2.85-1
3	1.38-6	7.16-3	4.35-2	1.56-3	6.16-3	9.43-3
	9.37+3	4.71+7	2.68+8	9.01+6	3.33+7	4.77+7
		1.15-3	2.16-1	1.27	4.16-2	9.15-2
4		4.46-5	8.11-3	4.62-2	1.47-3	3.12-3
	LEGEND	3.09+5	5.29+7	2.83+8	8.42+6	1.68+7
	$S_{v'v''}$		1.24-2	1.75-1	1.35	7.66-2
5	$f_{v'v''}$		4.78-4	6.54-3	4.89-2	2.69-3
			3.28+6	4.22+7	2.97+8	1.53+7
	$A_{v'v''}$			4.70-2	8.32-2	1.37
6				1.80-3	3.09-3	4.93-2
				1.22+7	1.97+7	2.96+8

[a]The fourth digit of an entry is the power of ten by which it is multiplied.

TABLE 6.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Fox-Herzberg System

$$(\Sigma|\frac{R_e}{ea_o}|^2 = 0.40)$$

v' \ v''	0	1	2	3	4	5	6	7	8	9	10
	8.68-4	6.84-3	2.45-2	5.32-2	7.92-2	8.56-2	7.00-2[a]				
0	1.75-5	1.32-4	4.54-4	9.44-4	1.34-3	1.39-3	1.08-3				
	1.85+4	1.29+5	4.05+5	7.72+5	1.00+6	9.43+5	6.68+5				
	3.57-3	2.04-2	4.68-2	5.32-2	2.61-2	8.36-4	1.34-2	4.88-2			
1	7.39-5	4.05-4	8.92-4	1.05-3	4.56-4	1.40-5	2.14-4	7.42-4			
	8.22+4	4.16+5	8.43+5	8.43+5	3.62+5	1.01+4	1.41+5	4.46+5			
	8.08-3	3.30-2	4.52-2	1.84-2	3.56-4	2.45-2	3.77-2	1.33-2	8.64-4		
2	1.71-4	6.72-4	8.84-4	3.45-4	6.40-6	4.22-4	6.20-4	2.09-4	1.29-5		
	2.00+5	7.25+5	8.79+5	3.16+5	5.38+3	3.24+5	4.36+5	1.34+5	7.52+3		
	1.34-2	3.86-2	2.73-2	2.94-4	1.86-2	2.85-2	3.37-3	1.02-2	3.46-2	2.04-2	
3	2.90-4	8.05-4	5.47-4	5.66-6	3.43-4	5.04-4	5.70-5	1.65-4	5.34-4	3.00-4	
	3.54+5	9.09+5	5.71+5	5.45+3	3.04+5	4.10+5	4.25+4	1.12+5	3.31+5	1.69+5	
	1.81-2	3.58-2	9.40-3	5.96-3	2.66-2	5.72-3	8.04-3	2.72-2	6.88-3	5.80-3	3.15-2
4	4.01-4	7.63-4	1.93-4	1.18-4	5.03-4	1.04-4	1.40-4	4.53-4	1.09-4	8.81-5	4.56-4
	5.11+5	9.02+5	2.11+5	1.19+5	4.69+5	8.90+4	1.10+5	3.26+5	7.21+4	5.28+4	2.48+5
		2.56-2	8.56-4	1.50-2	1.45-2	8.40-4	2.01-2	7.64-3	4.48-3	2.33-2	7.36-3
5		5.58-4	1.79-5	3.03-4	2.81-4	1.56-5	3.75-4	1.31-4	7.34-5	3.65-4	1.10-4
		6.88+5	2.05+4	3.20+5	2.75+5	1.41+4	2.98+5	9.96+4	5.12+4	2.32+5	6.38+4

[a]The fourth digit of an entry is the power of ten by which it is multiplied.

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$$S_{v'v''} = \Sigma\left|\frac{R_e}{ea_o}\right|^2 \cdot q_{v'v''} \tag{3}$$

$$f_{v'v''} = \frac{8\Pi^2 mc}{3he^2 \lambda_{v'v''}} \cdot \frac{S_{v'v''}}{(2 - \delta_{o,\Lambda''})(2S'' + 1)} \tag{4}$$

$$A_{v'v''} = \frac{64\Pi^4 \nu^3}{3hc^3} \cdot \frac{S_{v'v''}}{(2 - \delta_{o,\Lambda'})(2S' + 1)}\ ,\ \text{sec}^{-1} \tag{5}$$

In view of the relatively small variation of electronic transition moment expected across each of these band systems referred

TABLE 7.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Mulliken System

$$(\Sigma\left|\frac{R_e}{ea_o}\right|^2 = 0.13)$$

v' \ v''	0	1	2	3	4	5	6	7	8	9	10
	1.30-1	3.26-4	2.11-5[a]								
0	1.71-2	4.10-5	2.54-6								
	2.13+7	4.69+4	2.66+3								
	3.37-4	1.29-1	5.12-4	5.47-5							
1	4.61-5	1.69-2	6.44-5	6.59-6							
	6.24+4	2.11+7	7.37+4	6.90+3							
	1.19-5	5.43-4	1.29-1	5.86-4	9.46-5						
2	1.69-6	1.42-5	1.69-2	7.37-5	1.14-5						
	2.47+3	1.00+5	2.10+7	8.43+4	1.20+4						
		3.45-5	6.40-4	1.29-1	5.76-4	1.37-4					
3		4.90-6	8.74-5	1.69-2	7.25-5	1.65-5					
		7.14+3	1.18+5	2.10+7	8.29+4	1.74+4					
			6.62-5	6.45-4	1.29-1	5.07-4	1.77-4				
4			9.38-6	8.80-5	1.69-2	6.38-5	2.18-5				
			1.36+4	1.18+5	2.10+7	7.32+4	2.25+4				
				1.05-4	5.81-4	1.29-1	4.02-4	2.16-4			
5				1.49-5	7.91-5	1.69-2	5.06-5	2.61-5			
				2.15+4	1.06+5	2.09+7	5.80+4	2.76+4			
					1.47-4	4.71-4	1.29-1	2.81-4	2.50-4		
6					2.08-5	6.41-5	1.69-2	3.54-5	3.03-5		
					2.99+4	8.57+4	2.09+7	4.06+4	3.21+4		
						1.91-4	3.37-4	1.29-1	1.65-4	2.81-4	
7						2.69-5	4.58-5	1.69-2	2.08-5	3.41-5	
	LEGEND					3.87+4	6.11+4	2.09+7	2.39+4	3.62+4	
							2.34-4	2.04-4	1.29-1	7.24-5	3.09-4
8	$S_{v'v''}$						3.30-5	2.77-5	1.69-2	9.15-5	3.75-5
	$f_{v'v''}$						4.72+4	3.69+4	2.09+7	1.05+4	4.00+4
								2.73-4	9.32-5	1.29-1	1.56-5
9	$A_{v'v''}$							3.84-5	1.27-5	1.69-2	1.97-6
								5.48+4	1.68+4	2.09+7	2.27+3
									3.08-4	2.28-5	1.29-1
10									4.32-5	3.09-6	1.69-2
									6.16+4	4.11+3	2.09+7

[a]The fourth digit of an entry is the power of ten by which it is multiplied.

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to above, the $\Sigma|\frac{R_e}{ea_o}|^2$ values of Table 1 were used in Equation (3) to calculate an array of band strengths in each case. From these arrays, band oscillator strengths and band Einstein A coefficients were calculated using Equations (4) and (5). Composite arrays of these quantities are displayed in Tables 2-8 for the C_2 band systems.

TABLE 8.

$S_{v'v''}$, $f_{v'v''}$, and $A_{v'v''}$ (sec^{-1}) Values for the C_2 Deslandres-d'Azambuja System ($\Sigma|\frac{R_e}{ea_o}|^2 = 0.92$)

v' \ v''	0	1	2	3	4	5	6	7	8	9	10
	6.76-1	1.98-1	3.85-2	6.09-3	9.06-4	1.42-4[a]					
0	2.67-2	7.34-3	1.34-3	1.97-4	2.72-5	3.95-6					LEGEND
	1.20+7	2.91+6	4.64+5	5.96+4	7.10+3	8.81+2					$S_{v'v''}$
	2.17-1	3.27-1	2.62-1	8.83-2	2.04-2	4.14-3	8.60-4				$f_{v'v''}$
1	9.14-3	1.30-2	9.79-3	3.09-3	6.68-4	1.26-4	2.43-5				$A_{v'v''}$
	4.69+6	5.93+6	3.95+6	1.10+6	2.07+5	3.39+4	5.60+3				
	2.56-2	3.30-1	1.34-1	2.43-1	1.30-1	4.16-2	1.12-2	3.00-3			
2	1.14-3	1.40-2	5.35-3	9.14-3	4.59-3	1.38-3	3.45-4	8.59-5			
	6.61+5	7.22+6	2.47+6	3.73+6	1.65+6	4.34+5	9.48+5	2.04+4			
	9.94-4	6.26-2	3.82-1	4.43-2	1.80-1	1.49-1	6.44-2	2.28-2	7.75-3		
3	4.43-4	2.80-3	1.62-2	1.77-3	6.80-3	5.29-3	2.14-3	8.77-4	2.24-1		
	3.01+4	1.62+6	8.40+6	8.22+5	2.80+6	1.92+6	6.85+5	1.98+5	5.42+4		
	2.34-6	2.29-3	9.94-2	4.05-1	1.07-2	1.06-1	1.45-1	8.11-2	3.75-2	1.57-2	
4	1.16-7	1.08-4	4.44-3	1.71-2	4.28-4	4.00-3	5.15-3	2.70-3	1.17-3	4.57-4	
	8.16+1	6.87+4	2.55+6	8.86+6	1.98+5	1.65+6	1.88+6	8.69+5	3.29+5	1.12+5	
	9.66-6	1.29-4	2.31-3	1.29-1	4.24-1	2.26-3	4.12-2	1.22-1	8.20-2	5.10-2	2.57-2
5	4.97-7	6.33-6	1.08-4	5.72-3	1.78-2	8.99-5	1.55-3	4.32-3	2.73-3	1.59-3	7.47-4
	3.81+2	4.40+3	6.79+4	3.25+6	9.12+6	4.12+4	6.32+5	1.56+6	8.81+5	4.45+5	1.82+5
		6.44-5	1.09-3	4.26-4	1.38-1	4.45-1	1.80-3	3.41-3	9.29-2	6.15-2	5.80-2
6		3.27-6	5.29-5	1.97-5	6.05-3	1.86-2	7.09-5	1.27-4	3.26-3	2.03-3	1.79-3
		2.45+3	3.59+4	1.21+4	3.36+6	9.28+6	3.18+4	5.07+4	1.16+6	6.35+5	4.93+5
			1.57-4	4.64-3	2.25-3	1.15-1	4.51-1	6.97-3	1.27-2	7.19-2	2.38-2
7			7.85-6	2.21-4	1.02-4	4.96-3	1.84-2	2.70-4	4.64-4	2.48-3	7.71-4
			5.67+3	1.45+5	6.07+4	2.66+6	8.91+6	1.17+5	1.79+5	8.50+5	2.33+5
				4.29-5	1.07-2	2.59-2	5.20-2	3.74-1	1.90-2	8.40-2	6.88-2
8				2.10-6	4.98-4	1.15-3	2.19-3	1.49-2	7.17-4	2.99-3	2.31-3
				1.45+3	3.12+5	6.50+5	1.12+6	6.86+6	2.95+5	1.10+6	7.52+5
					7.87-4	9.12-3	8.10-2	2.00-4	1.62-1	1.39-2	1.44-1
9					3.73-5	4.12-4	3.48-3	8.15-6	6.25-3	5.07-4	4.95-3
					2.42+4	2.42+5	1.86+6	3.90+3	2.69+6	1.95+6	1.69+6
						6.85-3	2.03-3	5.46-2	4.17-2	1.67-3	9.66-3
10						3.12-4	8.80-5	2.25-3	1.63-3	6.16-5	3.37-4
						1.87+5	4.78+4	1.10+6	7.16+5	2.43+4	1.19+5

[a]The fourth digit of an entry is the power of ten by which it is multiplied.

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