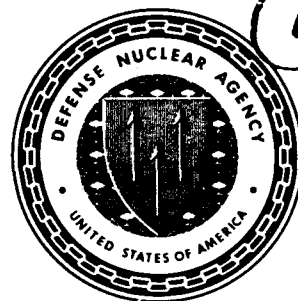




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Franck-Condon Factors, *R*-Centroids, Electronic Transition Moments, and Einstein Coefficients for Many Nitrogen and Oxygen Band Systems

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February 1992

Technical Report

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13. ABSTRACT (Maximum 200 words) Air fluorescence models require accurate Franck-Condon factors and Einstein coefficients for analyzing the intensities of N_2 , N_2^+ , and O_2^+ emissions produced by electron bombardment of air, such as in the aurora, high-altitude nuclear explosions, and rocket-borne electron gun experiments. In our previous report, improved vibrational and rotational constants based on the latest available spectroscopic measurements for several excited and ionic states important in air fluorescence modeling were derived. These constants have been used in the present work to calculate band origins, Franck-Condon factors, and r -centroids for many band systems of nitrogen and oxygen. These results, together with electronic transition moments obtained from published papers or derived here from published emission data and measured upper-state lifetimes, have been used to compute Einstein coefficients by the r -centroid method. Einstein coefficients by integration of the product of the electronic transition moment function and vibrational wavefunctions have also been computed for comparison. For band systems involving "perturbed" electronic states, Einstein coefficients have been derived by simply normalizing published emission data to measured upper-state lifetimes. In this report, tables of band origin wavelengths and wavenumbers, Franck-Condon factors, r -cen-				
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troids, electronic transition moments, and Einstein coefficients are presented for 17 N_2 , N_2^+ , and O_2^+ band systems. Plots of most of the electronic transition moment functions used in these calculations are also given. In addition, tables of Franck-Condon factors only are presented for 16 other band systems of nitrogen and oxygen, and tables of band wavelengths and Einstein coefficients are presented for 3 band systems having "perturbed" upper states.

PREFACE

The authors are grateful to J. M. Ajello, D. J. Burns, L. A. Collins, P. C. Cosby, G. K. James, S. R. Langhoff, B. Liu, H. Partridge, and J.-Y. Roncin for helpful discussions and correspondence and for providing reprints used as reference material in this report.



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CONVERSION TABLE

Conversion factors for U.S. customary to metric (SI) units of measurement

(Symbols of SI units given in parentheses in middle column)

To convert from	To	Multiply by
angstrom (Å)	meters (m)	$1.000\ 000 \times 10^{-10}$
atmosphere (normal)	kilo pascal (kPa)	$1.013\ 25 \times 10^2$
bar	kilo pascal (kPa)	$1.000\ 000 \times 10^2$
barn	meters (m ²)	$1.000\ 000 \times 10^{-28}$
British thermal unit (thermochemical)	joule (J)	$1.054\ 350 \times 10^3$
calorie (thermochemical)	joule (J)	4.184 000
cal (thermochemical)/cm ²	mega joule/m ² (MJ/m ²)	$4.184\ 000 \times 10^{-2}$
curie	giga Becquerel (GBq)*	$3.700\ 000 \times 10^1$
degree (angle)	radian (rad)	$1.745\ 329 \times 10^{-2}$
degree Fahrenheit (°F)	degree kelvin (K)	$T_K = (T_F + 459.67)/1.8$
electron volt	joule (J)	$1.602\ 19 \times 10^{-19}$
erg	joule (J)	$1.000\ 000 \times 10^{-7}$
erg/second	watt (W)	$1.000\ 000 \times 10^{-7}$
foot	meter (m)	$3.048\ 000 \times 10^{-1}$
foot-pound-force	joule (J)	1.355 818
gallon (U.S. liquid)	meter ³ (m ³)	$3.785\ 412 \times 10^{-3}$
inch	meter (m)	$2.540\ 000 \times 10^{-2}$
jerk	joule (J)	$1.000\ 000 \times 10^9$
joule/kilogram (J/kg) (radiation dose absorbed)	Gray (Gy)**	1.000 000
kilotons	tera joules	4.183
kip (1000 lbf)	newton (N)	$4.448\ 222 \times 10^3$
kip/inch ² (ksi)	kilo pascal (kPa)	$6.894\ 757 \times 10^3$
ktap	newton-second/m ² (N-s/m ²)	$1.000\ 000 \times 10^2$
micron	meter (m)	$1.000\ 000 \times 10^{-6}$
mil	meter (m)	$2.540\ 000 \times 10^{-5}$
mile (international)	meter (m)	$1.609\ 344 \times 10^3$
ounce	kilogram (kg)	$2.834\ 952 \times 10^{-2}$
pound-force (lbf avoirdupois)	newton (N)	4.448 222
pound-force inch	newton-meter (N-m)	$1.129\ 848 \times 10^{-1}$
pound-force/inch	newton/meter (N/m)	$1.751\ 268 \times 10^2$
pound-force/foot ²	kilo pascal (kPa)	$4.788\ 026 \times 10^{-2}$
pound-force/inch ² (psi)	kilo pascal (kPa)	6.894 757
pound-mass (lbm avoirdupois)	kilogram (kg)	$4.535\ 924 \times 10^{-1}$
pound-mass-foot ² (moment of inertia)	kilogram-meter ² (kg-m ²)	$4.214\ 011 \times 10^{-2}$
pound-mass/foot ³	kilogram/meter ³ (kg/m ³)	$1.601\ 846 \times 10^1$
rad (radiation dose absorbed)	Gray (Gy)**	$1.000\ 000 \times 10^{-2}$
roentgen	coulomb/kilogram (C/kg)	$2.579\ 760 \times 10^{-4}$
shake	second (s)	$1.000\ 000 \times 10^{-8}$
slug	kilogram (kg)	$1.459\ 390 \times 10^1$
torr (mm Hg, 0° C)	kilo pascal (kPa)	$1.333\ 22 \times 10^{-1}$

* The Becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.

** The Gray (Gy) is the SI unit of absorbed radiation.

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SECTION 1

INTRODUCTION

Einstein coefficients (radiative transition probabilities) for molecular nitrogen and oxygen bands are useful for calculating the emission spectra produced by electron bombardment of air, such as occurs, for example, in the aurora (Meier, 1987), high-altitude nuclear explosions (Boquist and Snyder, 1967), and rocket-borne electron gun experiments (O'Neil *et al.*, 1978a; 1978b). Accurate values of these coefficients are required for predicting the intensities of N_2 , N_2^+ , and O_2^+ emissions, which dominate the air fluorescence spectrum. They are also useful for other applications, such as calculating the radiation from high-temperature air (Landshoff and Magee, 1969; Avilova *et al.*, 1969), and analyzing the emissions from gas discharges (Cramarossa *et al.*, 1974) and afterglows (Golde and Thrush, 1973).

It is possible to measure Einstein coefficients in the laboratory; however, because there are so many bands of interest, with wavelengths ranging from extreme ultraviolet to far infrared, it is impractical to measure them all individually. Instead, simplifying theoretical relations can be combined with limited experimental data to calculate Einstein coefficients for the large number of bands required. Such calculations are often based on the r -centroid approximation (e.g., Nicholls and Stewart, 1962). Einstein coefficients of different bands in a given band system are related to the vibrational overlap integrals, or Franck-Condon factors, and to the electronic transition moment, which can be approximated as a function of the expectation value of the internuclear distance, or r -centroid. The latter function can be derived from measured transition probabilities or band strengths of a few of the bands in the system. Franck-Condon factors are also useful for calculating the branching ratios for populating various vibrational levels when an electronic state is excited from the ground state by electron impact. This is based on the close relationship between transition probabilities in electron impact at high energies and radiation absorption for optically-allowed transitions (Lassettre, 1965; Lassettre *et al.*, 1965).

It is also possible to derive electronic transition moments from quantum-mechanical calculations, without use of band strength measurements. Such calculations are difficult, but have very recently attained an accuracy comparable to that of many band intensity measurements. They usually cover a wider range of internuclear distances than covered by the r -centroid method. Their accuracy can sometimes be

increased by multiplying the calculated transition moment by a constant correction factor based on a measurement of one band intensity or radiative lifetime.

Many Einstein coefficients, Franck-Condon factors, and r -centroids for nitrogen and oxygen band systems have been published previously. In a monograph on the spectrum of molecular oxygen, Krupenie (1972) compiled from various sources and tabulated many of these quantities for several oxygen band systems, including the $A-X$ and $b-a$ band systems of O_2^+ , and several ionization systems of O_2 . In a similar monograph on molecular nitrogen, Lofthus and Krupenie (1977) compiled and presented many of these quantities for several band systems of N_2 and N_2^+ . More recently, Slanger (1986) tabulated Morse-potential Franck-Condon factors for the N_2 c'_4-a band system. James *et al.* (1988) tabulated Morse-potential Franck-Condon factors for the O_2^+ $A-X$ band system and O_2^+ $A-O_2$ X ionization system. Green *et al.* (1988) tabulated RKR Franck-Condon factors and r -centroids for the N_2 $B-A$ band system. Piper *et al.* (1989) tabulated Einstein coefficients for the N_2 $B-A$ band system, which they calculated from their measured electronic transition moment function. Marinelli *et al.* (1988) tabulated Einstein coefficients for the N_2 $a-X$ and $a-a'$ band systems; however, later measurements of the a state lifetime by Marinelli *et al.* (1989) indicated that their $a-X$ Einstein coefficients should be increased by about 35%. Ajello *et al.* (1989) tabulated Morse-potential Franck-Condon factors for the N_2 c'_4-X band system, and RKR Franck-Condon factors for several N_2 $b'-X$ bands. Allen and Lin (1989) listed both RKR and Morse-potential Franck-Condon factors for a few N_2 c'_4-X bands. And finally, Allen *et al.* (1990) tabulated both RKR and Morse-potential Franck-Condon factors for the N_2 $x-a'$, $y-a'$, and $y-w$ band systems.

However, the published literature falls far short of providing complete and accurate sets of radiative parameters for all of the band systems that contribute significantly to air fluorescence. In particular, values of Einstein coefficients and r -centroids are available for fewer than half of the band systems of interest. Moreover, many of the published values are based on older spectroscopic constants or radiative lifetimes that have been superseded by more recent measurements. In a previous report (Laher and Gilmore, 1991), the spectroscopic constants of the pertinent nitrogen and oxygen states were reviewed, and new constants for many of these states were derived. In the present work, these improved values have been employed to calculate new RKR potential curves and, thence, improved Franck-Condon factors and

r -centroids. Also, the available information on electronic transition moments has been examined, the best values determined or newly derived, and these used to calculate Einstein coefficients. The results from calculations employing both r -centroid and direct methods of computing Einstein coefficients are presented.

In addition, three band systems with "perturbed" upper electronic states are considered in this report. Einstein coefficients for these transitions cannot be calculated as simply as is possible for transitions involving unperturbed states. In these cases, the most practical alternative to a complex theoretical calculation is to derive Einstein coefficients from measured band intensities and radiative lifetimes. This is the approach that has been taken here.

SECTION 2

METHODS OF CALCULATION

2.1 RKR INTERNUCLEAR POTENTIAL ENERGY FUNCTIONS.

In the Rydberg-Klein-Rees (RKR) method of determining potential energy curves for diatomic molecules (Rydberg, 1931; Klein, 1932; Rees, 1947), the classical turning points are computed from experimental vibrational and rotational spectroscopic term values through the equations:

$$f(v) = \frac{h}{2\pi\sqrt{2\mu}} \int_{-1/2}^v [G(v) - G(v')]^{-1/2} dv', \quad (1)$$

and

$$g(v) = \frac{2\pi\sqrt{2\mu}}{h} \int_{-1/2}^v B_{v'} [G(v) - G(v')]^{-1/2} dv', \quad (2)$$

with the internuclear distances of the inner and outer turning points given by:

$$r_{\text{inner}}, r_{\text{outer}} = (f/g + f^2)^{1/2} \mp f. \quad (3)$$

In the above equations, h is Planck's constant, μ is the reduced mass of the molecule, and $G(v)$ and B_v are mathematical expressions involving tabulated spectroscopic constants which give the experimentally determined vibrational energy and rotational constant at each vibrational quantum number v . In order to maintain high accuracy and remove the singularity that occurs at $v' = v$, the above equations have been integrated using a 16 point Gauss-Jacobi quadrature (Stroud and Secrest, 1966), as detailed by Tellinghuisen (1972).

These integrations yield the turning points at the value of the potential energy function $U(r)$ corresponding to the energy $G(v)$. As a result, $U(r)$ is determined at unequally-spaced values of internuclear distance r . In order to use this potential to calculate wave functions, it is necessary to interpolate it to equally-spaced values of r . In addition, it may be necessary to extrapolate the potential beyond the region derived from experimental data. Frequently, the interpolation is done with a high-order Lagrange polynomial (Zare, 1964), which, although cumbersome and computationally expensive, is stable for interpolation. Functional forms for

the repulsive and attractive potential segments may then be smoothly joined to the experimentally determined curve in order to extrapolate the potential energy into regions where the wave function becomes small. Typically the wave functions derived from the potential are not very sensitive to the choice of extrapolation segments used.

In the present work, an interpolation and extrapolation method based upon a Morse-type function has been used. This method has been found to yield results in excellent agreement with those produced by a seventh-order Lagrange interpolating polynomial, with a reduction in computation time by a factor of 3. The Morse potential function is given by:

$$U(r) = D_e \{1 - \exp[-\beta(r - r_e)]\}^2, \quad (4)$$

where D_e is the dissociation energy, β is a constant, and r_e is the equilibrium internuclear distance. Equation (4) can be inverted to yield an expression for the exponent:

$$L(r) \equiv -\beta(r - r_e) = \ln \left[1 \pm \sqrt{U(r)/D_e} \right], \quad (5)$$

where the upper sign is for $r < r_e$ and the lower for $r > r_e$. Substitution of the RKR values of $U(r)$ in equation (5) yields a set of values for β and, hence, through equation (4), a set of Morse potentials, each of which passes through one of the RKR points and has the correct curve minimum and dissociation limit. If the entire RKR curve agreed with a Morse potential, these calculated Morse potentials would coincide, and $L(r)$ would be a linear function of r . Due to deviations from the Morse potential, the calculated $L(r)$ behavior is not exactly linear, but its variation is gradual enough that linear interpolation between successive RKR values provides excellent accuracy. Similarly, linear extrapolation of $L(r)$ provides reasonable extensions of the RKR potential to somewhat larger and smaller internuclear separations.

For the calculations presented in this report, the molecular constants tabulated by Laher and Gilmore (1991) were used to compute r_e , T_e , $G(v)$, and B_v . The dissociation energy, D_e , for each state was determined by subtracting T_e from the energy of the dissociation limit. For most of the states of N_2 and N_2^+ , and all of the states of O_2^+ , this limit energy was calculated by adding the T_0 and D^0 values listed by Lofthus and Krupenie (1977) and Krupenie (1972), respectively.

However, for two of the higher states of N_2 and one of N_2^+ the listed D^0 values correspond to the onset of predissociation due to the "avoided crossing" of another potential curve (see Herzberg, 1950, p. 296). In employing equation (5) to calculate a potential curve below the avoided crossing, it is better to use a D_e value based on the noninteracting "diabatic" curve that goes to a higher dissociation limit. The molecular orbital configurations of these three states (Lofthus and Krupenie, 1977) suggest that the appropriate limits and energies (in cm^{-1}) are: N_2 $C^3\Pi_u$, $^4S^0 + 2s2p^4\ ^4P$, 166850; N_2 $E^3\Sigma_g^+$, $^4S^0 + 3s\ ^4P$, 162054; N_2^+ $C^2\Sigma_u^+$, $^4S^0 + 2p^3\ ^5S^0$, 242725. Similarly, for the N_2 $D^3\Sigma_u^+$ state, whose dissociation energy is not listed by Lofthus and Krupenie, the appropriate limit is $^4S^0 + 3s\ ^4P$, 162054.

2.2 WAVE FUNCTIONS, R -CENTROIDS, AND FRANCK-CONDON FACTORS.

The RKR potential energy derived above was used in the radial Schrödinger equation to solve for the rotationless vibrational wavefunctions, $\psi(r)$, where r is the internuclear distance. The numerical method of solution of the radial Schrödinger equation has been described by Cooley (1961); it employs the Numerov (1933) method of integration. Cooley's procedure also uses an improved formula for the correction of trial eigenvalues, based upon the second-order iteration-variation method of Löwdin (1958). Since the accuracy of this predictor-corrector formula does not depend critically upon a small step size being used in the radial coordinate, relatively few potential energy steps (1024) were used in the integration. A brief description of the Cooley method as well as an assessment of its accuracy and numerical stability may be found in the work of Cashion (1963). Using the computed vibrational wavefunctions, the Franck-Condon factors, $q_{v'v''}$, and r -centroids, $\bar{r}_{v'v''}$, were then calculated from their defining integrals (Fraser, 1954; Nicholls and Stewart, 1962):

$$q_{v'v''} = \left[\int \psi_{v'}^* \psi_{v''} dr \right]^2, \quad (6)$$

$$\bar{r}_{v'v''} = \int \psi_{v'}^* r \psi_{v''} dr / \int \psi_{v'}^* \psi_{v''} dr, \quad (7)$$

by Simpson's rule integration, where the primes and double primes denote upper and lower states, respectively. Equation (7) shows that $\bar{r}_{v'v''}$ is a weighted mean of the internuclear distance for the $(v'-v'')$ band, with the weighting function $\psi_{v'}^* \psi_{v''}$. However, unlike conventional weighting functions, $\psi_{v'}^* \psi_{v''}$ can change sign over the

integration range. Consequently, the denominator of equation (7) can become very small even when the numerator is not so small, so that the r -centroid can become very large, lying beyond the range of r where the wavefunctions are appreciable. For similar reasons, the r -centroid can also go negative. However, such large or negative values occur only when the denominator is quite small. In such a situation, the Franck-Condon factor, which equals the square of the denominator, is very small, and the band is correspondingly very weak and usually of little practical importance. Moreover, in such cases, the Franck-Condon factor and intensity often vary significantly with rotational quantum number, a variation which is conventionally neglected.

2.3 ELECTRONIC TRANSITION MOMENTS AND EINSTEIN COEFFICIENTS.

A diatomic electronic-vibrational transition may be expressed as

$$^{2S'+1}\Lambda'(v') \longrightarrow ^{2S''+1}\Lambda''(v''), \quad (8)$$

where S is the spin quantum number, and Λ is the electronic angular momentum quantum number (Λ values of 0, 1, 2, ... are indicated by the state symbols Σ , Π , Δ , ...).

In accordance with the definition established by Schadee (1978) and Whiting *et al.* (1980) for the electronic transition moment, the Einstein coefficient, $A_{v',v''}$ (in s^{-1}), for a transition in which $S' = S''$ is related to the electronic transition moment, $R_e(r)$ (in electric dipole moment atomic units), by

$$A_{v',v''} = (2.026 \times 10^{-6}) \frac{(2 - \delta_{0,\Lambda'+\Lambda''})}{(2 - \delta_{0,\Lambda'})} \nu_{v',v''}^3 \left[\int \psi_{v'}^* R_e(r) \psi_{v''} dr \right]^2, \quad (9)$$

where $\nu_{v',v''}$ is the band origin wavenumber (in cm^{-1}) and $\delta_{0,\Lambda}$ is the Kronecker delta, which equals 1 if $\Lambda = 0$ and equals 0 otherwise. For an electronic transition involving a change in spin, the corresponding relation is often more complicated, involving several independent transition moments (Whiting *et al.*, 1973). However, only one such spin-forbidden transition has been observed in air fluorescence, the N_2 $A^3\Sigma_u^+ - X^1\Sigma_g^+$ Vegard-Kaplan band system. For this system the relation is simple; the fraction involving the Kronecker delta in equation (9) is just replaced by 2/3.

If the transition moment function, $R_e(r)$, for a band system is known from quantum-mechanical calculations, the Einstein coefficients for the bands can be calculated from equation (9). If, however, only experimental band strengths for some of the bands are known, equation (9) must first be inverted to solve for R_e in terms of the band strengths. The derived $R_e(r)$ can then be used to calculate the strengths or lifetimes of the other bands. The simplest method of performing this inversion is the r -centroid method (Fraser, 1954; Nicholls and Stewart, 1962). This method can be derived from a power series expansion of $R_e(r)$:

$$R_e(r) = a + br + cr^2 + \dots \quad (10)$$

The integral in equation (9) can then be written

$$\begin{aligned} \int \psi_v^* R_e(r) \psi_{v''} dr &= a \int \psi_v^* \psi_{v''} dr + b \int \psi_v^* r \psi_{v''} dr + c \int \psi_v^* r^2 \psi_{v''} dr + \dots \\ &= q_{v'v''}^{1/2} \left[a + b\bar{r}_{v'v''} + c\bar{r}_{v'v''}^2 Y_{v'v''}^{(2)} + \dots \right], \end{aligned} \quad (11)$$

where

$$Y_{v'v''}^{(2)} = \frac{\int \psi_v^* r^2 \psi_{v''} dr / \int \psi_v^* \psi_{v''} dr}{\bar{r}_{v'v''}^2} = \frac{\overline{r_{v'v''}^2}}{\bar{r}_{v'v''}^2}. \quad (12)$$

For many band systems $R_e(r)$ can be well approximated by either a constant or a linear function of r , at least over the range of r important for the stronger bands. In this case the cr^2 term and higher terms in equation (10) can be dropped, and equation (11) becomes simply

$$\int \psi_v^* R_e(r) \psi_{v''} dr = q_{v'v''}^{1/2} R_e(\bar{r}_{v'v''}). \quad (13)$$

This is the r -centroid approximation.

Even when $R_e(r)$ is significantly nonlinear, equation (13) is a good approximation if the quantity $Y_{v'v''}^{(2)}$ in equations (11) and (12), and similar higher-order quantities, $Y_{v'v''}^{(3)} = \overline{r^3}/\bar{r}^3$, etc., are near unity. McCallum *et al.* (1972) have presented extensive tables of $Y_{v'v''}^{(2)}$ and $Y_{v'v''}^{(3)}$ for a number of N_2 band systems. For all except a small fraction of the bands, these quantities are within 10 percent of unity. Those bands having greater deviations from unity all have Franck-Condon factors less than 0.03, so they are relatively weak. However, there is a general tendency for the $Y_{v'v''}^{(3)}$ values to deviate more from unity than the $Y_{v'v''}^{(2)}$ values, so if still higher-order terms in the

power series representation of $R_e(r)$ are important the r -centroid approximation is likely to be less accurate.

A more direct method of determining the typical accuracy of the r -centroid approximation is to calculate both sides of equation (13) independently, for a number of bands and band systems, and compare the results. A small calculation of this type was made by Fraser (1954) for the N_2 B - A band system, assuming three different exponential-power-law variations in $R_e(r)$. However, he treated only $v' = 0$, $v'' = 0-2$, where the Franck-Condon factors are all greater than 0.16, so it is not surprising that he found that equation (13) was an excellent approximation.

In the course of the present work, we computed both sides of equation (13) for 15 band systems of N_2 and N_2^+ and 2 band systems of O_2^+ , many with $v', v'' = 0-21$. Our results show that the r -centroid approximation is generally accurate for the stronger bands in a band system, which are usually the bands whose intensities can be most accurately measured experimentally. This justifies the standard r -centroid method of deducing $R_e(r)$ from band intensity measurements [e.g., Hartmann and Johnson (1978); Piper *et al.* (1989)]. Briefly, $R_e(r)$ is replaced by $R_e(\bar{r}_{v',v''})$ and equation (9) is rearranged to give

$$R_e(\bar{r}_{v',v''}) = \left[\frac{\text{const.} \times A_{v',v''}}{\nu_{v',v''}^3 q_{v',v''}} \right]^{1/2}, \quad (14)$$

where the constant can be obtained from equation (9). Sometimes, absolute values of the Einstein coefficients, $A_{v',v''}$, can be obtained from band absorption measurements, utilizing the well-known relationship between absorption and emission coefficients, or from emission measurements, if the population of the emitting level can be determined by other means. More often, emission measurements give only relative values of $A_{v',v''}$ and, hence, of $R_e(\bar{r}_{v',v''})$. These relative values are placed on an absolute scale by a measurement of the radiative lifetime of one of the emitting levels. The resulting values then determine the function $R_e(\bar{r})$ with an accuracy that is usually limited only by the accuracy of the band intensity measurements and the number and range of the $\bar{r}_{v',v''}$ values covered, rather than by the accuracy of the r -centroid approximation. In the present work, this method of deriving transition moments has been utilized for a few band systems for which published results are either unavailable or have been superseded by better intensity measurements.

2.4 TREATMENT OF TRANSITIONS INVOLVING "PERTURBED" ELECTRONIC STATES.

Significant fluorescent radiation is known to be emitted by some high-lying states of N_2 that have irregularly-spaced vibrational levels due to strong perturbations by nearby states of the same type (Herzberg, 1950). Typical effects of such perturbations on the vibrational and rotational levels of several high N_2 states are illustrated in a paper by Carroll *et al.* (1970). These perturbations also cause irregularities in the intensities of the various bands, as shown, for example, by the recent extensive measurements of Ajello *et al.* (1989) on the N_2 c'_4-X and $b'-X$ bands.

When two or more nearby electronic states of the same type interact strongly, it is possible to treat the resulting vibrational and rotational levels as mixtures of two or more "deperturbed" or "adiabatic" electronic states. This has been done by Stahel *et al.* (1983) for three $^1\Sigma_u^+$ and three $^1\Pi_u$ states of N_2 lying in the 12–14 eV region. In such situations, the proportions of the mixture vary with the vibrational level, so the conventional Born-Oppenheimer separation of electronic and nuclear motion is no longer valid. Consequently, the concept of an electronic transition moment as a function of internuclear distance is no longer applicable. It is still possible, in principle, to calculate the intensities of the bands in a band system using a coupled-state approach, as used by Stahel *et al.* However, the computations become quite complex even when just two or three coupled states are involved. The perturbed N_2 states of present interest lie in an energy region where, as one goes to higher vibrational levels, more and more coupled states must be included in the calculation.

In the present situation, the most practical method for deriving the Einstein coefficients of bands involving perturbed states is to use measured relative emission intensities, normalized by radiative lifetime measurements or absolute absorption measurements. This method has been applied here to the N_2 $b-X$, c'_4-X , and c'_4-a band systems. It should be noted, however, that the strength of a perturbation can change with the rotational level in a given vibrational level. Hence, the Einstein coefficients of the individual rotational lines in a perturbed band may differ. Consequently, the mean Einstein coefficient for a perturbed band may vary with temperature, since changing the temperature changes the relative contributions of the different rotational lines in a band.

SECTION 3

RESULTS FOR ELECTRONIC TRANSITION MOMENTS

Electronic transition moment functions for many of the N_2 , N_2^+ , and O_2^+ band systems considered in this report have been published or may be derived from published data using the method described in Section 2.3. Some of these band systems have been studied extensively, while for others little information is available. In the present work, an effort has been made to identify the most accurate electronic transition moments from the choices available; usually this involved selecting the most recent work. The recent advances in the quantum-mechanical calculation of diatomic dipole moments are demonstrated by the selection of such theoretical values as the best available values for eleven of the band systems treated, while values derived by the r -centroid method were selected for only four systems.

The best available $R_e(r)$ data for most of the band systems treated are plotted in Figures 1 through 13. Some of these figures also include, for comparison, other data not used in the subsequent calculations because they are known to be or appear to be less accurate than the data used. No figures are presented for two band systems for which similar figures in the original references are adequate, or for two band systems where no information on the variation of R_e with r is available.

As a convenience in making subsequent calculations of Einstein coefficients, we have derived mathematical fits to the preferred transition moments, of the form

$$R_e(r) = a + br + cr^2 + d \exp[-e(r - g)^2], \quad (15)$$

where $a, \dots, g$ are constant coefficients, $R_e(r)$ is in electric dipole moment atomic units, and r is in Å. These units are consistent with equation (9) for computing Einstein coefficients in units of s^{-1} . Our fits are indicated and plotted in Figures 1-13, and their coefficients are also listed in Table 1. The dipole moment functions for over half of the band systems treated could be satisfactorily fit with just a Gaussian term, i.e., the last term in equation (15). This expression has the advantage that it remains bounded everywhere and approaches zero for large values of r , which is known theoretically to be the correct behavior for most of the transitions considered. The dipole moment functions of the remaining band systems were fit with constant, linear, or quadratic expressions, corresponding to the first three terms on the right-hand side of equation (15), except for the $O_2^+ A-X$ system, where a constant plus

a Gaussian term was found necessary to obtain a good fit. Generally, in the ranges of r of practical interest, all of the fits appear to be essentially as accurate as the basic data that they fit.

Figures 1-13 and Table 1 are generally self-explanatory, except for one N_2^+ and two O_2^+ band systems. For the N_2^+ $A-X$ band system, Figure 9 shows two fairly recent quantum-mechanical results, and one semi-empirical curve deduced by Gattinger and Vallance Jones (1981) from measured relative band intensities, using the r -centroid method. The two theoretical $R_e(r)$ functions have similar shapes and agree within 10 percent. Probably the more recent one, from Langhoff *et al.* (1987), is more accurate. The semi-empirical curve was derived only over a limited range of r , and has a different shape, which gives unreasonable values of $R_e(r)$ if extrapolated very far. Gattinger and Vallance Jones' Figure 4 shows that this curve fits their data points quite well. However, when their data are corrected for the improved Franck-Condon factors calculated in the present work, and additional points are added from their tables and references, the data become more scattered, and do not fit their curve as well as they do the theoretical curves.

For the O_2^+ $A-X$ and $b-a$ band systems, the recent quantum-mechanical results of Blomberg and Liu (1988) for both systems, and of Langhoff *et al.* (1989) for the latter system, appear to be quite accurate. This conclusion is supported by the excellent agreement between the two calculations for the $b-a$ system, as shown in Figure 13. Blomberg and Liu's results for the $A-X$ system also agree reasonably well with the results of the somewhat more-approximate calculations of Wetmore *et al.* (1984) (see Figure 12). Accordingly, the most recent theoretical results have been fit as shown in Figures 12-13 and Table 1, for use in our subsequent calculations.

A semi-empirical $A-X$ curve deduced by Erman and Larsson (1977) from their measured lifetimes for $A(v = 0-7)$ is also included in Figure 12. This curve differs significantly from the two theoretical curves, particularly at large internuclear separations, where the theoretical curves approach a linear variation, as expected theoretically for this transition. Moreover, using Erman and Larsson's curve, we calculated A -state lifetimes about 20 percent shorter than they measured. Erman and Larsson also presented a transition moment curve for the $b-a$ system, based on their measured lifetimes for $b(v = 0-7)$. This curve has not been included in our Figure 13 because later measurements by Moseley *et al.* (1979) show that the

higher levels, $b(v > 3)$, have very short lifetimes due to predissociation, and all emissions observed by Erman and Larsson originated from $b(v = 0-3)$. This correction, combined with Erman and Larsson's listing of b -state lifetimes that increase by 22 percent from $v = 3$ to " $v = 7$," also indicates that their accuracy estimate of about ± 7 percent is overly optimistic.

In addition, we made an attempt to apply the r -centroid method to the recent relative intensity measurements on the $O_2^+ A-X$ bands by Schappe *et al.* (1988). However, the relative $R_e(r)$ values derived from their published intensities were widely scattered. Further study suggested that they probably had a bigger problem with overlapping bands than they assumed. For example, the (0-6) and (4-8) bands are nearly coincident, and so are the (0-7) and (6-10) bands, but Schappe *et al.* attributed the measured intensities entirely to the first band of each pair.

SECTION 4

BAND-ARRAY RESULTS

In this section, tables of calculated radiative transition parameters are presented for the 38 band systems considered in this report. Tables 2 through 18 give a complete set of radiative transition parameters for 17 N_2 , N_2^+ , and O_2^+ band systems that are important in emission. With the exception of Tables 6, 11, and 12, these tables include seven quantities for each $v'-v''$ band; they are (as ordered in the tables):

1. Band origin wavelength, $\lambda_{v'v''}$ (μm);
2. Band origin wavenumber, $\nu_{v'v''}$ (cm^{-1});
3. Franck-Condon factor, $q_{v'v''}$;
4. R -centroid, $\bar{r}_{v'v''}$ ($\text{\AA}$);
5. Electronic transition moment, $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units);
6. Einstein coefficient, $A_{v'v''}$ (s^{-1}), calculated by the r -centroid method;
7. Einstein coefficient, $A_{v'v''}$ (s^{-1}), calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

The last two items are Einstein coefficients calculated by the r -centroid approximation and by direct integration. Since the latter is the more accurate of the two values, it is placed at the end of the list so that it can be read from the tables more easily.

In Tables 6, 11, and 12, item #6 has been omitted. This is because these three band systems have constant $R_e(r)$ functions, and, as shown in Section 2, the r -centroid approximation is exact for $R_e(r)$ functions that are constant or vary linearly with internuclear distance. Thus, the two different methods of calculating Einstein coefficients yield the same result for these cases, as we have verified numerically for many bands in these three systems, as well as for a test case involving a linear variation.

For more than half of the band systems in Tables 2-18, radiative transition parameters are presented for v' , $v'' = 0-21$. The exceptions include the band systems that involve the N_2 $w^1\Delta_u$, $C^3\Pi_u$, $E^3\Sigma_g^+$, and $D^3\Sigma_u^+$ states, for which the available spectroscopic data are insufficient to permit reliable extrapolation to $v = 21$ (see Laher and Gilmore, 1991). In addition, results for the $N_2^+ B^2\Sigma_u^+ - X^2\Sigma_g^+$ system are limited to $v' = 0-10$, since the unusual behavior of the energy levels and potential curve of the B state prevent an adequate fit by the usual spectroscopic power series beyond $v = 8$ or 10 (Laher and Gilmore, 1991). It would be possible to extend the present $B-X$ calculations to higher vibrational levels by using a numerical RKR method, but since these levels are not significant in air fluorescence, this was not done.

For some of the bands in Tables 2-18, the wavelengths, wavenumbers, and Einstein coefficients have negative signs in front of their numerical values. This is to indicate that the transition is reversed. The N_2 $B-A$ (0-8) band at $8.85\ \mu\text{m}$ in Table 3 is an example. Since the A ($v'' = 8$) state is higher in energy than the B ($v' = 0$) state, the transition proceeds from the A state to the B state. Such cases are known as reverse bands.

The calculated strengths of bands with small Franck-Condon factors are often less accurate than those with larger Franck-Condon factors. Accordingly, in Tables 2-18, the Einstein coefficients calculated by direct integration are marked with asterisks if the corresponding Franck-Condon factors are less than 0.01. There are two situations in which small Franck-Condon factors arise. The first is when the wavefunctions of the upper and lower states overlap very little; in this case, the calculated band strength is usually quite accurate. The second is when the wavefunctions do overlap but, because of a near cancellation between similar contributions of positive and negative values of $\psi_v^* \psi_{v''}$, the resulting overlap integral is small. In this case, the overlap integral is sensitive to small variations in the potential energy curves, especially for high vibrational levels, and the resulting Franck-Condon factor may not be very accurate.

It is also interesting to note for which bands in the tables the Einstein coefficients calculated by the two methods disagree significantly. Accordingly, when the two values differ by more than 10%, the r -centroid value in the tables has been

enclosed in parentheses. Such disagreement tends to occur when $R_e(r)$ is significantly nonlinear and the Franck-Condon factor is small.

The radiative lifetimes of 14 N_2 , N_2^+ , and O_2^+ states have also been calculated and are presented in Table 19 as a function of vibrational level. These quantities were obtained by taking the inverse of the sum of the Einstein coefficients (calculated by direct integration) for transitions from a given upper level to all possible lower levels, which may include more than one electronic state. For example, the radiative lifetime for a given v' of the N_2 A state was found by summing over v'' all $A_v'v''$ values for the $A-X$ and $B-A$ -reverse band systems. The calculated lifetimes are generally in good agreement with the best available measurements, which can be verified by consulting the references given in Table 1. It should be noted, however, that radiative lifetimes for most of the levels listed in Table 19 have never been measured.

Tables 20 through 35 present tables of Franck-Condon factors for transitions between the upper states covered in the previous tables and the ground state, except for the N_2 $A-X$ and $a-X$ band systems, where Franck-Condon factors have already been presented in Tables 2 and 6. Eight of these tables cover N_2 band systems for which insufficient information is available to calculate accurate Einstein coefficients, generally because they are very weak ("forbidden") transitions. In addition, eight nitrogen and oxygen ionization systems are included for application to photoionization and electron-impact ionization problems. The Franck-Condon factors presented in these tables are generally more accurate than those in previously published work because the RKR potential energy curves used in the present calculations are based on spectroscopic constants that are valid to higher vibrational levels.

Tables 36 through 38 cover three N_2 band systems with perturbed upper states. As discussed in Section 2.4, perturbations involve mixing between electronic states, so the relations derived earlier for Franck-Condon factors, Einstein coefficients, etc., are no longer applicable. Consequently, Tables 36-38 simply list band origin or band head wavelengths derived from spectroscopic measurements, and Einstein coefficients derived from measurements of absolute absorption band intensities, relative emission band intensities and upper-state lifetimes. The sources and limitations of the basic data are indicated on the tables.

SECTION 5

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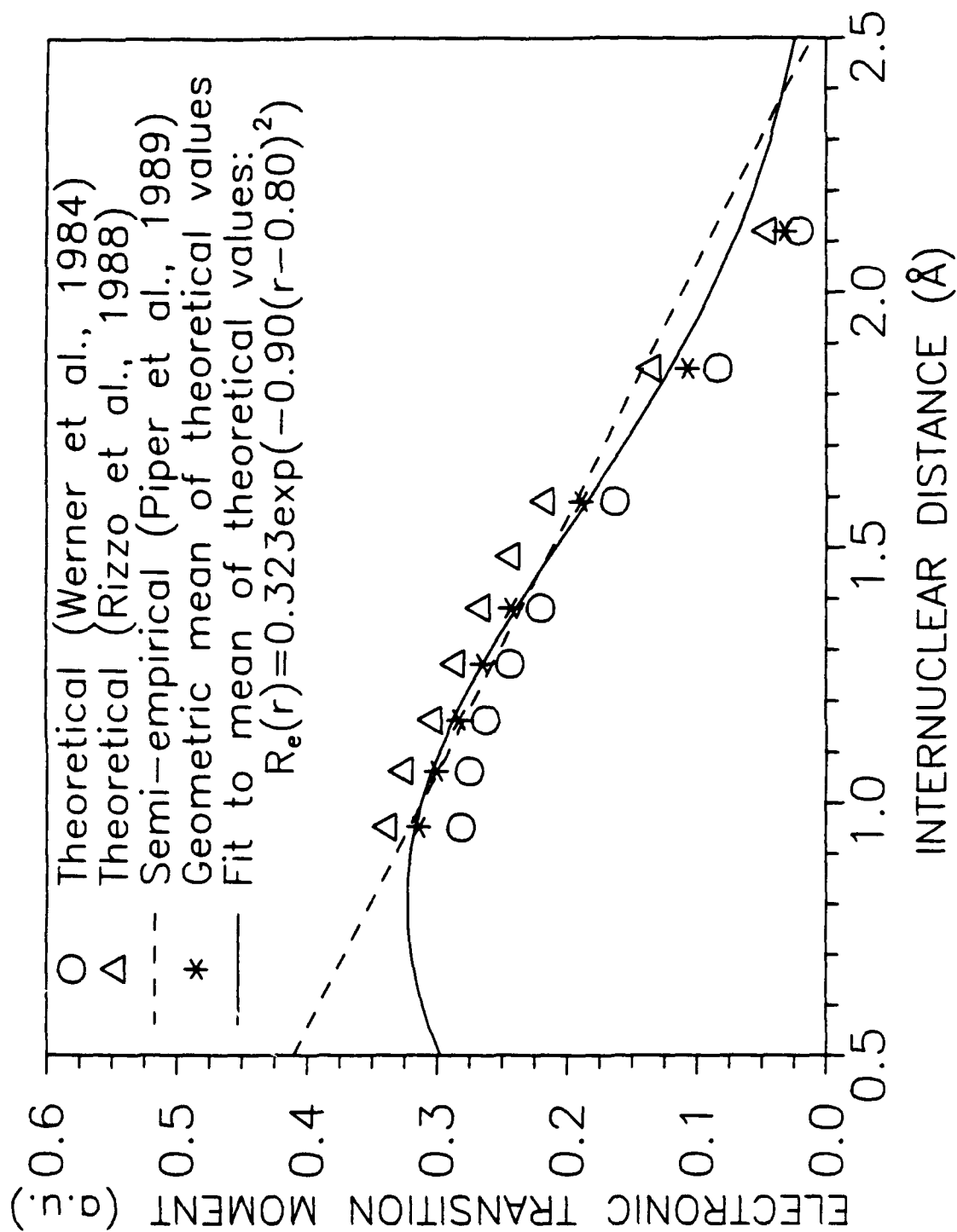


Figure 1. Electronic transition moment data and fit for the N_2 $B^3\Pi_g - A^3\Sigma_u^+$ band system.

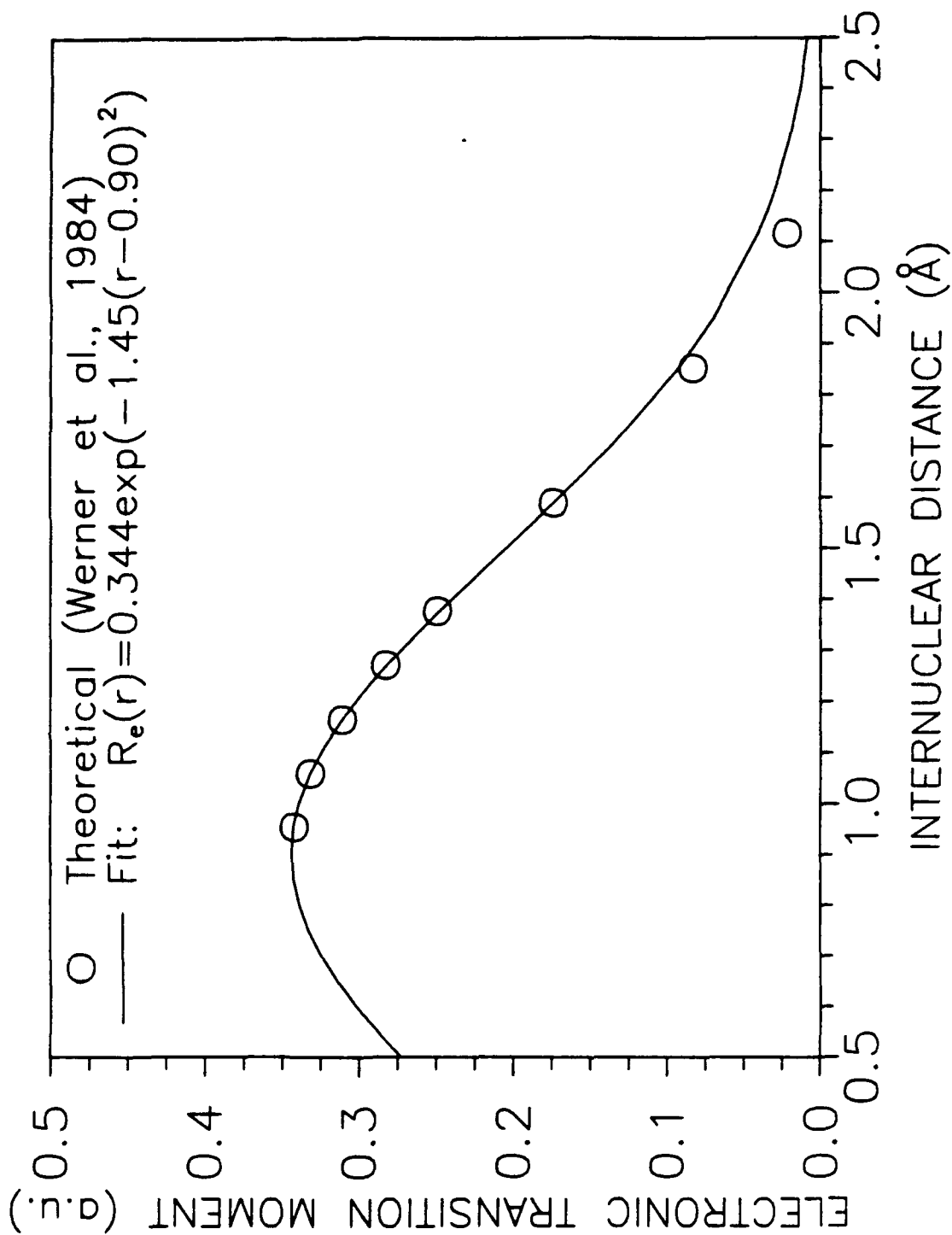


Figure 2. Electronic transition moment data and fit for the $N_2 W^3\Delta_u - B^3\Pi_g$ band system.

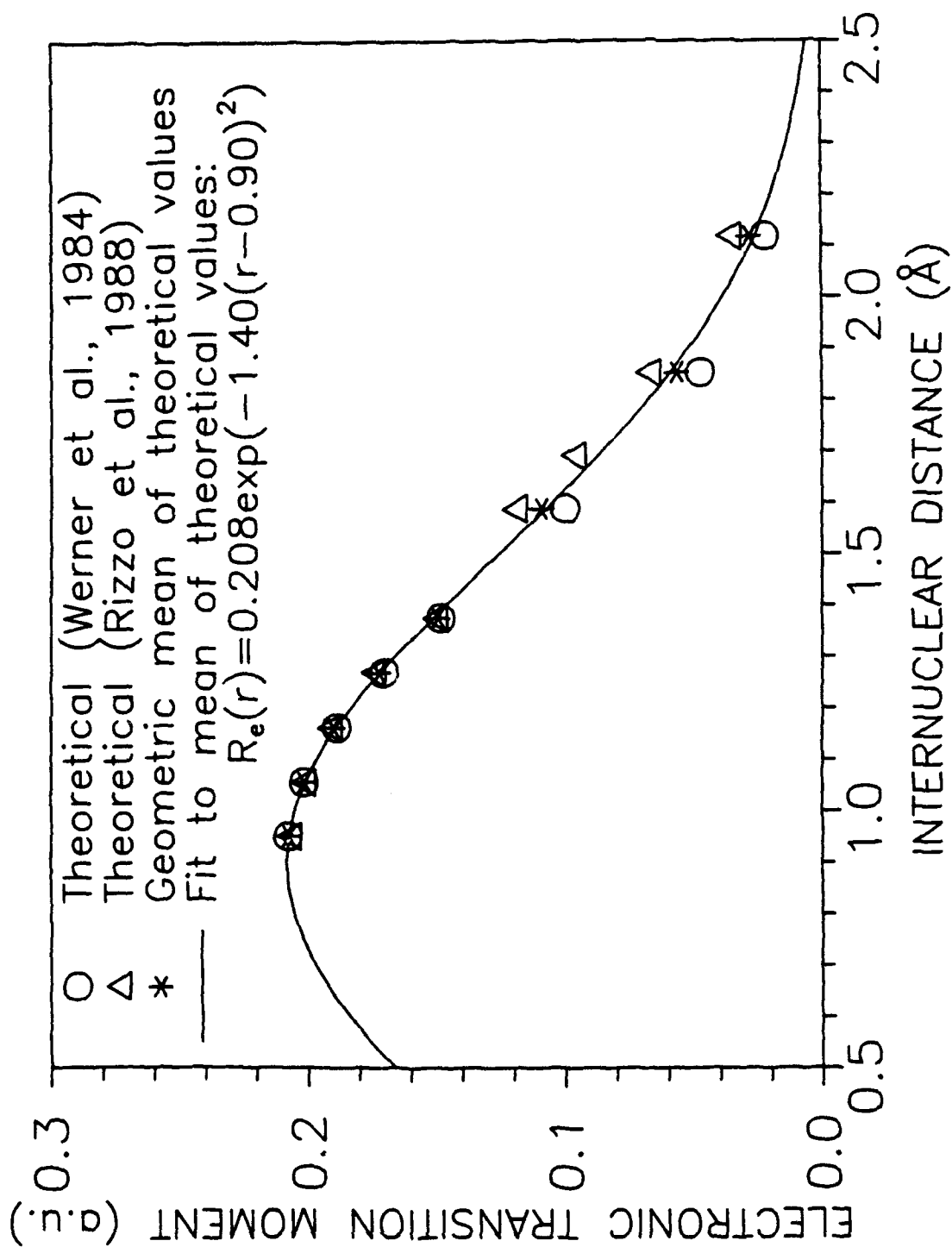


Figure 3. Electronic transition moment data and fit for the $N_2 B' {}^3\Sigma_u^- - B {}^3\Pi_g$ band system.

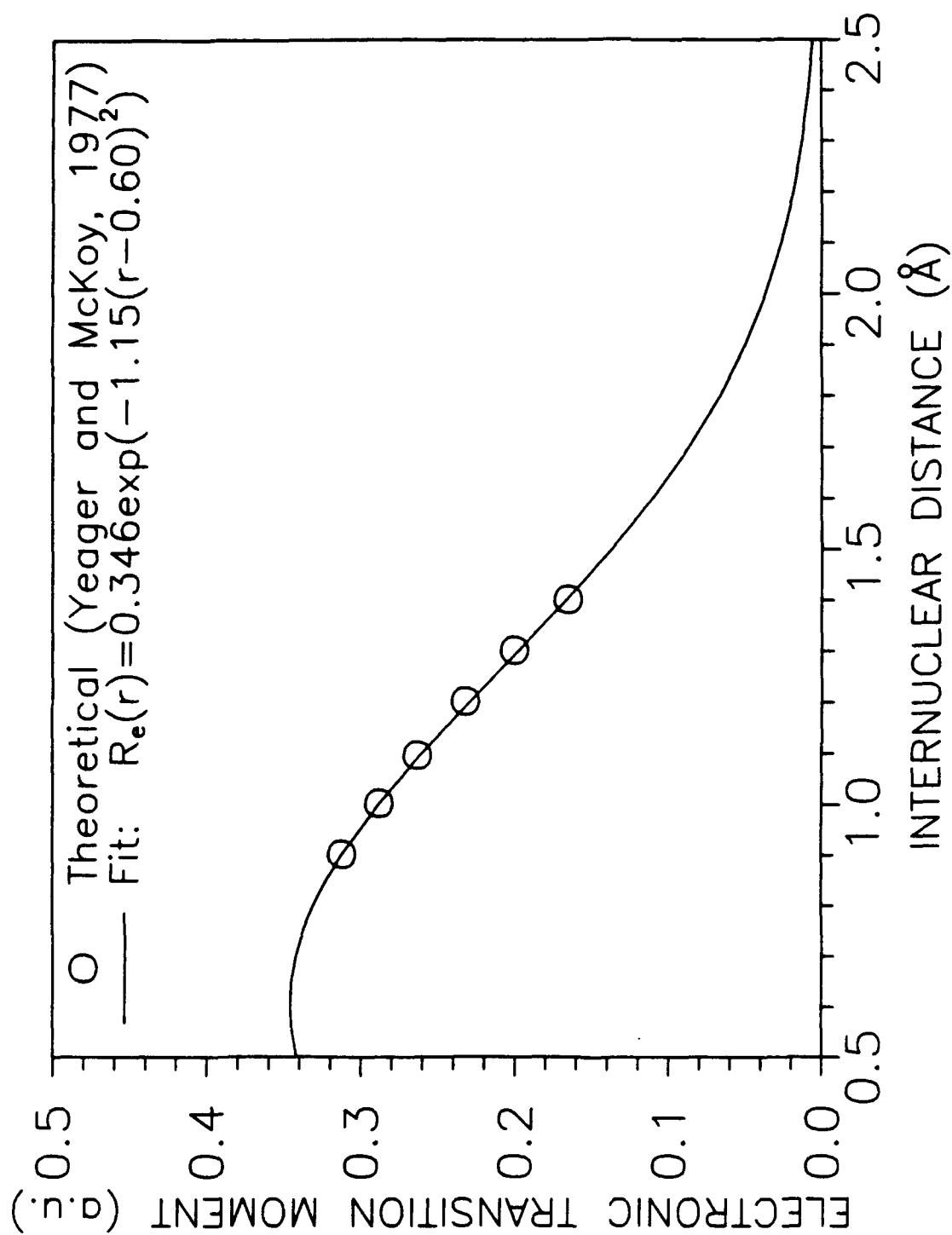


Figure 4. Electronic transition moment data and fit for the $N_2 a \ ^1\Pi_g - a' \ ^1\Sigma_u^-$ band system.

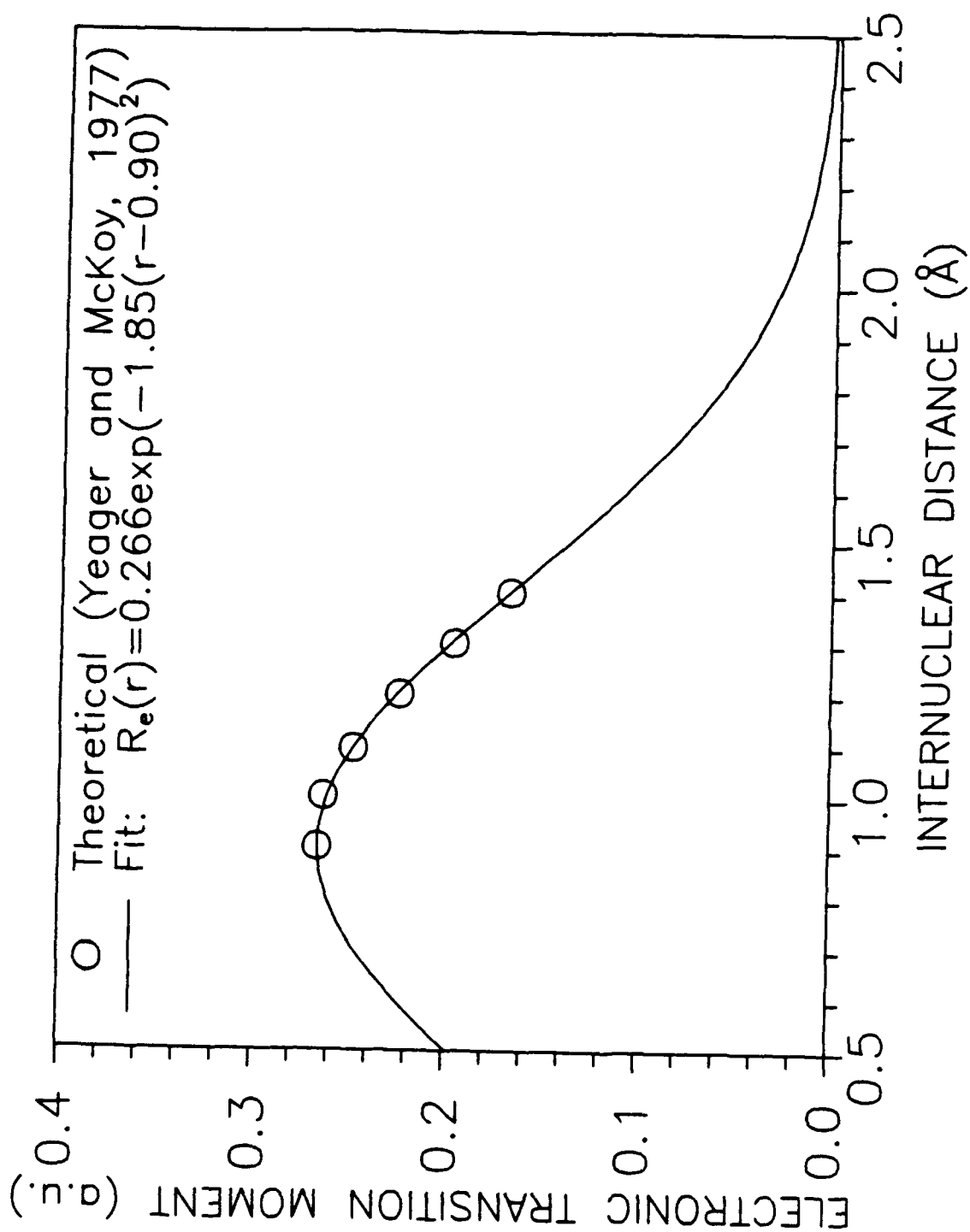


Figure 5. Electronic transition moment data and fit for the $N_2 w^1\Delta_g - a^1\Pi_g$ band system.

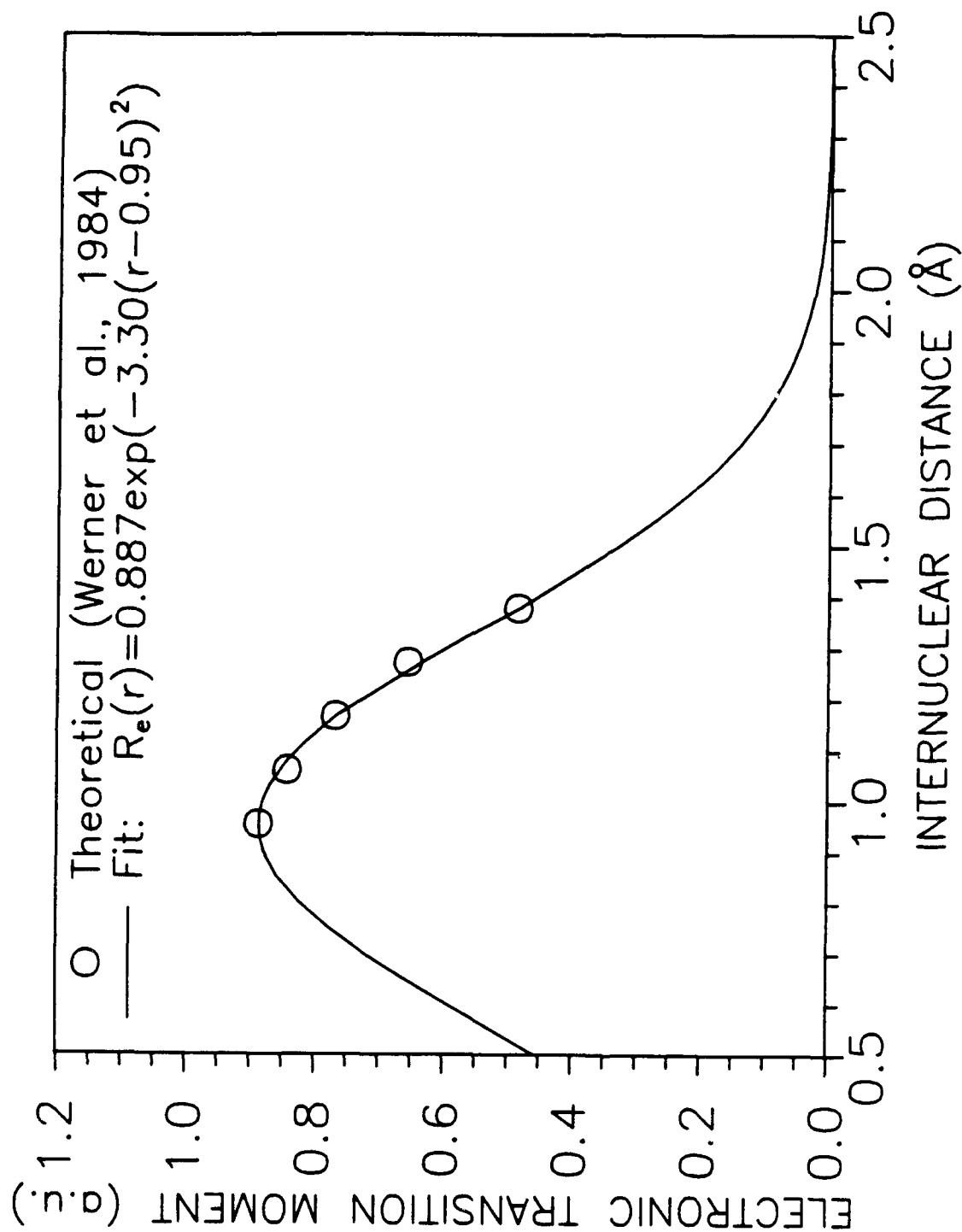


Figure 6. Electronic transition moment data and fit for the $N_2 C^3\Pi_u - B^3\Pi_g$ band system.

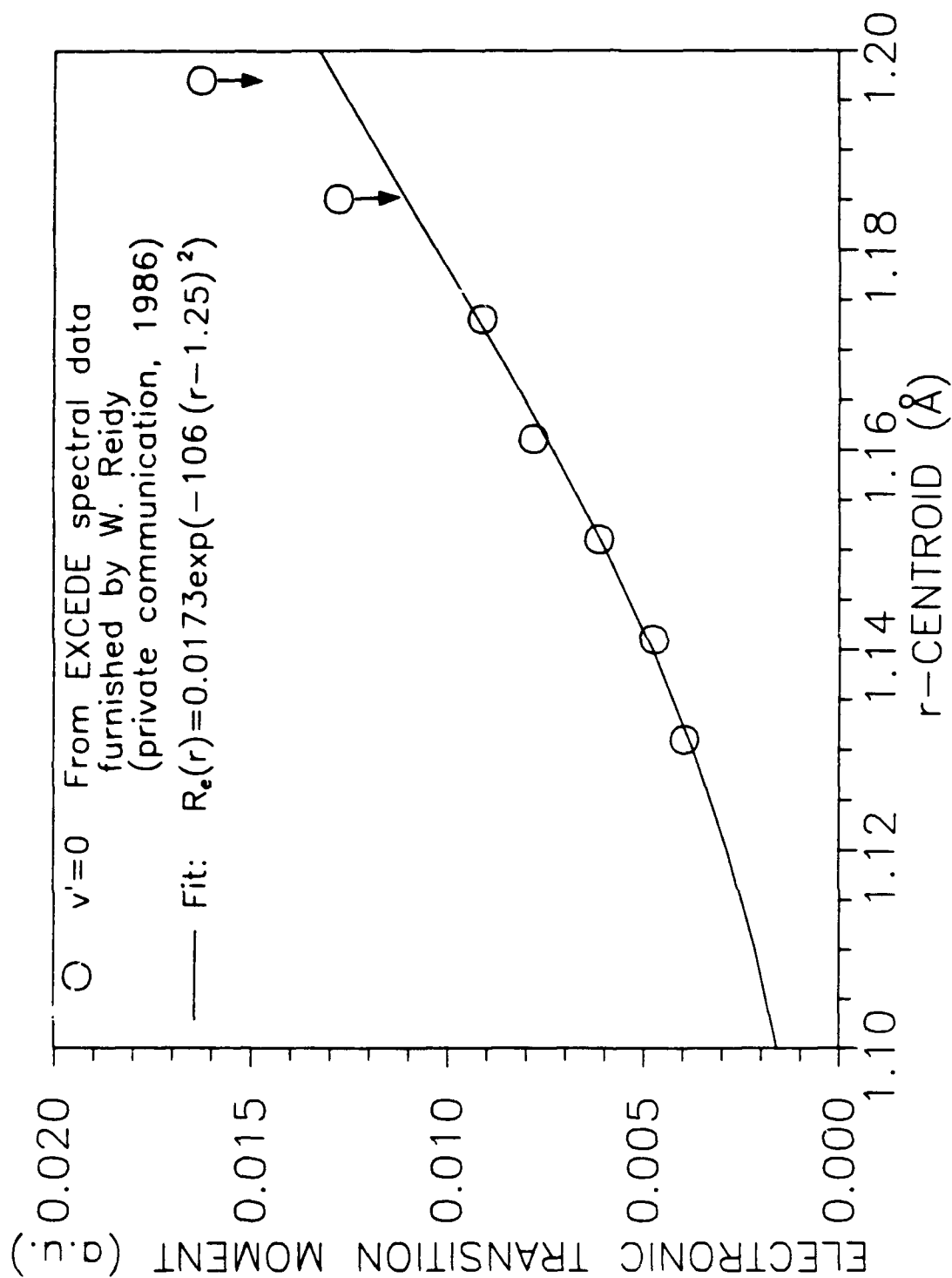


Figure 7. Electronic transition moment data and fit for the $N_2 E^3\Sigma_g^+ - A^3\Sigma_u^+$ band system.

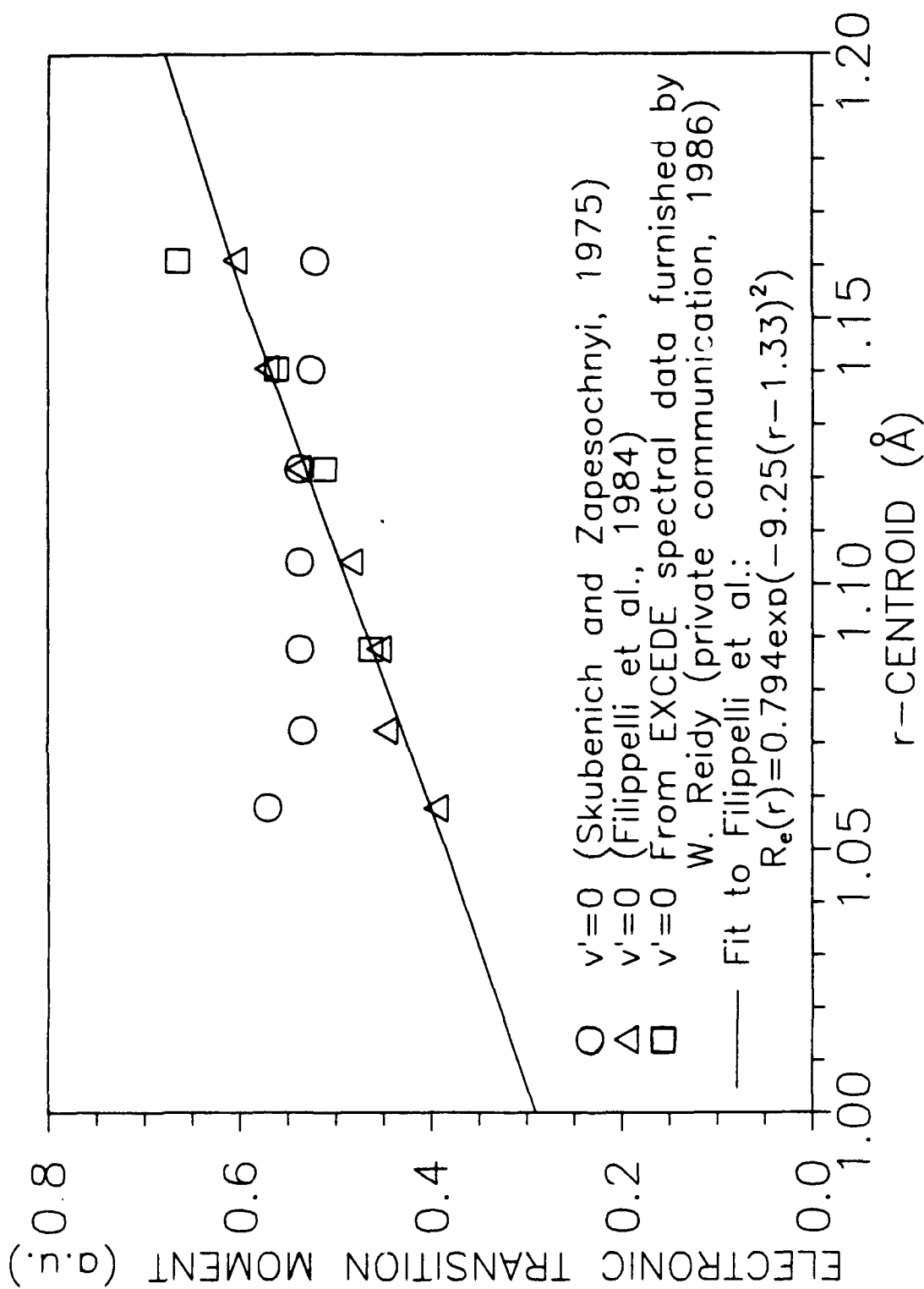


Figure 8. Electronic transition moment data and fit for the $N_2 D^3\Sigma_u^+ - B^3\Pi_g$ band system.

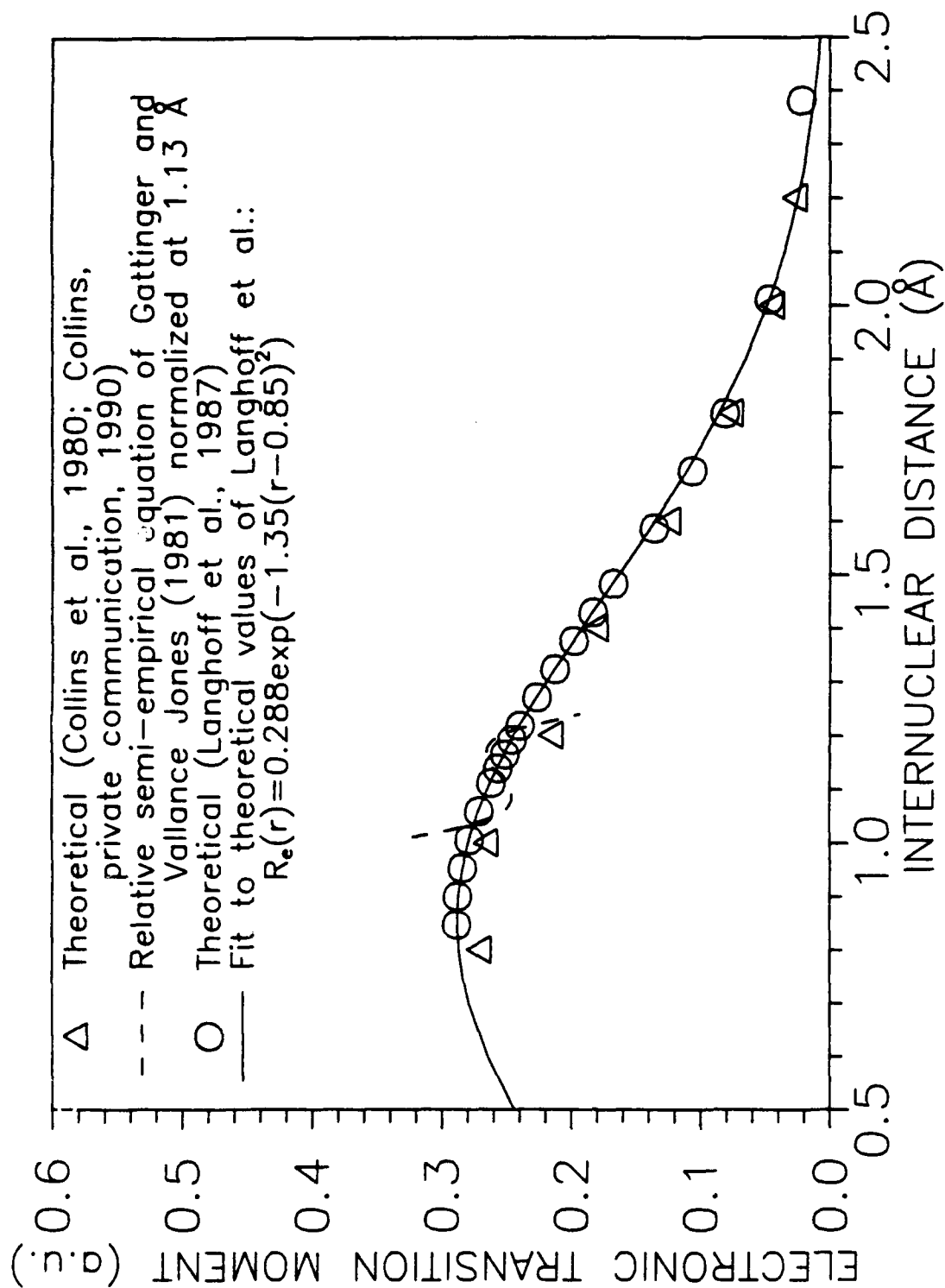


Figure 9. Electronic transition moment data and fit for the $N_2^+ A^2\Pi_u - X^2\Sigma_g^+$ band system.

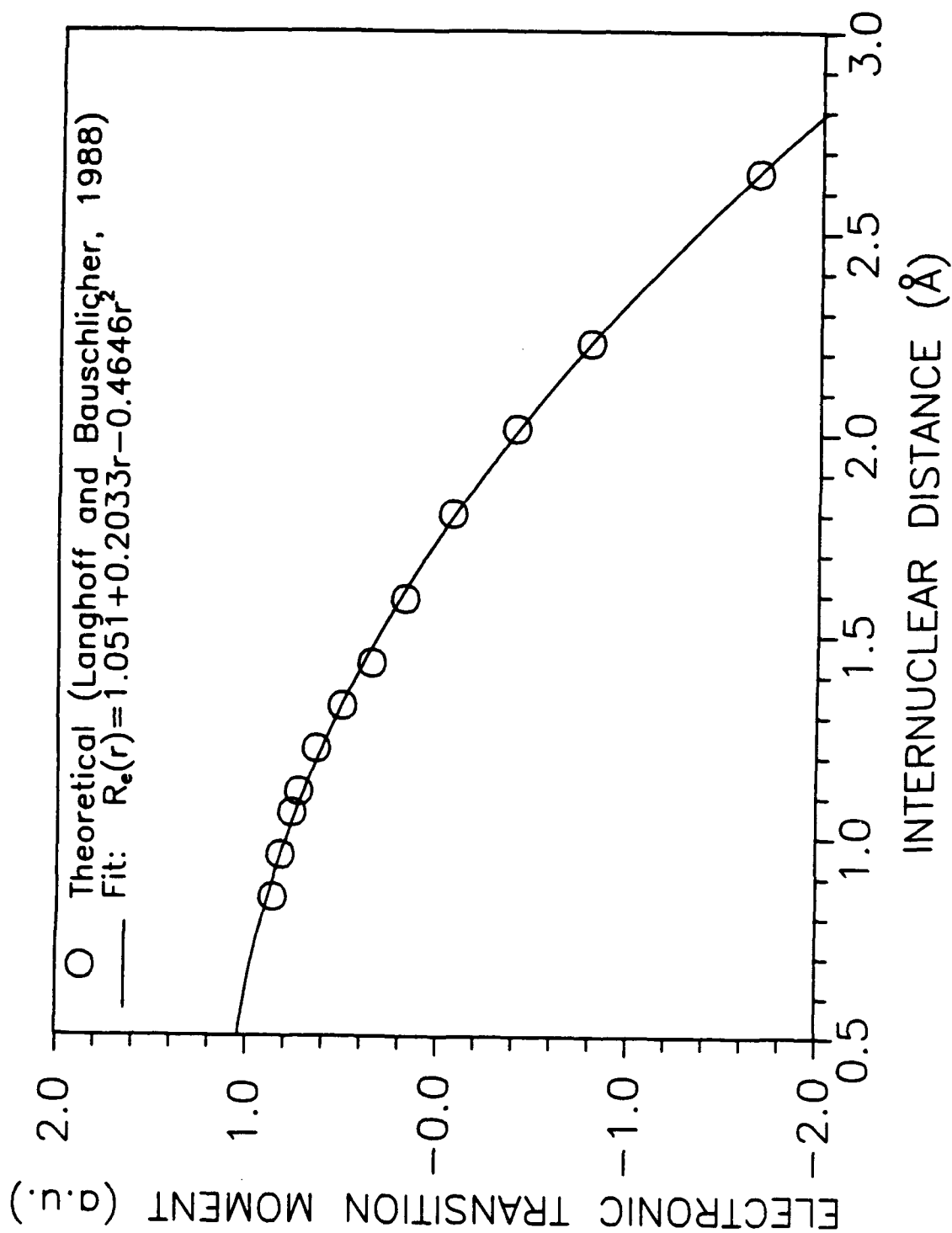


Figure 10. Electronic transition moment data and fit for the $N_2^+ B \ ^2\Sigma_u^+ - X \ ^2\Sigma_g^+$ band system.

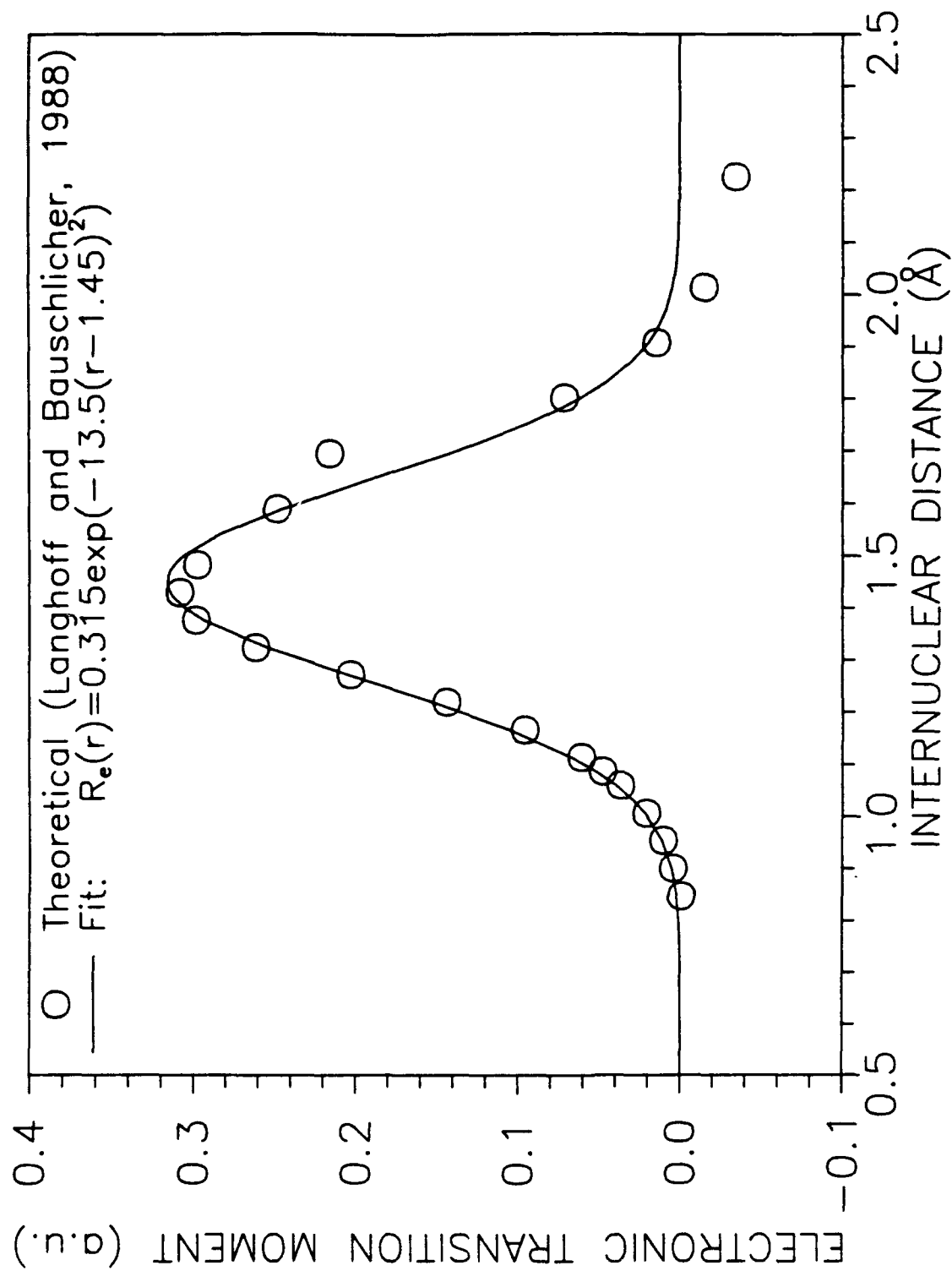


Figure 11. Electronic transition moment data and fit for the $N_2^+ C^2\Sigma_u^+ - X^2\Sigma_g^+$ band system.

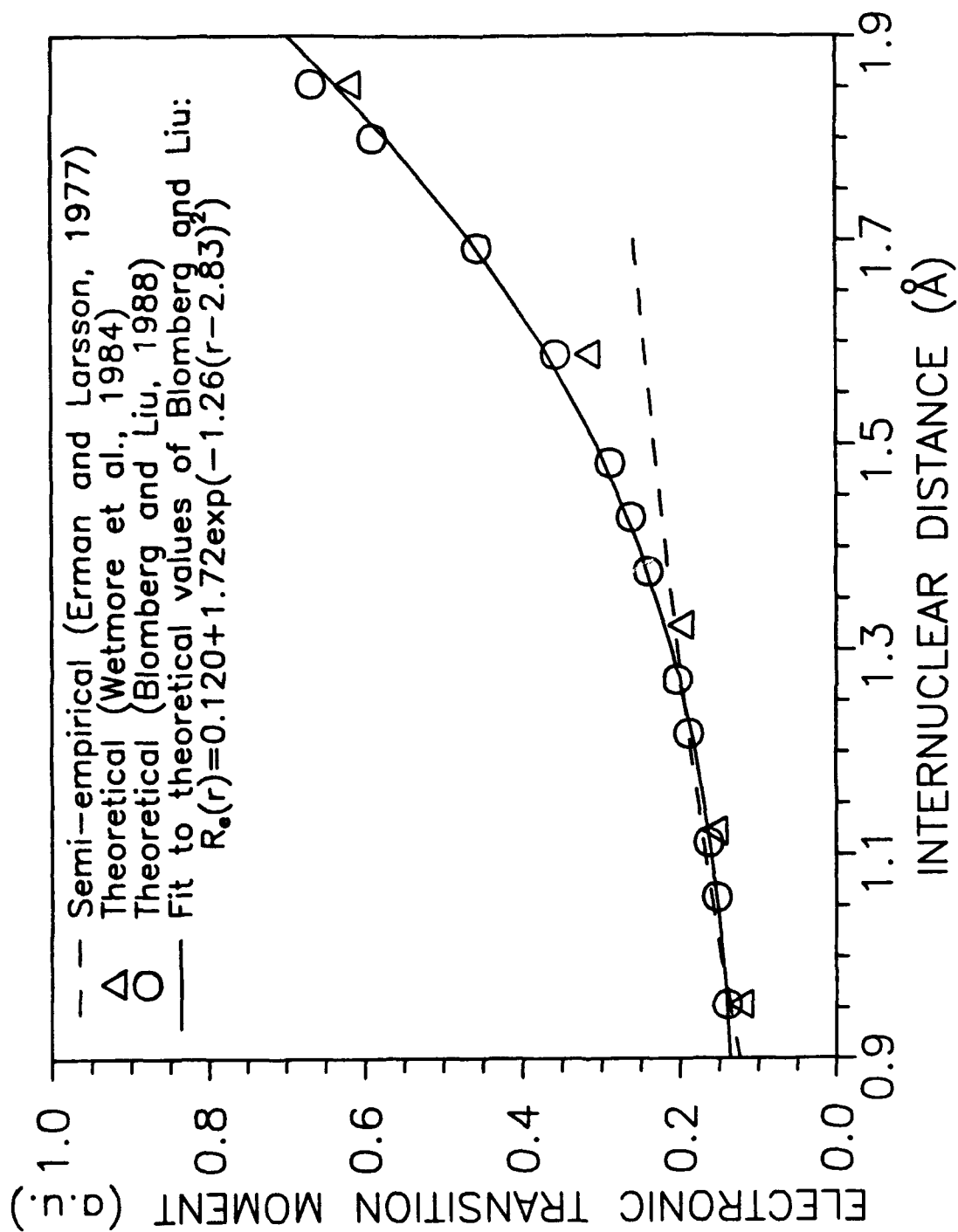


Figure 12. Electronic transition moment data and fit for the $O_2^+ A \ ^2\Pi_u - X \ ^2\Pi_g$ band system.

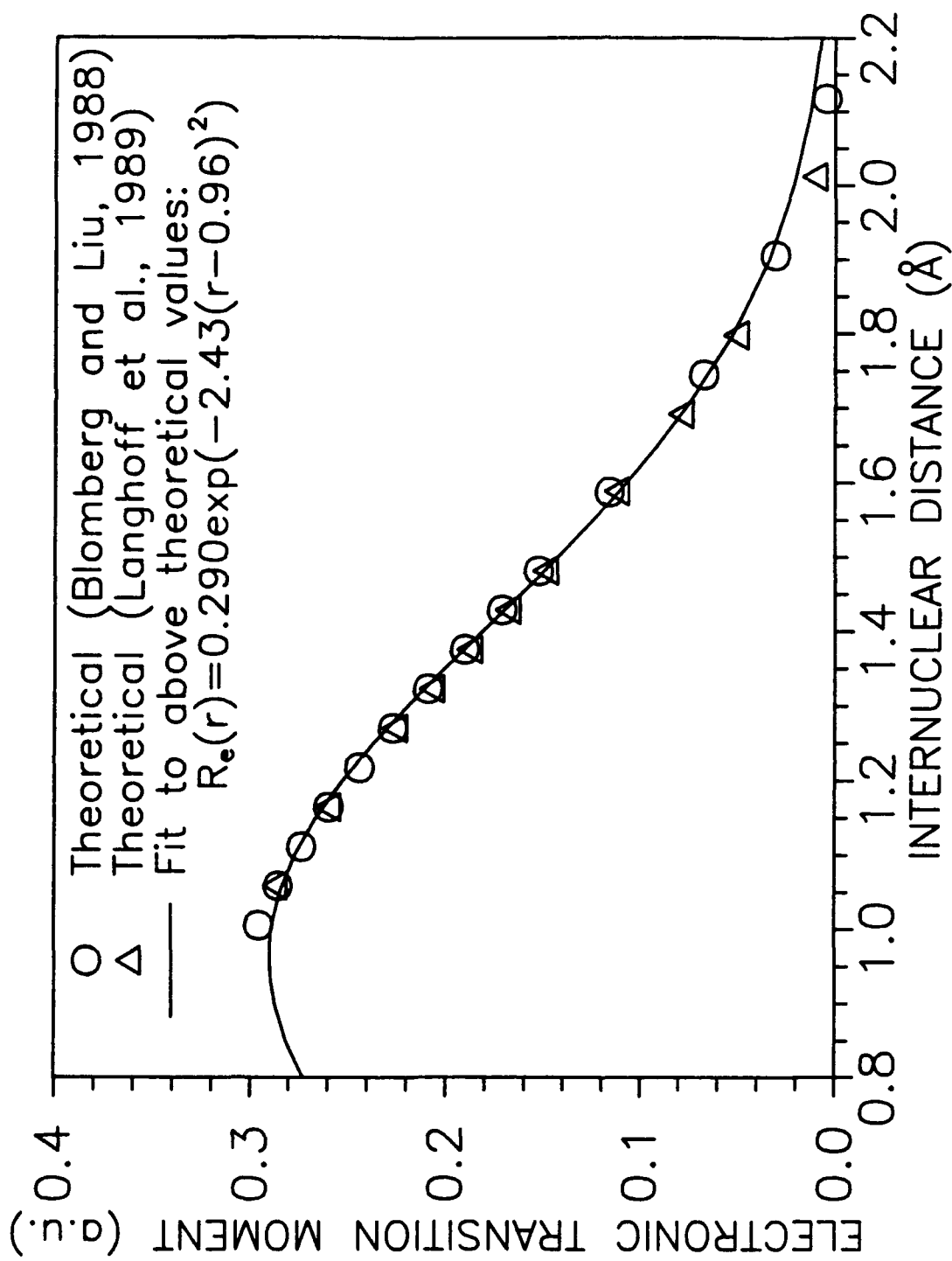


Figure 13. Electronic transition moment data and fit for the $O_2^+ b \ ^4\Sigma_g^- - a \ ^4\Pi_u$ band system.

Table 1. Coefficients of analytic fits to the electronic transition moments of N_2 , N_2^+ , and O_2^+ band systems.

$$R_e(r) = a + br + cr^2 + d \exp[-f(r-g)^2] \quad (R_e \text{ is in electric dipole moment atomic units; } r \text{ is in } \text{\AA}.)$$

Band system	a	b	c	d	f	g	References
N_2 $A^3\Sigma_u^+ - X^1\Sigma_g^+$	0.00119	-0.00117	0.000139				Shemansky (1969a), renormalized to give mean Einstein coefficients, averaged over substates.
$B^3\Pi_g - A^3\Sigma_u^+$				0.323	0.90	0.80	Fit to geometric mean of theoretical values of Werner <i>et al.</i> (1984) and Rizzo <i>et al.</i> (1988) (see Fig. 1).
$W^3\Delta_u - B^3\Pi_g$				0.344	1.45	0.90	Fit to theoretical values of Werner <i>et al.</i> (1984) (see Fig. 2).
$B'^3\Sigma_u^- - B^3\Pi_g$				0.208	1.40	0.90	Fit to geometric mean of theoretical values of Werner <i>et al.</i> (1984) and Rizzo <i>et al.</i> (1988) (see Fig. 3).
$a^1\Pi_g - X^1\Sigma_g^+$	0.00588						R_e = constant from Shemansky (1969b), renormalized to give a $\nu = 0$ lifetime of 58 μ s (Marinelli <i>et al.</i> , 1989). This includes a little contribution from electric quadrupole radiation; see Dahl and Oddershede (1986).
$a^1\Pi_g - a'^1\Sigma_u^-$				0.346	1.15	0.60	Fit to theoretical values of Yeager and McKoy (1977) (see Fig. 4).
$w^1\Delta_u - a^1\Pi_g$				0.266	1.85	0.90	Fit to theoretical values of Yeager and McKoy (1977) (see Fig. 5).
$C^3\Pi_u - B^3\Pi_g$				0.887	3.30	0.95	Fit to theoretical values of Werner <i>et al.</i> (1984) (see Fig. 6).

Table 1. Coefficients of analytic fits to the electronic transition moments of N_2 , N_2^+ , and O_2^+ band systems. - Continued

$$R_e(r) = a + br + cr^2 + d \exp[-f(r-g)^2] \quad (R_e \text{ is in electric dipole moment atomic units; } r \text{ is in } \text{\AA}.)$$

Band system	a	b	c	d	f	g	References
N_2							
$E^3\Sigma_g^+ - A^3\Sigma_u^+$				0.0173	106	1.25	Fit to relative $R_e(\bar{r})$ values derived from spectral measurements on the EXCEDE rocket-lofted electron-gun experiment (furnished by W. Reidy, private communication, 1986) (see Fig. 7); $R_e = \text{constant}$ is assumed for the $E-B$ and $E-C$ transitions. Absolute normalization from E -state lifetime of 190 μs (Borst and Zipf, 1971) and relative radiation rates of the three band systems (Freund, 1969).
$E^3\Sigma_g^+ - B^3\Pi_g$	0.00185						
$E^3\Sigma_g^+ - C^3\Pi_u$	0.0414						
$D^3\Sigma_u^- - B^3\Pi_g$				0.794	9.25	1.33	Fit to relative $R_e(\bar{r})$ values derived from emission data of Filippelli <i>et al.</i> (1984) (see Fig. 8); normalized to give a $v = 0$ lifetime of 14.1 ns (Kurzweg <i>et al.</i> , 1973).
N_2^+				0.288	1.35	0.85	Fit to theoretical values of Langhoff <i>et al.</i> (1987) (see Fig. 9).
$A^2\Pi_u - X^2\Sigma_g^+$							
$B^2\Sigma_u^- - X^2\Sigma_g^+$	1.051	0.2033	-0.4646				Fit to theoretical values of Langhoff and Bauschlicher (1988) (see Fig. 10). Calculation using this fit yields a $v = 0$ lifetime of 62.3 ns, which is within 2% of the measurement of Schmoranz <i>et al.</i> (1989) (see Table 19).
$C^2\Sigma_u^- - X^2\Sigma_g^+$				0.315	13.5	1.45	Fit to theoretical values of Langhoff and Bauschlicher (1988) (see Fig. 11).
O_2^+				1.72	1.26	2.83	Fit to theoretical values of Blomberg and Liu (1988) (see Fig. 12).
$A^2\Pi_u - X^2\Pi_g$	0.120						
$b^4\Sigma_g^- - a^4\Pi_u$				0.290	2.43	0.96	Fit to theoretical values of Blomberg and Liu (1988) and Langhoff <i>et al.</i> (1989) (see Fig. 13).

Table 2. Radiative transition parameters for $N_2 A^3\Sigma_u^+ - X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.2010 49754.8 9.74E-04 1.1850 -1.26E-06 (2.58E-07) 1.97E-07*	.2109 47424.4 8.13E-03 1.2019 -1.54E-05 2.79E-04 2.75E-04*	.2216 45122.9 3.21E-02 1.2193 -2.99E-05 3.57E-03 3.54E-03	.2334 42850.0 7.98E-02 1.2372 -4.48E-05 1.70E-02 1.69E-02	.2463 40606.0 1.40E-01 1.2555 -5.98E-05 4.54E-02 4.53E-02	.2605 38390.7 1.85E-01 1.2744 -7.53E-05 8.01E-02 8.01E-02	.2762 36204.2 1.91E-01 1.2939 -9.12E-05 1.02E-01 1.02E-01	.2937 34046.6 1.57E-01 1.3141 -1.07E-04 9.68E-02 9.69E-02	.3133 31917.9 1.06E-01 1.3350 -1.24E-04 7.16E-02 7.17E-02	.3354 29818.2 5.85E-02 1.3566 -1.41E-04 4.19E-02 4.20E-02	.3604 27747.4 2.70E-02 1.3791 -1.59E-04 1.97E-02 1.98E-02
1	.1954 51187.7 5.18E-03 1.1746 7.49E-06 5.27E-05 5.47E-05*	.2047 48857.3 3.21E-02 1.1911 -6.38E-06 2.06E-04 1.97E-04	.2148 46555.8 8.69E-02 1.2079 -2.04E-05 4.95E-03 4.91E-03	.2258 44282.9 1.31E-01 1.2251 -3.47E-05 1.85E-02 1.85E-02	.2379 42038.9 1.10E-01 1.2426 -4.92E-05 2.69E-02 2.69E-02	.2511 39823.6 4.02E-02 1.2597 -6.33E-05 1.37E-02 1.38E-02	.2657 37637.1 2.17E-05 1.1668 1.41E-05 (3.10E-07) 3.01E-09*	.2819 35479.5 3.66E-02 1.3034 -9.88E-05 2.16E-02 2.14E-02	.2998 33350.8 1.09E-01 1.3223 -1.14E-04 7.13E-02 7.12E-02	.3200 31251.1 1.50E-01 1.3428 -1.30E-04 1.05E-01 1.05E-01	.3427 29180.3 1.35E-01 1.3643 -1.48E-04 9.87E-02 9.87E-02
2	.1901 52592.9 1.47E-02 1.1646 1.59E-05 7.36E-04 7.45E-04	.1990 50262.6 6.59E-02 1.1806 2.44E-06 6.72E-05 6.97E-05	.2085 47961.0 1.14E-01 1.1969 -1.12E-05 2.14E-03 2.14E-03	.2189 45688.2 8.27E-02 1.2133 -2.49E-05 6.63E-03 6.66E-03	.2302 43444.1 1.13E-02 1.2275 -3.67E-05 1.69E-03 1.73E-03	.2425 41228.8 1.9E-02 1.2537 -5.84E-05 4.81E-03 4.73E-03	.2561 39042.4 7.76E-02 1.2693 -7.11E-05 3.16E-02 3.15E-02	.2711 36884.8 8.15E-02 1.2871 -8.56E-05 4.05E-02 4.06E-02	.2877 34756.1 2.20E-02 1.3039 -9.92E-05 1.23E-02 1.24E-02	.3062 32656.3 3.62E-03 1.3396 -1.28E-04 2.79E-03 2.73E-03*	.3270 30585.6 6.18E-02 1.3518 -1.38E-04 4.53E-02 4.51E-02
3	.1853 53970.4 2.99E-02 1.1551 2.40E-05 3.65E-03 3.70E-03	.1936 51640.1 9.32E-02 1.1706 1.09E-05 2.05E-03 2.06E-03	.2027 49338.5 9.01E-02 1.1863 -2.36E-06 8.11E-05 8.19E-05	.2125 47065.7 1.50E-02 1.2003 -1.41E-05 4.18E-04 4.40E-04	.2231 44821.6 1.53E-02 1.2242 -3.40E-05 2.15E-03 2.10E-03	.2347 42606.3 7.20E-02 1.2388 -4.61E-05 1.60E-02 1.60E-02	.2474 40419.9 4.55E-02 1.2550 -5.94E-05 1.43E-02 1.44E-02	.2614 38262.3 3.10E-05 1.1644 1.61E-05 (6.08E-07) 2.86E-09*	.2768 36133.5 4.24E-02 1.2969 -9.36E-05 2.37E-02 2.36E-02	.2938 34033.8 8.11E-02 1.3145 -1.08E-04 5.01E-02 5.02E-02	.3129 31963.1 3.68E-02 1.3325 -1.22E-04 2.42E-02 2.43E-02
4	.1808 55320.1 4.85E-02 1.1459 3.18E-05 1.12E-02 1.13E-02	.1887 52989.7 1.00E-01 1.1610 1.90E-05 7.27E-03 7.29E-03	.1973 50688.1 4.16E-02 1.1756 6.65E-06 3.23E-04 3.06E-04	.2065 48415.3 2.89E-03 1.2012 -1.48E-05 (9.77E-05) 8.56E-05*	.2166 46171.3 5.90E-02 1.2110 -2.30E-05 4.16E-03 4.11E-03	.2275 43956.0 4.13E-02 1.2260 -3.55E-05 5.57E-03 6.03E-03	.2394 41769.5 3.61E-04 1.2755 -7.62E-05 (2.06E-04) 1.87E-04*	.2524 39611.9 4.89E-02 1.2650 -6.76E-05 1.88E-02 1.86E-02	.2668 37483.2 5.34E-02 1.2811 -8.08E-05 2.48E-02 2.49E-02	.2826 35383.4 2.41E-03 1.2876 -8.60E-05 1.07E-03 1.11E-03*	.3002 33312.7 3.05E-02 1.3251 -1.16E-04 2.06E-02 2.04E-02
5	.1765 56641.8 6.70E-02 1.1371 3.93E-05 2.54E-02 2.55E-02	.1841 54311.4 8.56E-02 1.1517 2.69E-05 1.34E-02 1.34E-02	.1923 52009.8 6.49E-03 1.1632 1.71E-05 3.62E-04 3.39E-04*	.2011 49737.0 3.28E-02 1.1854 -1.60E-06 (1.39E-05) 1.05E-05	.2106 47492.9 5.30E-02 1.1996 -1.35E-05 1.40E-03 1.41E-03	.2209 45277.7 9.37E-04 1.2003 -1.41E-05 (2.33E-05) 3.08E-05*	.2321 43091.2 3.81E-02 1.2362 -4.39E-05 (3.02E-05) 7.86E-03	.2443 40933.6 4.48E-02 1.2510 -5.61E-05 1.31E-02 1.31E-02	.2577 38804.9 1.15E-04 1.2095 -2.18E-05 (4.31E-06) 7.97E-06*	.2724 36705.1 4.08E-02 1.2914 -8.91E-05 2.16E-02 2.15E-02	.2887 34634.4 5.10E-02 1.3076 -1.02E-04 2.99E-02 3.00E-02
6	.1726 57935.3 8.19E-02 1.1286 4.66E-05 4.67E-02 4.68E-02	.1798 55605.0 5.81E-02 1.1426 3.46E-05 1.62E-02 1.61E-02	.1876 53303.4 1.55E-03 1.1681 1.30E-05 (5.36E-05) 6.35E-05*	.1960 51030.5 5.49E-02 1.1749 7.24E-06 5.17E-04 5.24E-04	.2050 48786.5 1.62E-02 1.1876 -3.45E-06 (3.02E-05) 3.79E-05	.2147 46571.2 1.69E-02 1.2105 -2.26E-05 1.17E-03 1.13E-03	.2253 44384.8 4.82E-02 1.2236 -3.35E-05 6.39E-03 6.42E-03	.2368 42227.1 1.91E-03 1.2280 -3.72E-05 2.68E-04 2.92E-04*	.2494 40098.4 3.32E-02 1.2615 -6.48E-05 1.21E-02 1.20E-02	.2632 37998.7 4.04E-02 1.2761 -7.67E-05 1.74E-02 1.77E-02	.2783 35928.0 2.23E-06 1.7893 -4.58E-04 (2.94E-05) 2.63E-05*
7	.1689 59200.5 9.11E-02 1.1205 5.35E-05 7.31E-02 7.33E-02	.1758 56870.2 2.97E-02 1.1336 4.23E-05 1.32E-02 1.31E-02	.1833 54568.6 1.82E-02 1.1525 2.62E-05 2.74E-03 2.81E-03	.1912 52295.8 4.74E-02 1.1651 1.55E-05 2.21E-03 2.19E-03	.1998 50051.7 2.93E-05 1.2652 -6.78E-05 (2.28E-05) 1.68E-05*	.2090 47836.4 4.33E-02 1.1984 -1.25E-05 1.00E-03 9.83E-04	.2191 45650.0 1.44E-02 1.2106 -2.27E-05 9.50E-04 9.87E-04	.2299 43492.4 1.62E-02 1.2350 -4.29E-05 3.32E-03 3.25E-03	.2418 41363.6 4.21E-02 1.2478 -5.35E-05 (6.22E-05) 1.16E-02	.2547 39263.9 4.27E-04 1.2341 -4.22E-05 7.46E-05*	.2689 37193.2 3.65E-02 1.2868 -8.54E-05 1.85E-02 1.84E-02

Table 2. Radiative transition parameters for $N_2 A^3\Sigma_u^+ - X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	.3890 25705.8 1.04E-02 1.4025 -1.78E-04 7.50E-03 7.52E-03	.4221 23693.4 3.35E-03 1.4270 -1.97E-04 2.32E-03 2.33E-03*	.4606 21710.3 9.06E-04 1.4527 -2.16E-04 5.86E-04 5.88E-04*	.5062 19756.6 2.06E-04 1.4797 -2.37E-04 1.20E-04 1.21E-04*	.5608 17832.4 3.90E-05 1.5083 -2.58E-04 2.00E-05 2.01E-05*	.6274 15937.9 6.17E-06 1.5386 -2.81E-04 2.67E-06 2.68E-06*	.7106 14073.2 8.06E-07 1.5711 -3.05E-04 2.82E-07 2.84E-07*	.8171 12238.4 8.62E-08 1.6062 -3.31E-04 2.33E-08 2.34E-08*	.9584 10433.8 7.47E-09 1.6440 -3.58E-04 1.47E-09 1.48E-09*	1.1548 8659.5 5.17E-10 1.6849 -3.87E-04 6.78E-11 6.82E-11*	1.4460 6915.7 2.71E-11 1.7367 -4.23E-04 2.16E-12 2.18E-12*
1	.3685 27138.7 8.97E-02 1.3867 -1.65E-04 6.60E-02 6.61E-02	.3980 25126.3 4.62E-02 1.4101 -1.83E-04 3.33E-02 3.33E-02	.4321 23143.2 1.90E-02 1.4346 -2.02E-04 1.30E-02 1.30E-02	.4719 21189.5 6.30E-03 1.4603 -2.22E-04 4.00E-03 4.01E-03	.5191 19265.3 1.71E-03 1.4874 -2.43E-04 9.73E-04 9.76E-04*	.5757 17370.8 3.80E-04 1.5160 -2.64E-04 1.88E-04 1.89E-04*	.6449 15506.1 6.91E-05 1.5465 -2.87E-04 2.87E-05 2.88E-05*	.7315 13671.3 1.02E-05 1.5791 -3.11E-04 3.42E-06 3.43E-06*	.8427 11866.7 1.23E-06 1.6143 -3.37E-04 3.14E-07 3.16E-07*	.9908 10092.4 1.18E-07 1.6526 -3.64E-04 2.17E-08 2.18E-08*	1.1978 8348.6 8.99E-09 1.6940 -3.93E-04 1.09E-09 1.10E-09*
2	.3503 28544.0 1.27E-01 1.3724 -1.54E-04 9.45E-02 9.43E-02	.3769 26531.5 1.37E-01 1.3946 -1.71E-04 1.02E-01 1.02E-01	.4074 24548.4 1.00E-01 1.4179 -1.89E-04 7.18E-02 7.18E-02	.4426 22594.7 5.38E-02 1.4423 -2.08E-04 3.64E-02 3.64E-02	.4838 20670.5 2.23E-02 1.4681 -2.28E-04 1.38E-02 1.39E-02	.5326 18776.0 7.30E-03 1.4952 -2.49E-04 4.04E-03 4.05E-03*	.5913 16911.3 1.91E-03 1.5239 -2.70E-04 9.10E-04 9.13E-04*	.6633 15076.6 4.01E-04 1.5545 -2.93E-04 1.59E-04 1.60E-04*	.7535 13272.0 6.76E-05 1.5872 -3.17E-04 2.14E-05 2.15E-05*	.8697 11497.6 9.11E-06 1.6225 -3.42E-04 2.19E-06 2.20E-06*	1.0252 9753.8 9.71E-07 1.6610 -3.70E-04 1.67E-07 1.67E-07*
3	.3342 29921.5 9.23E-05 1.4392 -2.06E-04 1.42E-04 1.30E-04*	.3583 27909.0 4.58E-02 1.3821 -1.62E-04 3.51E-02 3.49E-02	.3857 25925.9 1.16E-01 1.4030 -1.78E-04 8.66E-02 8.64E-02	.4171 23972.2 1.35E-01 1.4260 -1.96E-04 9.60E-02 9.59E-02	.4536 22048.0 9.96E-02 1.4503 -2.14E-04 6.63E-02 6.64E-02	.4962 20153.5 5.28E-02 1.4760 -2.34E-04 3.20E-02 3.21E-02	.5468 18288.8 2.11E-02 1.5032 -2.55E-04 1.13E-02 1.14E-02	.6078 16454.1 6.56E-03 1.5319 -2.76E-04 3.01E-03 3.02E-03*	.6826 14649.4 1.60E-03 1.5626 -2.99E-04 6.05E-04 6.07E-04*	.7767 12875.1 3.07E-04 1.5954 -3.23E-04 9.22E-05 9.26E-05*	.8984 11131.3 4.65E-05 1.6310 -3.49E-04 1.05E-05 1.06E-05*
4	.3198 31271.1 7.61E-02 1.3425 -1.30E-04 5.33E-02 5.33E-02	.3418 29258.7 3.80E-02 1.3608 -1.45E-04 2.69E-02 2.70E-02	.3666 27275.6 5.32E-05 1.3711 -2.60E-04 9.83E-05 8.94E-05*	.3949 25321.9 4.65E-02 1.4129 -1.86E-04 3.51E-02 3.50E-02	.4274 23397.7 1.17E-01 1.4346 -2.02E-04 8.29E-02 8.27E-02	.4650 21503.2 1.31E-01 1.4586 -2.21E-04 8.59E-02 8.59E-02	.5092 19638.5 9.26E-02 1.4842 -2.40E-04 5.47E-02 5.48E-02	.5617 17803.7 4.63E-02 1.5113 -2.61E-04 7.98E-02 7.97E-02	.6250 15999.1 1.72E-02 1.5402 -2.82E-04 7.58E-03 7.60E-03	.7030 14224.8 4.89E-03 1.5709 -3.05E-04 1.77E-03 1.77E-03*	.8012 12481.0 1.08E-03 1.6039 -3.29E-04 3.06E-04 3.07E-04*
5	.3068 32592.8 2.16E-03 1.3121 -1.06E-04 1.13E-03 1.18E-03*	.3270 30580.4 3.15E-02 1.3533 -1.39E-04 2.34E-02 2.33E-02	.3497 28597.3 7.33E-02 1.3711 -1.53E-04 5.41E-02 5.41E-02	.3753 26643.5 3.06E-02 1.3894 -1.67E-04 2.19E-02 2.20E-02	.4045 24719.4 1.36E-03 1.4444 -2.10E-04 1.23E-03 1.19E-03*	.4381 22824.8 5.83E-02 1.4673 -2.10E-04 4.12E-02 4.11E-02	.4771 20960.1 1.24E-01 1.4927 -2.27E-04 7.98E-02 7.97E-02	.5229 19125.4 1.25E-01 1.5197 -2.47E-04 7.21E-02 7.21E-02	.5773 17320.8 8.05E-02 1.5486 -2.67E-04 4.03E-02 4.04E-02	.6432 15546.5 3.65E-02 1.5794 -2.89E-04 1.54E-02 1.55E-02	.7245 13802.6 1.22E-02 1.5794 -3.11E-04 4.20E-03 4.22E-03
6	.2951 33886.3 4.25E-02 1.3180 -1.11E-04 2.73E-02 2.72E-02	.3137 31873.9 4.38E-02 1.3343 -1.24E-04 2.93E-02 2.94E-02	.3346 29890.8 1.98E-04 1.2937 -9.10E-05 5.91E-05 6.97E-05*	.3579 27937.1 4.06E-02 1.3817 -1.61E-04 3.11E-02 3.09E-02	.3844 26012.9 6.93E-02 1.4003 -1.76E-04 5.09E-02 5.09E-02	.4146 24118.4 1.81E-02 1.4175 -1.89E-04 1.23E-02 1.24E-02	.4494 22253.7 8.03E-03 1.4612 -2.23E-04 5.93E-03 5.86E-03*	.4897 20419.0 7.85E-02 1.4770 -2.35E-04 4.98E-02 4.96E-02	.5372 18614.3 1.31E-01 1.5015 -2.53E-04 7.35E-02 7.35E-02	.5938 16840.0 1.14E-01 1.5284 -2.74E-04 5.52E-02 5.53E-02	.6624 15096.2 6.47E-02 1.5572 -2.95E-04 2.61E-02 2.62E-02
7	.2845 35151.6 3.15E-02 1.3014 -9.72E-05 1.75E-02 1.76E-02	.3018 33139.1 1.64E-03 1.3434 -1.31E-04 1.38E-03 1.33E-03*	.3210 31156.0 4.87E-02 1.3449 -1.32E-04 3.47E-02 3.47E-02	.3424 29202.3 3.17E-02 1.3611 -1.45E-04 2.24E-02 2.25E-02	.3666 27278.1 1.64E-03 1.4105 -1.84E-04 1.52E-03 1.48E-03*	.3940 25383.6 5.44E-02 1.4107 -1.84E-04 4.06E-02 4.05E-02	.4252 23518.9 5.91E-02 1.4301 -1.99E-04 4.11E-02 4.12E-02	.4612 21684.2 5.24E-03 1.4406 -2.07E-04 3.09E-03 3.14E-03*	.5030 19879.5 2.49E-02 1.4896 -2.44E-04 1.58E-02 1.57E-02	.5523 18105.2 1.03E-01 1.5111 -2.61E-04 5.62E-02 5.61E-02	.6112 16361.4 1.33E-01 1.5375 -2.80E-04 6.20E-02 6.20E-02

Table 2. Radiative transition parameters for $N_2 A^3\Sigma_u^+ - X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.1655 60437.1 9.39E-02 1.1126 6.03E-05 1.02E-01 1.02E-01	.1721 58106.8 9.34E-03 1.1241 5.04E-05 6.30E-03 6.21E-03*	.1792 55805.2 3.82E-02 1.1430 3.43E-05 1.05E-02 1.06E-02	.1868 53532.4 2.33E-02 1.1552 2.39E-05 2.76E-03 2.70E-03	.1950 51288.3 1.39E-02 1.1758 6.48E-06 1.07E-04 1.20E-04	.2038 49073.0 3.76E-02 1.1877 -3.53E-06 7.49E-05 8.00E-05	.2133 46886.6 5.31E-04 1.2274 -3.67E-05 9.93E-05 8.49E-05*	.2236 44729.0 4.05E-02 1.2219 -3.21E-05 5.04E-03 5.02E-03	.2347 42600.3 7.66E-03 1.2322 -4.06E-05 1.32E-03 1.37E-03*	.2469 40500.5 2.22E-02 1.2590 -6.27E-05 7.84E-03 7.75E-03	.2602 38429.8 3.36E-02 1.2721 -7.34E-05 1.39E-02 1.40E-02
9	.1622 61644.8 9.10E-02 1.1051 6.68E-05 1.28E-01 1.28E-01	.1686 59314.4 5.11E-04 1.1059 6.61E-05 6.29E-04 5.96E-04*	.1754 57012.9 4.84E-02 1.1344 4.16E-05 2.10E-02 2.10E-02	.1827 54740.0 4.15E-03 1.1430 3.43E-05 1.08E-03 1.03E-03*	.1905 52496.0 3.37E-02 1.1653 1.54E-05 1.55E-03 1.58E-03	.1989 50280.7 1.32E-02 1.1765 5.89E-06 7.89E-05 6.76E-05	.2079 48094.3 1.88E-02 1.1984 -1.25E-05 4.41E-04 4.20E-04	.2177 45936.6 2.71E-02 1.2103 -2.24E-05 1.79E-03 1.83E-03	.2283 43807.9 4.21E-03 1.2374 -4.49E-05 9.65E-04 9.22E-04*	.2398 41708.2 3.79E-02 1.2456 -5.17E-05 9.93E-03 9.93E-03	.2523 39637.5 1.25E-03 1.2443 -5.06E-05 2.68E-04 2.93E-04*
10	.1592 62823.2 8.40E-02 1.0979 7.30E-05 1.50E-01 1.50E-01	.1653 60492.8 1.93E-03 1.1189 5.49E-05 1.74E-03 1.80E-03*	.1718 58191.2 4.56E-02 1.1263 4.86E-05 2.86E-02 2.85E-02	.1788 55918.4 5.96E-04 1.1577 2.18E-05 6.68E-05 7.96E-05*	.1863 53674.3 3.88E-02 1.1561 2.31E-05 4.34E-03 4.34E-03	.1943 51459.1 1.31E-04 1.1315 4.41E-05 4.69E-05 3.62E-05*	.2030 49272.6 3.47E-02 1.1876 -3.45E-06 6.66E-05 6.39E-05	.2122 47115.0 3.75E-03 1.1950 -9.65E-06 4.93E-05 6.06E-05*	.2223 44986.3 2.69E-02 1.2212 -3.15E-05 3.29E-03 3.24E-03	.2332 42886.5 1.43E-02 1.2322 -4.06E-05 2.52E-03 2.58E-03	.2450 40815.8 1.35E-02 1.2578 -6.17E-05 4.73E-03 4.65E-03
11	.1563 63971.7 7.44E-02 1.0910 7.90E-05 1.64E-01 1.64E-01	.1622 61641.4 9.94E-03 1.1078 6.45E-05 1.31E-02 1.32E-02*	.1685 59339.8 3.38E-02 1.1185 5.52E-05 2.91E-02 2.90E-02	.1752 57066.9 9.69E-03 1.1373 3.91E-05 3.73E-03 3.80E-03*	.1824 54822.9 2.79E-02 1.1472 3.07E-05 5.85E-03 5.80E-03	.1901 52607.6 6.79E-03 1.1684 1.27E-05 2.16E-04 2.39E-04*	.1983 50421.2 2.86E-02 1.1777 4.88E-06 1.18E-04 1.11E-04	.2072 48263.5 2.78E-03 1.2037 -1.69E-05 1.21E-04 1.05E-04*	.2168 46134.8 3.14E-02 1.2101 -2.23E-05 2.07E-03 2.07E-03	.2271 44035.1 5.46E-05 1.3074 -1.02E-04 6.56E-05 5.45E-05*	.2383 41964.4 3.23E-02 1.2442 5.05E-05 8.23E-03 8.20E-03
12	.1536 65089.9 6.38E-02 1.0844 8.47E-05 1.71E-01 1.70E-01	.1593 62759.5 2.05E-02 1.1000 7.12E-05 3.47E-02 3.49E-02	.1654 60458.0 1.95E-02 1.1108 6.19E-05 2.23E-02 2.21E-02	.1719 58185.1 2.24E-02 1.1284 4.68E-05 1.31E-02 1.32E-02	.1788 55941.1 1.21E-02 1.1379 3.86E-05 4.25E-03 4.17E-03	.1861 53725.8 2.12E-02 1.1576 2.19E-05 2.13E-03 2.17E-03	.1940 51539.3 1.13E-02 1.1673 1.37E-05 3.91E-04 3.64E-04	.2025 49381.7 1.82E-02 1.1886 -4.29E-06 5.45E-05 4.66E-05	.2116 47253.0 1.42E-02 1.1989 -1.29E-05 3.38E-04 3.59E-04	.2215 45153.3 1.33E-02 1.2219 -3.21E-05 1.70E-03 1.65E-03	.2321 43082.6 2.02E-02 1.2322 -4.06E-05 3.60E-03 3.65E-03
13	.1511 66177.1 5.32E-02 1.0780 9.03E-05 1.70E-01 1.70E-01	.1566 63846.7 3.05E-02 1.0929 7.73E-05 6.41E-02 6.43E-02	.1625 61545.1 7.87E-03 1.1029 6.87E-05 1.17E-02 1.16E-02*	.1687 59272.3 3.12E-02 1.1207 5.34E-05 2.50E-02 2.51E-02	.1754 57028.2 1.72E-03 1.1241 5.04E-05 1.10E-03 1.05E-03*	.1824 54813.0 2.95E-02 1.1490 2.92E-05 5.59E-03 5.63E-03	.1900 52626.5 6.09E-04 1.1446 3.29E-05 1.30E-04 1.12E-04*	.1981 50468.9 2.81E-02 1.1788 3.95E-06 7.62E-05 7.87E-05	.2069 48340.2 7.24E-04 1.1756 6.65E-06 4.88E-06 1.99E-06*	.2163 46240.4 2.69E-02 1.2105 -2.26E-05 1.83E-03 1.81E-03	.2264 44169.7 1.99E-03 1.2133 -2.49E-05 1.44E-04 1.64E-04*
14	.1487 67232.4 4.35E-02 1.0720 9.55E-05 1.63E-01 1.63E-01	.1541 64902.1 3.81E-02 1.0864 8.30E-05 9.68E-02 9.70E-02	.1597 62600.5 1.35E-03 1.0924 7.78E-05 2.71E-03 2.64E-03*	.1658 60327.7 3.29E-02 1.1135 5.95E-05 3.46E-02 3.45E-02	.1722 58083.6 6.16E-04 1.1442 3.33E-05 1.80E-04 2.01E-04*	.1790 55868.4 2.69E-02 1.1409 3.61E-05 8.24E-03 8.20E-03	.1863 53681.9 2.79E-03 1.1644 1.61E-05 1.51E-04 1.70E-04*	.1941 51524.3 2.33E-02 1.1697 1.16E-05 5.82E-04 5.65E-04	.2024 49395.6 3.91E-03 1.1933 -8.23E-06 4.31E-05 3.39E-05*	.2114 47295.8 2.23E-02 1.2004 -1.42E-05 6.40E-04 6.56E-04	.2211 45225.1 3.46E-03 1.2264 -3.58E-05 5.54E-04 5.20E-04*
15	.1465 68255.1 3.49E-02 1.0661 1.01E-04 1.52E-01 1.52E-01	.1517 65924.8 4.26E-02 1.0802 8.84E-05 1.29E-01 1.29E-01	.1572 63623.2 1.40E-04 1.1136 5.95E-05 1.72E-04 1.91E-04*	.1630 61350.4 2.83E-02 1.1068 6.53E-05 3.77E-02 3.76E-02	.1692 59106.3 6.45E-03 1.1256 4.92E-05 4.35E-03 4.44E-03*	.1758 56891.1 1.72E-02 1.1330 4.28E-05 7.83E-03 7.76E-03	.1828 54704.6 1.23E-02 1.1523 2.64E-05 1.90E-03 1.95E-03	.1903 52547.0 1.09E-02 1.1603 1.96E-05 8.22E-04 7.88E-04	.1983 50418.3 1.55E-02 1.1810 2.10E-06 1.19E-05 1.53E-05	.2070 48318.5 8.17E-03 1.1895 -5.04E-06 3.16E-05 3.99E-05*	.2162 46247.8 1.67E-02 1.2120 -2.39E-05 1.27E-03 1.23E-03

Table 2. Radiative transition parameters for N_2 $A^3\Sigma_u^+-X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	.2748 36388.2 6.54E-04 1.3213 -1.13E-04 5.46E-04 5.15E-04*	.2909 34375.7 4.24E-02 1.3124 -1.06E-04 2.62E-02 2.61E-02	.3087 32392.6 1.87E-02 1.3262 -1.17E-04 1.18E-02 1.19E-02	.3285 30438.9 9.29E-03 1.3598 -1.44E-04 7.33E-03 7.22E-03*	.3507 28514.7 5.30E-02 1.3723 -1.54E-04 3.93E-02 3.93E-02	.3757 26620.2 1.58E-02 1.3869 -1.65E-04 1.10E-02 1.11E-02	.4040 24755.5 1.20E-02 1.4256 -1.95E-04 9.39E-03 9.29E-03	.4363 22920.8 6.64E-02 1.4407 -2.07E-04 4.63E-02 4.63E-02	.4736 21116.2 4.01E-02 1.4602 -2.22E-04 2.51E-02 2.52E-02	.5170 19341.8 1.09E-04 1.6217 -3.42E-04 1.25E-04 1.17E-04*	.5682 17598.0 5.40E-02 1.5221 -2.69E-04 2.87E-02 2.86E-02
9	.2660 37595.8 3.14E-02 1.2832 -8.25E-05 1.53E-02 1.53E-02	.2810 35583.4 2.08E-02 1.2961 -9.29E-05 1.09E-02 1.11E-02	.2976 33600.3 7.40E-03 1.3276 -1.18E-04 3.05E-03 5.21E-03*	.3160 31646.6 4.42E-02 1.3384 -1.27E-04 3.05E-02 3.05E-02	.3364 29722.4 5.47E-03 1.3469 -1.34E-04 3.47E-03 3.54E-03*	.3594 27827.9 2.47E-02 1.3845 -1.63E-04 1.92E-02 1.91E-02	.3852 25963.2 4.83E-02 1.4002 -1.76E-04 3.52E-02 3.53E-02	.4144 24128.4 2.42E-03 1.4014 -1.77E-04 1.43E-03 1.48E-03*	.4480 22323.8 3.28E-02 1.4527 -2.16E-04 2.30E-02 2.29E-02	.4866 20549.5 6.75E-02 1.4716 -2.31E-04 4.22E-02 4.22E-02	.5318 18805.7 1.65E-02 1.4883 -2.43E-04 8.76E-03 8.83E-03
10	.2579 38774.2 3.00E-02 1.2692 -7.11E-05 1.19E-02 1.20E-02	.2720 36761.8 1.06E-03 1.3116 -1.05E-04 7.91E-04 7.52E-04*	.2875 34778.6 3.79E-02 1.3080 -1.03E-04 2.26E-02 2.26E-02	.3046 32824.9 6.76E-03 1.3172 -1.10E-04 3.90E-03 3.98E-03*	.3236 30900.8 2.18E-02 1.3506 -1.37E-04 1.62E-02 1.61E-02	.3448 29006.2 3.59E-02 1.3645 -1.48E-04 2.58E-02 2.59E-02	.3684 27141.5 8.18E-05 1.5028 -2.54E-04 1.43E-04 1.30E-04*	.3952 25306.8 4.26E-02 1.4117 -1.85E-04 3.18E-02 3.17E-02	.4255 23502.2 3.13E-02 1.4280 -1.97E-04 2.13E-02 2.14E-02	.4602 21727.9 2.10E-03 1.4834 -2.40E-04 1.67E-03 1.63E-03*	.5004 19984.0 5.66E-02 1.4828 -2.39E-04 3.49E-02 3.48E-02
11	.2505 39922.7 2.92E-03 1.2487 -5.42E-05 7.40E-04 7.81E-04*	.2638 37910.3 2.60E-02 1.2807 -8.04E-05 1.24E-02 1.23E-02	.2783 35927.2 1.56E-02 1.2920 -8.96E-05 7.86E-03 7.96E-03	.2943 33973.5 1.11E-02 1.3217 -1.14E-04 7.55E-03 7.45E-03	.3120 32049.3 3.41E-02 1.3330 -1.23E-04 2.28E-02 2.29E-02	.3316 30154.8 1.11E-06 2.2446 -7.36E-04 2.22E-05 2.27E-05*	.3535 28290.1 3.72E-02 1.3763 -1.57E-04 2.80E-02 2.79E-02	.3780 26455.4 1.78E-02 1.3896 -1.67E-04 1.25E-02 1.26E-02	.4057 24650.7 1.02E-02 1.4278 -1.97E-04 7.98E-03 7.89E-03	.4371 22876.4 5.06E-02 1.4403 -2.07E-04 3.50E-02 3.50E-02	.4732 21132.6 9.39E-03 1.4519 -2.16E-04 5.57E-03 5.63E-03*
12	.2437 41040.9 6.60E-03 1.2587 -6.25E-05 2.40E-03 2.34E-03*	.2562 39028.5 2.80E-02 1.2673 -6.95E-05 1.08E-02 1.09E-02	.2699 37045.4 7.44E-04 1.3134 -1.07E-04 5.83E-04 5.50E-04*	.2850 35091.7 3.29E-02 1.3047 -9.99E-05 1.91E-02 1.91E-02	.3015 33167.5 2.38E-03 1.3066 -1.01E-04 1.20E-03 1.25E-03*	.3198 31273.0 2.69E-02 1.3452 -1.32E-04 1.95E-02 1.94E-02	.3400 29408.3 1.86E-02 1.3573 -1.42E-04 1.29E-02 1.30E-02	.3627 27573.5 8.48E-03 1.3927 -1.70E-04 6.93E-03 6.84E-03*	.3881 25768.9 4.06E-02 1.4032 -1.78E-04 2.98E-02 2.98E-02	.4168 23994.6 1.90E-03 1.3997 -1.75E-04 1.09E-03 1.13E-03*	.4494 22250.8 3.24E-02 1.4529 -2.16E-04 2.26E-02 2.25E-02
13	.2374 42128.1 2.49E-02 1.2439 -5.03E-05 6.36E-03 6.31E-03	.2493 40115.7 5.76E-03 1.2512 -5.63E-05 1.59E-03 1.64E-03*	.2622 38132.6 2.03E-02 1.2794 -7.94E-05 9.55E-03 9.47E-03	.2764 36178.8 1.38E-02 1.2894 -8.75E-05 6.74E-03 6.83E-03	.2919 34254.7 1.16E-02 1.3184 -1.11E-04 7.77E-03 7.67E-03	.3090 32360.2 2.58E-02 1.3289 -1.19E-04 1.68E-02 1.69E-02	.3279 30495.5 1.97E-03 1.3708 -1.53E-04 1.76E-03 1.71E-03*	.3489 28660.7 3.52E-02 1.3705 -1.52E-04 2.60E-02 2.60E-02	.3724 26856.1 2.63E-03 1.3711 -1.53E-04 1.61E-03 1.65E-03*	.3987 25081.8 2.80E-02 1.4160 -1.88E-04 2.11E-02 2.10E-02	.4285 23337.9 2.57E-02 1.4298 -1.99E-04 1.74E-02 1.75E-02
14	.2316 43183.5 2.36E-02 1.2326 -4.10E-05 4.30E-03 4.34E-03	.2429 41171.1 1.81E-03 1.2654 -6.79E-05 7.87E-04 7.47E-04*	.2552 39187.9 2.63E-02 1.2665 -6.88E-05 1.01E-02 1.01E-02	.2686 37234.2 1.52E-04 1.3450 -1.32E-04 1.85E-04 1.67E-04*	.2832 35310.0 2.85E-02 1.3026 -9.82E-05 1.63E-02 1.63E-02	.2993 33415.5 1.14E-03 1.2969 -9.36E-05 5.05E-04 5.37E-04*	.3169 31550.8 2.66E-02 1.3415 -1.29E-04 1.89E-02 1.89E-02	.3365 29716.1 8.99E-03 1.3506 -1.37E-04 5.95E-03 6.03E-03*	.3583 27911.5 1.70E-02 1.3844 -1.63E-04 1.34E-02 1.33E-02	.3826 26137.2 2.56E-02 1.3960 -1.72E-04 1.83E-02 1.84E-02	.4099 24393.3 2.94E-03 1.4414 -2.08E-04 2.49E-03 2.43E-03*
15	.2262 44206.2 7.85E-03 1.2204 -3.08E-05 8.72E-04 9.12E-04*	.2370 42193.8 1.62E-02 1.2449 -5.11E-05 4.29E-03 4.23E-03	.2487 40210.6 9.70E-03 1.2531 -5.79E-05 2.85E-03 2.92E-03*	.2614 38256.9 1.41E-02 1.2796 -7.95E-05 6.74E-03 6.65E-03	.2752 36332.8 1.40E-02 1.2884 -8.67E-05 6.81E-03 6.89E-03	.2904 34438.2 9.89E-03 1.3170 -1.10E-04 6.58E-03 6.49E-03*	.3070 32573.5 2.09E-02 1.3262 -1.17E-04 1.34E-02 1.35E-02	.3253 30738.8 4.00E-03 1.3612 -1.45E-04 3.30E-03 3.23E-03*	.3456 28934.2 2.90E-02 1.3663 -1.49E-04 2.11E-02 2.11E-02	.3682 27159.9 1.53E-05 1.6553 -3.66E-04 5.54E-05 4.95E-05*	.3935 25416.0 3.23E-02 1.4095 -1.83E-04 2.40E-02 2.40E-02

Table 2. Radiative transition parameters for $N_2 A^3\Sigma_u^+ - X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.1444 69244.2 2.76E-02 1.0606 1.05E-04 1.38E-01 1.38E-01	.1494 66913.8 4.41E-02 1.0743 9.35E-05 1.56E-01 1.56E-01	.1548 64612.2 2.97E-03 1.0912 7.88E-05 6.71E-03 6.83E-03*	.1604 62339.4 2.03E-02 1.1004 7.08E-05 3.34E-02 3.32E-02	.1664 60095.3 1.45E-02 1.1173 5.63E-05 1.35E-02 1.36E-02	.1728 57880.1 7.01E-03 1.1244 5.02E-05 4.63E-03 4.54E-03*	.1796 55693.6 2.06E-02 1.1440 3.34E-05 5.38E-03 5.42E-03	.1868 53536.0 1.69E-03 1.1457 3.20E-05 3.58E-04 3.30E-04*	.1945 51407.3 2.25E-02 1.1722 9.52E-06 3.75E-04 3.83E-04	.2028 49307.5 1.92E-04 1.1517 2.69E-05 (2.24E-05) 1.52E-05*	.2117 47236.8 2.28E-02 1.2022 -1.57E-05 7.97E-04 7.96E-04
17	.1425 70198.4 2.16E-02 1.0552 1.10E-04 1.23E-01 1.22E-01	.1473 67868.0 4.32E-02 1.0687 9.84E-05 1.77E-01 1.77E-01	.1525 65566.4 8.08E-03 1.0836 8.54E-05 2.24E-02 2.26E-02*	.1580 63293.6 1.20E-02 1.0942 7.62E-05 2.38E-02 2.36E-02	.1638 61049.6 2.08E-02 1.1105 6.21E-05 2.47E-02 2.49E-02	.1700 58834.3 1.00E-03 1.1100 6.26E-05 1.08E-03 1.03E-03*	.1765 56647.8 2.28E-02 1.1367 3.97E-05 8.80E-03 8.80E-03	.1835 54490.2 4.91E-04 1.1722 9.52E-06 (9.72E-06) 1.49E-05*	.1910 52361.5 2.00E-02 1.1640 1.65E-05 (1.05E-03) 1.04E-03	.1990 50261.8 3.24E-03 1.1875 -3.36E-06 (6.28E-06) 3.24E-06*	.2075 48191.0 1.66E-02 1.1931 -8.06E-06 1.63E-04 1.72E-04
18	.1406 71116.5 1.68E-02 1.0501 1.15E-04 1.07E-01 1.07E-01	.1454 68786.1 4.06E-02 1.0634 1.03E-04 1.89E-01 1.89E-01	.1504 66484.6 1.39E-02 1.0775 9.07E-05 4.53E-02 4.56E-02	.1557 64211.7 5.30E-03 1.0882 8.14E-05 1.26E-02 1.24E-02*	.1614 61967.7 2.35E-02 1.1043 6.75E-05 3.43E-02 3.44E-02	.1674 59752.4 3.15E-04 1.1394 3.74E-05 (1.27E-04) 1.43E-04*	.1737 57565.9 1.89E-02 1.1298 4.56E-05 1.01E-02 1.01E-02	.1805 55408.3 5.54E-03 1.1502 2.82E-05 1.01E-03 1.05E-03*	.1877 53279.6 1.17E-02 1.1557 2.35E-05 (1.31E-03) 1.27E-03	.1954 51179.9 1.15E-02 1.1761 6.23E-06 (8.07E-05) 8.99E-05	.2036 49109.1 6.18E-03 1.1829 5.03E-07 (2.50E-07) 2.41E-08*
19	.1389 71997.1 1.29E-02 1.0453 1.19E-04 9.22E-02 9.21E-02	.1435 69666.7 3.69E-02 1.0583 1.07E-04 1.95E-01 1.95E-01	.1484 67365.1 1.92E-02 1.0719 9.56E-05 7.23E-02 7.25E-02	.1536 65092.3 1.31E-03 1.0818 8.70E-05 3.69E-03 3.61E-03*	.1591 62848.3 2.23E-02 1.0986 7.24E-05 3.92E-02 3.91E-02	.1649 60633.0 3.56E-03 1.1176 5.60E-05 3.36E-03 3.44E-03*	.1711 58446.5 1.20E-02 1.1231 5.13E-05 8.53E-03 8.45E-03	.1777 56288.9 1.21E-02 1.1417 3.54E-05 3.66E-03 3.71E-03	.1846 54160.2 3.74E-03 1.1457 3.20E-05 8.21E-04 7.84E-04*	.1921 52060.5 1.73E-02 1.1681 1.30E-05 5.55E-04 5.69E-04	.2000 49989.7 3.17E-04 1.1546 2.44E-05 (3.19E-05) 2.36E-05*
20	.1373 72838.6 9.93E-03 1.0406 1.23E-04 7.84E-02 7.82E-02*	.1418 70508.2 3.27E-02 1.0535 1.12E-04 1.93E-01 1.93E-01	.1466 68206.6 2.32E-02 1.0667 1.00E-04 9.98E-02 1.00E-01	.1517 65933.8 3.28E-06 1.0384 1.25E-04 (1.98E-05) 1.39E-05*	.1570 63689.7 1.85E-02 1.0934 7.69E-05 3.81E-02 3.81E-02	.1627 61474.5 8.38E-03 1.1098 6.27E-05 1.03E-02 1.05E-02*	.1687 59288.0 5.46E-03 1.1159 5.75E-05 5.08E-03 4.99E-03*	.1750 57130.4 1.64E-02 1.1349 4.12E-05 6.99E-03 7.02E-03	.1818 55001.7 1.32E-04 1.1052 6.67E-05 (1.32E-04) 1.15E-04*	.1890 52901.9 1.72E-02 1.1608 1.92E-05 1.27E-03 1.26E-03	.1967 50831.2 1.50E-03 1.1876 -3.45E-06 (3.15E-06) 1.12E-06*
21	.1358 73639.2 7.58E-03 1.0362 1.27E-04 6.58E-02 6.57E-02*	.1402 71308.8 2.83E-02 1.0489 1.16E-04 1.86E-01 1.86E-01	.1449 69007.3 2.58E-02 1.0619 1.04E-04 1.25E-01 1.25E-01	.1498 66734.4 8.27E-04 1.0764 9.17E-05 2.79E-03 2.87E-03*	.1551 64490.4 1.35E-02 1.0885 8.11E-05 3.22E-02 3.20E-02	.1606 62275.1 1.27E-02 1.1038 6.79E-05 1.91E-02 1.92E-02	.1664 60088.6 1.29E-03 1.1060 6.60E-05 1.65E-03 1.59E-03*	.1726 57931.0 1.68E-02 1.1289 4.63E-05 9.48E-03 9.48E-03	.1792 55802.3 1.10E-03 1.1561 2.31E-05 (1.39E-04) 1.55E-04*	.1862 53702.6 1.26E-02 1.1539 2.50E-05 1.65E-03 1.62E-03	.1937 51631.8 6.64E-03 1.1746 7.49E-06 (6.94E-05) 7.99E-05*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

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$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	.2213 45195.2 2.40E-07 .1252 1.05E-03 (3.27E-05 1.62E-05*	.2316 43182.8 2.29E-02 1.2339 -4.20E-05 4.41E-03 4.41E-03	.2427 41199.7 1.66E-07 2.8299 -1.01E-03 (1.60E-05 2.13E-05*	.2548 39246.0 2.37E-02 1.2670 -6.93E-05 9.26E-03 9.25E-03	.2679 37321.8 1.10E-04 1.2132 -2.49E-05 (4.78E-06 8.78E-06*	.2823 35427.3 2.45E-02 1.3019 -9.76E-05 1.40E-02 1.40E-02	.2980 33562.6 1.15E-03 1.2959 -9.28E-05 5.04E-04 5.35E-04*	.3152 31727.8 2.40E-02 1.3394 -1.28E-04 1.69E-02 1.68E-02	.3342 29923.2 4.97E-03 1.3450 -1.32E-04 3.14E-03 3.21E-03*	.3553 28148.9 2.01E-02 1.3802 -1.60E-04 1.55E-02 1.54E-02	.3787 26405.0 1.40E-02 1.3898 -1.68E-04 9.79E-03 9.88E-03
17	.2167 46149.4 5.95E-03 1.2160 -2.72E-05 5.84E-04 5.52E-04*	.2266 44137.0 1.44E-02 1.2237 -3.36E-05 1.98E-04 1.93E-03	.2372 42153.9 7.55E-03 1.2480 -5.37E-05 3.70E-03 2.14E-03*	.2488 40200.2 1.40E-02 1.2554 -5.97E-05 3.44E-04 4.45E-03	.2613 38276.0 7.84E-03 1.2819 -8.14E-05 3.94E-03 3.86E-03*	.2749 36381.5 1.54E-02 1.2889 -8.71E-05 7.62E-03 7.69E-03	.2897 34516.8 6.72E-03 1.3180 -1.11E-04 4.56E-03 4.48E-03*	.3060 32682.0 1.87E-02 1.3251 -1.16E-04 1.19E-02 1.20E-02	.3239 30877.4 4.15E-03 1.3589 -1.43E-04 3.38E-03 3.31E-03*	.3436 29103.1 2.37E-02 1.3638 -1.47E-04 2.46E-03 1.71E-02	.3655 27359.3 1.01E-03 1.4168 -1.89E-04 9.98E-04 9.62E-04*
18	.2125 47067.5 1.55E-02 1.2051 -1.81E-05 7.14E-04 6.97E-04	.2220 45055.1 3.14E-03 1.2105 -2.26E-05 1.98E-04 2.19E-04*	.2322 43072.0 1.77E-02 1.2363 -4.40E-05 3.44E-03 3.67E-03	.2432 41118.3 1.83E-03 1.2371 -4.47E-05 3.44E-04 3.71E-04*	.2551 39194.1 1.91E-02 1.2688 -7.07E-05 7.75E-03 7.71E-03	.2681 37299.6 1.54E-03 1.2661 -6.85E-05 5.07E-04 5.39E-04*	.2822 35434.9 2.00E-02 1.3027 -9.83E-05 1.16E-02 1.15E-02	.2976 33600.1 2.08E-03 1.3022 -9.79E-05 1.02E-03 1.06E-03*	.3145 31795.5 2.03E-02 1.3390 -1.27E-04 1.43E-02 1.42E-02	.3331 30021.2 3.94E-03 1.3429 -1.31E-04 2.46E-03 2.51E-03*	.3536 28277.4 1.91E-02 1.3782 -1.58E-04 9.98E-04 1.46E-02
19	.2086 47948.1 1.85E-02 1.1966 -1.10E-05 3.34E-04 3.31E-04	.2177 45935.7 2.31E-04 1.2442 -5.05E-05 (7.73E-05 6.48E-05*	.2275 43952.6 1.79E-02 1.2269 -3.62E-05 2.69E-03 2.70E-03	.2381 41998.9 1.40E-03 1.2586 -6.24E-05 5.45E-04 5.13E-04*	.2495 40074.7 1.70E-02 1.2583 -6.21E-05 5.72E-03 5.75E-03	.2619 38180.2 2.55E-03 1.2892 -8.73E-05 1.46E-03 1.41E-03*	.2754 36315.5 1.70E-02 1.2908 -8.86E-05 8.65E-03 8.70E-03	.2900 34480.7 3.08E-03 1.3231 -1.15E-04 2.25E-03 2.19E-03*	.3060 32676.1 1.81E-02 1.3257 -1.17E-04 1.16E-02 1.17E-02	.3236 30901.8 2.71E-03 1.3613 -1.45E-04 2.27E-03 2.22E-03*	.3430 29158.0 2.05E-02 1.3631 -1.47E-04 1.47E-02 1.48E-02
20	.2050 48789.6 1.39E-02 1.1885 -4.20E-06 3.85E-05 4.20E-05	.2138 46777.2 5.46E-03 1.2108 -2.29E-05 3.94E-04 3.68E-04*	.2232 44794.1 9.80E-03 1.2176 -2.85E-05 9.68E-04 9.99E-04*	.2334 42840.4 9.30E-03 1.2405 -4.75E-05 2.23E-03 2.18E-03*	.2444 40916.2 6.75E-03 1.2470 -5.28E-05 1.74E-03 1.79E-03*	.2563 39021.7 1.22E-02 1.2723 -7.36E-05 5.31E-03 5.26E-03	.2691 37157.0 4.98E-03 1.2768 -7.73E-05 2.06E-03 2.11E-03*	.2831 35322.2 1.43E-02 1.3053 -1.00E-04 8.57E-03 8.51E-03	.2984 33517.6 4.32E-03 1.3091 -1.03E-04 2.35E-03 2.41E-03*	.3150 31743.3 1.56E-02 1.3404 -1.29E-04 1.11E-02 1.11E-02	.3333 29999.4 4.73E-03 1.3450 -1.32E-04 3.01E-03 3.07E-03*
21	.2017 49590.2 6.43E-03 1.1798 3.11E-06 (1.03E-05 7.14E-06*	.2102 47577.8 1.20E-02 1.2014 -1.50E-05 3.94E-04 3.78E-04	.2193 45594.7 2.13E-03 1.2049 -1.79E-05 (8.79E-05 1.01E-04*	.2291 43641.0 1.51E-02 1.2311 -3.97E-05 2.68E-03 2.67E-03	.2397 41716.8 2.93E-04 1.2140 -2.55E-05 (1.87E-05 2.55E-05*	.2511 39822.3 1.65E-02 1.2623 -6.54E-05 6.01E-03 6.00E-03	.2635 37957.6 2.42E-05 1.4159 -1.88E-04 (6.30E-05 5.45E-05*	.2768 36122.8 1.70E-02 1.2943 -9.15E-05 9.08E-03 9.09E-03	.2914 34318.2 3.97E-04 1.3493 -1.36E-04 3.98E-04 3.75E-04*	.3073 32543.9 1.76E-02 1.3281 -1.19E-04 1.16E-02 1.16E-02	.3247 30800.1 7.66E-04 1.3758 -1.57E-04 7.41E-04 7.10E-04*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 3. Radiative transition parameters for $N_2 B^3\Pi_g-A^3\Sigma_u^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.0469 9552.0 4.01E-01 1.2534 2.68E-01 5.09E+04 5.08E+04	1.2317 8119.1 3.30E-01 1.2160 2.76E-01 2.73E+04 2.73E+04	1.4895 6713.8 1.66E-01 1.1827 2.83E-01 8.15E+03 8.16E+03	1.8739 5336.3 6.72E-02 1.1526 2.88E-01 1.72E+03 1.73E+03	2.5084 3986.7 2.41E-02 1.1253 2.93E-01 2.66E+02 2.68E+02	3.7523 2665.0 8.09E-03 1.1002 2.97E-01 2.75E+01 2.76E+01*	7.2916 1371.4 2.62E-03 1.0772 3.01E-01 1.24E+00 1.25E+00*	94.1292 106.2 8.31E-04 1.0558 3.04E-01 1.87E-04 1.88E-04*	-8.8467 -1130.4 2.63E-04 1.0360 3.07E-01 -1.45E-01 -1.46E-01*	-4.2771 -2338.0 8.36E-05 1.0175 3.09E-01 -4.14E-01 -4.18E-01*	-2.8438 -3516.4 2.69E-05 1.0004 3.11E-01 -4.59E-01 -4.64E-01*
1	.8883 11257.3 4.00E-01 1.2979 2.58E-01 7.70E+04 7.70E+04	1.0179 9824.4 2.87E-03 1.3088 2.56E-01 3.60E+02 3.45E+02*	1.1878 8419.1 1.59E-01 1.2273 2.74E-01 1.44E+04 1.43E+04	1.4201 7041.6 1.96E-01 1.1920 2.81E-01 1.09E+04 1.09E+04	1.7569 5692.0 1.30E-01 1.1613 2.87E-01 4.00E+02 4.01E+03	2.2882 4370.3 6.57E-02 1.1336 2.92E-01 9.46E+02 9.49E+02	3.2502 3076.8 2.86E-02 1.1085 2.96E-01 1.48E+02 1.48E+02	5.5202 1811.5 1.14E-02 1.0854 3.00E-01 1.23E+01 1.24E+01	17.3933 574.9 4.31E-03 1.0640 3.03E-01 1.52E-01 1.54E-01*	-15.8042 -632.7 1.59E-02 1.0443 3.06E-01 -1.52E-01 -1.54E-01*	-5.5215 -1811.1 5.78E-04 1.0259 3.08E-01 -1.32E+00 -1.33E+00*
2	.7732 12933.5 1.61E-01 1.3475 2.46E-01 4.28E+04 4.29E+04	.8695 11500.7 2.76E-01 1.3087 2.56E-01 5.55E+04 5.54E+04	.9905 10095.4 6.90E-02 1.2571 2.67E-01 1.03E+04 1.03E+04	1.1471 8717.9 2.19E-02 1.2486 2.69E-01 2.13E+03 2.10E+03	1.3572 7368.3 1.24E-01 1.2027 2.79E-01 7.82E+03 7.79E+03	1.6538 6046.6 1.43E-01 1.1705 2.85E-01 5.19E+03 5.19E+03	2.1039 4753.0 1.07E-01 1.1424 2.90E-01 1.85E+03 1.85E+03	2.8671 3487.8 5.63E-02 1.1170 2.95E-01 4.20E+02 4.22E+02	4.4420 2251.2 2.74E-02 1.0938 2.98E-01 5.63E+01 5.66E+01	9.5828 1043.5 1.22E-02 1.0725 3.02E-01 2.57E+00 2.58E+00	-74.1757 -134.8 5.20E-03 1.0528 3.05E-01 -4.79E-03 -4.83E-03*
3	.6858 14580.8 3.39E-02 1.4035 2.32E-01 1.15E+04 1.16E+04	.7606 13147.9 2.77E-01 1.3567 2.44E-01 7.61E+04 7.61E+04	.8516 11742.7 9.61E-02 1.3235 2.52E-01 2.00E+04 1.99E+04	.9648 10365.2 1.52E-01 1.2708 2.64E-01 2.39E+04 2.40E+04	1.1092 9015.6 5.19E-03 1.1981 2.80E-01 6.02E+02 6.24E+02*	1.2997 7693.9 4.22E-02 1.2175 2.76E-01 2.96E+03 2.93E+03	1.5624 6400.3 1.07E-01 1.1808 2.83E-01 4.58E+03 4.56E+03	1.9474 5135.1 1.11E-01 1.1516 2.89E-01 2.54E+03 2.54E+03	2.5651 3898.5 8.00E-02 1.1258 2.93E-01 8.26E+02 8.28E+02	3.7163 2690.8 4.73E-02 1.1025 2.97E-01 1.65E+02 1.66E+02	6.6117 1512.5 2.49E-02 1.0811 3.00E-01 1.58E+01 1.58E+01
4	.6173 16199.1 4.04E-03 1.4684 2.16E-01 1.62E+03 1.63E+03*	.6772 14766.2 9.67E-02 1.4124 2.30E-01 3.34E+04 3.35E+04	.7484 13361.0 2.98E-01 1.3666 2.42E-01 8.41E+04 8.40E+04	.8345 11983.5 7.60E-03 1.3676 2.41E-01 1.54E+03 1.50E+03*	.9404 10633.9 1.51E-01 1.2827 2.62E-01 2.52E+04 2.52E+04	1.0739 9312.2 5.12E-02 1.2353 2.72E-01 6.20E+03 6.26E+03	1.2471 8018.6 2.19E-03 1.2740 2.64E-01 1.59E+02 1.50E+02*	1.4807 6753.4 5.47E-02 1.1933 2.81E-01 2.69E+03 2.67E+03	1.8126 5516.8 9.36E-02 1.1617 2.87E-01 2.62E+03 2.61E+03	2.3207 4309.1 8.96E-02 1.1732 2.92E-01 1.23E+03 1.23E+03	3.1941 3130.8 6.49E-02 1.1116 2.96E-01 3.53E+02 3.54E+02
5	.5622 17788.4 2.74E-04 1.5458 1.96E-01 1.19E+02 1.20E+02*	.6114 16355.5 1.62E-02 1.4772 2.14E-01 6.57E+03 6.59E+03	.6689 14950.3 1.69E-01 1.4215 2.28E-01 5.93E+04 5.95E+04	.7368 13572.8 2.44E-01 1.3775 2.39E-01 7.05E+04 7.03E+04	.8181 12223.1 1.04E-02 1.2875 2.60E-01 2.62E+03 2.69E+03	.9173 10901.5 9.55E-02 1.2959 2.59E-01 1.68E+04 1.66E+04	1.0408 9607.9 9.48E-02 1.2492 2.69E-01 1.23E+04 1.24E+04	1.1987 8342.7 8.77E-03 1.1919 2.81E-01 2.69E+03 8.37E+02*	1.4072 7106.1 1.39E-02 1.2143 2.76E-01 7.74E+02 7.58E+02	1.6954 5898.4 5.93E-02 1.1733 2.85E-01 2.00E+03 1.98E+03	2.1186 4720.1 8.09E-02 1.1453 2.90E-01 1.45E+03 1.45E+03
6	.5168 19348.6 1.01E-05 1.6441 1.70E-01 4.26E+00 4.23E+00*	.5582 17915.7 1.43E-03 1.5549 1.93E-01 6.20E+02 6.22E+02*	.6057 16510.5 3.89E-02 1.4862 2.11E-01 1.58E+04 1.59E+04	.6608 15133.0 2.30E-01 1.4310 2.25E-01 8.19E+04 8.21E+04	.7255 13783.3 1.57E-01 1.3903 2.36E-01 4.62E+04 4.60E+04	.8025 12461.7 5.81E-02 1.3214 2.53E-01 1.45E+04 1.47E+04	.8954 11168.1 3.55E-02 1.3149 2.66E-01 6.46E+03 6.37E+03	1.0098 9902.9 1.04E-01 1.2614 2.66E-01 1.46E+04 1.46E+04	1.1539 8666.3 3.95E-02 1.2181 2.76E-01 3.95E+03 (0.00E+00) 3.99E+03	1.3407 7458.6 1.75E-08 22.1050 0.00E+00 6.68E-01*	1.5923 6280.3 2.48E-02 1.1888 2.82E-01 9.86E+02 9.72E+02
7	.4789 20879.7 1.74E-07 1.7837 1.35E-01 5.85E-02 5.58E-02*	.5142 19446.8 6.42E-05 1.6539 1.67E-01 2.68E+01 2.66E+01*	.5543 18041.6 4.32E-03 1.5641 1.91E-01 1.87E+03 1.87E+03*	.6001 16664.1 7.16E-02 1.4954 2.09E-01 2.93E+04 2.93E+04	.6530 15314.4 2.66E-01 1.4410 2.23E-01 9.60E+04 9.61E+04	.7147 13992.7 7.47E-02 1.4071 2.32E-01 2.22E+04 2.20E+04	.7875 12699.2 1.06E-01 1.3368 2.49E-01 2.72E+04 2.73E+04	.8746 11434.0 3.08E-03 1.3797 2.38E-01 5.30E+02 5.02E+02*	.9806 10197.4 8.16E-02 1.2744 2.63E-01 1.22E+04 1.21E+04	1.1124 8989.7 6.78E-02 1.2324 2.73E-01 7.42E+03 7.44E+03	1.2802 7811.3 1.08E-02 1.1840 2.83E-01 8.34E+02 8.54E+02

Table 3. Radiative transition parameters for N_2 $B^3\Pi_g-A^3\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	-2.1436 -4665.0 8.85E-06 .9847 3.13E-01 -3.56E-01 -3.61E-01*	-1.7292 -5783.1 2.99E-06 .9706 3.14E-01 -2.31E-01 -2.34E-01*	-1.4555 -6870.3 1.04E-06 .9581 3.15E-01 -1.36E-01 -1.38E-01*	-1.2617 -7925.7 3.78E-07 .9475 3.16E-01 -7.63E-02 -7.73E-02*	-1.1175 -8948.4 1.43E-07 .9387 3.17E-01 -4.16E-02 -4.21E-02*	-1.0063 -9937.4 5.61E-08 .9318 3.18E-01 -2.25E-02 -2.27E-02*	-.9181 -10891.6 2.29E-08 .9263 3.18E-01 -1.21E-02 -1.22E-02*	-.8468 -11809.7 9.63E-09 .9215 3.18E-01 -6.52E-03 -6.57E-03*	-.7880 -12690.3 4.12E-09 .9164 3.19E-01 -3.47E-03 -3.49E-03*	-.7390 -13531.8 1.76E-09 .9096 3.19E-01 -1.80E-03 -1.81E-03*	-.6977 -14332.4 7.24E-10 .8987 3.20E-01 -8.83E-04 -8.90E-04*
1	-3.3788 -2959.6 2.10E-04 1.0090 3.10E-01 -2.12E+00 -2.15E+00*	-2.4523 -4077.8 7.71E-05 .9934 3.12E-01 -2.06E+00 -2.09E+00*	-1.9361 -5165.0 2.88E-05 .9792 3.13E-01 -1.58E+00 -1.60E+00*	-1.6076 -6220.4 1.10E-05 .9665 3.15E-01 -1.06E+00 -1.07E+00*	-1.3806 -7243.1 4.31E-06 .9553 3.16E-01 -6.61E-01 -6.69E-01*	-1.2148 -8232.1 1.74E-06 .9456 3.17E-01 -3.94E-01 -3.99E-01*	-1.0886 -9186.3 7.25E-07 .9373 3.17E-01 -2.29E-01 -2.32E-01*	-.9897 -10104.4 3.10E-07 .9300 3.18E-01 -1.31E-01 -1.32E-01*	-.9103 -10985.0 1.35E-07 .9231 3.18E-01 -7.36E-02 -7.43E-02*	-.8456 -11826.5 5.94E-08 .9159 3.19E-01 -4.04E-02 -4.08E-02*	-.7919 -12627.1 2.57E-08 .9067 3.19E-01 -2.14E-02 -2.16E-02*
2	-7.7920 -1283.4 2.15E-03 1.0345 3.07E-01 -1.74E+00 -1.75E+00*	-4.1640 -2401.6 8.77E-04 1.0177 3.09E-01 -4.70E+00 -4.75E+00*	-2.8664 -3488.7 3.57E-04 1.0021 3.11E-01 -5.94E+00 -6.00E+00*	-2.2007 -4544.1 1.46E-04 .9879 3.13E-01 -5.44E+00 -5.50E+00*	-1.7964 -5566.8 6.08E-05 .9750 3.14E-01 -4.19E+00 -4.24E+00*	-1.5254 -6555.8 2.57E-05 .9634 3.15E-01 -2.92E+00 -2.95E+00*	-1.3316 -7510.0 1.11E-05 .9530 3.16E-01 -1.90E+00 -1.93E+00*	-1.1865 -8428.2 4.90E-06 .9436 3.17E-01 -1.19E+00 -1.21E+00*	-1.0743 -9308.7 2.20E-06 .9349 3.17E-01 -7.23E-01 -7.32E-01*	-.9852 -10150.2 9.93E-07 .9262 3.18E-01 -4.26E-01 -4.31E-01*	-.9132 -10950.8 4.47E-07 .9166 3.19E-01 -2.41E-01 -2.44E-01*
3	27.4786 363.9 1.22E-02 1.0615 3.03E-01 1.09E-01 1.10E-01	-13.2578 -754.3 5.68E-03 1.0433 3.06E-01 -9.24E-01 -9.31E-01*	-5.4305 -1841.4 2.58E-03 1.0266 3.08E-01 -6.20E+00 -6.26E+00*	-3.4521 -2896.8 1.16E-03 1.0111 3.10E-01 -1.10E+01 -1.11E+01*	-2.5513 -3919.5 5.21E-04 .9968 3.12E-01 -1.23E+01 -1.25E+01*	-2.0373 -4908.5 2.35E-04 .9838 3.13E-01 -1.10E+01 -1.11E+01*	-1.7057 -5862.7 1.07E-04 .9718 3.14E-01 -8.62E+00 -8.72E+00*	-1.4747 -6780.9 4.93E-05 .9608 3.15E-01 -6.18E+00 -6.26E+00*	-1.3052 -7661.5 2.30E-05 .9505 3.16E-01 -4.18E+00 -4.23E+00*	-1.1761 -8502.9 1.08E-05 .9406 3.17E-01 -2.70E+00 -2.73E+00*	-1.0749 -9303.6 5.06E-06 .9304 3.18E-01 -1.67E+00 -1.69E+00*
4	5.0449 1982.2 4.02E-02 1.0901 2.99E-01 5.67E+01 5.69E+01	11.5737 864.0 2.25E-02 1.0705 3.02E-01 2.68E+00 2.70E+00	-44.8147 -223.1 1.18E-02 1.0523 3.05E-01 -4.95E-02 -4.98E-02	-7.8216 -1278.5 5.99E-03 1.0356 3.07E-01 -4.78E+00 -4.82E+00*	-4.3455 -2301.2 2.96E-03 1.0202 3.09E-01 -1.40E+01 -1.41E+01*	-3.0393 -3290.2 1.45E-03 1.0059 3.11E-01 -2.02E+01 -2.04E+01*	-2.3560 -4244.5 7.07E-04 .9927 3.12E-01 -2.13E+01 -2.16E+01*	-1.9370 -5162.6 3.46E-04 .9805 3.13E-01 -1.89E+01 -1.91E+01*	-1.6548 -6043.2 1.70E-04 .9690 3.14E-01 -1.50E+01 -1.52E+01*	-1.4525 -6884.6 8.35E-05 .9580 3.15E-01 -1.10E+01 -1.11E+01*	-1.3012 -7685.3 4.11E-05 .9471 3.16E-01 -7.56E+00 -7.65E+00*
5	2.7999 3571.5 7.35E-02 1.1211 2.94E-01 5.87E+02 5.87E+02	4.0761 2453.3 5.39E-02 1.0995 2.98E-01 1.43E+02 1.43E+02	7.3199 1366.1 3.47E-02 1.0798 3.01E-01 1.62E+01 1.63E+01	32.1787 310.8 2.05E-02 1.0616 3.03E-01 1.15E-01 1.16E-01	-14.0462 -711.9 1.15E-02 1.0449 3.06E-01 -1.58E+00 -1.59E+00	-5.8790 -1701.0 6.28E-03 1.0295 3.08E-01 -1.18E+01 -1.19E+01*	-3.7662 -2655.2 3.34E-03 1.0152 3.09E-01 -2.43E+01 -2.45E+01*	-2.7985 -3573.3 1.76E-03 1.0019 3.11E-01 -3.15E+01 -3.18E+01*	-2.2452 -4453.9 9.22E-04 .9894 3.12E-01 -3.22E+01 -3.25E+01*	-1.8884 -5295.4 4.81E-04 .9776 3.14E-01 -2.85E+01 -2.88E+01*	-1.6404 -6096.0 2.50E-04 .9661 3.15E-01 -2.27E+01 -2.30E+01*
6	1.9487 5131.7 5.83E-02 1.1565 2.88E-01 1.32E+03 1.31E+03	2.4916 4013.5 6.96E-02 1.1313 2.92E-01 7.78E+02 7.77E+02	3.4172 2926.4 6.14E-02 1.1093 2.96E-01 2.73E+02 2.73E+02	5.3448 1871.0 4.57E-02 1.0894 2.99E-01 5.43E+01 5.45E+01	11.7886 848.3 3.06E-02 1.0712 3.02E-01 3.45E+00 3.47E+00	-71.0500 -140.7 1.91E-02 1.0545 3.04E-01 -2.00E-02 -2.01E-02	-9.1328 -1095.0 1.14E-02 1.0391 3.06E-01 -5.69E+00 -5.73E+00	-4.9675 -2013.1 6.60E-03 1.0248 3.08E-01 -2.07E+01 -2.09E+01*	-3.4558 -2893.7 3.75E-03 1.0114 3.10E-01 -3.54E+01 -3.57E+01*	-2.6773 -3735.1 2.10E-03 .9987 3.11E-01 -4.30E+01 -4.34E+01*	-2.2047 -4535.8 1.17E-03 .9866 3.13E-01 -4.31E+01 -4.36E+01*
7	1.5009 6662.8 3.69E-03 1.2253 2.74E-01 1.66E+02 1.59E+02*	1.8036 5544.6 3.10E-02 1.1702 2.85E-01 8.69E+02 8.60E+02	2.2434 4457.4 5.42E-02 1.1425 2.90E-01 8.19E+02 8.15E+02	2.9394 3402.1 5.97E-02 1.1197 2.94E-01 4.13E+02 4.12E+02	4.2028 2379.4 5.22E-02 1.0995 2.98E-01 1.26E+02 1.26E+02	7.1926 1390.3 3.97E-02 1.0812 3.00E-01 1.95E+01 1.96E+01	22.9296 436.1 2.76E-02 1.0644 3.03E-01 4.26E-01 4.28E-01	-20.7470 -482.0 1.81E-02 1.0490 3.05E-01 -7.66E-01 -7.70E-01	-7.3390 -1362.6 1.14E-02 1.0346 3.07E-01 -1.10E+01 -1.11E+01	-4.5371 -2204.1 6.99E-03 1.0211 3.09E-01 -2.89E+01 -2.91E+01*	-3.3281 -3004.7 4.20E-03 1.0084 3.10E-01 -4.44E+01 -4.48E+01*

Table 3. Radiative transition parameters for $N_2 B^3\Pi_g-A^3\Sigma_u^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.4468 22381.5 1.00E-09 2.0299 8.27E-02 (1.56E-04) 1.06E-04*	.4774 20948.6 1.30E-06 1.7952 1.32E-01 4.25E-01 4.03E-01*	.5117 19543.4 2.33E-04 1.6639 1.65E-01 9.59E+01 9.51E+01*	.5505 18165.9 9.90E-03 1.5736 1.88E-01 4.26E+03 4.27E+03*	.5947 16816.2 1.12E-01 1.5050 2.06E-01 4.58E+04 4.60E+04	.6454 15494.6 2.71E-01 1.4515 2.20E-01 9.91E+04 9.91E+04	.7042 14201.0 2.01E-02 1.4385 2.24E-01 5.82E+03 5.71E+03	.7730 12935.8 1.28E-01 1.3499 2.46E-01 3.39E+04 3.40E+04	.8548 11699.2 4.74E-03 1.2500 2.69E-01 1.11E+03 1.16E+03*	.9532 10491.5 4.46E-02 1.2902 2.60E-01 7.05E+03 6.97E+03	1.0737 9313.2 7.74E-02 1.2452 2.70E-01 9.22E+03 9.22E+03
9	.4192 23854.0 2.04E-13 3.7747 1.12E-04 (7.06E-14) 5.74E-07*	.4460 22421.1 8.27E-09 2.0514 7.88E-02 (1.17E-03) 7.61E-04*	.4758 21015.8 5.45E-06 1.8078 1.29E-01 1.71E+00 1.62E+00*	.5092 19638.3 6.34E-04 1.6741 1.62E-01 2.56E+02 2.54E+02*	.5468 18288.7 1.91E-02 1.5834 1.86E-01 8.15E+03 8.15E+03	.5894 16967.0 1.55E-01 1.5148 2.04E-01 6.38E+04 6.40E+04	.6380 15673.4 2.49E-01 1.4629 2.17E-01 9.16E+04 9.15E+04	.6940 14408.2 1.90E-04 1.8640 1.16E-01 (1.56E+01) 1.02E+01*	.7592 13171.6 1.20E-01 1.3630 2.43E-01 3.27E+04 3.26E+04	.8358 11964.0 2.93E-02 1.2982 2.58E-01 6.77E+03 6.86E+03	.9272 10785.6 1.35E-02 1.3170 2.54E-01 2.20E+03 2.15E+03
10	.3953 25296.8 5.36E-14 1.5997 1.81E-01 (5.79E-08) 4.86E-08*	.4190 23864.0 6.22E-14 14.5540 0.00E+00 (0.00E+00) 1.31E-05*	.4453 22458.7 3.77E-08 2.0733 7.50E-02 (4.86E-03) 2.96E-03*	.4744 21081.2 1.68E-05 1.8205 1.26E-01 (4.86E-02) 4.81E+00*	.5068 19731.6 1.43E-03 1.6846 1.60E-01 5.67E+02 5.61E+02*	.5432 18409.9 3.25E-02 1.5934 1.83E-01 1.38E+04 1.38E+04	.5842 17116.3 1.98E-01 1.5251 2.01E-01 8.11E+04 8.13E+04	.6309 15851.1 2.06E-01 1.4753 2.14E-01 7.60E+04 7.59E+04	.6843 14614.5 1.02E-02 1.3519 2.45E-01 3.90E+03 3.99E+03	.7459 13466.8 8.96E-02 1.3774 2.39E-01 2.50E+04 2.48E+04	.8178 12228.5 5.92E-02 1.3171 2.54E-01 1.41E+04 1.42E+04
11	.3744 26710.0 1.70E-15 1.0771 3.01E-01 5.95E-09 5.75E-09*	.3956 25277.1 3.22E-14 2.8846 6.46E-03 (4.39E-11) 4.35E-08*	.4189 23871.9 2.97E-13 14.6460 0.00E+00 (0.00E+00) 6.01E-05*	.4446 22494.4 1.26E-07 2.0949 7.13E-02 (1.48E-02) 8.36E-03*	.4729 21144.7 4.28E-05 1.8336 1.23E-01 1.25E+01 1.17E+01*	.5045 19823.1 2.84E-03 1.6953 1.57E-01 2.11E+03 1.09E+03*	.5397 18529.5 5.04E-02 1.6037 1.80E-01 2.12E+04 2.12E+04	.5792 17264.3 2.34E-01 1.5357 1.98E-01 9.57E+04 9.58E+04	.6239 16027.7 1.52E-01 1.4895 2.10E-01 5.59E+04 5.58E+04	.6748 14820.0 3.88E-02 1.3934 2.35E-01 1.41E+04 1.43E+04	.7330 13641.7 5.15E-02 1.3953 2.35E-01 1.46E+04 1.44E+04
12	.3560 28093.2 4.85E-14 1.2610 2.66E-01 1.55E-07 1.52E-07*	.3751 26660.3 1.61E-14 1.8337 1.23E-01 (9.40E-09) 1.40E-08*	.3960 25255.1 1.99E-15 -14.2460 0.00E+00 (0.00E+00) 1.45E-06*	.4188 23877.6 5.12E-14 -58.5080 0.00E+00 (0.00E+00) 2.44E-04*	.4439 22528.0 3.44E-07 2.1151 6.80E-02 (3.69E-02) 1.94E-02*	.4716 21206.3 9.49E-05 1.8470 1.20E-01 2.65E+01 2.47E+01*	.5022 19912.7 5.10E-03 1.7063 1.54E-01 1.94E+03 1.91E+03*	.5363 18647.5 7.29E-02 1.6143 1.78E-01 3.02E+04 3.02E+04	.5744 17410.9 2.60E-01 1.5467 1.95E-01 1.06E+05 1.06E+05	.6172 16203.2 9.69E-02 1.5069 2.06E-01 3.54E+04 3.52E+04	.6656 15024.9 7.25E-02 1.4139 2.30E-01 2.63E+04 2.64E+04
13	.3396 29446.3 2.38E-14 1.2347 2.72E-01 9.12E-08 8.97E-08*	.3570 28013.4 3.88E-14 1.1724 2.85E-01 1.40E-07 1.29E-07*	.3758 26608.2 7.27E-14 .6158 3.13E-01 (2.72E-07) 4.31E-07*	.3963 25230.7 7.16E-13 -5.5336 6.51E-02 (9.87E-08) 1.38E-05*	.4187 23881.0 1.17E-11 -1.3319 6.49E-16 (1.36E-34) 8.62E-04*	.4433 22559.3 8.14E-07 2.1350 6.49E-02 (7.97E-02) 3.89E-02*	.4702 21265.8 1.90E-04 1.8608 1.17E-01 5.07E+01 4.70E+01*	.5000 20000.6 8.50E-03 1.7175 1.51E-01 3.15E+03 3.11E+03*	.5329 18764.0 9.94E-02 1.6252 1.75E-01 4.06E+04 4.06E+04	.5696 17556.3 2.73E-01 1.5583 1.92E-01 1.11E+05 1.11E+05	.6106 16377.9 5.03E-02 1.5307 2.00E-01 1.78E+04 1.77E+04
14	.3250 30768.9 1.39E-15 1.5158 2.03E-01 (3.40E-09) 3.88E-09*	.3409 29336.0 1.03E-13 1.2370 2.72E-01 3.89E-07 3.72E-07*	.3580 27930.7 2.00E-13 1.0240 3.08E-01 8.41E-07 8.16E-07*	.3766 26553.2 1.44E-12 .8833 3.21E-01 (5.61E-06) 6.41E-06*	.3968 25203.6 7.24E-12 .1627 2.24E-01 (1.18E-05) 7.56E-05*	.4187 23881.9 8.94E-11 -2.4150 2.94E-05 (2.13E-12) 2.45E-03*	.4427 22588.4 1.73E-06 2.1558 6.17E-02 (1.53E-01) 6.82E-02*	.4690 21323.1 3.49E-04 1.8749 1.14E-01 8.93E+01 8.22E+01*	.4978 20086.5 1.33E-02 1.7290 1.48E-01 4.82E+03 4.75E+03	.5297 18878.9 1.29E-01 1.6365 1.72E-01 5.20E+04 5.20E+04	.5650 17700.5 2.73E-01 1.5706 1.89E-01 1.09E+05 1.10E+05
15	.3119 32060.7 2.13E-14 1.3336 2.50E-01 8.85E-08 9.02E-08*	.3265 30627.8 1.90E-14 1.0659 3.03E-01 1.01E-07 9.98E-08*	.3422 29222.6 2.58E-13 1.0815 3.00E-01 1.18E-06 1.14E-06*	.3591 27845.1 1.53E-12 1.0411 3.06E-01 6.28E-06 6.10E-06*	.3774 26495.4 5.93E-12 .8420 3.22E-01 (2.32E-05) 2.77E-05*	.3972 25173.7 3.04E-11 .3094 2.60E-01 (6.63E-05) 2.67E-04*	.4188 23880.2 3.62E-10 -1.4002 4.14E-03 (1.71E-07) 5.91E-03*	.4422 22615.0 3.37E-06 2.1759 5.87E-02 (2.72E-01) 1.10E-01*	.4678 21378.4 6.04E-04 1.8893 1.11E-01 1.47E+02 1.35E+02*	.4958 20170.7 1.99E-02 1.7408 1.45E-01 7.00E+03 6.90E+03	.5265 18992.4 1.61E-01 1.6482 1.69E-01 6.36E+04 6.36E+04

Table 3. Radiative transition parameters for $N_2 B^3\Pi_g-A^3\Sigma_u^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	1.2248 8164.6 3.35E-02 1.2061 2.78E-01 2.86E+03 2.89E+03	1.4192 7046.4 1.16E-03 1.1146 2.95E-01 7.13E+01 7.71E+01*	1.6781 5959.2 9.35E-03 1.1918 2.81E-01 3.16E+02 3.09E+02*	2.0392 4903.9 3.29E-02 1.1554 2.88E-01 6.52E+02 6.47E+02	2.5765 3881.2 4.89E-02 1.1309 2.92E-01 4.95E+02 4.93E+02	3.4576 2892.1 5.16E-02 1.1101 2.96E-01 2.21E+02 2.21E+02	5.1601 1937.9 4.52E-02 1.0916 2.99E-01 5.95E+01 5.96E+01	9.8056 1019.8 3.53E-02 1.0747 3.01E-01 6.89E+00 6.91E+00	71.8231 139.2 2.55E-02 1.0592 3.04E-01 1.29E-02 1.29E-02	-14.2399 -702.3 1.75E-02 1.0447 3.06E-01 -2.30E+00 -2.31E+00	-6.6539 -1502.9 1.16E-02 1.0312 3.07E-01 -1.51E+01 -1.52E+01
9	1.0377 9637.0 6.59E-02 1.2585 2.67E-01 8.51E+03 8.47E+03	1.1739 8518.9 5.32E-02 1.2208 2.75E-01 5.04E+03 5.06E+03	1.3456 7431.7 1.34E-02 1.1803 2.83E-01 8.96E+02 9.13E+02	1.5683 6376.3 1.73E-04 1.3620 2.43E-01 5.37E+00 4.45E+00*	1.8679 5353.6 1.34E-02 1.1728 2.85E-01 3.37E+02 3.31E+02	2.2912 4364.6 3.22E-02 1.1435 2.90E-01 4.56E+02 4.53E+02	2.9322 3410.4 4.34E-02 1.1214 2.94E-01 3.01E+02 3.00E+02	4.0124 2492.3 4.49E-02 1.1024 2.97E-01 1.24E+02 1.24E+02	6.2048 1611.7 3.98E-02 1.0853 3.00E-01 3.03E+01 3.04E+01	12.9839 770.2 3.20E-02 1.0697 3.02E-01 2.70E+00 2.71E+00	-328.5799 -30.4 2.40E-02 1.0552 3.04E-01 -2.54E-04 -2.55E-04
10	.9025 11079.9 2.18E-04 1.5735 1.88E-01 (2.13E+01) 1.69E+01*	1.0038 9961.7 4.15E-02 1.2741 2.64E-01 5.77E+03 5.71E+03	1.1268 8874.6 5.98E-02 1.2344 2.72E-01 6.27E+03 6.27E+03	1.2789 7819.2 3.11E-02 1.1998 2.79E-01 2.35E+03 2.38E+03	1.4713 6796.5 4.23E-03 1.1513 2.89E-01 2.24E+02 2.33E+02*	1.7219 5807.5 1.81E-03 1.2152 2.76E-01 5.47E+01 5.17E+01*	2.0605 4853.3 3.00E-02 1.1588 2.87E-01 2.92E+02 2.87E+02	2.5412 3935.2 3.84E-02 1.1337 2.92E-01 3.15E+02 3.13E+02	3.2738 3054.6 3.95E-02 1.1138 2.95E-01 1.93E+02 1.92E+02	4.5186 2213.1 3.70E-02 1.0963 2.98E-01 7.71E+01 7.70E+01	7.0798 1412.5 3.57E-02 1.0805 3.01E-01 1.84E+01 1.84E+01
11	.8004 12493.1 7.96E-02 1.3320 2.50E-01 1.97E+04 1.97E+04	.8791 11374.9 6.40E-03 1.2510 2.69E-01 1.38E+03 1.43E+03*	.9720 10287.7 1.68E-02 1.2971 2.58E-01 2.47E+03 2.42E+03	1.0831 9232.4 5.13E-02 1.2489 2.69E-01 5.92E+03 5.89E+03	1.2181 8209.7 4.43E-02 1.2151 2.76E-01 3.79E+03 3.80E+03	1.3849 7220.6 1.67E-02 1.1821 2.83E-01 1.02E+03 1.04E+03	1.5958 6266.4 8.82E-04 1.1076 2.96E-01 3.86E+01 4.19E+01*	1.8697 5348.3 3.50E-03 1.1847 2.82E-01 8.64E+01 8.31E+01*	2.2383 4467.7 1.55E-02 1.1477 2.89E-01 2.35E+02 2.31E+02	2.7577 3626.2 2.72E-02 1.1257 2.93E-01 2.26E+02 2.24E+02	3.5390 2825.6 3.39E-02 1.1076 2.96E-01 1.36E+02 1.36E+02
12	.7207 13876.3 1.95E-02 1.4236 2.27E-01 5.45E+03 5.34E+03	.7838 12758.1 8.29E-02 1.3461 2.47E-01 2.12E+04 2.12E+04	.8568 11671.0 2.51E-02 1.2885 2.60E-01 5.48E+03 5.56E+03	.9420 10615.6 2.03E-03 1.3684 2.41E-01 2.87E+02 2.69E+02*	1.0424 9592.9 3.30E-02 1.2660 2.65E-01 4.15E+03 4.11E+03	1.1623 8603.9 4.67E-02 1.2302 2.73E-01 4.49E+03 4.49E+03	1.3072 7649.7 3.00E-02 1.2002 2.79E-01 2.12E+03 2.14E+03	1.4855 6731.5 8.63E-03 1.1685 2.85E-01 4.35E+02 4.45E+02*	1.7091 5851.0 4.38E-05 1.9347 3.17E-01 (1.79E+00) 2.59E+00*	1.9962 5009.5 4.53E-03 1.1382 2.86E-01 9.44E+01 9.13E+01*	2.3759 4208.9 1.48E-02 1.1382 2.91E-01 1.90E+02 1.87E+02
13	.6566 15229.4 9.99E-02 1.4302 2.26E-01 3.64E+04 3.65E+04	.7087 14111.2 2.15E-03 1.5231 2.02E-01 4.97E+02 4.66E+02*	.7678 13024.0 6.96E-02 1.3610 2.43E-01 1.84E+04 1.83E+04	.8355 11968.6 4.58E-02 1.3077 2.56E-01 1.04E+04 1.05E+04	.9136 10945.9 1.54E-03 1.1828 2.83E-01 3.28E+02 3.53E+02*	1.0043 9956.9 1.38E-02 1.2915 2.60E-01 1.86E+03 1.82E+03	1.1108 9002.7 3.77E-02 1.2468 2.70E-01 4.05E+03 4.03E+03	1.2369 8084.6 3.71E-02 1.2167 2.76E-01 3.02E+03 3.03E+03	1.3881 7204.0 1.96E-02 1.1903 2.81E-01 1.18E+03 1.19E+03	1.5717 6362.5 4.40E-03 1.1616 2.87E-01 1.89E+02 1.96E+02*	1.7979 5561.9 5.90E-05 1.2723 2.64E-01 (1.43E+00) 1.00E+00*
14	.6042 16552.0 1.76E-02 1.5740 1.88E-01 5.72E+03 5.68E+03	.6479 15433.8 1.14E-01 1.4455 2.22E-01 4.17E+04 4.17E+04	.6970 14346.6 1.96E-03 1.2663 2.65E-01 8.26E+02 8.82E+02*	.7524 13291.2 4.64E-02 1.3782 2.39E-01 1.26E+04 1.24E+04	.8151 12268.5 5.90E-02 1.3235 2.52E-01 1.40E+04 1.40E+04	.8866 11279.5 1.30E-02 1.2643 2.66E-01 2.67E+03 2.72E+03	.9685 10325.3 1.82E-03 1.3695 2.41E-01 2.36E+02 2.22E+02*	1.0630 9407.2 2.23E-02 1.2679 2.65E-01 2.64E+03 2.61E+03	1.1728 8526.6 3.47E-02 1.2343 2.72E-01 3.23E+03 3.23E+03	1.3012 7685.1 2.77E-02 1.2088 2.78E-01 1.96E+03 1.97E+03	1.4525 6884.5 1.28E-02 1.1869 2.82E-01 6.74E+02 6.85E+02
15	.5604 17843.8 2.59E-01 1.5837 1.86E-01 1.03E+05 1.03E+05	.5979 16725.6 1.67E-03 1.7615 1.40E-01 3.12E+02 3.00E+02*	.6394 15638.4 1.12E-01 1.4611 2.18E-01 4.10E+04 4.10E+04	.6857 14583.1 1.57E-02 1.3682 2.41E-01 5.75E+03 5.85E+03	.7374 13560.4 2.23E-02 1.4015 2.33E-01 6.10E+03 5.99E+03	.7955 12571.3 5.97E-02 1.3389 2.48E-01 1.48E+04 1.48E+04	.8608 11617.1 2.95E-02 1.2896 2.60E-01 6.33E+03 6.38E+03	.9347 10699.0 1.11E-03 1.1472 2.89E-01 2.30E+02 2.50E+02*	1.0185 9818.4 7.78E-03 1.3044 2.57E-01 9.82E+02 9.60E+02*	1.1140 8976.9 2.44E-02 1.2557 2.68E-01 2.56E+03 2.55E+03	1.2230 8176.3 2.86E-02 1.2283 2.74E-01 2.37E+03 2.38E+03

Table 3. Radiative transition parameters for N_2 $B^3\Pi_g-A^3\Sigma_u^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.3001 33321.5 7.87E-15 1.3359 2.49E-01 3.66E-08 3.75E-08*	.3136 31888.6 3.69E-15 1.9280 1.03E-01 (2.55E-09) 4.19E-09*	.3280 30483.4 1.82E-13 1.0855 3.00E-01 9.38E-07 9.17E-07*	.3436 29105.9 9.07E-13 1.0262 3.08E-01 4.30E-06 4.23E-06*	.3603 27756.2 4.86E-12 .9992 3.11E-01 2.04E-05 2.01E-05*	.3783 26434.5 1.89E-11 .7982 3.23E-01 (7.36E-05) 9.30E-05*	.3978 25141.0 1.33E-10 .5433 3.04E-01 (3.95E-04) 8.84E-04*	.4188 23875.8 1.10E-09 -.8678 2.64E-02 (2.12E-05) 1.27E-02*	.4417 22639.2 6.17E-06 2.1957 5.59E-02 (4.53E-01) 1.65E-01*	.4666 21431.5 9.92E-04 1.9038 1.08E-01 2.30E+02 2.09E+02*	.4938 20253.1 2.85E-02 1.7529 1.42E-01 9.74E+03 9.59E+03
17	.2894 34550.8 2.81E-15 1.2393 2.71E-01 1.72E-08 1.69E-08*	.3020 33117.9 2.57E-15 1.8350 1.23E-01 (2.86E-09) 4.35E-09*	.3153 31712.7 5.85E-14 1.0224 3.09E-01 3.60E-07 3.58E-07*	.3296 30335.2 3.72E-13 .9826 3.13E-01 2.06E-06 2.07E-06*	.3450 28985.6 2.66E-12 .9897 3.12E-01 1.28E-05 1.27E-05*	.3615 27663.9 1.73E-11 1.0157 3.09E-01 (7.08E-05) 6.90E-05*	.3792 26370.3 5.59E-11 .7801 3.22E-01 (2.16E-04) 2.81E-04*	.3983 25105.1 4.15E-10 .6605 3.17E-01 (1.34E-03) 2.35E-03*	.4190 23868.5 2.57E-09 -.6298 5.12E-02 (1.86E-04) 2.40E-02*	.4413 22660.8 1.07E-05 2.2150 5.32E-02 (7.16E-01) 2.34E-01*	.4655 21482.5 1.56E-03 1.9185 1.05E-01 (3.44E+02) 3.11E+02*
18	.2797 35748.4 2.15E-14 1.2759 2.63E-01 1.38E-07 1.37E-07*	.2914 34315.5 8.68E-15 1.2126 2.77E-01 5.45E-08 5.20E-08*	.3039 32910.3 3.34E-15 .5808 3.09E-01 (2.30E-08) 3.53E-08*	.3171 31532.8 1.01E-13 .8938 3.20E-01 6.55E-07 6.85E-07*	.3313 30183.1 1.21E-12 .9714 3.14E-01 6.67E-06 6.67E-06*	.3465 28861.4 8.52E-12 .9964 3.12E-01 4.03E-05 3.95E-05*	.3627 27567.9 3.91E-11 .9679 3.15E-01 1.64E-04 1.64E-04*	.3802 26302.7 1.27E-10 .7334 3.21E-01 (4.85E-04) 6.73E-04*	.3989 25066.1 1.09E-09 .7539 3.22E-01 (3.59E-03) 5.37E-03*	.4191 23858.4 4.70E-09 -.5988 5.55E-02 (3.98E-04) 4.02E-02*	.4409 22680.0 1.79E-05 2.2337 5.07E-02 (1.09E+00) 3.19E-01*
19	.2709 36913.8 1.58E-14 1.2783 2.63E-01 1.11E-07 1.11E-07*	.2818 35480.9 2.85E-14 1.3289 2.51E-01 1.62E-07 1.59E-07*	.2935 34075.6 2.32E-15 1.6956 1.57E-01 (4.56E-09) 7.23E-09*	.3058 32698.1 1.49E-14 .6887 3.19E-01 (1.08E-07) 1.35E-07*	.3190 31348.5 4.32E-13 .9482 3.16E-01 2.70E-06 2.70E-06*	.3330 30026.8 2.68E-12 .9069 3.19E-01 1.50E-05 1.56E-05*	.3480 28733.3 1.81E-11 .9691 3.14E-01 8.59E-05 8.47E-05*	.3641 27468.0 7.74E-11 .9351 3.17E-01 (9.09E-04) 3.34E-04*	.3812 26231.4 2.45E-10 .6760 3.18E-01 (8.17E-03) 1.38E-03*	.3996 25023.8 2.48E-09 .8372 3.22E-01 (2.54E-04) 1.08E-02*	.4194 23845.4 6.94E-09 -.7560 3.65E-02 (1.66E-02) 6.06E-02*
20	.2628 38046.5 4.34E-16 1.2702 2.64E-01 3.39E-09 3.38E-09*	.2731 36613.6 7.75E-15 1.3785 2.39E-01 4.39E-08 4.35E-08*	.2840 35208.4 4.45E-15 1.3429 2.47E-01 2.41E-08 2.64E-08*	.2956 33830.9 4.00E-16 -.3399 1.00E-01 (3.15E-10) 7.52E-09*	.3079 32481.2 8.14E-14 .8656 3.21E-01 5.84E-07 6.01E-07*	.3209 31159.6 6.57E-13 .8393 3.22E-01 4.18E-06 4.49E-06*	.3348 29866.0 5.59E-12 .9208 3.18E-01 3.06E-05 3.08E-05*	.3496 28600.8 3.13E-11 .9430 3.17E-01 1.49E-04 1.47E-04*	.3654 27364.2 1.28E-10 .8916 3.20E-01 5.43E-04 5.73E-04*	.3823 26156.5 4.26E-10 .6251 3.14E-01 (1.52E-03) 2.54E-03*	.4003 24978.2 5.19E-09 .9261 3.18E-01 (1.66E-02) 1.96E-02*
21	.2555 39146.2 7.68E-15 1.2794 2.62E-01 6.43E-08 6.42E-08*	.2652 37713.3 5.12E-15 1.2644 2.66E-01 3.93E-08 3.91E-08*	.2754 36308.0 1.38E-15 1.1271 2.93E-01 1.15E-08 1.23E-08*	.2863 34930.5 7.89E-16 1.3948 2.35E-01 (3.75E-09) 5.38E-09*	.2978 33580.9 9.58E-17 5.4900 8.15E-10 (4.88E-27) 4.02E-10*	.3100 32259.2 7.83E-14 .8176 3.23E-01 5.54E-07 5.37E-07*	.3229 30965.7 7.45E-13 .7645 3.22E-01 4.65E-06 5.14E-06*	.3367 29700.4 7.07E-12 .8653 3.21E-01 3.88E-05 3.95E-05*	.3513 28463.8 4.30E-11 .9074 3.19E-01 2.05E-04 2.03E-04*	.3669 27256.2 1.71E-10 .8234 3.22E-01 (7.31E-04) 8.22E-04*	.3835 26077.8 6.13E-10 .5337 3.03E-01 (2.02E-03) 4.02E-03*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 3. Radiative transition parameters for $N_2 B^3\Pi_g - A^3\Sigma_u^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	.5234 19104.6 1.93E-01 1.6604 1.66E-01 7.49E+04 7.49E+04	.5560 17986.4 2.33E-01 1.5979 1.82E-01 9.08E+04 9.11E+04	.5917 16899.2 2.22E-03 1.2989 2.58E-01 1.44E+03 1.48E+03*	.6312 15843.8 9.54E-02 1.4782 2.13E-01 3.49E+04 3.48E+04	.6747 14821.1 3.65E-02 1.3988 2.34E-01 1.32E+04 1.33E+04	.7230 13832.1 5.30E-03 1.4502 2.21E-01 1.38E+03 1.32E+03*	.7765 12877.9 4.84E-02 1.3550 2.44E-01 1.25E+04 1.24E+04	.8361 11959.8 4.28E-02 1.3079 2.56E-01 9.70E+03 9.72E+03	.9026 11079.2 1.03E-02 1.2495 2.69E-01 2.05E+03 2.09E+03	.9768 10237.7 3.50E-04 1.5266 2.01E-01 3.06E+01 2.80E+01*	1.0596 9437.1 1.15E-02 1.2878 2.60E-01 1.32E+03 1.31E+03
17	.4918 20333.9 3.94E-02 1.7653 1.39E-01 1.31E+04 1.29E+04	.5204 19215.7 2.29E-01 1.6731 1.62E-01 8.51E+04 8.52E+04	.5516 18128.6 1.98E-01 1.6134 1.78E-01 7.55E+04 7.58E+04	.5857 17073.2 1.64E-02 1.4512 2.20E-01 8.01E+03 8.00E+03	.6230 16050.5 6.99E-02 1.4983 2.08E-01 2.53E+04 2.52E+04	.6639 15061.5 5.65E-02 1.4201 2.28E-01 2.04E+04 2.05E+04	.7089 14107.3 3.73E-05 1.5731 3.08E-01 2.01E+01 5.28E+01*	.7582 13189.1 3.04E-02 1.3737 2.40E-01 8.12E+03 8.00E+03	.8124 12308.6 4.71E-02 1.3246 2.52E-01 1.13E+04 1.12E+04	.8721 11467.1 2.38E-02 1.2786 2.63E-01 5.01E+03 5.04E+03	.9375 10666.5 2.52E-02 1.1778 2.84E-01 4.99E+02 5.21E+02*
18	.4644 21531.5 2.38E-03 1.9332 1.02E-01 (4.96E+02) 4.46E+02*	.4899 20413.3 5.29E-02 1.7781 1.36E-01 1.70E+04 1.67E+04	.5174 19326.1 2.53E-01 1.6863 1.59E-01 9.36E+04 9.38E+04	.5473 18270.8 1.57E-01 1.6309 1.73E-01 5.82E+04 5.86E+04	.5798 17248.1 3.94E-02 1.4939 2.09E-01 1.79E+04 1.79E+04	.6150 16259.0 4.19E-02 1.5245 2.01E-01 1.48E+04 1.47E+04	.6534 15304.8 6.89E-02 1.4395 2.23E-01 2.49E+04 2.50E+04	.6951 14386.7 6.43E-03 1.3475 2.46E-01 2.36E+03 2.44E+03*	.7404 13506.1 1.27E-02 1.3995 2.33E-01 3.46E+03 3.36E+03	.7896 12664.6 4.09E-02 1.3413 2.48E-01 1.03E+04 1.02E+04	.8429 11864.0 3.47E-02 1.2990 2.58E-01 7.80E+03 7.79E+03
19	.4406 22696.9 2.91E-05 2.2510 4.85E-02 (1.62E+00) 4.29E-01*	.4634 21578.7 3.52E-03 1.9478 9.86E-02 (6.96E+02) 6.22E+02*	.4880 20491.5 6.93E-02 1.7912 1.33E-01 2.14E+04 2.11E+04	.5145 19436.1 2.77E-01 1.7002 1.56E-01 9.96E+04 1.00E+05	.5431 18413.4 1.14E-01 1.6514 1.68E-01 4.08E+04 4.12E+04	.5739 17424.4 6.56E-02 1.5204 2.02E-01 2.88E+04 2.86E+04	.6072 16470.2 1.80E-02 1.5669 1.90E-01 5.87E+03 5.84E+03	.6430 15552.1 7.01E-02 1.4594 2.18E-01 2.54E+04 2.54E+04	.6816 14671.5 2.04E-02 1.3910 2.36E-01 7.25E+03 7.36E+03	.7231 13830.0 1.82E-03 1.4652 2.17E-01 4.57E+02 4.20E+02*	.7675 13029.4 2.73E-02 1.3593 2.43E-01 7.26E+03 7.13E+03
20	.4196 23829.6 7.50E-09 -1.3019 6.05E-03 (7.53E-06) 8.09E-02*	.4403 22711.4 4.62E-05 2.2669 4.65E-02 (2.37E+00) 5.79E-01*	.4624 21624.2 5.09E-03 1.9625 9.56E-02 (9.53E+02) 8.47E+02*	.4862 20568.9 8.85E-02 1.8048 1.30E-01 2.64E+04 2.60E+04	.5116 19546.2 2.95E-01 1.7149 1.52E-01 1.03E+05 1.03E+05	.5389 18557.1 7.40E-02 1.6772 1.61E-01 2.50E+04 2.53E+04	.5681 17602.9 8.91E-02 1.5420 1.97E-01 3.80E+04 3.79E+04	.5993 16684.8 3.27E-03 1.6887 1.58E-01 7.72E+02 7.62E+02*	.6327 15804.2 6.02E-02 1.4820 2.12E-01 2.17E+04 2.16E+04	.6683 14962.7 3.56E-02 1.4176 2.29E-01 1.27E+04 1.28E+04	.7061 14162.1 7.94E-04 1.2792 2.62E-01 (3.14E+02) 3.52E+02*
21	.4011 24929.3 9.58E-09 1.0010 3.11E-01 2.91E-02 3.16E-02*	.4200 23811.1 5.78E-09 -2.5718 1.16E-05 (2.13E-11) 9.80E-02*	.4401 22723.9 7.19E-05 2.2823 4.47E-02 (3.41E+00) 7.73E-01*	.4615 21668.5 7.21E-03 1.9774 9.26E-02 (1.28E+03) 1.13E+03*	.4844 20645.8 1.11E-01 1.8191 1.27E-01 3.17E+04 3.12E+04	.5087 19656.8 3.05E-01 1.7307 1.48E-01 1.03E+05 1.04E+05	.5347 18702.6 4.04E-02 1.7140 1.52E-01 1.24E+04 1.27E+04	.5623 17784.5 1.04E-01 1.5613 1.91E-01 4.36E+04 4.34E+04	.5916 16903.9 4.50E-04 1.0296 3.08E-01 (4.17E+02) 4.79E+02*	.6226 16062.4 4.25E-02 1.5099 2.05E-01 1.50E+04 1.49E+04	.6552 15261.8 4.58E-02 1.4420 2.23E-01 1.64E+04 1.64E+04

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 4. Radiative transition parameters for $N_2 W^3\Delta_u-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}^*$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	136.1044 73.5 4.67E-01 1.2504 2.88E-01 3.11E-02 3.10E-02	-6.1281 -1631.8 3.88E-01 1.2982 2.73E-01 -2.55E+02 -2.55E+02	-3.0229 -3308.1 1.24E-01 1.3528 2.56E-01 -5.95E+02 -5.98E+02	-2.0180 -4955.4 1.95E-02 1.4177 2.33E-01 -2.61E+02 -2.63E+02	-1.5212 -6573.7 1.55E-03 1.4990 2.04E-01 -3.72E+01 -3.74E+01*	-1.2250 -8163.0 5.70E-05 1.6124 1.65E-01 -1.71E+00 -1.67E+00*	-1.0285 -9723.2 7.17E-07 1.6164 1.02E-01 (-1.38E-02)(-1.71E-13) -1.04E-02*	-0.8886 -11254.3 2.83E-10 3.5359 1.45E-05 (-8.94E-06)(-1.52E-11) -2.05E-04*	-0.7839 -12756.1 6.25E-11 1.5555 1.84E-01 (-6.72E-05)(-7.15E-15) -1.92E-03*	-0.7028 -14228.5 1.79E-13 2.6617 3.82E-03 (-6.92E-09) -6.83E-08*	-0.6381 -15671.4 1.93E-14 1.4711 2.14E-01 (-6.92E-09) -4.15E-09*
1	6.4311 1554.9 3.23E-01 1.2089 3.00E-01 2.20E+02 2.21E+02	-66.5097 -150.4 2.73E-02 1.2757 2.80E-01 -1.48E-02 -1.44E-02	-5.4745 -1826.6 3.43E-01 1.3083 2.70E-01 -3.09E+02 -3.08E+02	-2.8786 -3473.9 2.42E-01 1.3617 2.53E-01 -1.31E+03 -1.31E+03	-1.9638 -5092.2 5.93E-02 1.4265 2.30E-01 -8.40E+02 -8.46E+02	-1.4967 -6681.5 6.36E-03 1.5085 2.01E-01 -1.56E+02 -1.56E+02*	-1.2133 -8241.7 2.91E-04 1.6243 1.61E-01 -8.52E+00 -8.33E+00*	-1.0232 -9772.8 4.09E-06 1.8408 9.53E-02 (-7.03E-02)(-4.11E-31) -4.96E-02*	-0.8869 -11274.6 4.91E-10 5.4968 1.70E-14 (-6.72E-05)(-7.15E-15) -1.26E-01*	-0.7845 -12747.0 5.99E-10 1.6163 1.63E-01 (-6.72E-05)(-7.15E-15) -9.67E-03*	-0.7047 -14189.9 6.99E-13 3.3927 4.20E-05 (-6.92E-09) -1.11E-06*
2	3.3206 3011.5 1.39E-01 1.1727 3.09E-01 7.36E+02 7.39E+02	7.6556 1306.2 2.11E-01 1.2189 2.97E-01 8.40E+01 8.37E+01	-27.0233 -370.1 2.39E-02 1.2372 2.92E-01 -2.09E-01 -2.15E-01	-4.9570 -2017.3 1.92E-01 1.3208 2.66E-01 -2.26E+02 -2.24E+02	-2.7506 -3635.6 3.05E-01 1.3711 2.49E-01 -1.85E+03 -1.85E+03	-1.9139 -5224.9 1.12E-01 1.4355 2.27E-01 -1.67E+03 -1.68E+03	-1.4738 -6785.1 1.57E-02 1.5182 1.98E-01 -3.88E+02 -3.90E+02	-1.2025 -8316.2 8.60E-04 1.6367 1.57E-01 -2.46E+01 -2.39E+01*	-1.0185 -9818.0 1.31E-05 1.8683 8.83E-02 0.00E+00 -1.26E-01*	-0.8857 -11290.5 2.13E-11 -35.1380 0.00E+00 (-2.64E-04) -9.67E-03*	-0.7853 -12733.4 3.07E-09 1.6765 1.44E-01 (-2.64E-04) -1.59E-04*
3	2.2505 4443.4 4.91E-02 1.1405 3.16E-01 8.73E+02 8.79E+02	3.6522 2738.1 1.95E-01 1.1809 3.07E-01 7.62E+02 7.63E+02	9.4180 1061.8 6.89E-02 1.2330 2.93E-01 1.43E+01 1.41E+01	-17.0795 -585.5 1.07E-01 1.2590 2.85E-01 -3.54E+00 -3.57E+00	-4.5376 -2203.8 6.86E-02 1.3397 2.60E-01 -1.00E+02 -9.87E+01	-2.6364 -3793.1 3.11E-01 1.3812 2.46E-01 -2.08E+03 -2.08E+03	-1.8680 -5353.3 1.69E-01 1.4448 2.24E-01 -2.62E+03 -2.64E+03	-1.4526 -6884.4 3.01E-02 1.5281 1.94E-01 -7.49E+02 -7.52E+02	-1.1924 -8386.2 1.93E-03 1.6496 1.52E-01 -5.36E+01 -5.19E+01*	-1.0143 -9858.6 3.11E-05 1.8995 8.08E-02 (-3.94E-01)(-2.91E-09) -2.19E-01*	-0.8848 -11301.5 9.53E-09 -1.2926 3.23E-04 (-2.91E-09) -3.48E-02*
4	1.7092 5850.6 1.55E-02 1.1115 3.22E-01 6.53E+02 6.60E+02	2.4124 4145.3 1.07E-01 1.1480 3.15E-01 1.52E+03 1.53E+03	4.0502 2469.0 1.62E-01 1.1899 3.05E-01 4.57E+02 4.55E+02	12.1693 821.7 4.31E-03 1.2842 2.78E-01 3.74E-01 3.46E-01*	-12.5540 -796.6 1.54E-01 1.2708 2.82E-01 -1.26E+01 -1.26E+01	-4.1914 -2385.8 8.57E-03 1.3962 2.41E-01 -1.37E+01 -1.29E+01*	-2.5342 -3946.1 2.75E-01 1.3922 2.42E-01 -2.01E+03 -2.00E+03	-1.8258 -5477.1 2.21E-01 1.4545 2.20E-01 -3.56E+03 -3.58E+03	-1.4329 -6978.9 4.93E-02 1.5383 1.91E-01 -1.23E+03 -1.24E+03	-1.1832 -8451.4 3.65E-03 1.6631 1.48E-01 -9.75E+01 -9.41E+01*	-1.0107 -9894.3 6.00E-05 1.9357 7.26E-02 (-6.21E-01) -2.74E-01*
5	1.3825 7233.4 4.61E-03 1.0850 3.27E-01 3.79E+02 3.83E+02*	1.8090 5528.1 4.60E-02 1.1187 3.21E-01 1.62E+03 1.63E+03	2.5962 3851.8 1.37E-01 1.1559 3.13E-01 1.55E+03 1.55E+03	4.5362 2204.5 9.29E-02 1.2005 3.02E-01 1.84E+02 1.82E+02	17.0594 586.2 9.44E-03 1.1959 3.03E-01 3.53E-01 3.72E-01*	-9.9691 -1003.1 1.49E-01 1.2819 2.78E-01 -2.36E+01 -2.35E+01	-3.9012 -2563.3 2.90E-03 1.2027 3.01E-01 -8.98E+00 -9.97E+00*	-2.4424 -4094.4 2.17E-01 1.4047 2.38E-01 -1.70E+03 -1.69E+03	-1.7869 -5596.2 2.63E-01 1.4645 2.17E-01 -4.38E+03 -4.40E+03	-1.4147 -7068.6 7.27E-02 1.5688 1.87E-01 -1.82E+03 -1.82E+03	-1.1749 -8511.5 6.09E-03 1.6773 1.43E-01 -1.56E+02 -1.50E+02*
6	1.1639 8591.7 1.33E-03 1.0607 3.31E-01 1.87E+02 1.90E+02*	1.4521 6886.4 1.74E-02 1.0921 3.26E-01 1.22E+03 1.24E+03	1.9193 5210.1 7.90E-02 1.1260 3.19E-01 2.31E+03 2.32E+03	2.8067 3562.8 1.31E-01 1.1642 3.11E-01 1.16E+03 1.16E+03	5.1426 1944.5 3.34E-02 1.2162 2.98E-01 4.41E+01 4.30E+01	28.1484 355.3 4.59E-02 1.2258 2.95E-01 3.63E-01 3.69E-01	-8.2991 -1205.0 1.10E-01 1.2940 2.75E-01 -2.94E+01 -2.91E+01	-3.6549 -2736.0 2.91E-02 1.2989 2.73E-01 -9.01E+01 -9.25E+01	-2.3597 -4237.8 1.52E-01 1.4195 2.33E-01 -1.27E+03 -1.26E+03	-1.7512 -5710.3 2.92E-01 1.4750 2.13E-01 -5.00E+03 -5.02E+03	-1.3980 -7153.2 9.92E-02 1.5596 1.83E-01 -2.46E+03 -2.47E+03
7	1.0075 9925.8 3.78E-04 1.0384 3.35E-01 8.38E+01 8.53E+01*	1.2165 8220.5 6.09E-03 1.0677 3.30E-01 7.48E+02 7.58E+02*	1.5281 6544.2 3.73E-02 1.0992 3.25E-01 2.23E+03 2.25E+03	2.0421 4896.9 1.01E-01 1.1337 3.18E-01 2.43E+03 2.44E+03	3.0501 3278.6 9.83E-02 1.1734 3.09E-01 6.68E+02 6.64E+02	5.9196 1689.3 3.44E-03 1.2656 2.83E-01 2.70E+00 2.47E+00*	77.4629 129.1 8.13E-02 1.2393 2.91E-01 3.00E-02 3.03E-02	-7.1328 -1402.0 6.27E-02 1.3090 2.70E-01 -2.55E+01 -2.50E+01	-3.4438 -2903.8 6.56E-02 1.3215 2.66E-01 -2.30E+02 -2.33E+02	-2.2851 -4376.2 9.47E-02 1.4384 2.26E-01 -8.21E+02 -8.12E+02	-1.7185 -5819.1 3.08E-01 1.4860 2.09E-01 -5.38E+03 -5.39E+03

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$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	-0.5853 -17084.6 1.36E-16 2.3841 1.41E-02 (-2.74E-13) -1.42E-11*	-0.5415 -18467.8 2.82E-17 1.3515 2.56E-01 (-2.36E-11) -2.14E-11*	-0.5045 -19820.8 1.19E-17 1.8307 9.80E-02 (-1.80E-12) -1.46E-12*	-0.4730 -21143.4 1.30E-17 1.1748 3.08E-01 (-2.37E-11) -2.66E-11*	-0.4457 -22435.3 1.15E-16 1.4071 2.37E-01 -1.47E-10 -1.57E-10*	-0.4220 -23696.1 1.98E-17 1.7176 1.30E-01 (-9.09E-12) -1.28E-11*	-0.4012 -24925.4 1.23E-16 1.1610 3.12E-01 -3.74E-10 -3.77E-10*	-0.3828 -26123.0 4.55E-16 1.2731 2.81E-01 -1.30E-09 -1.30E-09*	-0.3665 -27288.3 2.75E-16 1.3329 2.62E-01 -7.77E-10 -7.91E-10*	-0.3519 -28421.1 2.71E-19 -1.4147 1.45E-04 (-2.66E-11) -1.30E-11*	-0.3387 -29520.7 3.55E-16 1.2060 3.00E-01 -1.67E-09 -1.66E-09*
1	-0.6409 -15603.1 2.78E-13 1.5623 1.82E-01 (-7.08E-08) -3.97E-08*	-0.5887 -16986.3 4.33E-17 7.2107 2.87E-26 (0.00E+00) -1.25E-09*	-0.5453 -18339.4 3.55E-15 1.4228 2.31E-01 -2.37E-09 -2.33E-09*	-0.5086 -19662.0 7.72E-16 1.3136 2.68E-01 -8.57E-10 -9.42E-10*	-0.4772 -20953.8 2.81E-16 1.1617 3.11E-01 -5.07E-10 -4.65E-10*	-0.4502 -22214.6 1.89E-15 1.2070 3.00E-01 -3.78E-09 -3.72E-09*	-0.4265 -23443.9 1.67E-15 1.2128 2.98E-01 -3.88E-09 -3.88E-09*	-0.4058 -24641.5 2.88E-16 1.2404 2.91E-01 -7.37E-10 -7.51E-10*	-0.3875 -25806.9 1.57E-16 1.1221 3.20E-01 -5.60E-10 -5.57E-10*	-0.3712 -26939.6 1.18E-15 1.1690 3.10E-01 -4.47E-09 -4.46E-09*	-0.3566 -28039.3 1.71E-15 1.1817 3.07E-01 -7.17E-09 -7.13E-09*
2	-0.7069 -14146.5 4.14E-13 7.2072 3.06E-26 (0.00E+00) -8.76E-06*	-0.6439 -15529.7 1.95E-12 1.6800 1.42E-01 -2.33E-07 -9.08E-08*	-0.5923 -16882.8 1.82E-15 -0.8581 3.89E-03 -2.69E-13 -1.57E-08*	-0.5493 -18205.4 8.53E-16 2.3934 1.36E-02 -1.92E-12 -1.06E-10*	-0.5129 -19497.2 1.45E-15 1.0616 3.31E-01 -2.38E-09 -2.30E-09*	-0.4817 -20758.0 4.43E-15 1.2007 3.02E-01 -7.31E-09 -6.96E-09*	-0.4548 -21987.3 2.48E-15 1.2332 2.93E-01 -4.57E-09 -6.48E-09*	-0.4313 -23184.9 1.70E-17 1.7327 1.26E-01 -6.82E-12 -1.12E-11*	-0.4107 -24350.3 1.89E-15 1.1577 3.12E-01 -5.39E-09 -5.32E-09*	-0.3924 -25483.0 4.77E-15 1.1787 3.07E-01 -1.51E-08 -1.49E-08*	-0.3762 -26582.7 4.15E-15 1.1715 3.09E-01 -1.51E-08 -1.48E-08*
3	-0.7865 -12714.7 1.12E-08 1.7371 1.25E-01 (-7.21E-04) -3.78E-04*	-0.7093 -14097.9 1.95E-12 -3.5191 1.73E-13 -3.33E-31 -4.44E-05*	-0.6472 -15450.9 7.31E-12 1.7557 1.19E-01 -7.74E-07 -2.10E-07*	-0.5962 -16773.5 1.28E-13 0.8232 3.41E-01 -1.42E-07 -1.97E-07*	-0.5535 -18065.4 1.62E-15 -0.7847 5.61E-03 -6.12E-13 -1.92E-08*	-0.5174 -19326.1 1.79E-15 0.9097 3.44E-01 -3.10E-09 -3.58E-09*	-0.4865 -20555.5 5.51E-17 1.2572 2.86E-01 -7.93E-11 -2.82E-11*	-0.4597 -21753.1 1.53E-15 1.1105 3.23E-01 -3.31E-09 -3.48E-09*	-0.4363 -22918.4 4.92E-15 1.1109 3.23E-01 -1.25E-08 -1.25E-08*	-0.4158 -24051.2 6.49E-15 1.0994 3.25E-01 -1.93E-08 -1.91E-08*	-0.3976 -25150.8 5.41E-15 1.0831 3.28E-01 -1.87E-08 -1.85E-08*
4	-0.8844 -11307.4 9.05E-08 0.2061 1.71E-01 (-7.76E-03) -1.00E-01*	-0.7880 -12690.7 3.18E-08 1.8022 1.06E-01 -1.47E-03 -5.99E-04*	-0.7121 -14043.7 5.50E-11 -0.0527 9.23E-02 -2.63E-06 -1.67E-04*	-0.6508 -15366.3 2.59E-11 1.8454 9.41E-02 -1.68E-06 -1.65E-07*	-0.6003 -16658.1 7.91E-13 1.0576 3.32E-01 -8.16E-07 -7.40E-07*	-0.5581 -17918.9 8.98E-16 6.7755 6.27E-23 -2.44E-06 -2.91E-08*	-0.5222 -19148.3 8.00E-15 1.5286 1.94E-01 -4.28E-09 -4.58E-09*	-0.4915 -20345.8 9.78E-15 1.1170 3.21E-01 -1.72E-08 -1.88E-08*	-0.4649 -21511.2 1.21E-14 1.0403 3.34E-01 -2.72E-08 -2.90E-08*	-0.4416 -22643.9 1.37E-14 1.0218 3.37E-01 -3.66E-08 -3.78E-08*	-0.4212 -23743.6 1.45E-14 1.0196 3.37E-01 -4.46E-08 -4.50E-08*
5	-1.0076 -9924.7 9.93E-05 1.9786 6.37E-02 (-7.97E-01) -2.29E-01*	-0.8843 -11307.9 4.43E-07 0.7464 3.32E-01 -1.43E-01 -2.43E-01*	-0.7898 -12661.0 7.49E-08 1.8745 8.68E-02 -2.32E-03 -5.50E-04*	-0.7151 -13983.6 4.51E-10 1.7151 3.27E-01 -2.68E-04 -5.16E-04*	-0.6546 -15275.4 6.57E-11 1.9845 6.25E-02 -1.85E-06 -2.47E-07*	-0.6047 -16536.2 3.15E-12 1.2415 2.90E-01 -2.44E-06 -1.74E-06*	-0.5629 -17765.5 1.56E-14 3.5411 1.39E-05 -3.45E-17 -5.07E-08*	-0.5273 -18963.1 6.48E-14 1.4036 2.38E-01 -5.08E-08 -4.45E-08*	-0.4968 -20128.5 5.47E-14 1.0737 3.29E-01 -9.80E-08 -1.02E-07*	-0.4703 -21261.2 5.83E-14 1.0056 3.38E-01 -1.30E-07 -1.39E-07*	-0.4472 -22360.9 6.74E-14 1.0046 3.39E-01 -1.75E-07 -1.81E-07*
6	-1.1674 -8566.3 9.29E-03 1.6923 1.38E-01 -2.27E+02 -2.16E+02*	-1.0051 -9949.6 1.44E-04 2.0310 5.38E-02 -8.35E-01 -8.28E-02*	-0.8848 -11302.6 1.55E-06 1.0316 3.35E-01 -5.12E-01 -5.17E-01*	-0.7921 -12625.2 1.50E-07 1.9584 6.78E-02 -2.81E-03 -1.04E-04*	-0.7185 -13917.0 2.30E-09 1.0624 3.31E-01 -1.38E-03 -1.35E-03*	-0.6589 -15177.8 1.30E-10 2.1819 3.18E-02 -9.25E-07 -8.58E-06*	-0.6095 -16407.2 1.16E-11 1.4170 2.33E-01 -5.67E-06 -3.38E-06*	-0.5680 -17604.7 3.46E-14 3.5677 1.14E-05 -4.93E-17 -1.14E-07*	-0.5328 -18770.1 3.40E-13 1.3506 2.56E-01 -2.99E-07 -2.41E-07*	-0.5024 -19902.8 3.24E-13 1.0726 3.29E-01 -5.62E-07 -5.62E-07*	-0.4761 -21002.5 3.39E-13 1.0176 3.37E-01 -7.24E-07 -7.53E-07*
7	-1.3827 -7232.3 1.28E-01 1.5708 1.79E-01 -3.14E+03 -3.14E+03*	-1.1607 -8615.5 1.32E-02 1.7081 1.33E-01 -3.04E+02 -2.88E+02*	-1.0032 -9968.6 1.86E-04 2.0976 4.30E-02 -6.91E-01 -8.19E-03*	-0.8856 -11291.1 4.40E-06 1.2131 2.98E-01 -1.14E+00 -9.78E-01*	-0.7947 -12583.0 2.56E-07 2.0635 4.83E-02 -2.41E-03 -5.67E-04*	-0.7223 -13843.8 8.78E-09 1.2702 2.82E-01 -3.75E-03 -3.00E-03*	-0.6634 -15073.1 1.83E-10 2.5240 7.51E-03 -7.18E-08 -6.42E-05*	-0.6146 -16270.7 3.57E-11 1.5880 1.73E-01 -9.34E-06 -4.24E-06*	-0.5735 -17436.1 7.44E-14 3.1578 2.12E-04 -3.59E-14 -1.20E-07*	-0.5385 -18568.8 1.63E-12 1.3087 2.70E-01 -1.54E-06 -1.21E-06*	-0.5084 -19668.4 1.60E-12 1.0827 3.28E-01 -2.65E-06 -2.55E-06*

Table 4. Radiative transition parameters for $N_2 W^3\Delta_u-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.8900 11235.6 1.07E-04 1.0177 3.37E-01 3.51E+01 3.57E+01*	1.0493 9530.3 2.04E-03 1.0453 3.34E-01 3.99E+02 4.05E+02*	1.2732 7854.0 1.56E-02 1.0747 3.29E-01 1.66E+03 1.68E+03	1.6112 6206.7 5.92E-02 1.1065 3.23E-01 3.00E+03 3.02E+03	2.1794 4588.4 1.05E-01 1.1416 3.16E-01 2.06E+03 2.06E+03	3.3343 2999.1 5.73E-02 1.1844 3.06E-01 2.93E+02 2.89E+02	6.9497 1438.9 2.81E-03 1.1449 3.15E-01 1.69E+00 1.86E+00*	-108.4975 -92.2 9.88E-02 1.2503 2.88E-01 -1.30E-02 -1.30E-02	-6.2736 -1594.0 2.48E-02 1.3328 2.62E-01 -1.40E+01 -1.35E+01	-3.2611 -3066.4 9.74E-02 1.3358 2.61E-01 -3.88E+02 -3.91E+02	-2.2176 -4509.3 4.98E-02 1.4658 2.16E-01 -4.33E+02 -4.26E+02
9	.7986 12521.2 3.07E-05 .9986 3.39E-01 1.41E+01 1.43E+01*	.9246 10815.9 6.68E-04 1.0246 3.36E-01 1.94E+02 1.97E+02*	1.0941 9139.6 6.10E-03 1.0523 3.33E-01 1.04E+03 1.06E+03*	1.3347 7492.3 2.94E-02 1.0819 3.28E-01 2.70E+03 2.72E+03	1.7024 5874.0 7.66E-02 1.1140 3.22E-01 3.26E+03 3.27E+03	2.3339 4284.7 9.22E-02 1.1501 3.14E-01 1.45E+03 1.45E+03	3.6704 2724.5 2.31E-02 1.2001 3.02E-01 8.61E+01 8.36E+01	8.3791 1193.4 2.06E-02 1.1958 3.03E-01 6.52E+00 6.73E+00	-32.4286 -308.4 9.57E-02 1.2610 2.85E-01 -4.61E-01 -4.59E-01	-5.6154 -1780.8 4.10E-03 1.4012 2.39E-01 -2.68E+00 -2.44E+00*	-3.1020 -3223.7 1.17E-01 1.3478 2.57E-01 -5.25E+02 -5.26E+02
10	.7255 13782.6 8.89E-06 .9809 3.41E-01 5.48E+00 5.60E+00*	.8280 12077.3 2.16E-04 1.0054 3.39E-01 8.85E+01 9.02E+01*	.9614 10401.1 2.28E-03 1.0315 3.35E-01 5.84E+02 5.94E+02*	1.1424 8753.8 1.32E-02 1.0593 3.32E-01 1.98E+03 2.00E+03	1.4014 7135.5 4.50E-02 1.0891 3.27E-01 3.54E+03 3.56E+03	1.8030 5546.2 8.45E-02 1.1217 3.20E-01 3.00E+03 3.00E+03	2.5088 3986.0 6.78E-02 1.1594 3.12E-01 8.47E+02 8.39E+02	4.0735 2454.9 3.79E-03 1.2400 2.91E-01 9.61E+00 8.86E+00*	10.4922 953.1 4.37E-02 1.2122 2.99E-01 6.84E+00 6.95E+00	-19.2549 -519.3 7.76E-02 1.2725 2.81E-01 -1.74E+00 -1.73E+00	-5.0962 -1962.2 5.15E-04 1.0226 3.37E-01 (-8.94E-01) -1.23E+00*
11	.6658 15020.0 2.62E-06 .9645 3.42E-01 2.10E+00 2.15E+00*	.7511 13314.7 7.00E-05 .9876 3.40E-01 3.87E+01 3.95E+01*	.8592 11638.4 8.27E-04 1.0122 3.38E-01 3.02E+02 3.07E+02*	1.0009 9991.1 5.60E-03 1.0385 3.35E-01 1.27E+03 1.28E+03*	1.1943 8372.8 2.33E-02 1.0664 3.30E-01 3.02E+03 3.05E+03	1.4742 6783.5 5.89E-02 1.0965 3.25E-01 3.94E+03 3.96E+03	1.9145 5223.3 8.13E-02 1.1298 3.19E-01 2.38E+03 2.38E+03	2.7084 3692.2 4.06E-02 1.1705 3.09E-01 3.97E+02 3.90E+02	4.5654 2190.4 5.35E-04 1.0506 3.33E-01 1.26E+00 1.59E+00*	13.9282 718.0 6.20E-02 1.2241 2.95E-01 4.06E+00 4.09E+00	-13.7945 -724.9 5.29E-02 1.2857 2.77E-01 -3.14E+00 -3.08E+00
12	.6160 16233.1 7.83E-07 .9490 3.43E-01 7.97E-01 8.16E-01*	.6883 14527.8 2.27E-05 .9709 3.41E-01 1.65E+01 1.68E+01*	.7781 12851.6 2.96E-04 .9943 3.40E-01 1.47E+02 1.50E+02*	.8925 11204.3 2.27E-03 1.0191 3.37E-01 7.34E+02 7.46E+02*	1.0432 9586.0 1.11E-02 1.0455 3.34E-01 2.20E+03 2.22E+03	1.2505 7996.7 3.48E-02 1.0736 3.29E-01 3.91E+03 3.95E+03	1.5536 6436.5 6.76E-02 1.1041 3.24E-01 3.83E+03 3.84E+03	2.0386 4905.4 6.85E-02 1.1383 3.17E-01 1.64E+03 1.63E+03	2.9381 3403.6 1.79E-02 1.1857 3.06E-01 1.34E+02 1.29E+02	5.1783 1931.1 9.27E-03 1.1677 3.10E-01 1.30E+01 1.37E+01*	20.4814 488.2 7.03E-02 1.2347 2.92E-01 1.42E+00 1.42E+00
13	.5740 17422.2 2.38E-07 .9342 3.43E-01 3.00E-01 3.08E-01*	.6363 15716.8 7.42E-06 .9552 3.42E-01 6.85E+00 7.01E+00*	.7122 14040.6 1.06E-04 .9775 3.41E-01 6.88E+01 7.03E+01*	.8069 12393.3 8.95E-04 1.0011 3.39E-01 3.97E+02 4.04E+02*	.9281 10775.0 4.97E-03 1.0261 3.36E-01 1.42E+03 1.45E+03*	1.0886 9185.7 1.86E-02 1.0526 3.33E-01 3.23E+03 3.26E+03	1.3114 7625.5 4.59E-02 1.0810 3.28E-01 4.44E+03 4.47E+03	1.6408 6094.4 6.94E-02 1.1119 3.22E-01 3.30E+03 3.31E+03	2.1774 4592.6 5.01E-02 1.1477 3.15E-01 9.73E+02 9.62E+02	3.2050 3120.2 4.05E-03 1.2182 2.97E-01 2.20E+01 2.04E+01*	5.9621 1677.3 2.38E-02 1.1890 3.05E-01 2.11E+01 2.17E+01
14	.5380 18587.0 7.30E-08 .9193 3.44E-01 1.12E-01 1.15E-01*	.5924 16881.7 2.44E-06 .9401 3.43E-01 2.80E+00 2.87E+00*	.6577 15205.4 3.75E-05 .9616 3.42E-01 3.12E+01 3.20E+01*	.7376 13558.1 3.48E-04 .9842 3.40E-01 2.04E+02 2.08E+02*	.8375 11939.8 2.15E-03 1.0079 3.38E-01 8.49E+02 8.64E+02*	.9661 10350.5 9.23E-03 1.0331 3.35E-01 2.33E+03 2.36E+03*	1.1376 8790.3 2.74E-02 1.0598 3.31E-01 4.15E+03 4.19E+03	1.3776 7259.2 5.43E-02 1.0884 3.27E-01 4.49E+03 4.51E+03	1.7369 5757.4 6.38E-02 1.1200 3.21E-01 2.54E+03 2.53E+03	2.3337 4285.0 3.07E-02 1.1586 3.12E-01 4.77E+02 4.68E+02	3.5186 2842.1 1.37E-05 .3696 2.29E-01 3.34E-02 3.25E-01*
15	.5069 19727.5 2.25E-08 .9037 3.44E-01 4.14E-02 4.26E-02*	.5549 18022.2 8.07E-07 .9251 3.44E-01 1.13E+00 1.16E+00*	.6118 16345.9 1.33E-05 .9463 3.43E-01 1.39E+01 1.42E+01*	.6803 14698.7 1.34E-04 .9681 3.42E-01 1.00E+02 1.03E+02*	.7645 13080.4 9.09E-04 .9909 3.40E-01 4.76E+02 4.85E+02*	.8702 11491.1 4.37E-03 1.0149 3.37E-01 1.53E+03 1.55E+03*	1.0070 9930.9 1.50E-02 1.0402 3.34E-01 3.34E+03 3.38E+03	1.1905 8399.8 3.64E-02 1.0671 3.30E-01 4.77E+03 4.80E+03	1.4497 6898.0 5.83E-02 1.0960 3.25E-01 4.10E+03 4.11E+03	1.8431 5425.5 5.26E-02 1.1285 3.19E-01 1.73E+03 1.72E+03	2.5109 3982.6 1.45E-02 1.1731 3.09E-01 1.77E+02 1.71E+02

Table 4. Radiative transition parameters for $N_2 W^3\Delta_u-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v'v''$	11	12	13	14	15	16	17	18	19	20	21
8	-1.6885 -5922.5 3.12E-01 1.4977 2.05E-01 -5.51E+03 -5.53E+03	-1.3688 -7305.7 1.57E-01 1.5824 1.75E-01 -3.80E+03 -3.80E+03	-1.1549 -8658.8 1.76E-02 1.7250 1.28E-01 -3.80E+02 -3.57E+02	-1.0019 -9981.3 2.13E-04 2.1871 3.11E-02 (-4.17E-01) -4.83E-01*	-8871 -11273.2 1.07E-05 1.3432 2.59E-01 (-2.07E+00) -1.67E+00*	-7978 -12534.0 3.68E-07 2.2075 2.88E-02 (-1.22E-03) -7.90E-03*	-7266 -13763.3 2.74E-08 1.4174 2.33E-01 (-7.89E-03) -5.73E-03*	-6684 -14960.9 1.37E-10 3.4454 2.86E-05 (-7.59E-13) -3.01E-04*	-6201 -16126.2 8.94E-11 1.7769 1.13E-01 (-9.67E-06) -1.60E-06*	-5794 -17259.0 9.58E-14 2.4432 1.09E-02 (-1.18E-10) -7.38E-09*	-5447 -18358.6 5.88E-12 1.2793 2.79E-01 (-5.75E-06) -4.50E-06*
9	-2.1566 -4636.9 2.01E-02 1.5147 1.99E-01 -1.60E+02 -1.56E+02	-1.6611 -6020.1 3.06E-01 1.5102 2.00E-01 -5.44E+03 -5.46E+03	-1.3563 -7373.1 1.86E-01 1.5944 1.71E-01 -6.41E+03 -4.42E+03	-1.1500 -8695.7 2.23E-02 1.7431 1.23E-01 -4.48E+02 -4.17E+02	-1.0012 -9987.6 2.13E-04 2.3165 1.88E-02 (-1.51E-01) -2.42E+00*	-8890 -11248.3 2.28E-05 1.4446 2.24E-01 (-3.30E+00) -2.59E+00*	-8014 -12477.7 4.26E-07 2.4332 1.14E-02 (-2.17E-04) -3.85E-02*	-7312 -13675.3 7.29E-08 1.5347 1.92E-01 (-1.39E-02) -9.27E-03*	-6738 -14840.6 1.16E-12 33.3270 0.00E+00 0.00E+00 -1.07E-03*	-6260 -15973.4 1.84E-10 2.0076 5.81E-02 (-5.13E-06) -2.52E-06*	-5857 -17073.0 1.84E-15 -7.5240 1.40E-45 0.00E+00 -4.28E-07*
10	-2.9626 -3375.4 1.22E-01 1.3590 2.53E-01 -6.12E+02 -6.10E+02	-2.1014 -4758.6 4.35E-03 1.6521 1.51E-01 -2.18E+01 -2.02E+01*	-1.6362 -6111.7 2.93E-01 1.5236 1.96E-01 -5.20E+03 -5.22E+03	-1.3451 -7434.3 2.14E-01 1.6069 1.67E-01 -4.95E+03 -4.96E+03	-1.1460 -8726.1 2.71E-02 1.7627 1.17E-01 -4.99E+02 -4.58E+02	-1.0013 -9986.9 1.78E-04 2.5273 7.40E-03 (-1.96E-02) -7.27E+00*	-8916 -11216.2 4.41E-05 1.5295 1.94E-01 (-4.73E+00) -3.63E+00*	-8056 -12413.8 3.52E-07 2.8784 1.18E-03 (-1.90E-06) -1.28E-01*	-7364 -13579.2 1.68E-07 1.6382 1.56E-01 (-2.08E-02) -1.22E-02*	-6797 -14711.9 6.43E-10 -3.616 3.42E-02 (-4.85E-06) -3.07E-03*	-6324 -15811.6 2.95E-10 2.3409 1.69E-02 (-6.79E-07) -6.51E-05*
11	-4.6771 -2138.1 9.60E-03 1.2505 2.88E-01 -1.58E+01 -1.66E+01*	-2.8398 -3521.3 1.16E-01 1.3700 2.50E-01 -6.37E+02 -6.33E+02	-2.0516 -4874.4 2.83E-06 -8.1663 0.00E+00 0.00E+00 -9.38E+00*	-1.6137 -6196.9 2.76E-01 1.5380 1.91E-01 -4.84E+03 -4.87E+03	-1.3353 -7488.8 2.41E-01 1.6200 1.62E-01 -5.40E+03 -5.41E+03	-1.1429 -8749.6 3.16E-02 1.7841 1.11E-01 (-5.26E+02) -4.75E+02	-1.0021 -9978.9 1.10E-04 2.9491 7.81E-04 (-1.35E-04) -1.70E+01*	-8947 -11176.5 7.76E-05 1.6050 1.67E-01 (-6.15E+00) -4.59E+00*	-8103 -12341.8 1.30E-07 4.3788 8.23E-09 (-3.35E-17) -3.37E-01*	-7421 -13474.6 3.38E-07 1.7389 1.24E-01 (-2.57E-02) -1.18E-02*	-6861 -14574.2 5.96E-09 7487 3.33E-01 (-4.14E-03) -7.40E-03*
12	-10.8118 -924.9 2.92E-02 1.3030 2.72E-01 -3.46E+00 -3.36E+00	-4.3325 -2308.1 2.54E-02 1.2844 2.78E-01 -4.87E+01 -5.01E+01	-2.7314 -3661.2 1.01E-01 1.3814 2.46E-01 -6.04E+02 -5.98E+02	-2.0065 -4983.8 3.62E-01 1.1526 3.14E-01 -8.92E+01 -9.84E+01*	-1.5935 -6275.6 2.57E-01 1.5537 1.85E-01 -4.42E+03 -4.46E+03	-1.3269 -7536.4 2.66E-01 1.6336 1.58E-01 -5.74E+03 -5.76E+03	-1.1408 -8765.7 3.55E-02 1.8077 1.04E-01 (-5.25E+02) -4.62E+02	-1.0037 -9963.3 3.36E-05 4.3055 1.71E-08 (-1.97E-14) -3.38E+01*	-8986 -11128.7 1.25E-04 1.6762 1.44E-01 (-7.22E+00) -5.13E+00*	-8156 -12261.4 1.68E-08 -8.0302 0.00E+00 0.00E+00 -7.57E-01*	-7484 -13361.1 5.89E-07 1.8477 9.35E-02 (-2.49E-02) -5.91E-03*
13	37.8656 264.1 6.80E-02 1.2452 2.89E-01 2.13E-01 2.12E-01	-8.9355 -1119.1 1.16E-02 1.3317 2.63E-01 -2.26E+00 -2.15E+00	-4.0450 -2472.2 4.24E-02 1.3023 2.72E-01 -9.60E+01 -9.75E+01	-2.6352 -3794.8 8.14E-02 1.3936 2.42E-01 -5.26E+02 -5.19E+02	-1.9659 -5086.6 1.19E-02 1.2779 2.80E-01 -2.48E+02 -2.54E+02	-1.5755 -6347.4 2.39E-01 1.5708 1.79E-01 -3.97E+03 -4.02E+03	-1.3198 -7576.7 2.90E-01 1.6479 1.53E-01 -5.97E+03 -6.01E+03	-1.1397 -8774.3 3.83E-02 1.8343 9.70E-02 (-4.93E+02) -4.19E+02	-1.0061 -9939.7 1.01E-06 15.1450 0.00E+00 0.00E+00 -6.01E+01*	-9031 -11072.4 1.86E-04 1.7477 1.21E-01 (-7.53E+00) -4.86E+00*	-8216 -12172.1 9.38E-07 0993 1.36E-01 (-6.32E-02) -1.49E+00*
14	6.9984 1428.9 3.82E-02 1.2022 3.01E-01 2.05E+01 2.08E+01	218.9094 45.7 5.76E-02 1.2562 2.86E-01 9.11E-04 9.02E-04	-7.6490 -1307.4 2.01E-03 1.4175 2.33E-01 (-4.94E-01) -4.33E-01*	-3.8024 -2629.9 5.66E-02 1.3154 2.68E-01 -1.50E+02 -1.51E+02	-2.5499 -3921.8 6.15E-02 1.4070 2.37E-01 -4.22E+02 -4.14E+02	-1.9295 -5182.6 2.20E-02 1.3215 2.66E-01 -4.38E+02 -4.40E+02	-1.5596 -6411.9 2.22E-01 1.5893 1.73E-01 -3.54E+03 -3.61E+03	-1.3141 -7609.5 3.12E-01 1.6629 1.48E-01 -6.09E+03 -6.14E+03	-1.1396 -8774.8 3.97E-02 1.8648 8.92E-02 (-4.32E+02) -3.48E+02	-1.0093 -9907.6 1.03E-04 -1.021 8.02E-02 (-1.30E+00) -9.73E+01*	-9085 -11007.2 2.52E-04 1.8247 9.96E-02 (-6.74E+00) -3.56E+00*
15	3.8919 2569.5 4.10E-03 1.1402 3.16E-01 1.41E+01 1.52E+01*	8.4300 1186.2 4.83E-02 1.2132 2.98E-01 1.46E+01 1.47E+01	-59.9535 -166.8 4.29E-02 1.2684 2.83E-01 -3.22E-02 -3.16E-02	-6.7142 -1489.4 1.86E-04 8542 3.43E-01 (-1.47E-01) -2.74E-01*	-3.5955 -2781.2 6.61E-02 1.3265 2.64E-01 -2.01E+02 -2.02E+02	-2.4740 -4042.0 4.33E-02 1.4223 2.32E-01 -3.11E+02 -3.03E+02	-1.8970 -5271.4 3.18E-02 1.3429 2.59E-01 -6.33E+02 -6.30E+02	-1.5459 -6468.9 2.09E-01 1.6095 1.66E-01 -3.15E+03 -3.23E+03	-1.3099 -7634.3 3.32E-01 1.6787 1.43E-01 -6.10E+03 -6.18E+03	-1.1406 -8767.0 3.92E-02 1.9008 8.05E-02 (-3.47E+02) -2.57E+02	-1.0135 -9866.7 4.75E-04 8300 3.42E-01 (-1.08E+02) -1.46E+02*

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$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.4798 20843.8 6.87E-09 .8856 3.44E-01 1.49E-02 1.54E-02*	.5225 19138.5 2.66E-07 .9094 3.44E-01 4.48E-01 4.60E-01*	.5727 17462.2 4.72E-06 .9311 3.44E-01 6.01E+00 6.16E+00*	.6323 15814.9 5.10E-05 .9526 3.43E-01 4.80E+01 4.91E+01*	.7044 14196.6 3.77E-04 .9747 3.41E-01 2.54E+02 2.60E+02*	.7932 12607.3 2.00E-03 .9977 3.39E-01 9.34E+02 9.51E+02*	.9052 11047.1 7.76E-03 1.0219 3.37E-01 2.40E+03 2.44E+03*	1.0509 9516.0 2.20E-02 1.0473 3.33E-01 4.26E+03 4.31E+03	1.2478 8014.2 4.39E-02 1.0744 3.29E-01 4.96E+03 4.99E+03	1.5286 6541.8 5.70E-02 1.1039 3.24E-01 3.39E+03 3.39E+03	1.9612 5098.9 3.84E-02 1.1379 3.17E-01 1.03E+03 1.02E+03
17	.4559 21935.6 2.03E-09 .8628 3.43E-01 5.13E-03 5.35E-03*	.4943 20230.3 8.68E-08 .8917 3.44E-01 1.72E-01 1.78E-01*	.5390 18554.0 1.66E-06 .9153 3.44E-01 2.54E+00 2.61E+00*	.5915 16906.7 1.93E-05 .9373 3.43E-01 2.23E+01 2.29E+01*	.6541 15288.4 1.54E-04 .9591 3.42E-01 1.31E+02 1.34E+02*	.7300 13699.2 8.92E-04 .9815 3.41E-01 5.39E+02 5.50E+02*	.8238 12138.9 3.84E-03 1.0047 3.39E-01 1.59E+03 1.62E+03*	.9427 10607.9 1.24E-02 1.0290 3.36E-01 3.37E+03 3.41E+03	1.0982 9106.0 2.92E-02 1.0546 3.32E-01 4.94E+03 4.98E+03	1.3100 7633.6 4.87E-02 1.0819 3.28E-01 4.72E+03 4.73E+03	1.6153 6190.7 5.10E-02 1.1120 3.22E-01 2.54E+03 2.53E+03
18	.4347 23002.9 5.63E-10 .8298 3.42E-01 1.62E-03 1.72E-03*	.4695 21297.6 2.74E-08 .8698 3.44E-01 6.33E-02 6.59E-02*	.5096 19621.3 5.76E-07 .8978 3.44E-01 1.04E+00 1.08E+00*	.5564 17974.1 7.24E-06 .9214 3.44E-01 1.01E+01 1.03E+01*	.6114 16355.8 6.23E-05 .9436 3.43E-01 6.49E+01 6.65E+01*	.6772 14766.5 3.90E-04 .9657 3.42E-01 2.97E+02 3.04E+02*	.7572 13206.3 1.84E-03 .9883 3.40E-01 9.92E+02 1.01E+03*	.8565 11675.2 6.59E-03 1.0117 3.38E-01 2.42E+03 2.46E+03*	.9830 10173.4 1.79E-02 1.0361 3.35E-01 4.28E+03 4.33E+03	1.1493 8700.9 3.58E-02 1.0619 3.31E-01 5.24E+03 5.28E+03	1.3778 7258.0 4.98E-02 1.0896 3.27E-01 4.11E+03 4.12E+03
19	.4159 24045.6 1.36E-10 .7738 3.36E-01 (4.31E-04) 4.81E-04*	.4476 22340.3 8.13E-09 .8392 3.42E-01 2.15E-02 2.27E-02*	.4839 20664.0 1.93E-07 .8765 3.44E-01 4.08E-01 4.24E-01*	.5259 19016.8 2.66E-06 .9040 3.44E-01 4.39E+00 4.53E+00*	.5748 17398.5 2.48E-05 .9277 3.44E-01 3.12E+01 3.20E+01*	.6325 15809.2 1.67E-04 .9502 3.43E-01 1.58E+02 1.61E+02*	.7018 14249.0 8.57E-04 .9725 3.41E-01 5.86E+02 5.98E+02*	.7863 12717.9 3.38E-03 .9952 3.40E-01 1.62E+03 1.65E+03*	.8916 11216.1 1.03E-02 1.0187 3.37E-01 3.34E+03 3.39E+03	1.0263 9743.6 2.38E-02 1.0433 3.34E-01 4.98E+03 5.03E+03	1.2047 8300.7 4.07E-02 1.0693 3.30E-01 5.13E+03 5.16E+03
20	.3990 25063.6 2.36E-11 .6471 3.14E-01 (7.41E-05) 9.84E-05*	.4281 23358.2 2.13E-09 .7892 3.38E-01 6.27E-03 6.90E-03*	.4612 21682.0 6.11E-08 .8477 3.43E-01 1.48E-01 1.56E-01*	.4991 20034.7 9.47E-07 .8834 3.44E-01 1.83E+00 1.89E+00*	.5430 18416.4 9.64E-06 .9105 3.44E-01 1.44E+01 1.49E+01*	.5943 16827.1 7.06E-05 .9343 3.43E-01 8.04E+01 8.25E+01*	.6550 15266.9 3.91E-04 .9569 3.42E-01 3.30E+02 3.38E+02*	.7280 13735.8 1.68E-03 .9793 3.41E-01 1.02E+03 1.04E+03*	.8174 12234.0 5.64E-03 1.0022 3.39E-01 2.40E+03 2.44E+03*	.9292 10761.6 1.48E-02 1.0259 3.36E-01 4.21E+03 4.27E+03	1.0731 9318.7 2.95E-02 1.0506 3.33E-01 5.36E+03 5.40E+03
21	.3838 26056.6 1.27E-12 .0136 1.10E-01 (5.54E-07) 7.13E-06*	.4107 24351.3 4.23E-10 .6835 3.21E-01 (1.28E-03) 1.60E-03*	.4410 22675.0 1.73E-08 .8025 3.39E-01 4.69E-02 5.11E-02*	.4756 21027.7 3.19E-07 .8563 3.43E-01 7.07E-01 7.43E-01*	.5152 19409.4 3.63E-06 .8905 3.44E-01 6.37E+00 6.60E+00*	.5612 17820.1 2.91E-05 .9173 3.44E-01 3.94E+01 4.06E+01*	.6150 16259.9 1.74E-04 .9410 3.43E-01 1.79E+02 1.83E+02*	.6789 14728.8 8.12E-04 .9637 3.42E-01 6.15E+02 6.28E+02*	.7560 13227.0 2.98E-03 .9863 3.40E-01 1.62E+03 1.65E+03*	.8507 11754.6 8.66E-03 1.0094 3.38E-01 3.26E+03 3.30E+03*	.9698 10311.7 1.97E-02 1.0332 3.35E-01 4.92E+03 4.97E+03

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 4. Radiative transition parameters for $N_2 W^3\Delta_u-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	2.7132 3685.7 4.06E-03 1.2003 3.02E-01 3.76E+01 3.49E+01*	4.3431 2302.5 1.31E-02 1.1690 3.10E+01 3.10E+01 3.22E+01	10.5325 949.4 5.23E-02 1.2235 2.96E-01 7.92E+00 7.93E+00	-26.7994 -373.1 2.77E-02 1.2831 2.78E-01 -2.25E-01 -2.19E-01	-6.0061 -1665.0 4.27E-03 1.2084 3.00E-01 -3.58E+00 -3.90E+00*	-3.4179 -2925.8 7.02E-02 1.3367 2.61E-01 -2.43E+02 -2.42E+02	-2.4067 -4155.1 2.83E-02 1.4407 2.25E-01 -2.08E+02 -2.01E+02	-1.8682 -5352.7 4.00E-02 1.3539 2.55E-01 -8.09E+02 -7.99E+02	-1.5342 -6518.0 2.00E-01 1.6311 1.58E-01 -2.81E+03 -2.91E+03	-1.3071 -7650.8 3.51E-01 1.6953 1.37E-01 -6.01E+03 -6.11E+03	-1.1428 -8750.4 3.67E-02 1.9452 7.06E-02 (-2.48E+02) -1.56E+02
17	2.0931 4777.5 2.40E-02 1.1485 3.15E-01 5.24E+02 5.12E+02	2.9461 3394.3 7.61E-05 1.4673 2.16E-01 2.81E-01 1.41E-01*	4.8989 2041.3 2.35E-02 1.1842 3.06E-01 3.78E+01 3.87E+01	13.9141 718.7 5.02E-02 1.2338 2.93E-01 3.23E+00 3.22E+00	-17.4475 -573.1 1.48E-02 1.3033 2.72E-01 -4.17E-01 -4.00E-01	-5.4528 -1833.9 1.18E-02 1.2529 2.87E-01 -1.22E+01 -1.27E+01	-3.2645 -3063.3 6.95E-02 1.3464 2.58E-01 -2.69E+02 -2.68E+02	-2.3470 -4260.8 1.68E-02 1.4642 2.17E-01 -1.24E+02 -1.18E+02	-1.8429 -5426.2 4.57E-02 1.3577 2.54E-01 -9.53E+02 -9.35E+02	-1.5246 -6559.0 1.95E-01 1.6540 1.51E-01 -2.54E+03 -2.65E+03	-1.3057 -7658.6 3.67E-01 1.7130 1.32E-01 -5.82E+03 -5.93E+03
18	1.7109 5844.9 4.14E-02 1.1205 3.21E-01 1.72E+03 1.70E+03	2.2413 4461.6 1.20E-02 1.1621 3.11E-01 2.09E+02 2.01E+02	3.2169 3108.6 1.73E-03 1.1120 3.22E-01 1.09E+01 1.22E+01*	5.5990 1786.0 3.23E-02 1.1959 3.03E-01 3.42E+01 3.47E+01	20.2357 494.2 4.34E-02 1.2445 2.90E-01 8.90E-01 8.82E-01	-13.0447 -766.6 5.78E-03 1.3384 2.60E-01 -3.58E-01 -3.34E-01*	-5.0101 -1996.0 2.06E-02 1.2740 2.81E-01 -2.62E+01 -2.69E+01	-3.1313 -3193.5 6.52E-02 1.3559 2.54E-01 -2.79E+02 -2.76E+02	-2.2942 -4358.9 8.84E-03 1.4964 2.05E-01 -6.26E+01 -5.83E+01*	-1.8210 -5491.6 4.84E-02 1.3543 2.55E-01 -1.06E+03 -1.03E+03	-1.5172 -6591.3 1.97E-01 1.6780 1.43E-01 -2.34E+03 -2.47E+03
19	1.4519 6887.6 4.71E-02 1.0974 3.25E-01 3.30E+03 3.29E+03	1.8167 5504.3 3.01E-02 1.1296 3.19E-01 1.03E+03 1.02E+03	2.4089 4151.3 3.89E-03 1.1851 3.06E-01 5.27E+01 4.90E+01*	3.5352 2828.7 7.22E-03 1.1523 3.14E-01 3.26E+01 3.43E+01*	6.5067 1536.9 3.79E-02 1.2063 3.00E-01 2.51E+01 2.53E+01	36.2190 276.1 3.41E-02 1.2561 2.86E-01 1.19E-01 1.17E-01	-10.4903 -953.3 1.03E-03 1.4453 2.24E-01 (-9.05E-02) -7.62E-02*	-4.6494 -2150.8 2.89E-02 1.2833 2.76E-01 -4.44E+01 -4.52E+01	-3.0155 -3316.2 5.85E-02 1.3656 2.51E-01 -2.73E+02 -2.70E+02	-2.2477 -4448.9 3.81E-03 1.5459 1.88E-01 (-2.40E+01) -2.12E+01*	-1.8023 -5548.6 4.77E-02 1.3404 2.60E-01 -1.11E+03 -1.07E+03
20	1.2649 7905.5 4.30E-02 1.0769 3.29E-01 4.65E+03 4.66E+03	1.5332 6522.3 4.12E-02 1.1055 3.24E-01 2.42E+03 2.41E+03	1.9345 5169.2 1.91E-02 1.1399 3.16E-01 5.34E+02 5.21E+02	2.5997 3846.6 2.74E-04 1.2905 2.76E-01 (2.40E+00) 1.78E+00*	3.9142 2554.8 1.44E-02 1.1697 3.10E-01 4.66E+01 4.81E+01	7.7278 1294.0 3.95E-02 1.2164 2.98E-01 1.54E+01 1.54E+01	154.6312 64.7 2.41E-02 1.2694 2.82E-01 1.05E-03 1.03E-03	-8.8270 -1132.9 6.86E-05 .6154 3.06E-01 (-1.89E-02) -6.59E-02*	-4.3511 -2298.3 3.53E-02 1.2993 2.73E-01 -6.48E+01 -6.55E+01	-2.9146 -3431.0 5.08E-02 1.3761 2.48E-01 -2.55E+02 -2.51E+02	-2.2072 -4530.7 1.07E-03 1.6392 1.56E-01 (-4.88E+00) -3.46E+00*
21	1.1238 8898.5 3.41E-02 1.0580 3.32E-01 5.36E+03 5.39E+03	1.3306 7515.3 4.24E-02 1.0845 3.27E-01 3.91E+03 3.91E+03	1.6228 6162.2 3.30E-02 1.1139 3.22E-01 1.62E+03 1.60E+03	2.0663 4839.6 9.88E-03 1.1526 3.14E-01 2.23E+02 2.14E+02*	2.8186 3547.8 6.70E-04 1.0807 3.28E-01 (6.53E+00) 7.79E+00*	4.3725 2287.0 2.13E-02 1.1821 3.07E-01 4.86E+01 4.96E+01	9.4547 1057.7 3.76E-02 1.2264 2.95E-01 7.82E+00 7.80E+00	-71.4868 -139.9 1.51E-02 1.2860 2.77E-01 -6.43E-03 -6.22E-03	-7.6613 -1305.3 1.94E-03 1.1643 3.11E-01 (-8.46E-01) -9.54E-01*	-4.1017 -2438.0 3.95E-02 1.3081 2.70E-01 -8.48E+01 -8.53E+01	-2.8267 -3537.7 4.32E-02 1.3889 2.43E-01 -2.29E+02 -2.25E+02

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 5. Radiative transition parameters for N_2 $B' \ ^3\Sigma_u^- - B \ ^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.5280 6544.5 4.81E-01 1.2498 1.75E-01 1.68E+04 1.67E+04	2.0664 4839.2 3.84E-01 1.2983 1.67E-01 4.89E+03 4.90E+03	3.1616 3163.0 1.17E-01 1.3542 1.56E-01 3.65E+02 3.66E+02	6.5977 1515.7 1.71E-02 1.4215 1.42E-01 4.87E+00 4.92E+00	-97.4459 -102.6 1.22E-03 1.5083 1.24E-01 -4.10E-05 -4.13E-05*	-5.9105 -1691.9 3.72E-05 1.6375 9.72E-02 -3.44E-03 -3.36E-03*	-3.0749 -3252.1 2.83E-07 1.9315 4.69E-02 (-4.35E-05)(-2.40E-06) -1.96E-05*	-2.0907 -4783.2 4.27E-10 .4620 1.59E-01 (-2.40E-06)(-1.80E-07) -1.08E-05*	-1.5911 -6285.0 6.55E-11 1.7599 7.39E-02 (-1.80E-07)(-1.20E-16) -1.01E-07*	-1.2891 -9200.3 2.11E-14 -1.4747 7.75E-05 (-1.20E-16)(-4.10E-10) -1.24E-08*	-1.0869 -9200.3 3.16E-14 1.6706 9.06E-02 (-4.10E-10) -2.16E-10*
1	1.2442 8037.2 3.20E-01 1.2074 1.82E-01 2.24E+04 2.24E+04	1.5793 6331.9 3.57E-02 1.2732 1.71E-01 1.08E+03 1.05E+03	2.1479 4655.6 3.55E-01 1.3083 1.65E-01 3.94E+03 3.93E+03	3.3241 3008.3 2.32E-01 1.3630 1.54E-01 6.08E+02 6.11E+02	7.1941 1390.0 5.24E-02 1.4303 1.40E-01 1.12E+01 1.13E+01	-50.1875 -199.3 5.00E-03 1.5182 1.22E-01 -1.19E-03 -1.20E-03*	-5.6835 -1759.5 1.85E-04 1.6516 9.44E-02 -1.82E-02 -1.76E-02*	-3.0390 -3290.5 1.46E-06 1.9797 4.07E-02 (-1.75E-04)(-5.77E-05) -4.87E-05*	-2.0867 -4792.4 6.03E-09 .8399 2.07E-01 (-5.77E-05)(-1.05E-06) -8.85E-05*	-1.5962 -6264.8 5.38E-10 1.8265 6.26E-02 (-1.05E-06)(-1.99E-08) -4.47E-07*	-1.2974 -9207.7 1.18E-12 .3426 1.35E-01 (-1.99E-08) -1.53E-07*
2	1.0520 9505.8 1.34E-01 1.1706 1.88E-01 1.64E+04 1.65E+04	1.2820 7800.5 2.21E-01 1.2170 1.81E-01 1.39E+04 1.38E+04	1.6329 6124.3 1.66E-02 1.2285 1.79E-01 4.94E+02 5.12E+02	2.2337 4477.0 2.14E-01 1.3205 1.62E-01 2.05E+03 2.04E+03	3.4981 2858.7 3.01E-01 1.3724 1.52E-01 6.61E+02 6.63E+02	7.8778 1269.4 1.00E-01 1.4394 1.38E-01 1.59E+01 1.60E+01	-34.3849 -290.8 1.23E-02 1.5284 1.20E-01 -8.79E-03 -8.83E-03	-5.4888 -1821.9 5.34E-04 1.6666 9.14E-02 -5.47E-02 -5.28E-02*	-3.0087 -3323.7 4.16E-06 2.0398 3.38E-02 (-3.52E-04) -2.50E-05*	-2.0850 -4796.2 4.05E-08 1.0630 2.01E-01 -3.64E-04 -3.96E-04*	-1.6028 -6239.0 2.35E-09 1.9018 5.11E-02 (-3.01E-06) -6.82E-07*
3	.9132 10950.7 4.57E-02 1.1379 1.92E-01 8.99E+03 9.06E+03	1.0816 9245.4 1.93E-01 1.1784 1.87E-01 2.15E+04 2.15E+04	1.3212 7569.1 8.12E-02 1.2302 1.79E-01 4.55E+03 4.49E+03	1.6887 5921.8 9.44E-02 1.2555 1.74E-01 2.41E+03 2.44E+03	2.3237 4303.5 8.94E-02 1.3379 1.59E-01 7.30E+02 7.19E+02	3.6843 2714.2 3.19E-01 1.3823 1.50E-01 5.84E+02 5.84E+02	8.6653 1154.0 1.53E-01 1.4488 1.37E-01 1.78E+01 1.79E+01	-26.5222 -377.0 2.35E-02 1.5388 1.18E-01 -3.53E-02 -3.54E-02	-5.3224 -1878.9 1.17E-03 1.6825 8.83E-02 -1.22E-01 -1.17E-01*	-2.9839 -3351.3 8.42E-06 2.1182 2.61E-02 (-4.36E-04) -3.33E-05*	-2.0859 -4794.2 1.82E-07 1.2145 1.81E-01 -1.33E-03 -1.27E-03*
4	.8083 12372.0 1.40E-02 1.1085 1.96E-01 4.13E+03 4.17E+03	.9375 10666.7 1.01E-01 1.1451 1.91E-01 1.82E+04 1.83E+04	1.1123 8990.4 1.67E-01 1.1870 1.85E-01 1.69E+04 1.69E+04	1.3618 7343.1 9.15E-03 1.2656 1.73E-01 4.37E+02 4.15E+02*	1.7468 5724.8 1.48E-01 1.2675 1.72E-01 3.34E+03 3.35E+03	2.4181 4135.5 1.91E-02 1.3767 1.51E-01 1.25E+02 1.21E+02	3.8831 2575.3 2.96E-01 1.3931 1.48E-01 4.50E+02 4.49E+02	9.5765 1044.2 2.04E-01 1.4584 1.34E-01 1.70E+01 1.71E+01	-21.8531 -457.6 3.85E-02 1.5496 1.15E-01 -9.94E-02 -9.97E-02	-5.1812 -1930.0 2.14E-03 1.6995 8.50E-02 -2.25E-01 -2.14E-01*	-2.9648 -3372.9 1.33E-05 2.2268 1.77E-02 (-3.23E-04) -9.01E-04*
5	.7262 13769.8 4.06E-03 1.0817 1.99E-01 1.70E+03 1.72E+03*	.8289 12064.5 4.22E-02 1.1154 1.95E-01 1.14E+04 1.15E+04	.9626 10388.2 1.34E-01 1.1526 1.90E-01 2.20E+04 2.21E+04	1.1440 8740.9 1.04E-01 1.1969 1.84E-01 9.52E+03 9.43E+03	1.4040 7122.6 4.21E-03 1.1699 1.88E-01 2.18E+02 2.36E+02*	1.8072 5533.4 1.53E-01 1.2782 1.70E-01 3.05E+03 3.05E+03	2.5169 3973.1 1.62E-05 -.6362 7.65E-03 2.41E-04 1.76E+00*	4.0949 2442.1 2.50E-01 1.4051 1.46E-01 3.12E+02 3.11E+02	10.6355 940.2 2.48E-01 1.4685 1.32E-01 1.47E+01 1.47E+01	-18.7903 -532.2 5.68E-02 1.4685 1.13E-01 -2.21E-01 -2.22E-01	-5.0631 -1975.1 3.45E-03 1.7179 8.16E-02 -3.59E-01 -3.37E-01*
6	.6603 15144.4 1.14E-03 1.0571 2.01E-01 6.48E+02 6.58E+02*	.7441 13439.1 1.55E-02 1.0884 1.98E-01 5.97E+03 6.03E+03	.8501 11762.8 7.40E-02 1.1224 1.94E-01 1.84E+04 1.85E+04	.9886 10115.5 1.33E-01 1.1604 1.89E-01 2.00E+04 1.99E+04	1.1769 8497.2 4.41E-02 1.2105 1.82E-01 3.62E+03 3.55E+03	1.4476 6908.0 3.43E-02 1.2180 1.81E-01 1.49E+03 1.53E+03	1.8699 5347.7 1.24E-01 1.2894 1.68E-01 2.18E+03 2.16E+03	2.6201 3816.7 1.46E-02 1.2703 1.72E-01 9.72E+01 1.02E+02	4.3199 2314.9 1.93E-01 1.4189 1.43E-01 1.98E+02 1.97E+02	11.8707 842.4 2.84E-01 1.4789 1.30E-01 1.16E+01 1.17E+01	-16.6533 -600.5 7.75E-02 1.5723 1.11E-01 -4.15E-01 -4.16E-01
7	.6062 16495.9 3.16E-04 1.0344 2.03E-01 2.36E+02 2.40E+02*	.6761 14790.6 5.26E-03 1.0637 2.00E-01 2.77E+03 2.81E+03*	.7625 13114.3 3.37E-02 1.0952 1.97E-01 1.20E+04 1.21E+04	.8721 11467.0 9.72E-02 1.1296 1.93E-01 2.22E+04 2.23E+04	1.0154 9848.7 1.06E-01 1.1690 1.88E-01 1.45E+04 1.44E+04	1.2107 8259.5 8.54E-03 1.2407 1.77E-01 6.10E+02 5.78E+02*	1.4927 6699.2 6.95E-02 1.2329 1.78E-01 2.69E+03 2.72E+03	1.9349 5168.2 8.15E-02 1.3025 1.66E-01 1.25E+03 1.24E+03	2.7275 3666.4 4.45E-02 1.3065 1.65E-01 2.42E+02 2.47E+02	4.5581 2193.9 1.38E-01 1.4355 1.39E-01 1.15E+02 1.13E+02	13.3152 751.0 3.09E-01 1.4899 1.28E-01 8.67E+00 8.70E+00

Table 5. Radiative transition parameters for N_2 $B' \ ^3\Sigma_u^- - B \ ^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	- .9422 -10613.5 1.57E-16 .6392 1.89E-01 (-1.36E-11) -3.22E-11*	-.8336 -11996.7 4.06E-16 1.3247 1.62E-01 -3.71E-11 -3.45E-11*	-.7491 -13349.8 4.26E-16 1.1838 1.86E-01 -7.09E-11 -7.23E-11*	-.6816 -14672.4 1.35E-16 1.2125 1.65E-01 -2.85E-11 -2.93E-11*	-.6264 -15964.2 1.85E-18 .4912 1.65E-01 (-4.13E-13) -1.28E-12*	-.5806 -17225.0 1.80E-16 1.1217 1.94E-01 -7.02E-11 -7.16E-11*	-.5419 -18454.3 3.85E-16 1.1830 1.86E-01 -1.70E-10 -1.70E-10*	-.5089 -19651.9 2.81E-16 1.2364 1.78E-01 -1.36E-10 -1.36E-10*	-.4804 -20817.3 2.93E-17 1.4039 1.46E-01 -1.14E-11 -1.20E-11*	-.4556 -21950.0 8.80E-17 1.1080 1.96E-01 -7.23E-11 -7.43E-11*	-.4338 -23049.7 4.23E-16 1.1938 1.84E-01 -3.57E-10 -3.57E-10*
1	-1.0964 -9120.9 2.59E-13 1.8395 6.05E-02 (-1.46E-09) -2.67E-10*	-.9520 -10504.1 5.62E-16 .122 1.85E-01 -4.53E-11 -9.68E-11*	-.8434 -11857.1 3.86E-15 1.4212 1.42E-01 -2.64E-10 -2.47E-10*	-.7587 -13179.7 9.24E-16 1.3088 1.65E-01 -1.16E-10 -1.21E-10*	-.6910 -14471.6 2.83E-16 1.1227 1.94E-01 -6.55E-11 -6.27E-11*	-.6356 -15732.3 2.34E-15 1.1911 1.85E-01 -6.30E-10 -6.24E-10*	-.5896 -16961.7 2.48E-15 1.2091 1.82E-01 -8.13E-10 -8.10E-10*	-.5507 -18159.2 6.07E-16 1.2376 1.77E-01 -2.32E-10 -2.31E-10*	-.5175 -19324.6 1.18E-16 1.1261 1.94E-01 -6.48E-11 -6.56E-11*	-.4888 -20457.4 1.47E-15 1.1916 1.85E-01 -8.69E-10 -8.66E-10*	-.4639 -21557.0 2.17E-15 1.2025 1.83E-01 -1.48E-09 -1.47E-09*
2	-1.3068 -7652.2 1.67E-11 .8689 2.08E-01 (-6.55E-07) -9.80E-07*	-1.1068 -9035.4 1.15E-12 2.0223 3.57E-02 (-2.20E-09) -5.42E-10*	-.9626 -10388.5 2.25E-14 1.1617 1.89E-01 (-1.83E-09) -1.44E-09*	-.8539 -11711.1 4.26E-16 3.0134 4.01E-04 (-2.22E-16) -5.28E-11*	-.7691 -13002.9 1.58E-15 1.0104 2.05E-01 -2.94E-10 -3.23E-10*	-.7011 -14263.7 5.14E-15 1.1914 1.85E-01 -1.03E-09 -9.95E-10*	-.6455 -15493.0 3.06E-15 1.2019 1.83E-01 -7.74E-10 -7.58E-10*	-.5991 -16690.6 1.59E-16 1.2372 1.77E-01 -4.71E-11 -4.62E-11*	-.5600 -17856.0 9.56E-16 1.1735 1.87E-01 -3.87E-10 -3.87E-10*	-.5266 -18988.7 3.19E-15 1.1830 1.86E-01 -1.53E-09 -1.52E-09*	-.4978 -20088.4 3.27E-15 1.1822 1.86E-01 -1.86E-09 -1.84E-09*
3	-1.6110 -6207.4 7.05E-09 1.9936 3.90E-02 (-5.20E-06) -6.04E-08*	-1.3174 -7590.6 1.22E-10 1.1292 1.93E-01 -4.02E-06 -4.09E-06*	-1.1181 -8943.6 4.20E-12 2.1613 2.24E-02 (-3.07E-09) -1.51E-08*	-.9741 -10266.2 3.78E-13 1.3305 1.61E-01 (-2.13E-08) -1.60E-08*	-.8652 -11558.1 6.92E-15 .2516 1.16E-01 (-2.89E-10) -3.16E-09*	-.7801 -12818.8 2.14E-15 .7327 2.00E-01 (-3.66E-10) -6.70E-10*	-.7118 -14048.2 5.72E-16 1.0612 2.01E-01 (-1.29E-10) -1.15E-10*	-.6559 -15245.7 1.63E-16 1.1581 1.90E-01 (-4.21E-11) -5.05E-11*	-.6093 -16411.1 1.74E-15 1.1346 1.93E-01 -5.79E-10 -5.90E-10*	-.5700 -17543.9 3.08E-15 1.1285 1.93E-01 -1.26E-09 -1.26E-09*	-.5364 -18643.5 2.89E-15 1.1211 1.94E-01 -1.43E-09 -1.41E-09*
4	-2.0894 -4786.1 6.23E-07 1.3276 1.61E-01 (-3.59E-03) -3.22E-03*	-1.6209 -6169.3 1.58E-08 2.1171 2.62E-02 (-5.16E-06) -3.93E-06*	-1.3294 -7522.4 6.01E-10 1.3002 1.66E-01 (-1.43E-05) -1.26E-05*	-1.1306 -8845.0 9.90E-12 2.4054 8.72E-03 (-1.05E-09) -1.57E-07*	-.9865 -10136.8 1.91E-12 1.4546 1.35E-01 (-7.39E-08) -4.96E-08*	-.8774 -11397.6 1.48E-14 .0149 6.95E-02 (-2.15E-10) -8.08E-09*	-.7920 -12626.9 2.31E-15 2.2855 1.42E-02 (-1.89E-12) -1.23E-11*	-.7234 -13824.5 2.68E-15 1.2908 1.68E-01 (-4.05E-10) -4.48E-10*	-.6671 -14989.9 2.74E-15 1.0640 2.00E-01 (-7.52E-10) -8.37E-10*	-.6202 -16122.6 3.15E-15 1.0125 2.04E-01 -1.12E-09 -1.19E-09*	-.5806 -17222.3 3.78E-15 1.0123 2.04E-01 -1.64E-09 -1.68E-09*
5	-2.9514 -3388.3 1.66E-05 2.3913 9.25E-03 (-1.12E-04) -5.22E-03*	-2.0958 -4771.5 1.76E-06 1.4181 1.43E-01 (-7.90E-03) -6.87E-03*	-1.6328 -6124.5 2.72E-08 2.3000 1.34E-02 (-2.27E-06) -4.99E-05*	-1.3428 -7447.1 2.34E-09 1.4300 1.40E-01 (-3.85E-05) -3.13E-05*	-1.1443 -8738.9 1.18E-11 3.0719 2.82E-04 (-1.26E-12) -1.10E-06*	-1.0000 -9999.7 6.72E-12 1.5917 1.07E-01 (-1.54E-07) -8.43E-08*	-.8905 -11229.1 6.74E-14 .4101 1.49E-01 (-4.28E-09) -2.20E-08*	-.8047 -12426.6 1.74E-14 1.9827 4.03E-02 (-1.10E-10) -1.17E-11*	-.7357 -13592.0 1.32E-14 1.2386 1.77E-01 (-2.12E-09) -2.05E-09*	-.6791 -14724.7 1.05E-14 .9779 2.06E-01 (-2.90E-09) -3.31E-09*	-.6319 -15824.4 1.45E-14 1.0253 2.07E-01 -4.98E-09 -5.42E-09*
6	-4.9661 -2013.6 5.06E-03 1.7378 7.79E-02 -5.08E-01 -4.70E-01*	-2.9439 -3396.9 1.58E-05 2.6785 2.48E-03 (-7.73E-06) -1.86E-02*	-2.1053 -4749.9 4.25E-06 1.4952 1.27E-01 (-1.48E-02) -1.26E-02*	-1.6468 -6072.5 3.39E-08 2.6195 3.32E-03 (-1.69E-07) -2.71E-04*	-1.3579 -7364.3 7.43E-09 1.5382 1.18E-01 (-8.33E-05) -6.28E-05*	-1.1594 -8625.1 2.11E-12 7.7851 3.13E-30 (0.00E+00) -5.15E-06*	-1.0148 -9854.5 2.01E-11 1.7316 7.90E-02 (-2.43E-07) -8.40E-08*	-.9048 -11052.0 4.57E-13 .9264 2.08E-01 (-5.40E-08) -6.39E-08*	-.8185 -12217.4 5.99E-14 1.9274 4.75E-02 (-4.99E-10) -6.67E-11*	-.7491 -13350.1 8.88E-14 1.2141 1.81E-01 (-1.41E-08) -1.25E-08*	-.6921 -14449.8 9.05E-14 1.0253 2.04E-01 -2.29E-08 -2.40E-08*
7	-15.1024 -662.1 9.98E-02 1.5842 1.08E-01 -6.86E-01 -6.86E-01*	-4.8891 -2045.4 6.86E-03 1.7597 7.39E-02 (-6.50E-03) -5.90E-01*	-2.9426 -3398.4 9.78E-06 3.3355 5.15E-05 (-2.06E-09) -5.10E-02*	-2.1182 -4721.0 9.06E-06 1.5643 1.12E-01 (-2.43E-02) -2.02E-02*	-1.6631 -6012.8 2.48E-08 3.4033 3.22E-05 (-1.14E-11) -1.01E-03*	-1.3748 -7273.6 1.99E-08 1.6374 9.72E-02 (-1.46E-04) -9.91E-05*	-1.1761 -8503.0 2.92E-11 -1.0751 8.84E-04 (-2.84E-11) -1.84E-05*	-1.0309 -9700.5 4.76E-11 1.9032 5.09E-02 (-2.28E-07) -4.05E-09*	-.9203 -10865.9 2.04E-12 1.2600 1.74E-01 (-1.60E-07) -1.23E-07*	-.8334 -11998.6 2.54E-13 1.7283 7.96E-02 (-5.64E-09) -2.50E-09*	-.7635 -13098.3 5.30E-13 1.2087 1.82E-01 (-8.00E-08) -6.85E-08*

Table 5. Radiative transition parameters for N_2 $B' \ ^3\Sigma_u^- - B \ ^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.5610 17824.4 8.73E-05 1.0135 2.04E-01 8.37E+01 8.52E+01*	.6204 16119.1 1.71E-03 1.0410 2.02E-01 1.19E+03 1.21E+03*	.6924 14442.9 1.36E-02 1.0704 2.00E-01 6.65E+03 6.73E+03	.7815 12795.6 5.44E-02 1.1021 1.97E-01 1.78E+04 1.80E+04	.8947 11177.3 1.05E-01 1.1371 1.92E-01 2.19E+04 2.20E+04	1.0430 9588.0 6.80E-02 1.1789 1.87E-01 8.46E+03 8.36E+03	1.2457 8027.8 2.62E-04 1.1789 2.06E-01 (2.34E+01) 3.37E+01*	1.5392 6496.7 9.24E-02 1.2438 1.76E-01 3.19E+03 3.21E+03	2.0021 4994.9 4.19E-02 1.3202 1.6E-01 5.59E+02 5.45E+02	2.8389 3522.4 7.55E-02 1.3237 1.62E-01 3.50E+02 3.55E+02	4.8087 2079.5 9.05E-02 1.4569 1.35E-01 5.99E+01 5.92E+01
9	.5227 19130.1 2.43E-05 .9942 2.06E-01 2.91E+01 2.97E+01*	.5739 17424.8 5.45E-04 1.0201 2.04E-01 4.86E+02 4.95E+02*	.6350 15748.5 5.16E-03 1.0477 2.02E-01 3.33E+03 3.37E+03*	.7092 14101.2 2.60E-02 1.0772 1.99E-01 1.17E+04 1.19E+04	.8011 12482.9 7.21E-02 1.1092 1.96E-01 1.85E+04 2.19E+04	.9180 10893.6 9.62E-02 1.1449 1.91E-01 1.85E+04 1.84E+04	1.0714 9333.4 3.30E-02 1.1919 1.85E-01 3.71E+03 3.63E+03	1.2817 7802.4 1.16E-02 1.1802 1.86E-01 7.75E+02 8.11E+02	1.5872 6300.5 9.76E-02 1.2538 1.75E-01 3.02E+03 3.01E+03	2.0712 4828.1 1.45E-02 1.3520 1.56E-01 1.62E+02 1.54E+02	2.9540 3385.2 9.96E-02 1.3361 1.59E-01 3.98E+02 4.00E+02
10	.4899 20413.0 6.87E-06 .9765 2.06E-01 1.01E+01 1.03E+01*	.5345 18707.7 1.72E-04 1.0007 2.05E-01 1.92E+02 1.96E+02*	.5872 17031.4 1.87E-03 1.0267 2.03E-01 1.55E+03 1.57E+03*	.6500 15384.1 1.13E-02 1.0544 2.01E-01 6.76E+03 6.85E+03	.7264 13765.8 4.05E-02 1.0840 1.98E-01 1.69E+04 1.70E+04	.8213 12176.5 8.20E-02 1.1164 1.95E-01 2.28E+04 2.29E+04	.9419 10616.3 7.59E-02 1.1534 1.90E-01 1.33E+04 1.32E+04	1.1007 9085.3 9.61E-03 1.2154 1.81E-01 9.57E+02 9.11E+02*	1.3187 7583.4 3.17E-02 1.2017 1.83E-01 1.88E+03 1.92E+03	1.6364 6111.0 8.76E-02 1.2640 1.73E-01 2.42E+03 2.40E+03	2.1422 4668.1 1.58E-03 1.4789 1.30E-01 (1.10E+01) 9.35E+00*
11	.4614 21673.2 1.98E-06 .9602 2.07E-01 3.50E+00 3.58E+00*	.5008 19967.9 5.42E-05 .9664 2.06E-01 7.42E+01 7.57E+01*	.5467 18291.6 6.60E-04 1.0073 2.05E-01 6.86E+02 6.98E+02*	.6008 16644.3 4.62E-03 1.0333 2.03E-01 3.56E+03 3.61E+03*	.6655 15026.0 2.01E-02 1.0611 2.01E-01 1.11E+04 1.13E+04	.7442 13436.7 5.41E-02 1.0909 1.98E-01 2.08E+04 2.09E+04	.8420 11876.5 8.22E-02 1.1238 1.94E-01 2.10E+04 2.10E+04	.9666 10345.5 5.08E-02 1.1631 1.89E-01 8.13E+03 8.03E+03	1.1308 8843.6 2.92E-04 1.3905 1.49E-01 (1.81E+01) 1.33E+01*	1.3566 7371.2 5.11E-02 1.2143 1.81E-01 2.72E+03 2.76E+03	1.6868 5928.3 6.85E-02 1.2749 1.71E-01 1.69E+03 1.67E+03
12	.4365 22910.8 5.82E-07 .9453 2.08E-01 1.22E+00 1.25E+00*	.4716 21205.4 1.72E-05 .9664 2.07E-01 2.84E+01 2.90E+01*	.5121 19529.2 2.30E-04 .9893 2.06E-01 2.94E+02 3.00E+02*	.5592 17881.9 1.82E-03 1.0138 2.04E-01 1.76E+03 1.79E+03*	.6149 16263.6 9.22E-03 1.0400 2.02E-01 6.59E+03 6.68E+03*	.6815 14674.3 3.06E-02 1.0679 2.00E-01 1.57E+04 1.58E+04	.7625 13114.1 6.40E-02 1.0980 1.97E-01 2.27E+04 2.28E+04	.8633 11583.0 7.33E-02 1.1316 1.93E-01 1.72E+04 1.71E+04	.9919 10081.2 2.75E-02 1.1752 1.87E-01 4.00E+03 3.90E+03	1.1616 8608.8 3.08E-03 1.1317 1.93E-01 2.96E+02 3.25E+02*	1.3955 7165.9 6.40E-02 1.2245 1.80E-01 3.08E+03 3.10E+03
13	.4145 24125.7 1.75E-07 .9316 2.08E-01 4.31E-01 4.41E-01*	.4460 22420.4 5.52E-06 .9512 2.07E-01 1.08E+01 1.11E+01*	.4821 20744.1 8.00E-05 .9727 2.06E-01 1.24E+02 1.26E+02*	.5236 19096.8 6.98E-04 .9958 2.05E-01 8.31E+02 8.47E+02*	.5721 17478.5 4.01E-03 1.0204 2.04E-01 3.61E+03 3.67E+03*	.6294 15889.3 1.57E-02 1.0466 2.02E-01 1.04E+04 1.05E+04	.6979 14329.1 4.12E-02 1.0747 1.99E-01 1.95E+04 1.97E+04	.7814 12798.0 6.81E-02 1.1052 1.96E-01 2.23E+04 2.23E+04	.8853 11296.2 5.81E-02 1.1400 1.92E-01 1.25E+04 1.24E+04	1.0179 9823.7 1.04E-02 1.1493 1.84E-01 1.36E+03 1.30E+03	1.1932 8380.8 1.35E-02 1.1719 1.88E-01 1.13E+03 1.18E+03
14	.3950 25318.1 5.39E-08 .9186 2.08E-01 1.53E-01 1.57E-01*	.4235 23612.8 1.80E-06 .9372 2.08E-01 4.14E+00 4.23E+00*	.4559 21936.5 2.79E-05 .9573 2.07E-01 5.12E+01 5.23E+01*	.4929 20289.2 2.65E-04 .9790 2.06E-01 3.81E+02 3.89E+02*	.5356 18670.9 1.69E-03 1.0023 2.05E-01 1.87E+03 1.90E+03*	.5854 17081.7 7.53E-03 1.0270 2.03E-01 6.29E+03 6.38E+03*	.6443 15521.4 2.36E-02 1.0533 2.01E-01 1.45E+04 1.46E+04	.7148 13990.4 5.00E-02 1.0816 1.99E-01 2.19E+04 2.21E+04	.8007 12488.6 6.58E-02 1.1126 1.98E-01 1.98E+04 1.98E+04	.9078 11016.1 4.03E-02 1.1493 1.91E-01 7.95E+03 7.83E+03	1.0446 9573.2 1.51E-03 1.2519 1.75E-01 (1.64E+02) 1.45E+02*
15	.3775 26487.9 1.69E-08 .9060 2.08E-01 5.50E-02 5.63E-02*	.4035 24782.6 5.94E-07 .9239 2.08E-01 1.58E+00 1.62E+00*	.4328 23106.3 9.80E-06 .9429 2.08E-01 2.11E+01 2.16E+01*	.4660 21459.1 9.97E-05 .9634 2.07E-01 1.71E+02 1.75E+02*	.5040 19840.8 6.94E-04 .9854 2.06E-01 9.32E+02 9.50E+02*	.5479 18251.5 3.45E-03 1.0088 2.05E-01 3.56E+03 3.62E+03*	.5991 16691.3 1.24E-02 1.0337 2.03E-01 9.63E+03 9.76E+03	.6596 15160.2 3.18E-02 1.0601 2.01E-01 1.81E+04 1.83E+04	.7322 13658.4 5.55E-02 1.0886 1.98E-01 2.25E+04 2.25E+04	.8206 12185.9 5.78E-02 1.1203 1.94E-01 1.60E+04 1.59E+04	.9308 10743.0 2.36E-02 1.1606 1.89E-01 4.25E+03 4.15E+03

Table 5. Radiative transition parameters for N_2 $B' \ ^3\Sigma_u^- - B \ ^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	15.0065 666.4 3.25E-01 1.5014 1.25E-01 6.13E+00 6.15E+00	-13.9500 -716.8 1.23E-01 1.5966 1.05E-01 -1.02E+00 -1.02E+00	-4.8312 -2069.9 8.69E-03 1.7842 6.97E-02 (-7.57E-01) -6.70E-01*	-2.9477 -3392.5 1.70E-06 6.6440 1.81E-21 (-4.40E-43) -1.16E-01*	-2.1348 -4684.3 1.73E-05 1.6297 9.87E-02 (-3.51E-02) -2.81E-02*	-1.6821 -5945.1 2.31E-09 1.7366 0.00E+00 (0.00E+00) -2.97E-03*	-1.3938 -7174.4 4.54E-08 4.79E-04 7.81E-02 (-2.07E-04) -1.13E-04*	-1.1945 -8372.0 4.57E-10 .6182 1.86E-01 (-1.89E-05) -5.37E-05*	-1.0485 -9537.4 8.22E-11 2.1699 2.18E-02 (-6.84E-08) -4.43E-07*	-.9372 -10670.1 7.00E-12 1.5494 1.15E-01 (-2.29E-07) -1.31E-07*	-.8496 -11769.8 7.52E-13 1.5562 1.14E-01 (-3.22E-08) -1.92E-08*
9	5.0709 1972.0 5.37E-02 1.4865 1.29E-01 2.76E+01 2.71E+01	16.9831 588.8 3.34E-01 1.5135 1.23E-01 4.17E+00 4.18E+00	-13.0852 -764.2 1.46E-01 1.6096 1.03E-01 -1.40E+00 -1.40E+00	-4.7920 -2086.8 1.04E-02 1.8118 6.50E-02 (-8.05E-01) -6.87E-01	-2.9598 -3378.6 2.95E-06 -2.8422 6.36E-10 (-9.33E-20) -2.32E-01*	-2.1554 -4639.4 2.97E-05 1.6948 8.59E-02 (-4.44E-02) -3.35E-02*	-1.7039 -5868.8 3.66E-08 -1.1831 4.79E-04 (-3.43E-09) -7.33E-03*	-1.4152 -7066.3 8.85E-08 1.8455 5.95E-02 (-2.24E-04) -7.14E-05*	-1.2148 -8231.7 2.71E-09 1.0805 1.99E-01 -1.21E-04 -1.31E-04*	-1.0679 -9364.5 8.71E-11 2.7312 1.90E-03 (-5.25E-10) -5.05E-06*	-.9556 -10464.1 2.02E-11 1.8300 6.20E-02 (-1.81E-07) -2.56E-08*
10	3.0723 3254.9 1.13E-01 1.3466 1.57E-01 3.92E+02 3.93E+02	5.3427 1871.7 2.79E-02 1.5328 1.19E-01 1.05E+01 1.02E+01	19.2800 518.7 3.37E-01 1.5263 1.20E-01 2.76E+00 2.76E+00	-12.4391 -803.9 1.68E-01 1.6231 1.00E-01 -1.77E+00 -1.78E+00	-4.7715 -2095.8 1.16E-02 1.8439 5.98E-02 (-7.76E-01) -6.25E-01	-2.9793 -3356.5 3.76E-05 2.172 1.08E-01 (-3.38E-02) -4.15E-01*	-2.1806 -4585.9 4.62E-05 1.7636 7.33E-02 (-4.85E-02) -3.28E-02*	-1.7291 -5783.5 3.78E-07 .5325 1.72E-01 (-4.40E-03) -1.56E-02*	-1.4391 -6948.8 1.45E-07 1.9803 4.06E-02 (-2.54E-02) -1.39E-06*	-1.2374 -8081.6 1.08E-08 1.3185 1.63E-01 (-5.47E-05) -2.63E-04*	-1.0892 -9181.2 2.01E-11 5.8073 4.75E-16 (-7.09E-36) -2.60E-05*
11	2.2148 4515.1 1.10E-03 1.0952 1.97E-01 (1.60E+01) 1.99E+01*	3.1929 3131.9 1.17E-01 1.3562 1.56E-01 3.51E+02 3.50E+02	5.6215 1778.9 1.18E-02 1.6178 1.01E-01 2.76E+00 2.65E+00	21.9162 456.3 3.36E-01 1.5399 1.17E-01 1.78E+00 1.79E+00	-11.9680 -835.6 1.89E-01 1.6373 5.97E-02 -2.12E+00 -2.12E+00	-4.7702 -2096.3 1.23E-02 1.8822 5.39E-02 (-6.70E-01) -4.90E-01	-3.0069 -3325.7 1.46E-04 .8577 2.08E-01 (-4.69E-01) -6.74E-01*	-2.2108 -4523.3 6.47E-05 1.8412 6.02E-02 (-4.40E-02) -2.35E-02*	-1.7579 -5688.6 1.64E-06 1.0191 2.04E-01 (-2.54E-02) -2.91E-02*	-1.4660 -6821.4 1.88E-07 2.1767 2.12E-02 (-5.47E-05) -1.90E-04*	-1.2625 -7921.0 3.31E-08 1.4822 1.29E-01 (-5.58E-04) -6.29E-04*
12	1.7383 5752.7 4.66E-02 1.2876 1.69E-01 1.02E+03 1.00E+03	2.2886 4369.5 9.14E-03 1.2417 1.77E-01 9.65E+01 1.03E+02*	3.3152 3016.4 1.12E-01 1.3653 1.54E-01 2.93E+02 2.92E+02	5.9037 1693.8 3.38E-03 1.8278 6.24E-02 (2.59E-01) 1.96E-01*	24.8754 402.0 3.34E-01 1.5544 1.14E-01 1.15E+00 1.16E+00	-11.6445 -858.8 2.09E-01 1.6522 9.42E-02 -2.38E+00 -2.38E+00	-4.7890 -2088.1 1.22E-02 1.9296 4.72E-02 (-5.02E-01) -3.07E-01	-3.0435 -3285.7 3.86E-04 1.1450 1.91E-01 -1.02E+00 -1.01E+00*	-2.2467 -4451.1 8.01E-05 1.9367 4.62E-02 (-3.06E-02) -8.41E-03*	-1.7909 -5583.8 4.97E-06 1.2655 1.73E-01 -5.23E-02 -4.76E-02*	-1.4962 -6683.5 1.70E-07 2.5510 4.58E-03 (-2.16E-06) -1.54E-03*
13	1.4352 6967.7 6.84E-02 1.2340 1.78E-01 2.97E+03 2.97E+03	1.7907 5584.4 2.69E-02 1.3041 1.66E-01 5.19E+02 5.03E+02	2.3633 4231.4 2.14E-02 1.2747 1.71E-01 1.92E+02 1.99E+02	3.4378 2908.8 1.01E-01 1.3740 1.52E-01 2.33E+02 2.30E+02	6.1844 1617.0 2.49E-04 3.0467 3.28E-04 (4.60E-07) 1.78E-01*	28.0746 356.2 3.32E-01 1.5698 1.11E-01 7.50E-01 7.58E-01	-11.4526 -873.2 2.26E-01 1.6680 9.11E-02 -2.53E+00 -2.53E+00	-4.8292 -2070.7 1.12E-02 1.9916 3.92E-02 (-3.11E-01) -1.25E-01	-3.0901 -3236.1 8.29E-04 1.3151 1.63E-01 (-1.52E+00) -1.38E+00*	-2.2889 -4368.8 8.05E-05 2.0685 3.08E-02 (-1.36E-02) -1.35E-04*	-1.8287 -5468.5 1.22E-05 1.4272 1.41E-01 (-8.01E-02) -6.79E-02*
14	1.2255 8160.1 2.66E-02 1.1881 1.85E-01 2.01E+03 2.06E+03	1.4756 6776.8 6.47E-02 1.2433 1.76E-01 2.54E+03 2.53E+03	1.8437 5423.8 1.21E-02 1.3297 1.61E-01 2.03E+02 1.92E+02	2.4383 4101.2 3.45E-02 1.2922 1.68E-01 2.71E+02 2.77E+02	3.5595 2809.4 8.73E-02 1.3823 1.50E-01 1.77E+02 1.75E+02	6.4575 1548.6 3.23E-04 -.1219 4.82E-02 (1.13E-02) 1.06E+00*	31.3255 319.2 3.33E-01 1.5860 1.08E-01 5.08E-01 5.15E-01	-11.3852 -878.3 2.40E-01 1.6848 8.79E-02 -2.55E+00 -2.55E+00	-4.8931 -2043.7 9.26E-03 2.0790 2.97E-02 (-1.41E-01) -1.04E-02*	-3.1482 -3176.4 1.55E-03 1.4332 1.40E-01 (-1.96E+00) -1.75E+00*	-2.3386 -4276.1 7.13E-05 2.2864 1.20E-01 (-2.25E-03) -2.02E+00*
15	1.0718 9329.9 3.98E-04 1.0182 2.04E-01 (5.46E+01) 7.10E+01*	1.2584 7946.7 3.85E-02 1.1994 1.84E-01 2.64E+03 2.67E+03	1.5166 6593.6 5.54E-02 1.2530 1.75E-01 1.97E+03 1.95E+03	1.8972 5271.0 3.37E-03 1.3876 1.49E-01 (4.45E+01) 4.01E+01*	2.5131 3979.2 4.59E-02 1.3046 1.65E-01 3.21E+02 3.25E+02	3.6786 2718.4 7.26E-02 1.3900 1.49E-01 (9.82E-01) 1.28E+02	6.7157 1489.1 1.86E-03 .7195 1.99E-01 (9.82E-01) 2.05E+00*	34.3066 291.5 3.36E-01 1.6030 1.04E-01 3.66E-01 3.73E-01	-11.4432 -873.9 2.51E-01 1.7027 8.44E-02 -2.42E+00 -2.43E+00	-4.9835 -2006.6 6.54E-03 2.2181 1.83E-02 -3.58E-02 -3.71E-02*	-3.2193 -3106.3 2.59E-03 1.5253 1.20E-01 (-2.28E+00) -2.02E+00*

Table 5. Radiative transition parameters for N_2 $B' \ ^3\Sigma_u^- - B \ ^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
16	.3619 27635.2 5.35E-09 .8930 2.08E-01 1.98E-02 2.03E-02*	.3857 25929.9 1.99E-07 .9110 2.08E-01 6.08E-01 6.22E-01*	.4123 24253.6 3.46E-06 .9294 2.08E-01 8.65E+00 8.85E+00*	.4424 22606.3 3.76E-05 .9488 2.07E-01 7.57E+01 7.73E+01*	.4765 20988.0 2.82E-04 .9696 2.07E-01 4.51E+02 4.60E+02*	.5155 19398.7 1.54E-03 .9918 2.06E-01 1.92E+03 1.96E+03*	.5606 17838.5 6.19E-03 1.0154 2.04E-01 5.94E+03 6.03E+03*	.6132 16307.4 1.84E-02 1.0403 2.02E-01 1.33E+04 1.34E+04	.6754 14805.6 3.94E-02 1.0669 2.00E-01 2.08E+04 2.09E+04	.7500 13333.2 5.67E-02 1.0957 1.97E-01 2.12E+04 2.12E+04	.8410 11890.3 4.61E-02 1.1285 1.93E-01 1.18E+04 1.16E+04
17	.3477 28759.8 1.70E-09 .8786 2.08E-01 7.08E-03 7.28E-03*	.3696 27054.5 6.70E-08 .8979 2.08E-01 2.33E-01 2.39E-01*	.3940 25378.2 1.23E-06 .9162 2.08E-01 3.54E+00 3.62E+00*	.4214 23730.9 1.42E-05 .9350 2.08E-01 3.31E+01 3.39E+01*	.4522 22112.6 1.14E-04 .9548 2.07E-01 2.14E+02 2.18E+02*	.4872 20523.4 6.70E-04 .9759 2.06E-01 1.00E+03 1.02E+03*	.5273 18963.1 2.97E-03 .9983 2.05E-01 3.46E+03 3.52E+03*	.5737 17432.1 9.97E-03 1.0220 2.04E-01 8.89E+03 9.01E+03*	.6277 15930.2 2.50E-02 1.0470 2.02E-01 1.67E+04 1.68E+04	.6917 14457.8 4.50E-02 1.0738 1.99E-01 2.19E+04 2.20E+04	.7683 13014.9 5.35E-02 1.1030 1.96E-01 1.84E+04 1.84E+04
18	.3349 29861.8 5.34E-10 .8613 2.08E-01 2.48E-03 2.57E-03*	.3552 28156.5 2.26E-08 .8837 2.08E-01 8.83E-02 9.07E-02*	.3776 26480.2 4.40E-07 .9028 2.08E-01 1.44E+00 1.47E+00*	.4027 24832.9 5.36E-06 .9215 2.08E-01 1.44E+01 1.47E+01*	.4308 23214.6 4.56E-05 .9408 2.08E-01 9.97E+01 1.02E+02*	.4624 21625.3 2.88E-04 .9610 2.07E-01 5.06E+02 5.17E+02*	.4984 20065.1 1.39E-03 .9823 2.06E-01 1.93E+03 1.97E+03*	.5395 18534.0 5.15E-03 1.0048 2.05E-01 5.58E+03 5.66E+03*	.5871 17032.2 1.46E-02 1.0286 2.03E-01 1.21E+04 1.23E+04	.6427 15559.8 3.13E-02 1.0537 2.01E-01 1.94E+04 1.95E+04	.7084 14116.9 4.78E-02 1.0807 1.99E-01 2.16E+04 2.16E+04
19	.3232 30941.0 1.62E-10 .8384 2.07E-01 8.34E-04 8.70E-04*	.3420 29235.7 7.50E-09 .8667 2.08E-01 3.28E-02 3.38E-02*	.3629 27559.4 1.57E-07 .8884 2.08E-01 5.75E-01 5.91E-01*	.3859 25912.2 2.02E-06 .9079 2.08E-01 6.17E+00 6.33E+00*	.4116 24293.9 1.83E-05 .9270 2.08E-01 4.59E+01 4.69E+01*	.4404 22704.6 1.23E-04 .9467 2.07E-01 2.51E+02 2.56E+02*	.4729 21144.4 6.36E-04 .9672 2.07E-01 1.04E+03 1.06E+03*	.5099 19613.3 2.57E-03 .9887 2.06E-01 3.33E+03 3.39E+03*	.5521 18111.5 8.12E-03 1.0113 2.05E-01 8.18E+03 8.30E+03*	.6010 16639.0 1.99E-02 1.0352 2.03E-01 1.53E+04 1.54E+04	.6581 15196.1 3.65E-02 1.0605 2.01E-01 2.09E+04 2.11E+04
20	.3125 31997.5 4.58E-11 .8041 2.05E-01 2.56E-04 2.73E-04*	.3301 30292.2 2.40E-09 .8443 2.07E-01 1.16E-02 1.21E-02*	.3495 28615.9 5.48E-08 .8716 2.08E-01 2.25E-01 2.32E-01*	.3708 26968.6 7.58E-07 .8935 2.08E-01 2.61E+00 2.68E+00*	.3945 25350.3 7.27E-06 .9133 2.08E-01 2.08E+01 2.13E+01*	.4209 23761.0 5.20E-05 .9328 2.08E-01 1.22E+02 1.25E+02*	.4504 22200.8 2.87E-04 .9527 2.07E-01 5.47E+02 5.59E+02*	.4838 20669.7 1.25E-03 .9735 2.07E-01 1.91E+03 1.95E+03*	.5217 19167.9 4.33E-03 .9952 2.05E-01 5.21E+03 5.30E+03*	.5651 17695.5 1.18E-02 1.0179 2.04E-01 1.11E+04 1.12E+04	.6153 16252.6 2.51E-02 1.0419 2.02E-01 1.79E+04 1.81E+04
21	.3027 33031.0 1.10E-11 .7424 2.01E-01 (6.52E-05) 7.34E-05*	.3192 31325.7 7.16E-10 .8108 2.06E-01 3.78E-03 4.02E-03*	.3373 29649.4 1.86E-08 .8499 2.07E-01 8.42E-02 8.77E-02*	.3571 28002.1 2.79E-07 .8769 2.08E-01 1.07E+00 1.11E+00*	.3790 26383.8 2.87E-06 .8988 2.08E-01 9.25E+00 9.50E+00*	.4033 24794.6 2.18E-05 .9189 2.08E-01 5.82E+01 5.97E+01*	.4304 23234.3 1.28E-04 .9387 2.08E-01 2.81E+02 2.87E+02*	.4608 21703.3 5.98E-04 .9589 2.07E-01 1.06E+03 1.08E+03*	.4950 20201.5 2.23E-03 .9799 2.06E-01 3.18E+03 3.23E+03*	.5339 18729.0 6.71E-03 1.0017 2.05E-01 7.51E+03 7.63E+03*	.5785 17286.1 1.60E-02 1.0245 2.04E-01 1.39E+04 1.41E+04

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 5. Radiative transition parameters for N_2 $B' \ ^3\Sigma_u^- - B \ ^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	.9545 10477.1 1.06E-02 1.1765 1.87E-01 1.73E+03 1.66E+03	1.0996 9093.9 5.12E-03 1.1400 1.92E-01 5.75E+02 6.14E+02*	1.2918 7740.9 4.65E-02 1.2090 1.82E-01 2.90E+03 2.92E+03	1.5581 6418.3 4.32E-02 1.2634 1.73E-01 1.39E+03 1.36E+03	1.9507 5126.4 9.67E-05 1.9243 4.79E-02 1.21E-01 5.46E-05*	2.5869 3865.7 5.43E-02 1.3147 1.64E-01 3.40E+02 3.43E+02	3.7932 2636.3 5.85E-02 1.3966 1.47E-01 9.43E+01 9.21E+01	6.9506 1438.7 3.56E-03 .8595 2.08E-01 (1.85E+00) 2.83E+00*	36.5813 273.4 3.44E-01 1.6208 1.01E-01 2.88E-01 2.95E-01	-11.6363 -859.4 2.57E-01 1.7221 8.08E-02 -2.16E+00 -2.17E+00	-5.1046 -1959.0 3.48E-03 2.4940 5.93E-03 (-1.87E-03) -2.71E-01*
17	.8619 11601.7 3.29E-02 1.1375 1.92E-01 7.71E+03 7.59E+03	.9786 10218.5 2.76E-02 1.2100 1.82E-01 3.94E+02 3.61E+02*	1.1280 8865.5 1.31E-02 1.1638 1.89E-01 1.32E+03 1.36E+03	1.3258 7542.9 4.97E-02 1.2179 1.81E-01 2.82E+03 2.83E+03	1.5997 6251.1 3.06E-02 1.2753 1.71E-01 8.85E+02 8.65E+02	2.0039 4990.3 1.08E-03 1.1015 1.97E-01 (2.11E+01) 2.58E+01*	2.6589 3760.9 5.94E-02 1.3235 1.62E-01 3.36E+02 3.38E+02	3.9011 2563.4 4.59E-02 1.4014 1.46E-01 (6.71E+01) 6.51E+01	7.1531 1398.0 4.59E-03 .8609 2.08E-01 (2.19E+00) 3.29E+00*	37.6997 265.3 3.58E-01 1.6392 9.68E-02 2.54E-01 2.61E-01	-11.9846 -834.4 2.58E-01 1.7433 7.69E-02 -1.80E+00 -1.80E+00
18	.7872 12703.7 4.66E-02 1.1106 1.96E-01 1.48E+04 1.47E+04	.8834 11320.5 2.05E-02 1.1479 1.91E-01 4.39E+03 4.29E+03	1.0033 9967.5 1.89E-05 1.8154 6.44E-02 (3.14E-01) 1.17E-03*	1.1568 8644.9 2.17E-02 1.1773 1.87E-01 1.99E+03 2.03E+03	1.3600 7353.0 4.85E-02 1.2266 1.79E-01 2.51E+03 2.50E+03	1.6414 6092.3 1.95E-02 1.2898 1.68E-01 5.06E+02 4.89E+02	2.0564 4862.9 4.82E-03 1.2078 1.82E-01 7.46E+01 8.09E+01*	2.7283 3665.3 6.15E-02 1.3316 1.60E-01 3.15E+02 3.16E+02	4.0001 2500.0 3.51E-02 1.4027 1.46E-01 4.74E+01 4.55E+01	7.3141 1367.2 4.51E-03 .7645 2.03E-01 (1.92E+00) 3.45E+00*	37.3734 267.6 3.79E-01 1.6581 9.31E-02 2.55E-01 2.64E-01
19	.7255 13783.0 4.75E-02 1.0878 1.98E-01 1.98E+04 1.98E+04	.8065 12399.7 3.74E-02 1.1186 1.95E-01 1.10E+04 1.08E+04	.9052 11046.7 1.04E-02 1.1617 1.89E-01 2.04E+03 1.96E+03	1.0284 9724.1 1.54E-03 1.0975 1.97E-01 (2.23E+02) 2.51E+02*	1.1859 8432.3 2.92E-02 1.1877 1.85E-01 2.44E+03 2.48E+03	1.3944 7171.5 4.39E-02 1.2353 1.78E-01 2.07E+03 2.06E+03	1.6829 5942.1 1.08E-02 1.3096 1.65E-01 2.48E+02 2.36E+02	2.1077 4744.6 9.88E-03 1.2408 1.77E-01 1.34E+02 1.41E+02*	2.7939 3579.2 6.12E-02 1.3396 1.59E-01 2.86E+02 2.86E+02	4.0875 2446.5 2.61E-02 1.3973 1.47E-01 3.36E+01 3.18E+01	7.4249 1346.8 3.23E-03 .4922 1.65E-01 (8.69E-01) 3.33E+00*
20	.6739 14839.4 4.00E-02 1.0674 2.00E-01 2.12E+04 2.13E+04	.7432 13456.2 4.40E-02 1.0950 1.97E-01 1.69E+04 1.69E+04	.8262 12103.2 2.74E-02 1.1272 1.94E-01 7.37E+03 7.25E+03	.9276 10780.6 3.70E-03 1.1849 1.86E-01 6.48E+02 6.04E+02*	1.0539 9488.7 5.91E-03 1.1398 1.92E-01 7.54E+02 7.98E+02*	1.2154 8227.9 3.43E-02 1.1967 1.84E-01 2.62E+03 2.65E+03	1.4289 6998.6 3.71E-02 1.2443 1.76E-01 1.60E+03 1.58E+03	1.7238 5801.0 4.82E-03 1.3415 1.58E-01 9.57E+01 8.86E+01*	2.1572 4635.7 1.51E-02 1.2580 1.74E-01 1.85E+02 1.92E+02	2.8548 3502.9 5.92E-02 1.3482 1.57E-01 2.54E+02 2.54E+02	4.1610 2403.3 1.86E-02 1.3772 1.51E-01 2.40E+01 2.24E+01
21	.6300 15873.0 2.98E-02 1.0486 2.02E-01 1.97E+04 1.98E+04	.6901 14489.7 4.11E-02 1.0743 1.99E-01 2.02E+04 2.02E+04	.7612 13136.7 3.82E-02 1.1025 1.96E-01 1.35E+04 1.34E+04	.8464 11814.1 1.78E-02 1.1370 1.92E-01 4.41E+03 4.30E+03	.9504 10522.3 4.38E-04 1.2692 1.72E-01 (6.12E+01) 4.93E+01*	1.0797 9261.5 1.16E-02 1.1573 1.90E-01 1.34E+03 1.39E+03	1.2450 8032.1 3.66E-02 1.2051 1.83E-01 2.57E+03 2.58E+03	1.4632 6834.6 2.95E-02 1.2539 1.75E-01 1.16E+03 1.14E+03	1.7639 5669.2 1.40E-03 1.4128 1.44E-01 (2.15E+01) 1.86E+01*	2.2044 4536.5 1.97E-02 1.2681 1.72E-01 2.21E+02 2.27E+02	2.9097 3436.8 5.65E-02 1.3594 1.55E-01 2.23E+02 2.22E+02

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 6. Radiative transition parameters for N_2 $a^1\Pi_g-X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.1450 68951.3 4.28E-02 1.1578 5.88E-03 9.83E+02	.1501 66620.9 1.51E-01 1.1807 5.88E-03 3.14E+03	.1555 64319.3 2.48E-01 1.2043 5.88E-03 4.63E+03	.1612 62046.5 2.50E-01 1.2287 5.88E-03 4.19E+03	.1672 59802.4 1.73E-01 1.2541 5.88E-03 2.60E+03	.1736 57587.2 8.77E-02 1.2806 5.88E-03 1.17E+03	.1805 55400.7 3.35E-02 1.3083 5.88E-03 3.99E+02	.1878 53243.1 9.88E-03 1.3373 5.88E-03 1.04E+02*	.1956 51114.4 2.28E-03 1.3680 5.88E-03 2.13E+01*	.2040 49014.6 4.12E-04 1.4005 5.88E-03 3.40E+00*	.2130 46943.9 5.88E-05 1.4351 5.88E-03 4.26E-01*
1	.1416 70617.6 1.15E-01 1.1414 5.88E-03 2.85E+03	.1464 68287.2 1.93E-01 1.1633 5.88E-03 4.31E+03	.1515 65985.6 8.09E-02 1.1849 5.88E-03 1.63E+03	.1570 63712.8 4.22E-04 1.2447 5.88E-03 7.65E+00*	.1627 61468.8 8.85E-02 1.2374 5.88E-03 1.44E+03	.1688 59253.5 1.87E-01 1.2618 5.88E-03 2.72E+03	.1752 57067.0 1.76E-01 1.2880 5.88E-03 2.28E+03	.1821 54909.4 1.02E-01 1.3155 5.88E-03 1.19E+03	.1895 52780.7 4.14E-02 1.3445 5.88E-03 4.27E+02	.1973 50681.0 1.23E-02 1.3751 5.88E-03 1.12E+02	.2057 48610.2 2.75E-03 1.4076 5.88E-03 2.21E+01*
2	.1384 72256.1 1.70E-01 1.1258 5.88E-03 4.50E+03	.1430 69925.8 9.74E-02 1.1463 5.88E-03 2.33E+03	.1479 67624.2 3.15E-03 1.1809 5.88E-03 6.83E+01*	.1530 65351.3 1.08E-01 1.1939 5.88E-03 2.10E+03	.1585 63107.3 8.58E-02 1.2157 5.88E-03 1.51E+03	.1642 60892.0 6.97E-04 1.2091 5.88E-03 1.10E+01*	.1703 58705.6 6.68E-02 1.2709 5.88E-03 9.47E+02	.1768 56547.9 1.67E-01 1.2958 5.88E-03 2.11E+03	.1838 54419.2 1.61E-01 1.3230 5.88E-03 1.82E+03	.1911 52319.5 9.23E-02 1.3518 5.88E-03 9.26E+02	.1990 50248.8 3.56E-02 1.3824 5.88E-03 3.16E+02
3	.1354 73866.9 1.83E-01 1.1109 5.88E-03 5.16E+03	.1398 71536.5 1.26E-02 1.1278 5.88E-03 3.22E+02	.1444 69234.9 7.50E-02 1.1553 5.88E-03 1.74E+03	.1493 66962.1 6.95E-02 1.1750 5.88E-03 1.46E+03	.1545 64718.1 3.72E-03 1.2126 5.88E-03 7.06E+01*	.1600 62502.8 9.59E-02 1.2247 5.88E-03 1.64E+03	.1658 60316.3 6.48E-02 1.2465 5.88E-03 9.96E+02	.1719 58158.7 3.37E-04 1.3311 5.88E-03 4.65E+00*	.1785 56030.0 8.24E-02 1.3047 5.88E-03 1.02E+03	.1854 53930.2 1.66E-01 1.3308 5.88E-03 1.83E+03	.1928 51859.5 1.42E-01 1.3594 5.88E-03 1.39E+03
4	.1325 75449.9 1.60E-01 1.0966 5.88E-03 4.82E+03	.1368 73119.6 6.01E-03 1.1238 5.88E-03 1.65E+02*	.1412 70818.0 9.66E-02 1.1387 5.88E-03 2.40E+03	.1459 68545.2 6.19E-04 1.1333 5.88E-03 1.40E+01*	.1508 66301.1 7.76E-02 1.1843 5.88E-03 1.58E+03	.1560 64085.9 3.69E-02 1.2032 5.88E-03 6.79E+02	.1616 61899.4 1.78E-02 1.2370 5.88E-03 2.96E+02	.1674 59741.8 9.74E-02 1.2558 5.88E-03 1.45E+03	.1736 57613.1 3.41E-02 1.2768 5.88E-03 4.57E+02	.1801 55513.3 1.12E-02 1.3197 5.88E-03 1.35E+02	.1871 53442.6 1.14E-01 1.3393 5.88E-03 1.22E+03
5	.1299 77005.4 1.22E-01 1.0830 5.88E-03 3.90E+03	.1339 74675.1 4.61E-02 1.1053 5.88E-03 1.34E+03	.1382 72373.5 4.72E-02 1.1226 5.88E-03 1.25E+03	.1427 70100.6 3.36E-02 1.1485 5.88E-03 8.10E+02	.1474 67856.6 5.67E-02 1.1659 5.88E-03 1.24E+03	.1523 65641.3 8.64E-03 1.1985 5.88E-03 1.71E+02*	.1576 63454.9 7.89E-02 1.2132 5.88E-03 1.41E+03	.1631 61297.2 7.10E-03 1.2262 5.88E-03 1.15E+02*	.1690 59168.5 4.92E-02 1.2658 5.88E-03 7.14E+02	.1752 57068.8 8.44E-02 1.2873 5.88E-03 1.10E+03	.1818 54998.1 6.09E-03 1.3002 5.88E-03 7.10E+01*
6	.1273 78533.3 8.34E-02 1.0698 5.88E-03 2.83E+03	.1312 76203.0 8.45E-02 1.0909 5.88E-03 2.62E+03	.1353 73901.4 4.80E-03 1.1031 5.88E-03 1.36E+02*	.1396 71628.6 7.26E-02 1.1317 5.88E-03 1.87E+03	.1441 69384.5 2.81E-03 1.1396 5.88E-03 6.58E+01*	.1489 67169.2 6.36E-02 1.1754 5.88E-03 1.35E+03	.1539 64982.8 1.43E-02 1.1905 5.88E-03 2.74E+02	.1592 62825.2 4.17E-02 1.2234 5.88E-03 7.25E+02	.1648 60696.5 5.36E-02 1.2420 5.88E-03 8.40E+02	.1707 58596.7 2.90E-03 1.2904 5.88E-03 4.09E+01*	.1769 56526.0 8.13E-02 1.2967 5.88E-03 1.03E+03
7	.1249 80033.8 5.28E-02 1.0572 5.88E-03 1.90E+03	.1287 77703.5 9.92E-02 1.0776 5.88E-03 3.26E+03	.1326 75401.9 5.47E-03 1.1038 5.88E-03 1.64E+02*	.1367 73129.1 5.67E-02 1.1165 5.88E-03 1.55E+03	.1411 70885.0 1.71E-02 1.1427 5.88E-03 4.26E+02	.1456 68669.7 4.67E-02 1.1578 5.88E-03 1.06E+03	.1504 66483.3 1.33E-02 1.1879 5.88E-03 2.73E+02	.1555 64325.7 5.68E-02 1.2027 5.88E-03 1.06E+03	.1608 62197.0 1.47E-03 1.2533 5.88E-03 2.48E+01*	.1664 60097.2 6.84E-02 1.2519 5.88E-03 1.04E+03	.1723 58026.5 1.31E-02 1.2671 5.88E-03 1.80E+02

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 6. Radiative transition parameters for N_2 $a^1\Pi_g-X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	.2227 44902.3 6.59E-06 1.4724 5.88E-03 4.18E-02*	.2332 42889.9 5.75E-07 1.5129 5.88E-03 3.18E-03*	.2445 40906.7 3.86E-08 1.5575 5.88E-03 1.85E-04*	.2567 38953.0 1.95E-09 1.6076 5.88E-03 8.06E-06*	.2701 37028.9 7.20E-11 1.6641 5.88E-03 2.56E-07*	.2846 35134.3 1.85E-12 1.7306 5.88E-03 5.63E-09*	.3006 33269.6 2.18E-14 1.9218 5.88E-03 5.62E-11*	.3181 31434.9 3.24E-16 1.8591 5.88E-03 7.06E-13*	.3375 29630.3 4.19E-16 1.2575 5.88E-03 7.64E-13*	.3590 27856.0 2.46E-16 1.2008 5.88E-03 3.72E-13*	.3830 26112.1 3.30E-17 1.2536 5.88E-03 4.12E-14*
1	.2147 46568.6 4.69E-04 1.4423 5.88E-03 3.32E+00*	.2244 44556.2 6.14E-05 1.4797 5.88E-03 3.81E-01*	.2349 42573.1 6.15E-06 1.5203 5.88E-03 3.32E-02*	.2462 40619.4 4.66E-07 1.5651 5.88E-03 2.19E-03*	.2584 38695.2 2.62E-08 1.6155 5.88E-03 1.06E-04*	.2717 36800.7 1.06E-09 1.6739 5.88E-03 3.69E-06*	.2862 34936.0 2.92E-11 1.7440 5.88E-03 8.73E-08*	.3021 33101.2 5.03E-13 1.8331 5.88E-03 1.28E-09*	.3195 31296.6 3.06E-15 2.1335 5.88E-03 6.57E-12*	.3387 29522.3 7.35E-17 1.6000 5.88E-03 1.32E-13*	.3600 27778.5 1.74E-17 1.2260 5.88E-03 2.61E-14*
2	.2074 48207.1 9.83E-03 1.4149 5.88E-03 7.72E+01*	.2165 46194.7 2.00E-03 1.4496 5.88E-03 1.38E+01*	.2262 44211.6 3.06E-04 1.4871 5.88E-03 1.85E+00*	.2366 42257.9 3.50E-05 1.5278 5.88E-03 1.85E-01*	.2479 40333.7 2.99E-06 1.5729 5.88E-03 1.37E-02*	.2602 38439.2 1.86E-07 1.6236 5.88E-03 7.42E-04*	.2734 36574.5 8.24E-09 1.6828 5.88E-03 2.82E-05*	.2879 34739.8 2.45E-10 1.7551 5.88E-03 7.18E-07*	.3036 32935.1 4.61E-12 1.8384 5.88E-03 1.15E-08*	.3209 31160.8 4.03E-14 2.0007 5.88E-03 8.54E-11*	.3399 29417.0 4.97E-16 1.8867 5.88E-03 8.86E-13*
3	.2007 49817.9 7.25E-02 1.3898 5.88E-03 6.28E+02	.2092 47805.5 2.49E-02 1.4223 5.88E-03 1.91E+02	.2182 45822.4 6.07E-03 1.4571 5.88E-03 4.09E+01*	.2280 43868.7 1.08E-03 1.4946 5.88E-03 6.38E+00*	.2384 41944.5 3.01E-05 1.5355 5.88E-03 7.29E-01*	.2497 40050.0 1.35E-05 1.5808 5.88E-03 6.07E-02*	.2619 38185.3 9.32E-07 1.6320 5.88E-03 3.64E-03*	.2751 36350.5 4.51E-08 1.6916 5.88E-03 1.52E-04*	.2895 34545.9 1.43E-09 1.7658 5.88E-03 4.14E-06*	.3051 32771.6 2.74E-11 1.8618 5.88E-03 6.76E-08*	.3223 31027.7 2.80E-13 1.9756 5.88E-03 5.85E-10*
4	.1945 51401.0 1.64E-01 1.3672 5.88E-03 1.56E+03	.2025 49388.6 1.15E-01 1.3975 5.88E-03 9.71E+02	.2109 47405.4 4.97E-02 1.4299 5.88E-03 3.71E+02	.2200 45451.7 1.46E-02 1.4647 5.88E-03 9.58E+01	.2297 43527.5 3.01E-03 1.5023 5.88E-03 1.74E+01*	.2402 41633.0 4.49E-04 1.5434 5.88E-03 2.27E+00*	.2515 39768.3 4.82E-05 1.5889 5.88E-03 2.12E-01*	.2636 37933.6 3.68E-06 1.6405 5.88E-03 1.41E-02*	.2768 36129.0 1.93E-07 1.7008 5.88E-03 6.39E-04*	.2911 34354.7 6.61E-09 1.7759 5.88E-03 1.88E-05*	.3066 32610.8 1.29E-10 1.8809 5.88E-03 3.14E-07*
5	.1888 52956.4 4.48E-02 1.3497 5.88E-03 4.66E+02	.1963 50944.0 1.46E-01 1.3755 5.88E-03 1.35E+03	.2042 48960.9 1.49E-01 1.4054 5.88E-03 1.22E+03	.2127 47007.2 8.26E-02 1.4377 5.88E-03 6.01E+02	.2218 45083.0 2.93E-02 1.4725 5.88E-03 1.88E+02	.2315 43188.5 7.08E-03 1.5101 5.88E-03 3.99E+01*	.2420 41323.8 1.20E-03 1.5514 5.88E-03 5.94E+00*	.2532 39489.1 1.44E-04 1.5972 5.88E-03 6.22E-01*	.2654 37684.4 1.21E-05 1.6492 5.88E-03 4.55E-02*	.2785 35910.1 6.93E-07 1.7105 5.88E-03 2.25E-03*	.2927 34166.3 2.52E-08 1.7871 5.88E-03 7.05E-05*
6	.1835 54484.4 4.77E-02 1.3186 5.88E-03 5.40E+02	.1906 52471.9 3.37E-03 1.3761 5.88E-03 3.41E+01*	.1981 50488.8 9.64E-02 1.3846 5.88E-03 8.69E+02	.2060 48535.1 1.60E-01 1.4135 5.88E-03 1.28E+03	.2145 46610.9 1.18E-01 1.4456 5.88E-03 8.35E+02	.2236 44716.4 5.10E-02 1.4804 5.88E-03 3.19E+02	.2334 42851.7 1.45E-02 1.5181 5.88E-03 7.97E+01	.2438 41017.0 2.80E-03 1.5595 5.88E-03 1.35E+01*	.2550 39212.4 3.77E-04 1.6056 5.88E-03 1.59E+00*	.2671 37438.0 3.49E-05 1.6582 5.88E-03 1.28E-01*	.2802 35694.2 2.15E-06 1.7204 5.88E-03 6.86E-03*
7	.1786 55984.9 3.63E-02 1.3077 5.88E-03 4.46E+02	.1853 53972.4 8.24E-02 1.3288 5.88E-03 9.08E+02	.1923 51989.3 8.31E-03 1.3429 5.88E-03 8.18E+01*	.1999 50035.6 4.05E-02 1.3958 5.88E-03 3.55E+02	.2079 48111.4 1.43E-01 1.4221 5.88E-03 1.12E+03	.2164 46216.9 1.46E-01 1.4538 5.88E-03 1.01E+03	.2255 44352.2 7.87E-02 1.4885 5.88E-03 4.81E+02	.2352 42517.5 2.63E-02 1.5263 5.88E-03 1.42E+02	.2456 40712.9 5.83E-03 1.5678 5.88E-03 2.76E+01*	.2568 38938.5 8.78E-04 1.6142 5.88E-03 3.63E+00*	.2689 37194.7 8.92E-05 1.6673 5.88E-03 3.22E-01*

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 6. Radiative transition parameters for N_2 $a^1\Pi_g-X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v'-v''$	0	1	2	3	4	5	6	7	8	9	10
8	.1227 81507.0 3.15E-02 1.0450 5.88E-03 1.20E+03	.1263 79176.6 9.21E-02 1.0648 5.88E-03 3.20E+03	.1301 76875.0 3.30E-02 1.0865 5.88E-03 1.05E+03	.1340 74602.2 1.86E-02 1.1009 5.88E-03 5.40E+02	.1382 72358.1 5.32E-02 1.1256 5.88E-03 1.41E+03	.1426 70142.9 4.12E-03 1.1347 5.88E-03 9.96E+01*	.1472 67956.4 5.46E-02 1.1674 5.88E-03 1.20E+03	.1520 65798.8 4.27E-03 1.1756 5.88E-03 8.52E+01*	.1571 63670.1 5.14E-02 1.2126 5.88E-03 9.29E+02	.1624 61570.3 1.59E-02 1.2272 5.88E-03 2.59E+02	.1681 59499.6 3.42E-02 1.2628 5.88E-03 5.05E+02
9	.1206 82952.9 1.79E-02 1.0333 5.88E-03 7.17E+02	.1240 80622.5 7.37E-02 1.0527 5.88E-03 2.71E+03	.1277 78320.9 6.04E-02 1.0730 5.88E-03 2.03E+03	.1315 76048.1 1.69E-04 1.0522 5.88E-03 5.20E+00*	.1355 73804.1 5.48E-02 1.1109 5.88E-03 1.54E+03	.1397 71588.8 9.31E-03 1.1380 5.88E-03 2.39E+02*	.1441 69402.3 3.93E-02 1.1505 5.88E-03 9.20E+02	.1487 67244.7 1.66E-02 1.1791 5.88E-03 3.53E+02	.1536 65116.0 3.76E-02 1.1930 5.88E-03 7.28E+02	.1587 63016.3 1.32E-02 1.2258 5.88E-03 2.31E+02	.1641 60945.5 4.94E-02 1.2397 5.88E-03 7.84E+02
10	.1185 84371.6 9.85E-03 1.0220 5.88E-03 4.14E+02*	.1219 82041.3 5.32E-02 1.0409 5.88E-03 2.06E+03	.1254 79739.7 7.34E-02 1.0606 5.88E-03 2.61E+03	.1291 77466.9 9.44E-03 1.0840 5.88E-03 3.07E+02*	.1329 75222.8 2.81E-02 1.0965 5.88E-03 8.37E+02	.1370 73007.6 3.92E-02 1.1202 5.88E-03 1.07E+03	.1412 70821.1 4.85E-03 1.1293 5.88E-03 1.21E+02*	.1456 68663.5 4.77E-02 1.1603 5.88E-03 1.08E+03	.1503 66534.8 6.68E-04 1.1476 5.88E-03 1.38E+01*	.1552 64435.0 4.98E-02 1.2033 5.88E-03 9.33E+02	.1603 62364.3 1.16E-03 1.1953 5.88E-03 1.96E+01*
11	.1166 85763.4 5.26E-03 1.0111 5.88E-03 2.32E+02*	.1199 83433.1 3.56E-02 1.0297 5.88E-03 1.45E+03	.1233 81131.5 7.15E-02 1.0489 5.88E-03 2.68E+03	.1268 78858.6 3.15E-02 1.0695 5.88E-03 1.08E+03	.1305 76614.6 4.64E-03 1.0794 5.88E-03 1.46E+02*	.1344 74399.3 4.91E-02 1.1059 5.88E-03 1.42E+03	.1385 72212.9 5.11E-03 1.1346 5.88E-03 1.35E+02*	.1427 70055.3 3.39E-02 1.1441 5.88E-03 8.16E+02	.1472 67926.5 1.84E-02 1.1716 5.88E-03 4.04E+02	.1519 65826.8 2.38E-02 1.1841 5.88E-03 4.76E+02	.1568 63756.1 2.45E-02 1.2145 5.88E-03 4.45E+02
12	.1148 87128.3 2.75E-03 1.0005 5.88E-03 1.27E+02*	.1179 84797.9 2.26E-02 1.0188 5.88E-03 9.64E+02	.1212 82496.4 6.05E-02 1.0376 5.88E-03 2.38E+03	.1247 80223.5 5.06E-02 1.0572 5.88E-03 1.83E+03	.1282 77979.5 1.10E-02 1.0897 5.88E-03 3.67E+01*	.1320 75764.2 3.29E-02 1.0924 5.88E-03 1.00E+03	.1359 73577.7 2.89E-02 1.1156 5.88E-03 8.06E+02	.1400 71420.1 5.42E-03 1.1245 5.88E-03 1.38E+02*	.1443 69291.4 4.20E-02 1.1541 5.88E-03 9.78E+02	.1488 67191.7 2.81E-02 1.1627 5.88E-03 5.98E+02*	.1536 65120.9 4.31E-02 1.1951 5.88E-03 8.33E+02
13	.1130 88466.4 1.41E-03 .9903 5.88E-03 6.86E+01*	.1161 86136.1 1.37E-02 1.0084 5.88E-03 6.13E+02	.1193 83834.5 4.64E-02 1.0268 5.88E-03 1.92E+03	.1226 81561.6 5.93E-02 1.0458 5.88E-03 2.25E+03	.1261 79317.6 1.38E-02 1.0673 5.88E-03 4.82E+02	.1297 77102.3 1.09E-02 1.0781 5.88E-03 3.49E+02	.1335 74915.9 4.24E-02 1.1017 5.88E-03 1.25E+03	.1374 72758.2 2.59E-03 1.1332 5.88E-03 7.00E+01*	.1416 70629.5 3.00E-02 1.1386 5.88E-03 7.39E+02	.1459 68529.8 1.88E-02 1.1653 5.88E-03 4.24E+02	.1505 66459.1 1.48E-02 1.1759 5.88E-03 3.05E+02
14	.1114 89777.9 7.19E-04 .9805 5.88E-03 3.65E+01*	.1144 87447.6 8.05E-03 .9983 5.88E-03 3.77E+02*	.1174 85146.0 3.32E-02 1.0163 5.88E-03 1.43E+03	.1207 82873.1 5.79E-02 1.0349 5.88E-03 2.31E+03	.1240 80629.1 3.12E-02 1.0547 5.88E-03 1.14E+03	.1275 78413.8 2.50E-04 1.0398 5.88E-03 8.44E+00*	.1312 76227.4 3.46E-02 1.0888 5.88E-03 1.07E+03	.1350 74069.7 2.10E-02 1.1119 5.88E-03 5.97E+02	.1390 71941.0 6.07E-03 1.1205 5.88E-03 1.58E+02*	.1432 69841.3 3.71E-02 1.1488 5.88E-03 8.86E+02	.1476 67770.6 3.79E-04 1.2111 5.88E-03 8.26E+00*
15	.1098 91062.9 3.63E-04 .9710 5.88E-03 1.92E+01*	.1127 88732.6 4.61E-03 .9885 5.88E-03 2.26E+02*	.1157 86431.0 2.24E-02 1.0063 5.88E-03 1.01E+03	.1188 84158.2 5.00E-02 1.0245 5.88E-03 2.09E+03	.1221 81914.1 4.42E-02 1.0435 5.88E-03 1.70E+03	.1255 79698.8 4.29E-03 1.0677 5.88E-03 1.52E+02*	.1290 77512.4 1.65E-02 1.0758 5.88E-03 5.38E+02	.1327 75354.8 3.57E-02 1.0983 5.88E-03 1.07E+03	.1366 73226.1 1.04E-03 1.1358 5.88E-03 2.87E+01*	.1406 71126.3 2.72E-02 1.1340 5.88E-03 6.85E+02	.1448 69055.6 1.81E-02 1.1599 5.88E-03 4.18E+02

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

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$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	.1740 57458.0 5.11E-02 1.2809 5.88E-03 6.79E+02	.1804 55445.6 2.34E-03 1.3373 5.88E-03 2.79E+01*	.1870 53462.5 7.72E-02 1.3385 5.88E-03 8.27E+02	.1941 51508.8 4.34E-02 1.3604 5.88E-03 4.15E+02	.2017 49584.6 5.16E-03 1.4199 5.88E-03 4.41E+01*	.2097 47690.1 1.03E-01 1.4315 5.88E-03 7.82E+02	.2182 45825.4 1.59E-01 1.4623 5.88E-03 1.07E+03	.2273 43990.6 1.09E-01 1.4968 5.88E-03 6.51E+02	.2370 42186.0 4.34E-02 1.5346 5.88E-03 2.28E+02	.2475 40411.7 1.10E-02 1.5763 5.88E-03 5.10E+01	.2586 38667.8 1.86E-03 1.6230 5.88E-03 7.53E+00*
9	.1698 58903.9 2.26E-03 1.2902 5.88E-03 3.24E+01*	.1758 56891.5 6.43E-02 1.2912 5.88E-03 8.29E+02	.1821 54908.4 8.99E-03 1.3033 5.88E-03 1.04E+02*	.1888 52954.7 4.11E-02 1.3496 5.88E-03 4.28E+02	.1960 51030.5 7.55E-02 1.3712 5.88E-03 7.03E+02	.2035 49136.0 3.34E-03 1.3729 5.88E-03 2.77E+01*	.2115 47271.3 5.45E-02 1.4424 5.88E-03 4.03E+02	.2201 45436.5 1.52E-01 1.4712 5.88E-03 9.97E+02	.2292 43631.9 1.37E-01 1.5053 5.88E-03 7.97E+02	.2389 41857.6 6.56E-02 1.5431 5.88E-03 3.37E+02	.2493 40113.8 1.92E-02 1.5850 5.88E-03 8.69E+01
10	.1658 60322.7 5.07E-02 1.2500 5.88E-03 7.79E+02	.1715 58310.3 8.93E-03 1.2611 5.88E-03 1.24E+02*	.1775 56327.1 4.01E-02 1.3020 5.88E-03 5.02E+02	.1839 54373.4 4.03E-02 1.3199 5.88E-03 4.54E+02	.1907 52449.3 7.48E-02 1.3691 5.88E-03 7.56E+01*	.1978 50554.7 8.02E-02 1.3813 5.88E-03 7.26E+02	.2054 48690.0 2.85E-02 1.4019 5.88E-03 2.30E+02	.2134 46855.3 1.59E-02 1.4590 5.88E-03 1.15E+02	.2220 45050.7 1.24E-01 1.4806 5.88E-03 7.97E+02	.2311 43276.4 1.56E-01 1.5141 5.88E-03 8.87E+02	.2408 41532.5 9.15E-02 1.5518 5.88E-03 4.59E+02
11	.1620 61714.4 2.46E-02 1.2279 5.88E-03 4.05E+02	.1675 59702.0 2.15E-02 1.2621 5.88E-03 3.21E+02	.1733 57718.9 3.78E-02 1.2768 5.88E-03 5.09E+02	.1793 55765.2 8.48E-03 1.3193 5.88E-03 1.03E+02*	.1857 53841.0 6.08E-02 1.3309 5.88E-03 6.64E+02	.1925 51946.5 1.67E-03 1.3197 5.88E-03 1.64E+01*	.1997 50081.8 5.64E-02 1.3920 5.88E-03 4.96E+02	.2073 48247.1 6.07E-02 1.4143 5.88E-03 4.78E+02	.2153 46442.4 1.42E-04 1.6356 5.88E-03 9.96E-01*	.2239 44668.1 8.45E-02 1.4911 5.88E-03 5.27E+02	.2330 42924.3 1.62E-01 1.5233 5.88E-03 8.97E+02
12	.1585 63079.3 1.15E-03 1.2472 5.88E-03 2.02E+01*	.1638 61066.9 4.51E-02 1.2393 5.88E-03 7.20E+02	.1693 59083.8 5.86E-04 1.3127 5.88E-03 8.47E+00*	.1750 57130.1 5.12E-02 1.2877 5.88E-03 6.68E+02	.1811 55205.9 1.19E-03 1.2724 5.88E-03 1.40E+01*	.1876 53311.4 5.17E-02 1.3417 5.88E-03 5.49E+02	.1944 51446.7 2.27E-02 1.3578 5.88E-03 2.17E+02	.2016 49611.9 2.27E-02 1.4059 5.88E-03 1.95E+02	.2092 47807.3 7.92E-02 1.4250 5.88E-03 6.07E+02	.2172 46033.0 9.30E-03 1.4362 5.88E-03 6.36E+01*	.2258 44289.2 4.35E-02 1.5041 5.88E-03 2.65E+02
13	.1552 64417.4 3.06E-02 1.2058 5.88E-03 5.73E+02	.1602 62405.0 8.52E-03 1.2148 5.88E-03 1.45E+02*	.1655 60421.9 3.59E-02 1.2502 5.88E-03 5.54E+02	.1710 58468.2 9.56E-03 1.2598 5.88E-03 1.34E+02*	.1769 56544.0 3.54E-02 1.2990 5.88E-03 4.48E+02	.1830 54649.5 2.06E-02 1.3126 5.88E-03 2.35E+02	.1894 52784.8 2.38E-02 1.3547 5.88E-03 2.45E+02	.1963 50950.1 4.91E-02 1.3709 5.88E-03 4.55E+02	.2035 49145.4 1.76E-03 1.4484 5.88E-03 1.46E+01*	.2111 47371.1 7.40E-02 1.4357 5.88E-03 5.51E+02	.2192 45627.3 3.48E-02 1.4564 5.88E-03 2.32E+02
14	.1521 65728.9 3.54E-02 1.1879 5.88E-03 7.04E+02	.1569 63716.5 6.22E-03 1.2221 5.88E-03 1.13E+02*	.1620 61733.4 3.12E-02 1.2296 5.88E-03 5.15E+02	.1673 59779.7 1.09E-02 1.2648 5.88E-03 1.63E+02	.1728 57855.5 3.29E-02 1.2751 5.88E-03 4.46E+02	.1787 55961.0 9.66E-03 1.3154 5.88E-03 1.19E+02*	.1849 54096.3 4.33E-02 1.3256 5.88E-03 4.80E+02	.1913 52261.6 2.41E-03 1.3872 5.88E-03 2.41E+01*	.1982 50456.9 5.87E-02 1.3821 5.88E-03 5.29E+02	.2054 48682.6 4.64E-03 1.3834 5.88E-03 3.75E+01*	.2130 46938.8 4.94E-02 1.4473 5.88E-03 3.58E+02
15	.1492 67014.0 9.41E-03 1.1685 5.88E-03 1.98E+02*	.1538 65001.5 3.21E-02 1.1987 5.88E-03 6.17E+02	.1587 63018.4 1.53E-03 1.1925 5.88E-03 2.69E+01*	.1638 61064.7 3.81E-02 1.2407 5.88E-03 6.08E+02	.1691 59140.5 8.47E-05 1.1331 5.88E-03 1.23E+00*	.1747 57246.0 4.20E-02 1.2865 5.88E-03 5.53E+02	.1806 55381.3 1.89E-04 1.2083 5.88E-03 2.25E+00*	.1868 53546.6 4.66E-02 1.3369 5.88E-03 5.02E+02	.1933 51742.0 3.75E-03 1.3358 5.88E-03 3.64E+01*	.2001 49967.6 4.53E-02 1.3938 5.88E-03 3.96E+02	.2074 48223.8 2.56E-02 1.4093 5.88E-03 2.01E+02

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$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.1083 92321.6 1.82E-04 .9618 5.88E-03 1.01E+01*	.1111 89991.3 2.59E-03 .9791 5.88E-03 1.32E+02*	.1140 87689.7 1.46E-02 .9966 5.88E-03 6.88E+02	.1171 85416.9 3.97E-02 1.0145 5.88E-03 1.73E+03	.1202 83172.8 4.96E-02 1.0329 5.88E-03 2.00E+03	.1235 80957.5 1.68E-02 1.0532 5.88E-03 6.23E+02	.1270 78771.1 2.93E-03 1.0593 5.88E-03 1.00E+02*	.1305 76613.5 3.41E-02 1.0859 5.88E-03 1.07E+03	.1343 74484.8 1.47E-02 1.1090 5.88E-03 4.24E+02	.1382 72385.0 6.94E-03 1.1173 5.88E-03 1.84E+02*	.1422 70314.3 3.30E-02 1.1443 5.88E-03 8.04E+02
17	.1069 93554.2 9.16E-05 .9530 5.88E-03 5.25E+00*	.1096 91223.8 1.44E-03 .9700 5.88E-03 7.66E+01*	.1125 88922.2 9.17E-03 .9873 5.88E-03 4.52E+02*	.1154 86649.4 2.96E-02 1.0049 5.88E-03 1.35E+03	.1185 84405.4 4.80E-02 1.0229 5.88E-03 2.02E+03	.1217 82190.1 2.99E-02 1.0420 5.88E-03 1.16E+03	.1250 80003.6 4.20E-04 1.0821 5.88E-03 1.51E+01*	.1285 77846.0 2.08E-02 1.0737 5.88E-03 6.89E+02	.1321 75717.3 2.91E-02 1.0956 5.88E-03 8.84E+02	.1358 73617.6 2.02E-04 1.1563 5.88E-03 5.64E+00*	.1398 71546.8 2.53E-02 1.1302 5.88E-03 6.49E+02
18	.1055 94760.7 4.61E-05 .9445 5.88E-03 2.75E+00*	.1082 92430.4 7.92E-04 .9613 5.88E-03 4.38E+01*	.1110 90128.8 5.64E-03 .9783 5.88E-03 2.89E+02*	.1138 87856.0 2.10E-02 .9956 5.88E-03 9.98E+02	.1168 85611.9 4.20E-02 1.0133 5.88E-03 1.85E+03	.1199 83396.6 3.88E-02 1.0317 5.88E-03 1.58E+03	.1231 81210.2 7.19E-03 1.0534 5.88E-03 2.70E+02*	.1265 79052.6 7.11E-03 1.0605 5.88E-03 2.46E+02*	.1300 76923.9 3.20E-02 1.0836 5.88E-03 1.02E+03	.1336 74824.1 9.54E-03 1.1072 5.88E-03 2.80E+02*	.1375 72753.4 8.08E-03 1.1148 5.88E-03 2.18E+02*
19	.1042 95941.5 2.32E-05 .9363 5.88E-03 1.44E+00*	.1068 93611.1 4.34E-04 .9528 5.88E-03 2.49E+01*	.1095 91309.5 3.40E-03 .9696 5.88E-03 1.82E+02*	.1123 89036.7 1.44E-02 .9867 5.88E-03 7.11E+02	.1152 86792.6 3.42E-02 1.0041 5.88E-03 1.56E+03	.1182 84577.4 4.21E-02 1.0220 5.88E-03 1.78E+03	.1214 82390.9 1.79E-02 1.0415 5.88E-03 7.01E+02	.1246 80233.3 3.42E-04 1.0291 5.88E-03 1.24E+01*	.1280 78104.6 2.37E-02 1.0721 5.88E-03 7.91E+02	.1316 76004.8 2.27E-02 1.0936 5.88E-03 6.98E+02	.1353 73934.1 1.62E-05 .9604 5.88E-03 4.59E-01*
20	.1030 97096.5 1.18E-05 .9285 5.88E-03 7.57E-01*	.1055 94766.2 2.37E-04 .9448 5.88E-03 1.41E+01*	.1081 92464.6 2.03E-03 .9613 5.88E-03 1.12E+02*	.1109 90191.8 9.57E-03 .9781 5.88E-03 4.92E+02*	.1137 87947.7 2.63E-02 .9952 5.88E-03 1.25E+03	.1166 85732.5 4.05E-02 1.0128 5.88E-03 1.79E+03	.1197 83546.0 2.77E-02 1.0312 5.88E-03 1.13E+03	.1229 81388.4 1.84E-03 1.0581 5.88E-03 6.95E+01*	.1262 79259.7 1.16E-02 1.0604 5.88E-03 4.05E+02	.1296 77159.9 2.87E-02 1.0820 5.88E-03 9.22E+02	.1332 75089.2 5.46E-03 1.1068 5.88E-03 1.62E+02*
21	.1018 98226.2 6.04E-06 .9211 5.88E-03 4.01E-01*	.1043 95895.8 1.29E-04 .9370 5.88E-03 7.99E+00*	.1068 93594.2 1.20E-03 .9533 5.88E-03 6.89E+01*	.1095 91321.4 6.23E-03 .9698 5.88E-03 3.33E+02*	.1123 89077.4 1.94E-02 .9867 5.88E-03 9.63E+02	.1151 86862.1 3.58E-02 1.0039 5.88E-03 1.64E+03	.1181 84675.6 3.38E-02 1.0218 5.88E-03 1.44E+03	.1212 82518.0 8.81E-03 1.0423 5.88E-03 3.47E+02*	.1244 80389.3 2.70E-03 1.0455 5.88E-03 9.84E+01*	.1277 78289.6 2.49E-02 1.0711 5.88E-03 8.38E+02	.1312 76218.8 1.66E-02 1.0925 5.88E-03 5.16E+02

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 6. Radiative transition parameters for N_2 $a^1\Pi_g-X^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	.1465 68272.7 8.64E-04 1.1907 5.88E-03 1.93E+01*	.1509 66260.3 2.87E-02 1.1817 5.88E-03 5.84E+02	.1556 64277.1 1.12E-02 1.2121 5.88E-03 2.09E+02	.1605 62323.4 1.86E-02 1.2205 5.88E-03 3.15E+02	.1656 60399.2 2.19E-02 1.2527 5.88E-03 3.38E+02	.1709 58504.7 1.28E-02 1.2617 5.88E-03 1.80E+02	.1766 56640.0 2.81E-02 1.2984 5.88E-03 3.57E+02	.1825 54805.3 1.34E-02 1.3080 5.88E-03 1.55E+02	.1887 53000.7 2.89E-02 1.3493 5.88E-03 3.02E+02	.1952 51226.3 2.31E-02 1.3618 5.88E-03 2.18E+02	.2021 49482.5 2.03E-02 1.4083 5.88E-03 1.73E+02
17	.1439 69505.2 1.67E-02 1.1555 5.88E-03 3.93E+02	.1482 67492.8 6.36E-03 1.1619 5.88E-03 1.37E+02*	.1526 65509.7 3.09E-02 1.1926 5.88E-03 6.08E+02	.1573 63556.0 2.41E-10 -63.3420 5.88E-03 4.33E-06*	.1623 61631.8 3.30E-02 1.2326 5.88E-03 5.42E+02	.1674 59737.3 3.12E-03 1.2755 5.88E-03 4.66E+01*	.1728 57872.6 3.14E-02 1.2757 5.88E-03 4.27E+02	.1785 56037.8 7.16E-03 1.3164 5.88E-03 8.82E+01*	.1844 54233.2 3.31E-02 1.3227 5.88E-03 3.70E+02	.1906 52458.9 7.32E-03 1.3690 5.88E-03 7.40E+01*	.1972 50715.1 4.20E-02 1.3752 5.88E-03 3.84E+02
18	.1414 70711.8 2.93E-02 1.1406 5.88E-03 7.27E+02	.1456 68699.3 1.09E-03 1.1827 5.88E-03 2.47E+01*	.1499 66716.2 2.35E-02 1.1765 5.88E-03 4.89E+02	.1544 64762.5 1.44E-02 1.2052 5.88E-03 2.74E+02	.1591 62838.3 9.98E-03 1.2116 5.88E-03 1.73E+02*	.1641 60943.8 2.73E-02 1.2442 5.88E-03 4.34E+02	.1693 59079.1 2.37E-03 1.2400 5.88E-03 3.42E+01*	.1747 57244.4 3.45E-02 1.2874 5.88E-03 4.53E+02	.1804 55439.8 3.06E-04 1.2306 5.88E-03 3.65E+00*	.1863 53665.4 3.93E-02 1.3347 5.88E-03 4.26E+02	.1926 51921.6 2.20E-04 1.2671 5.88E-03 2.16E+00*
19	.1391 71892.5 2.40E-02 1.1271 5.88E-03 6.24E+02	.1431 69880.1 1.47E-02 1.1521 5.88E-03 3.51E+02	.1473 67897.0 4.78E-03 1.1566 5.88E-03 1.05E+02*	.1516 65943.2 2.85E-02 1.1877 5.88E-03 5.73E+02	.1562 64019.1 6.91E-04 1.2440 5.88E-03 1.27E+01*	.1610 62124.6 2.60E-02 1.2256 5.88E-03 4.37E+02	.1659 60259.8 9.44E-03 1.2592 5.88E-03 1.45E+02*	.1712 58425.1 1.77E-02 1.2653 5.88E-03 2.47E+02	.1766 56620.5 1.97E-02 1.3003 5.88E-03 2.51E+02	.1823 54846.2 1.21E-02 1.3072 5.88E-03 1.39E+02	.1883 53102.3 2.69E-02 1.3474 5.88E-03 2.83E+02
20	.1369 73047.6 9.51E-03 1.1130 5.88E-03 2.60E+02*	.1408 71035.2 2.60E-02 1.1377 5.88E-03 6.52E+02	.1448 69052.0 9.87E-04 1.1796 5.88E-03 2.28E+01*	.1490 67098.3 2.00E-02 1.1722 5.88E-03 4.22E+02	.1534 65174.1 1.58E-02 1.1999 5.88E-03 3.05E+02	.1580 63279.6 5.09E-03 1.2026 5.88E-03 9.03E+01*	.1628 61414.9 2.80E-02 1.2373 5.88E-03 4.54E+02	.1678 59580.2 4.22E-06 1.8198 5.88E-03 6.26E-02*	.1731 57775.6 3.02E-02 1.2782 5.88E-03 4.09E+02	.1786 56001.3 3.34E-03 1.3242 5.88E-03 4.11E+01*	.1843 54257.4 2.85E-02 1.3223 5.88E-03 3.19E+02
21	.1348 74177.2 5.12E-04 1.0820 5.88E-03 1.46E+01*	.1386 72164.8 2.30E-02 1.1249 5.88E-03 6.05E+02	.1425 70181.7 1.23E-02 1.1496 5.88E-03 2.98E+02	.1466 68228.0 4.13E-03 1.1528 5.88E-03 9.19E+01*	.1508 66303.8 2.59E-02 1.1837 5.88E-03 5.29E+02	.1553 64409.3 1.77E-03 1.2250 5.88E-03 3.30E+01*	.1599 62544.6 1.98E-02 1.2196 5.88E-03 3.39E+02	.1647 60709.8 1.44E-02 1.2506 5.88E-03 2.25E+02	.1698 58905.2 7.95E-03 1.2543 5.88E-03 1.14E+02*	.1750 57130.9 2.63E-02 1.2904 5.88E-03 3.44E+02	.1805 55387.1 1.35E-03 1.2740 5.88E-03 1.61E+01*

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 7. Radiative transition parameters for N_2 $a^1\Pi_g - a'^1\Sigma_u^-$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	8.2515 1211.9 6.01E-01 1.2527 2.12E-01 9.74E+01 9.74E+01	-33.9751 -294.3 2.81E-01 1.2008 2.28E-01 -1.51E+00 -1.51E+00	-5.6281 -1776.8 8.75E-02 1.1576 2.42E-01 -1.16E+02 -1.17E+02	-3.0905 -3235.7 2.32E-02 1.1203 2.53E-01 -2.04E+02 -2.05E+02	-2.1408 -4671.3 5.70E-03 1.0876 2.63E-01 -1.63E+02 -1.64E+02	-1.6437 -6083.7 1.36E-03 1.0583 2.72E-01 -9.13E+01 -9.20E+01	-1.3381 -7473.3 3.19E-04 1.0318 2.79E-01 -4.21E+01 -4.25E+01	-1.1312 -8840.2 7.55E-05 1.0078 2.86E-01 -1.73E+01 -1.75E+01	-.9819 -10184.6 1.81E-05 .9859 2.92E-01 -6.59E+00 -6.67E+00	-.8691 -11506.7 4.42E-06 .9657 2.97E-01 -2.40E+00 -2.43E+00	-.7808 -12806.7 1.11E-06 .9473 3.01E-01 -8.53E-01 -8.66E-01
1	3.4743 2878.2 3.30E-01 1.3101 1.94E-01 5.98E+02 5.98E+02	7.2886 1372.0 1.47E-01 1.2688 2.07E-01 3.30E+01 3.30E+01	-90.5412 -110.4 2.78E-01 1.2095 2.26E-01 -7.74E-02 -7.74E-02	-6.3721 -1569.3 1.57E-01 1.1648 2.40E-01 -1.41E+02 -1.41E+02	-3.3279 -3004.9 6.04E-02 1.1269 2.51E-01 -4.20E+02 -4.21E+02	-2.2638 -4417.4 1.95E-02 1.0938 2.61E-01 -4.66E+02 -4.67E+02	-1.7221 -5807.0 5.75E-03 1.0643 2.70E-01 -3.33E+02 -3.35E+02	-1.3940 -7173.9 1.62E-03 1.0378 2.78E-01 -1.87E+02 -1.88E+02	-1.1739 -8518.3 4.45E-04 1.0137 2.84E-01 -9.01E+01 -9.10E+01	-1.0162 -9840.4 1.22E-04 .9917 2.90E-01 -3.95E+01 -4.00E+01	-.8976 -11140.3 3.34E-05 .9715 2.95E-01 -1.63E+01 -1.65E+01
2	2.2140 4516.8 6.39E-02 1.3798 1.72E-01 3.52E+02 3.51E+02	3.3217 3010.5 4.06E-01 1.3196 1.91E-01 8.17E+02 8.17E+02	6.5442 1528.1 8.92E-03 1.3294 1.88E-01 2.27E+00 2.28E+00	144.5651 69.2 1.85E-01 1.2196 2.23E-01 6.14E-03 6.13E-03	-7.3185 -1366.4 1.80E-01 1.1723 2.37E-01 -1.05E+02 -1.05E+02	-3.5986 -2778.9 9.62E-02 1.1336 2.49E-01 -5.20E+02 -5.21E+02	-2.3990 -4168.4 3.95E-02 1.1001 2.60E-01 -7.80E+02 -7.83E+02	-1.8066 -5535.3 1.41E-02 1.0705 2.68E-01 -6.96E+02 -7.00E+02	-1.4535 -6879.7 4.64E-03 1.0438 2.76E-01 -4.66E+02 -4.69E+02	-1.2192 -8201.8 1.46E-03 1.0196 2.83E-01 -2.61E+02 -2.64E+02	-1.0524 -9501.8 4.50E-04 .9975 2.88E-01 -1.30E+02 -1.32E+02
3	1.6320 6127.5 5.25E-03 1.4705 1.45E-01 5.13E+01 5.03E+01	2.1639 4621.3 1.48E-01 1.3885 1.69E-01 8.45E+02 8.43E+02	3.1859 3138.8 3.60E-01 1.3300 1.87E-01 7.92E+02 7.94E+02	5.9526 1679.9 1.23E-02 1.2070 2.26E-01 6.06E+00 6.03E+00	40.9231 244.4 9.04E-02 1.2329 2.18E-01 1.27E-01 1.27E-01	-8.5609 -1168.1 1.63E-01 1.1804 2.35E-01 -5.81E+01 -5.80E+01	-3.9098 -2557.7 1.19E-01 1.1406 2.47E-01 -4.95E+02 -4.95E+02	-2.5481 -3924.6 6.11E-02 1.1066 2.58E-01 -9.92E+02 -9.95E+02	-1.8979 -5269.0 2.59E-02 1.0766 2.66E-01 -1.09E+03 -1.10E+03	-1.5172 -6591.1 9.88E-03 1.0498 2.74E-01 -8.61E+02 -8.67E+02	-1.2673 -7891.1 3.53E-03 1.0255 2.81E-01 -5.54E+02 -5.59E+02
4	1.2969 7710.6 1.69E-04 1.6063 1.08E-01 (1.83E+00) 1.66E+00	1.6118 6204.4 1.77E-02 1.4796 1.42E-01 1.73E+02 1.70E+02	2.1178 4721.9 2.26E-01 1.3974 1.67E-01 1.34E+03 1.34E+03	3.0647 3263.0 2.68E-01 1.3421 1.84E-01 6.37E+02 6.40E+02	5.4722 1827.4 6.19E-02 1.2483 2.13E-01 3.48E+01 3.47E+01	24.0982 415.0 2.82E-02 1.2562 2.11E-01 1.82E-01 1.81E-01	-10.2605 -974.6 1.24E-01 1.1895 2.32E-01 -2.51E+01 -2.50E+01	-4.2708 -2341.5 1.26E-01 1.1478 2.45E-01 -3.92E+02 -3.92E+02	-2.7130 -3685.9 7.94E-02 1.1131 2.56E-01 -1.05E+03 -1.05E+03	-1.9968 -5008.0 3.97E-02 1.0829 2.65E-01 -1.41E+03 -1.42E+03	-1.5853 -6308.0 1.73E-02 1.0559 2.72E-01 -1.31E+03 -1.31E+03
5	1.0792 9266.1 1.25E-06 1.9156 4.73E-02 (4.50E-03) 7.14E-04	1.2887 7759.8 7.29E-04 1.6185 1.05E-01 7.60E+00 6.85E+00	1.5930 6277.4 3.73E-02 1.4890 1.39E-01 3.63E+02 3.56E+02	2.0753 4818.5 2.88E-01 1.4067 1.64E-01 1.75E+03 1.75E+03	2.9560 3382.9 1.74E-01 1.3570 1.79E-01 4.38E+02 4.41E+02	5.0750 1970.4 1.11E-01 1.2637 2.08E-01 7.47E+01 7.45E+01	17.2160 580.9 2.10E-03 1.3609 1.78E-01 2.63E-02 2.58E-02	-12.7221 -786.0 7.97E-02 1.2003 2.29E-01 -8.20E+00 -8.16E+00	-4.6939 -2130.4 1.16E-01 1.1554 2.43E-01 -2.69E+02 -2.68E+02	-2.8964 -3452.5 9.11E-02 1.1199 2.54E-01 -9.76E+02 -9.77E+02	-2.1041 -4752.5 5.32E-02 1.0892 2.63E-01 -1.60E+03 -1.60E+03
6	.9264 10794.0 1.42E-09 .3303 3.18E-01 (3.67E-04) 5.40E-04	1.0767 9287.8 6.01E-06 1.9519 4.23E-02 1.75E-02 1.02E-03	1.2812 7805.3 1.88E-03 1.6311 1.02E-01 1.88E+01 1.69E+01	1.5757 6346.4 6.27E-02 1.4985 1.37E-01 6.07E+02 5.97E+02	2.0363 4910.8 3.29E-01 1.4164 1.61E-01 2.04E+03 2.04E+03	2.8585 3498.4 9.70E-02 1.3771 1.73E-01 2.51E+02 2.55E+02	4.7421 2108.8 1.41E-01 1.2751 2.05E-01 1.13E+02 1.12E+02	13.4790 741.9 3.49E-03 1.1300 2.50E-01 1.81E-01 1.83E-01	-16.5974 -602.5 4.14E-02 1.2146 2.24E-01 -1.84E+00 -1.83E+00	-5.1959 -1924.6 9.65E-02 1.1636 2.40E-01 -1.61E+02 -1.60E+02	-3.1012 -3224.6 9.43E-02 1.1268 2.51E-01 -8.10E+02 -8.09E+02
7	.8134 12294.5 1.40E-10 1.8458 5.81E-02 (1.78E-06) 1.70E-09	.9269 10788.2 1.52E-08 .6611 3.45E-01 (4.59E-03) 3.61E-03	1.0746 9305.8 1.66E-05 1.9935 3.71E-02 (3.73E-02) 4.48E-06	1.2744 7846.9 3.78E-03 1.6442 9.87E-02 (3.61E+01) 3.21E+01	1.5597 6411.3 9.25E-02 1.5083 1.34E-01 8.87E+02 8.72E+02	2.0005 4998.9 3.49E-01 1.4266 1.58E-01 2.19E+03 2.20E+03	2.7706 3609.3 4.35E-02 1.4093 1.63E-01 1.10E+02 1.13E+02	4.4595 2242.4 1.50E-01 1.2855 2.02E-01 1.39E+02 1.39E+02	11.1360 898.0 2.07E-02 1.1988 2.29E-01 1.59E+00 1.59E+00	-23.5783 -424.1 1.51E-02 1.2390 2.16E-01 -2.19E-01 -2.16E-01	-5.8001 -1724.1 7.15E-02 1.1728 2.37E-01 -8.36E-01 -8.32E-01

Table 7. Radiative transition parameters for N_2 $a^1\Pi_g - a'^1\Sigma_u^-$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	-.7100 -14084.7 2.84E-07 .9304 3.05E-01 -2.99E-01 -3.04E-01*	-.6518 -15341.0 7.48E-08 .9149 3.09E-01 -1.04E-01 -1.06E-01*	-.6033 -16575.8 2.03E-08 .9007 3.12E-01 -3.65E-02 -3.71E-02*	-.5621 -17789.0 5.69E-09 .8876 3.15E-01 -1.28E-02 -1.31E-02*	-.5268 -18981.0 1.64E-09 .8753 3.17E-01 -4.56E-03 -4.65E-03*	-.4962 -20151.8 4.84E-10 .8634 3.19E-01 -1.64E-03 -1.67E-03*	-.4694 -21301.6 1.47E-10 .8520 3.22E-01 -5.94E-04 -6.05E-04*	-.4458 -22430.6 4.54E-11 .8408 3.24E-01 -2.17E-04 -2.22E-04*	-.4248 -23538.8 1.43E-11 .8298 3.26E-01 -8.01E-05 -8.17E-05*	-.4061 -24626.3 4.52E-12 .8171 3.28E-01 -2.94E-05 -3.00E-05*	-.3892 -25693.3 1.39E-12 .7981 3.31E-01 -1.05E-05 -1.07E-05*
1	-.8053 -12418.4 9.25E-06 .9530 3.00E-01 -6.46E+00 -6.55E+00*	-.7313 -13674.7 2.61E-06 .9359 3.04E-01 -2.49E+00 -2.53E+00*	-.6707 -14909.4 7.49E-07 .9203 3.07E-01 -9.51E-01 -9.66E-01*	-.6202 -16122.7 2.20E-07 .9059 3.11E-01 -3.61E-01 -3.67E-01*	-.5775 -17314.7 6.61E-08 .8927 3.14E-01 -1.37E-01 -1.39E-01*	-.5410 -18485.5 2.04E-08 .8804 3.16E-01 -5.20E-02 -5.30E-02*	-.5093 -19635.3 6.40E-09 .8687 3.18E-01 -1.99E-02 -2.03E-02*	-.4816 -20764.2 2.05E-09 .8571 3.21E-01 -7.65E-03 -7.80E-03*	-.4572 -21872.4 6.67E-10 .8449 3.23E-01 -2.95E-03 -3.01E-03*	-.4355 -22960.0 2.18E-10 .8313 3.25E-01 -1.13E-03 -1.16E-03*	-.4162 -24027.0 7.12E-11 .8151 3.28E-01 -4.31E-04 -4.42E-04*
2	-.9277 -10779.9 1.37E-04 .9773 2.94E-01 -6.02E+01 -6.09E+01*	-.8308 -12036.2 4.19E-05 .9587 2.98E-01 -2.64E+01 -2.67E+01*	-.7535 -13270.9 1.29E-05 .9416 3.03E-01 -1.12E+01 -1.13E+01*	-.6904 -14484.2 4.01E-06 .9258 3.06E-01 -4.63E+00 -4.70E+00*	-.6379 -15676.1 1.27E-06 .9113 3.10E-01 -1.89E+00 -1.92E+00*	-.5936 -16847.0 4.07E-07 .8978 3.12E-01 -7.70E-01 -7.83E-01*	-.5557 -17996.8 1.33E-07 .8852 3.15E-01 -3.12E-01 -3.18E-01*	-.5229 -19125.7 4.43E-08 .8732 3.18E-01 -1.27E-01 -1.29E-01*	-.4942 -20233.9 1.50E-08 .8615 3.20E-01 -5.15E-02 -5.25E-02*	-.4690 -21321.4 5.16E-09 .8496 3.22E-01 -2.09E-02 -2.13E-02*	-.4467 -22388.4 1.77E-09 .8364 3.24E-01 -8.46E-03 -8.65E-03*
3	-1.0906 -9169.1 1.21E-03 1.0034 2.87E-01 -3.12E+02 -3.15E+02*	-.9592 -10425.4 4.08E-04 .9831 2.92E-01 -1.60E+02 -1.62E+02*	-.8576 -11660.1 1.36E-04 .9645 2.97E-01 -7.71E+01 -7.81E+01*	-.7768 -12873.4 4.54E-05 .9473 3.01E-01 -3.56E+01 -3.61E+01*	-.7110 -14065.4 1.52E-05 .9314 3.05E-01 -1.59E+01 -1.62E+01*	-.6563 -15236.2 5.14E-06 .9167 3.08E-01 -7.01E+00 -7.12E+00*	-.6103 -16386.0 1.76E-06 .9030 3.11E-01 -3.04E+00 -3.09E+00*	-.5709 -17515.0 6.11E-07 .8902 3.14E-01 -1.31E+00 -1.33E+00*	-.5370 -18623.1 2.15E-07 .8781 3.17E-01 -5.64E-01 -5.74E-01*	-.5073 -19710.7 7.65E-08 .8662 3.19E-01 -2.42E-01 -2.46E-01*	-.4813 -20777.7 2.75E-08 .8540 3.21E-01 -1.03E-01 -1.05E-01*
4	-1.3182 -7586.1 6.95E-03 1.0315 2.79E-01 -9.59E+02 -9.66E+02*	-1.1309 -8842.4 2.65E-03 1.0093 2.85E-01 -6.04E+02 -6.09E+02*	-.9924 -10077.1 9.77E-04 .9889 2.91E-01 -3.42E+02 -3.46E+02*	-.8857 -11290.3 3.54E-04 .9702 2.96E-01 -1.80E+02 -1.83E+02*	-.8011 -12482.3 1.27E-04 .9529 3.00E-01 -9.03E+01 -9.15E+01*	-.7324 -13653.1 4.58E-05 .9370 3.04E-01 -4.36E+01 -4.42E+01*	-.6755 -14802.9 1.65E-05 .9221 3.07E-01 -2.05E+01 -2.08E+01*	-.6277 -15931.9 6.01E-06 .9083 3.10E-01 -9.48E+00 -9.63E+00*	-.5869 -17040.1 2.21E-06 .8954 3.13E-01 -4.33E+00 -4.40E+00*	-.5516 -18127.6 8.17E-07 .8830 3.16E-01 -1.96E+00 -2.00E+00*	-.5210 -19194.6 3.05E-07 .8709 3.18E-01 -8.85E-01 -9.01E-01*
5	-1.6582 -6030.6 2.64E-02 1.0620 2.71E-01 -1.72E+03 -1.73E+03*	-1.3723 -7286.9 1.18E-02 1.0375 2.78E-01 -1.43E+03 -1.44E+03*	-1.1735 -8521.6 4.96E-03 1.0152 2.84E-01 -1.00E+03 -1.01E+03*	-1.0272 -9734.9 2.00E-03 .9948 2.89E-01 -6.24E+02 -6.30E+02*	-.9152 -10926.8 7.83E-04 .9760 2.94E-01 -3.58E+02 -3.62E+02*	-.8266 -12097.7 3.03E-04 .9586 2.98E-01 -1.94E+02 -1.96E+02*	-.7549 -13247.5 1.16E-04 .9426 3.02E-01 -1.00E+02 -1.02E+02*	-.6956 -14376.4 4.47E-05 .9276 3.06E-01 -5.03E+01 -5.10E+01*	-.6458 -15484.6 1.72E-05 .9137 3.09E-01 -2.47E+01 -2.51E+01*	-.6034 -16572.1 6.66E-06 .9006 3.12E-01 -1.19E+01 -1.21E+01*	-.5669 -17639.2 2.59E-06 .8880 3.15E-01 -5.70E+00 -5.80E+00*
6	-2.2209 -4502.7 6.44E-02 1.0956 2.61E-01 -1.62E+03 -1.62E+03*	-1.7364 -5759.0 3.61E-02 1.0682 2.69E-01 -2.02E+03 -2.03E+03*	-1.4299 -6993.7 1.80E-02 1.0435 2.76E-01 -1.90E+03 -1.91E+03*	-1.2185 -8206.9 8.26E-03 1.0211 2.82E-01 -1.47E+03 -1.48E+03*	-1.0640 -9398.9 3.61E-03 1.0006 2.88E-01 -1.01E+03 -1.01E+03*	-.9461 -10569.7 1.53E-03 .9818 2.93E-01 -6.26E+02 -6.32E+02*	-.8533 -11719.6 6.33E-04 .9644 2.97E-01 -3.64E+02 -3.68E+02*	-.7783 -12848.5 2.59E-04 .9482 3.01E-01 -2.02E+02 -2.04E+02*	-.7165 -13956.7 1.05E-04 .9332 3.05E-01 -1.08E+02 -1.09E+02*	-.6647 -15044.2 4.28E-05 .9191 3.08E-01 -5.60E+01 -5.68E+01*	-.6207 -16111.2 1.74E-05 .9059 3.11E-01 -2.85E+01 -2.90E+01*
7	-3.3309 -3002.2 8.94E-02 1.1340 2.49E-01 -6.09E+02 -6.08E+02*	-2.3483 -4258.5 7.15E-02 1.1022 2.59E-01 -1.50E+03 -1.50E+03*	-1.8204 -5493.2 4.53E-02 1.0744 2.67E-01 -2.17E+03 -2.18E+03*	-1.4911 -6706.4 2.49E-02 1.0496 2.74E-01 -2.29E+03 -2.30E+03*	-1.2661 -7898.4 1.25E-02 1.0271 2.81E-01 -1.97E+03 -1.98E+03*	-1.1026 -9069.2 5.92E-03 1.0065 2.86E-01 -1.46E+03 -1.48E+03*	-.9786 -10219.1 2.69E-03 .9876 2.91E-01 -9.85E+02 -9.95E+02*	-.8812 -11348.0 1.19E-03 .9701 2.96E-01 -6.15E+02 -6.22E+02*	-.8028 -12456.2 5.17E-04 .9539 3.00E-01 -3.63E+02 -3.68E+02*	-.7383 -13543.7 2.23E-04 .9388 3.03E-01 -2.06E+02 -2.09E+02*	-.6844 -14610.7 9.54E-05 .9246 3.07E-01 -1.13E+02 -1.15E+02*

Table 7. Radiative transition parameters for N_2 $a^1\Pi_g - a'^1\Sigma_u^-$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.7263 13767.6 8.90E-13 .8519 3.22E-01 (4.87E-07) 3.21E-07*	.8156 12261.4 9.87E-10 1.9181 4.69E-02 (8.11E-06) 1.05E-06*	.9277 10778.9 8.36E-08 .8785 3.16E-01 (2.12E-02) 1.35E-02*	1.0730 9320.0 3.42E-05 2.0421 3.17E-02 (5.62E-02) 6.69E-03*	1.2683 7884.5 6.48E-03 1.6578 9.56E-02 (5.88E+01) 5.18E+01*	1.5451 6472.0 1.25E-01 1.5184 1.31E-01 1.18E+03 1.16E+03	1.9676 5082.4 3.52E-01 1.4373 1.55E-01 2.23E+03 2.25E+03	2.6914 3715.5 1.28E-02 1.4805 1.42E-01 2.67E+01 2.81E+01	4.2174 2371.1 1.41E-01 1.2958 1.98E-01 1.49E+02 1.49E+02	9.5326 1049.0 4.34E-02 1.2196 2.23E-01 5.03E+00 5.02E+00	-39.8459 -251.0 2.13E-03 1.3203 1.91E-01 -4.95E-03 -4.81E-03*
9	.6573 15213.5 1.77E-14 2.3696 9.44E-03 (1.13E-11) 3.64E-09*	.7295 13707.3 1.22E-11 1.0336 2.79E-01 (4.93E-06) 2.89E-06*	.8180 12224.8 3.78E-09 2.0006 3.63E-02 (1.84E-05) 2.02E-05*	.9289 10765.9 3.22E-07 1.0362 2.78E-01 (6.28E-02) 3.72E-02*	1.0718 9330.4 5.81E-05 2.1001 2.60E-02 (6.47E-02) 5.65E-02*	1.2630 7917.9 9.99E-03 1.6719 9.23E-02 (8.56E+01) 7.47E+01*	1.5318 6528.3 1.58E-01 1.5287 1.28E-01 1.47E+03 1.45E+03	1.9374 5161.4 3.41E-01 1.4488 1.51E-01 2.17E+03 2.19E+03	2.6198 3817.0 7.54E-04 1.9240 4.61E-02 (1.81E-01) 5.72E-02*	4.0081 2494.9 1.20E-01 1.3066 1.95E-01 1.44E+02 1.44E+02	8.3686 1194.9 6.43E-02 1.2327 2.18E-01 1.06E+01 1.06E+01
10	.6012 16632.3 3.93E-17 2.5371 4.62E-03 (7.83E-15) 1.02E-10*	.6611 15126.1 6.19E-14 3.2137 1.34E-04 (7.80E-15) 8.16E-08*	.7329 13643.6 7.94E-11 1.1629 2.40E-01 (2.36E-05) 1.29E-05*	.8207 12184.7 1.02E-08 2.1031 2.57E-02 (2.48E-05) 1.55E-04*	.9303 10749.1 9.75E-07 1.1572 2.42E-01 (1.44E-01) 8.34E-02*	1.0710 9336.7 8.52E-05 2.1709 2.03E-02 (5.76E-02) 2.31E-01*	1.2583 7947.1 1.42E-02 1.6867 8.90E-02 (1.14E+02) 9.88E+01	1.5197 6580.2 1.91E-01 1.5394 1.25E-01 1.74E+03 1.72E+03	1.9099 5235.8 3.22E-01 1.4611 1.47E-01 2.04E+03 2.07E+03	2.5551 3913.7 2.20E-03 1.0159 2.84E-01 (2.15E+01) 1.94E+01*	3.8260 2613.7 9.48E-02 1.2185 1.91E-01 1.25E+02 1.25E+02
11	.5548 18024.1 1.32E-15 1.3209 1.90E-01 5.69E-10 5.90E-10*	.6054 16517.8 8.13E-15 1.7196 8.19E-02 (4.97E-10) 1.87E-11*	.6651 15035.4 2.00E-13 3.8656 1.63E-06 (3.68E-18) 5.19E-07*	.7366 13576.5 3.62E-10 1.2709 2.06E-01 (7.81E-05) 4.01E-05*	.8237 12140.9 2.14E-08 2.2336 1.61E-02 (2.01E-05) 7.42E-04*	.9321 10728.4 2.50E-06 1.2552 2.11E-01 (2.78E-01) 1.61E-01*	1.0708 9338.9 1.10E-04 2.2607 1.45E-02 (3.83E-02) 6.76E-01*	1.2544 7972.0 1.90E-02 1.7021 8.56E-02 (1.43E+02) 1.22E+02	1.5088 6627.6 2.23E-01 1.5503 1.22E-01 1.98E+03 1.96E+03	1.8848 5305.5 2.97E-01 1.4744 1.44E-01 1.85E+03 1.89E+03	2.4966 4005.5 1.21E-02 1.2161 2.24E-01 7.87E+01 7.31E+01
12	.5158 19388.9 1.46E-16 1.2686 2.07E-01 9.22E-11 8.79E-11*	.5592 17882.7 1.71E-16 .9205 3.07E-01 (1.87E-10) 1.37E-10*	.6097 16400.3 7.81E-14 1.7458 7.65E-02 (4.08E-09) 4.79E-11*	.6693 14941.4 1.28E-13 7.7711 7.17E-27 (0.00E+00) 2.66E-06*	.7404 13505.8 1.30E-09 1.3647 1.77E-01 (2.03E-04) 9.70E-05*	.8269 12093.3 3.63E-08 2.4136 7.88E-03 (8.07E-06) 2.68E-03*	.9343 10703.7 5.60E-06 1.3378 1.85E-01 (4.76E-01) 2.74E-01*	1.0710 9336.9 1.27E-04 2.3796 9.06E-03 (1.72E-02) 1.61E+00*	1.2512 7992.5 2.43E-02 1.7183 8.21E-02 (1.69E+02) 1.42E+02	1.4992 6670.3 2.54E-01 1.5615 1.19E-01 2.18E+03 2.16E+03	1.8621 5370.4 2.69E-01 1.4889 1.39E-01 1.64E+03 1.69E+03
13	.4825 20727.1 4.61E-16 1.2920 1.99E-01 3.31E-10 3.35E-10*	.5203 19220.8 1.45E-16 1.2086 2.26E-01 (1.06E-10) 1.21E-10*	.5637 17738.4 1.93E-16 .7697 3.35E-01 (2.45E-10) 7.63E-11*	.6143 16279.5 2.83E-13 1.9307 4.52E-02 (5.05E-09) 1.26E-08*	.6737 14843.9 1.52E-13 -9.2188 1.4500 (0.00E+00) 1.03E-05*	.7445 13431.4 3.87E-09 1.4500 1.51E-01 (4.32E-04) 1.86E-04*	.8304 12041.9 4.92E-08 2.6883 2.30E-03 (9.17E-07) 7.95E-03*	.9368 10675.0 1.13E-05 1.4100 1.63E-01 (7.38E-01) 4.20E-01*	1.0717 9330.6 1.29E-04 2.5474 4.42E-03 (4.13E-03) 3.35E+00*	1.2487 8008.5 2.97E-02 1.7533 7.86E-02 (1.91E+02) 1.57E+02	1.4907 6708.5 2.82E-01 1.5731 1.16E-01 2.34E+03 2.33E+03
14	.4538 22038.6 8.68E-16 1.2782 2.04E-01 7.82E-10 7.84E-10*	.4870 20532.3 2.03E-17 1.4596 1.48E-01 (7.78E-12) 1.00E-11*	.5249 19049.9 1.42E-15 1.3200 1.91E-01 (7.23E-10) 6.49E-10*	.5685 17591.0 8.40E-16 1.2259 2.21E-01 (4.51E-10) 2.64E-12*	.6190 16155.4 9.92E-13 2.0684 2.90E-02 (7.12E-09) 1.04E-07*	.6783 14742.9 6.28E-12 -1.3137 5.13E-03 (1.07E-09) 3.26E-05*	.7489 13353.4 9.95E-09 1.5307 1.28E-01 (7.84E-04) 2.88E-04*	.8343 11986.5 5.03E-08 3.1814 1.63E-04 (4.64E-09) 2.02E-02*	.9397 10642.1 2.09E-05 1.4752 1.43E-01 (1.05E+00) 5.85E-01*	1.0730 9320.0 1.12E-04 2.8062 1.28E-03 (3.03E-04) 6.24E+00*	1.2469 8020.0 3.51E-02 1.7533 7.50E-02 (2.06E+02) 1.66E+02
15	.4288 23323.6 9.57E-17 1.2719 2.06E-01 1.04E-10 1.05E-10*	.4584 21817.3 9.50E-17 1.1722 2.37E-01 1.13E-10 1.10E-10*	.4918 20334.9 1.04E-15 1.1845 2.34E-01 9.70E-10 9.00E-10*	.5298 18876.0 2.66E-15 1.3548 1.80E-01 (1.17E-09) 1.04E-09*	.5734 17440.4 1.69E-14 1.4690 1.45E-01 (3.83E-09) 6.38E-11*	.6239 16028.0 2.62E-12 2.2611 1.45E-02 (4.59E-09) 6.19E-07*	.6831 14638.4 5.24E-11 -.0113 2.25E-01 (1.69E-05) 8.86E-05*	.7535 13271.5 2.25E-08 1.6098 1.07E-01 (1.22E-03) 3.38E-04*	.8384 11927.1 3.16E-08 4.3896 2.33E-08 (5.87E-17) 4.56E-02*	.9430 10605.0 3.59E-05 1.5358 1.26E-01 (1.39E+00) 7.42E-01*	1.0747 9305.0 7.91E-05 3.2694 9.55E-05 (1.18E-06) 1.07E+01*

Table 7. Radiative transition parameters for N_2 $a^1\Pi_g - a'^1\Sigma_u^-$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	-6.5401 -1529.0 4.67E-02 1.1837 2.34E-01 -3.70E+01 -3.67E+01	-3.5902 -2785.3 7.82E-02 1.1417 2.47E-01 -4.17E+02 -4.16E+02	-2.4875 -4020.0 7.38E-02 1.1089 2.57E-01 -1.28E+03 -1.28E+03	-1.9108 -5233.3 5.27E-02 1.0807 2.65E-01 -2.15E+03 -2.16E+03	-1.5564 -6425.3 3.20E-02 1.0557 2.72E-01 -2.56E+03 -2.57E+03	-1.3165 -7596.1 1.75E-02 1.0331 2.79E-01 -2.42E+03 -2.43E+03	-1.1434 -8745.9 8.94E-03 1.0124 2.85E-01 -1.96E+03 -1.98E+03*	-1.0127 -9874.9 4.35E-03 0.9934 2.90E-01 -1.42E+03 -1.44E+03*	-.9105 -10983.0 2.05E-03 0.9759 2.94E-01 -9.51E+02 -9.61E+02*	-.8285 -12070.6 9.44E-04 0.9596 2.98E-01 -5.98E+02 -6.05E+02*	-.7612 -13137.6 4.29E-04 0.9444 3.02E-01 -3.59E+02 -3.64E+02*
9	-120.3022 -83.1 5.58E-04 0.9748 2.94E-01 -1.13E-04 -1.21E-04*	-7.4659 -1339.4 2.57E-02 1.1981 2.29E-01 -1.32E+01 -1.30E+01	-3.8848 -2574.1 6.31E-02 1.1499 2.44E-01 -2.60E+02 -2.59E+02	-2.6403 -3787.4 7.12E-02 1.1158 2.55E-01 -1.02E+03 -1.02E+03	-2.0083 -4979.4 5.76E-02 1.0871 2.63E-01 -2.00E+03 -2.00E+03	-1.6260 -6150.2 3.86E-02 1.0618 2.71E-01 -2.67E+03 -2.67E+03	-1.3699 -7300.0 2.29E-02 1.0391 2.77E-01 -2.78E+03 -2.79E+03	-1.1864 -8429.0 1.26E-02 1.0183 2.83E-01 -2.45E+03 -2.46E+03	-1.0485 -9537.1 6.54E-03 0.9993 2.88E-01 -1.91E+03 -1.92E+03*	-.9412 -10624.7 3.27E-03 0.9817 2.93E-01 -1.36E+03 -1.38E+03*	-.8553 -11691.7 1.59E-03 0.9653 2.97E-01 -9.10E+02 -9.20E+02*
10	7.4870 1335.7 7.94E-02 1.2432 2.15E-01 1.77E+01 1.77E+01	126.0224 79.4 7.09E-03 1.1493 2.45E-01 4.29E-04 4.33E-04*	-8.6554 -1155.4 1.08E-02 1.2211 2.22E-01 -3.33E+00 -3.28E+00	-4.2219 -2368.6 4.66E-02 1.1591 2.42E-01 -1.46E+02 -1.45E+02	-2.8085 -3560.6 6.45E-02 1.1230 2.53E-01 -7.52E+02 -7.50E+02	-2.1135 -4731.4 5.93E-02 1.0937 2.61E-01 -1.74E+03 -1.74E+03	-1.7003 -5881.2 4.38E-02 1.0681 2.69E-01 -2.61E+03 -2.62E+03	-1.4265 -7010.2 2.83E-02 1.0451 2.76E-01 -3.00E+03 -3.01E+03	-1.2318 -8118.4 1.67E-02 1.0242 2.81E-01 -2.86E+03 -2.88E+03	-1.0863 -9205.9 9.25E-03 1.0051 2.86E-01 -2.40E+03 -2.42E+03*	-.9734 -10272.9 4.90E-03 0.9875 2.91E-01 -1.83E+03 -1.84E+03*
11	3.6665 2727.4 6.89E-02 1.3323 1.87E-01 9.87E+01 9.88E+01	6.7976 1471.1 8.71E-02 1.2527 2.12E-01 2.52E+01 2.51E+01	42.2994 236.4 1.81E-02 1.1807 2.35E-01 2.67E-02 2.68E-02	-10.2369 -976.9 2.42E-03 1.2801 2.03E-01 -3.78E-01 -3.66E-01*	-4.6108 -2168.8 3.10E-02 1.1700 2.38E-01 -7.27E+01 -7.20E+01	-2.9943 -3339.7 5.48E-02 1.1307 2.50E-01 -5.18E+02 -5.16E+02	-2.2274 -4489.5 5.79E-02 1.1004 2.59E-01 -1.43E+03 -1.43E+03	-1.7799 -5618.4 4.73E-02 1.0743 2.67E-01 -2.43E+03 -2.43E+03	-1.4866 -6726.6 3.31E-02 1.0512 2.74E-01 -3.06E+03 -3.07E+03	-1.2797 -7814.1 2.10E-02 1.0302 2.80E-01 -3.17E+03 -3.18E+03	-1.1260 -8881.1 1.24E-02 1.0110 2.85E-01 -2.85E+03 -2.87E+03
12	2.4436 4092.3 2.62E-02 1.2687 2.07E-01 1.56E+02 1.47E+02	3.5261 2836.0 4.58E-02 1.3492 1.81E-01 6.96E+01 6.98E+01	6.2450 1601.3 8.77E-02 1.2618 2.09E-01 3.19E+01 3.18E+01	25.7719 388.0 3.04E-02 1.1970 2.30E-01 1.90E-01 1.90E-01	-12.4385 -804.0 3.37E-06 -1.4890 2.29E-03 (-3.72E-08) -9.55E-03*	-5.0638 -1974.8 1.80E-02 1.1840 2.34E-01 -3.06E+01 -3.02E+01	-3.2004 -3124.6 4.36E-02 1.1389 2.48E-01 -3.31E+02 -3.29E+02	-2.3510 -4253.5 5.36E-02 1.1073 2.57E-01 -1.11E+03 -1.11E+03	-1.8651 -5361.7 4.86E-02 1.0807 2.65E-01 -2.14E+03 -2.14E+03	-1.5506 -6449.3 3.70E-02 1.0573 2.72E-01 -2.97E+03 -2.98E+03	-1.3304 -7516.3 2.51E-02 1.0362 2.78E-01 -3.33E+03 -3.35E+03
13	1.8415 5430.4 2.41E-01 1.5047 1.35E-01 1.43E+03 1.48E+03	2.3957 4174.1 4.15E-02 1.2949 1.99E-01 2.41E+02 2.29E+02	3.4021 2939.4 2.72E-02 1.3720 1.74E-01 4.26E+01 4.28E+01	5.7933 1726.1 8.26E-02 1.2709 2.06E-01 3.66E+01 3.65E+01	18.7209 534.2 4.17E-02 1.2088 2.26E-01 6.57E-01 6.56E-01	-15.7068 -636.7 2.28E-03 1.0903 2.62E-01 -1.64E-01 -1.69E-01*	-5.5976 -1786.5 8.36E-03 1.2054 2.27E-01 -9.95E+00 -9.77E+00*	-3.4300 -2915.4 3.23E-02 1.1481 2.45E-01 -1.94E+02 -1.93E+02	-2.4853 -4023.6 4.72E-02 1.1144 2.55E-01 -8.12E+02 -8.09E+02	-1.9565 -5111.1 4.78E-02 1.0872 2.63E-01 -1.79E+03 -1.79E+03	-1.6186 -6178.1 3.95E-02 1.0635 2.70E-01 -2.76E+03 -2.76E+03
14	1.4833 6741.9 3.08E-01 1.5851 1.13E-01 2.46E+03 2.46E+03	1.8230 5485.6 2.15E-01 1.5220 1.30E-01 1.22E+03 1.28E+03	2.3524 4250.9 5.58E-02 1.3113 1.93E-01 3.25E+02 3.10E+02	3.2920 3037.6 1.38E-02 1.4070 1.64E-01 2.10E+01 2.12E+01	5.4181 1845.7 7.36E-02 1.2802 2.03E-01 3.87E+01 3.85E+01	14.8185 674.8 5.04E-02 1.2185 2.23E-01 1.56E+00 1.55E+00	-21.0533 -475.0 7.70E-03 1.1436 2.46E-01 -2.03E-01 -2.05E-01*	-6.2347 -1603.9 2.50E-03 1.2512 2.12E-01 -1.88E+00 -1.82E+00*	-3.6872 -2712.1 2.18E-02 1.1588 2.42E-01 -1.03E+02 -1.02E+02	-2.6318 -3799.6 3.94E-02 1.1220 2.53E-01 -5.61E+02 -5.58E+02	-2.0548 -4866.6 4.50E-02 1.0939 2.61E-01 -1.43E+03 -1.43E+03
15	1.2458 8026.9 4.03E-02 1.7725 7.12E-02 (2.14E+02) 1.68E+02	1.4770 6770.6 3.32E-01 1.5974 1.10E-01 2.54E+03 2.55E+03	1.8064 5535.9 1.91E-01 1.5410 1.25E-01 1.02E+03 1.09E+03	2.3134 4322.7 6.79E-02 1.3230 1.44E-01 4.00E+02 3.82E+02	3.1942 3130.7 5.28E-03 1.4743 1.44E-01 6.77E+00 6.87E+00*	5.1024 1959.9 6.23E-02 1.2900 2.00E-01 3.81E+01 3.79E+01	12.3451 810.0 5.58E-02 1.2273 2.20E-01 2.91E+00 2.90E+00	-31.3580 -318.9 1.47E-02 1.1655 2.40E-01 -1.11E-01 -1.12E-01	-7.0073 -1427.1 1.17E-04 1.5746 1.16E-01 (-1.85E-02) -1.23E-02*	-3.9767 -2514.6 1.31E-02 1.1724 2.37E-01 -4.75E+01 -4.68E+01	-2.7920 -3581.6 3.11E-02 1.1303 2.50E-01 -3.63E+02 -3.60E+02

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$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.4068 24582.3 2.62E-16 1.2692 2.07E-01 3.37E-10 3.37E-10*	.4333 23076.1 2.89E-16 1.2151 2.24E-01 3.61E-10 3.58E-10*	.4631 21593.6 1.18E-16 .9797 2.93E-01 2.07E-10 2.02E-10*	.4967 20134.7 7.78E-16 1.0836 2.64E-01 8.99E-10 7.54E-10*	.5348 18699.1 5.14E-15 1.4165 1.61E-01 1.76E-09 1.68E-09*	.5785 17286.7 8.51E-14 1.6464 9.82E-02 8.60E-09 7.12E-10*	.6290 15897.1 5.36E-12 2.5477 4.41E-03 8.49E-10 2.83E-06*	.6882 14530.2 2.59E-10 .5253 3.44E-01 1.90E-04 2.09E-04*	.7584 13185.8 4.57E-08 1.6911 8.80E-02 1.64E-03 2.57E-04*	.8429 11863.7 3.22E-09 13.2760 0.00E+00 0.00E+00 9.29E-02*	.9466 10563.7 5.77E-05 1.5937 1.11E-01 1.70E+00 8.51E-01*
17	.3874 25814.8 7.23E-16 1.2646 2.08E-01 1.09E-09 1.09E-09*	.4114 24308.6 1.60E-16 1.2050 2.27E-01 2.40E-10 2.39E-10*	.4381 22826.1 4.84E-17 1.6131 1.06E-01 1.32E-11 1.27E-11*	.4680 21367.2 1.86E-17 -.0693 2.07E-01 1.57E-11 1.19E-10*	.5017 19931.7 3.65E-15 1.1383 2.48E-01 3.60E-09 3.00E-09*	.5400 18519.2 1.22E-14 1.4180 1.60E-01 4.02E-09 4.70E-09*	.5838 17129.6 3.80E-13 1.7754 7.06E-02 1.93E-08 1.22E-08*	.6344 15762.7 8.58E-12 2.9954 4.71E-04 1.51E-11 1.03E-05*	.6936 14418.3 9.72E-10 .8326 3.25E-01 6.24E-04 4.35E-04*	.7636 13096.2 8.35E-08 1.7781 7.01E-02 1.87E-03 5.37E-05*	.8477 11796.2 2.80E-08 -3.4871 1.57E-09 2.30E-19 1.73E-01*
18	.3701 27021.4 2.83E-16 1.2560 2.11E-01 5.04E-10 5.04E-10*	.3919 25515.1 3.27E-18 1.0007 2.88E-01 9.11E-12 9.16E-12*	.4161 24032.7 1.07E-16 1.3781 1.72E-01 8.97E-11 9.21E-11*	.4430 22573.8 2.31E-18 3.7180 4.83E-06 1.25E-21 1.32E-11*	.4731 21138.2 9.99E-16 .9330 3.05E-01 1.77E-09 1.65E-09*	.5070 19725.8 1.07E-14 1.1628 2.40E-01 9.63E-09 7.95E-09*	.5454 18336.2 1.03E-14 1.4552 1.49E-01 2.87E-09 5.71E-09*	.5893 16969.3 1.41E-12 1.8799 5.26E-02 3.86E-08 8.53E-08*	.6400 15624.9 8.93E-12 3.9652 7.64E-07 4.03E-17 3.18E-05*	.6992 14302.8 3.02E-09 1.0398 2.77E-01 1.37E-03 8.03E-04*	.7691 13002.8 1.38E-07 1.8762 5.32E-02 1.73E-03 1.16E-04*
19	.3546 28202.1 1.33E-17 1.3176 1.91E-01 2.21E-11 2.22E-11*	.3746 26695.9 5.73E-17 1.2702 2.06E-01 9.41E-11 9.46E-11*	.3966 25213.4 6.40E-18 1.2304 2.19E-01 9.98E-12 1.06E-11*	.4210 23754.5 2.02E-17 .9280 3.06E-01 5.12E-11 4.98E-11*	.4480 22318.9 2.47E-16 .8345 3.25E-01 5.87E-10 6.01E-10*	.4783 20906.5 2.42E-15 .9305 3.05E-01 4.17E-09 3.74E-09*	.5124 19516.9 1.91E-14 1.2053 2.27E-01 1.48E-08 1.17E-08*	.5510 18150.0 7.07E-16 1.5658 1.18E-01 1.20E-10 4.97E-09*	.5950 16805.6 4.19E-12 1.9958 3.68E-02 5.47E-08 4.62E-07*	.6458 15483.5 3.10E-12 8.1076 2.45E-29 0.00E+00 8.61E-05*	.7050 14183.5 8.08E-09 1.1962 2.30E-01 2.47E-03 1.31E-03*
20	.3406 29357.2 3.77E-16 1.2695 2.07E-01 8.26E-10 8.26E-10*	.3591 27851.0 1.16E-16 1.2324 2.18E-01 2.42E-10 2.42E-10*	.3792 26368.5 3.45E-17 1.3889 1.69E-01 3.66E-11 3.58E-11*	.4015 24909.6 9.85E-17 1.2556 2.11E-01 1.37E-10 1.33E-10*	.4260 23474.0 4.87E-17 .8717 3.18E-01 1.29E-10 1.27E-10*	.4533 22061.6 2.39E-16 .6258 3.46E-01 6.21E-10 7.44E-10*	.4837 20672.0 4.67E-15 .9750 2.94E-01 7.24E-09 5.94E-09*	.5180 19305.1 3.14E-14 1.2939 1.99E-01 1.81E-08 1.41E-08*	.5568 17960.7 3.60E-14 1.5092 1.34E-01 7.55E-09 2.21E-09*	.6010 16638.6 1.07E-11 2.1233 2.40E-02 5.73E-08 1.94E-06*	.6519 15338.6 3.60E-12 -7.6198 6.23E-35 0.00E+00 2.07E-04*
21	.3280 30486.8 4.62E-16 1.2609 2.09E-01 1.16E-09 1.16E-09*	.3451 28980.6 6.24E-17 1.2021 2.28E-01 1.60E-10 1.60E-10*	.3637 27498.1 5.56E-17 1.3469 1.82E-01 7.78E-11 7.72E-11*	.3840 26039.2 5.69E-17 1.3093 1.94E-01 7.66E-11 7.47E-11*	.4064 24603.7 2.17E-18 1.5010 1.36E-01 1.21E-12 2.03E-12*	.4312 23191.2 9.20E-18 2.2595 1.46E-02 4.94E-14 2.89E-13*	.4587 21801.6 3.51E-16 .6710 3.44E-01 8.71E-10 8.80E-10*	.4894 20434.7 7.85E-15 1.0745 2.67E-01 9.69E-09 6.89E-09*	.5238 19090.3 2.74E-14 1.4712 1.45E-01 8.06E-09 5.93E-09*	.5628 17768.2 4.66E-13 1.5530 1.22E-01 7.86E-08 1.97E-10*	.6072 16468.2 2.29E-11 2.2826 1.33E-02 3.69E-08 6.90E-06*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

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$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	1.0769 9285.6 3.70E-05 4.3673 2.82E-08 (4.79E-14) 1.71E+01*	1.2454 8029.3 4.50E-02 1.7929 6.74E-02 (2.14E+02) 1.62E+02	1.4718 6794.6 3.54E-01 1.6101 1.07E-01 2.58E+03 2.60E+03	1.7917 5581.4 1.70E-01 1.5620 1.19E-01 8.51E+02 9.15E+02	2.2782 4389.4 7.71E-02 1.3316 1.87E-01 4.62E+02 4.41E+02	3.1070 3218.6 9.90E-04 1.6900 8.82E-02 (5.21E+01) 4.46E-01*	4.8338 2068.7 5.03E-02 1.3006 1.97E-01 3.50E+01 3.48E+01	10.6405 939.8 5.80E-02 1.2356 2.17E-01 4.61E+00 4.59E+00	-59.3916 -168.4 2.20E-02 1.1795 2.35E-01 -2.36E-02 -2.36E-02	-7.9623 -1255.9 6.31E-04 1.0017 2.87E-01 -4.18E-01 -4.48E-01*	-4.3049 -2322.9 6.56E-03 1.1924 2.31E-01 -1.78E+01 -1.74E+01*
17	.9507 10518.2 8.71E-05 1.6507 9.72E-02 (1.94E+00) 8.70E-01*	1.0797 9261.9 4.25E-06 10.6530 0.00E+00 (0.00E+00) 2.58E+01*	1.2458 8027.2 4.90E-02 1.8148 6.34E-02 (2.06E+02) 1.50E+02	1.4676 6813.9 3.75E-01 1.6232 1.04E-01 2.59E+03 2.62E+03	1.7787 5621.9 1.52E-01 1.5849 1.13E-01 7.01E+02 7.66E+02	2.2466 4451.1 8.33E-02 1.3380 1.85E-01 5.09E+02 4.85E+02	3.0291 3301.3 3.17E-05 -.7378 4.42E-02 (4.51E-03) 1.44E+00*	4.6033 2172.4 3.88E-02 1.3124 1.93E-01 3.00E+01 2.99E+01	9.3970 1064.2 5.71E-02 1.2436 2.15E-01 6.44E+00 6.41E+00	-427.9173 -23.4 2.86E-02 1.1902 2.32E-01 -7.96E-05 -7.96E-05	-9.1712 -1090.4 3.27E-03 1.1054 2.58E-01 -1.14E+00 -1.17E+00*
18	.8529 11724.7 2.77E-07 -.3929 1.11E-01 (1.12E-02) 2.99E-01*	.9553 10468.4 1.24E-04 1.7083 8.43E-02 (2.05E+00) 7.66E-01*	1.0830 9233.7 1.06E-05 -4.6256 7.96E-15 (1.07E-27) 3.70E+01*	1.2468 8020.5 5.21E-02 1.8386 5.93E-02 (1.91E+02) 1.31E+02	1.4645 6828.5 3.94E-01 1.6368 1.01E-01 2.57E+03 2.62E+03	1.7675 5657.7 1.37E-01 1.6098 1.07E-01 (5.75E+02) 6.40E+02	2.2184 4507.8 8.67E-02 1.3425 1.84E-01 5.42E+02 5.14E+02	2.9595 3378.9 1.48E-03 1.0305 2.80E-01 9.02E+00 8.67E+00*	4.4039 2270.7 2.85E-02 1.3261 1.89E-01 2.41E+01 2.40E+01	8.4518 1183.2 5.40E-02 1.2515 2.12E-01 8.17E+00 8.13E+00	86.0763 116.2 3.39E-02 1.1993 2.29E-01 5.65E-03 5.64E-03
19	.7749 12905.5 2.04E-07 1.9938 3.71E-02 (1.22E-03) 1.75E-03*	.8584 11649.2 1.11E-06 .4202 3.33E-01 (3.95E-01) 4.79E-01*	.9602 10414.5 1.67E-04 1.7684 7.20E-02 (1.98E+00) 5.38E-01*	1.0868 9201.2 9.86E-05 -.5650 7.26E-02 (8.21E-01) 5.07E+01*	1.2486 8009.2 5.41E-02 1.8646 5.50E-02 (1.70E+02) 1.07E+02	1.4623 6838.4 4.12E-01 1.6507 9.72E-02 2.52E+03 2.59E+03	1.7579 5688.6 1.25E-01 1.6367 1.01E-01 (4.72E+02) 5.35E+02	2.1932 4559.6 8.75E-02 1.3451 1.83E-01 5.61E+02 5.29E+02	2.8973 3451.4 4.48E-03 1.1657 2.39E-01 2.14E+01 2.05E+01*	4.2303 2363.9 1.98E-02 1.3428 1.83E-01 1.78E+01 1.78E+01	7.7107 1296.9 4.92E-02 1.2594 2.10E-01 9.57E+00 9.52E+00
20	.7112 14060.5 1.92E-08 1.3245 1.89E-01 (3.88E-03) 1.87E-03*	.7810 12804.2 2.68E-07 2.1460 2.21E-02 (5.60E-04) 8.01E-03*	.8643 11569.5 3.16E-06 .8075 3.29E-01 (1.07E+00) 7.17E-01*	.9656 10356.3 2.13E-04 1.8333 6.02E-02 (1.73E+00) 2.42E-01*	1.0912 9164.3 3.24E-04 .3625 3.24E-01 (5.31E+01) 6.65E+01*	1.2510 7993.5 5.48E-02 1.8934 5.05E-02 (1.45E+02) 8.10E+01	1.4612 6843.7 4.29E-01 1.6651 9.39E-02 2.46E+03 2.54E+03	1.7499 5714.7 1.17E-01 1.6651 9.39E-02 (3.88E+02) 4.49E+02	2.1708 4606.5 8.62E-02 1.3455 1.83E-01 5.69E+02 5.33E+02	2.8417 3519.0 8.35E-03 1.2189 2.23E-01 3.65E+01 3.54E+01*	4.0783 2452.0 1.29E-02 1.3646 1.77E-01 1.20E+01 1.20E+01
21	.6583 15190.2 9.40E-11 -1.0060 1.78E-02 (2.12E-07) 4.46E-04*	.7177 13933.9 4.12E-08 1.4376 1.54E-01 (5.39E-03) 2.25E-03*	.7875 12699.2 3.02E-07 2.3649 9.62E-03 (1.16E-04) 2.48E-02	.8706 11485.9 7.42E-06 1.0422 2.76E-01 (1.74E+00) 1.00E+00*	.9714 10293.9 2.55E-04 1.9062 4.86E-02 (1.33E+00) 1.83E-02*	1.0961 9123.1 7.54E-04 .7826 3.33E-01 (1.29E+02) 8.41E+01*	1.2542 7973.3 5.40E-02 1.9259 4.58E-02 (1.16E+02) 5.44E+01	1.4411 6844.3 4.46E-01 1.6800 9.05E-02 2.37E+03 2.48E+03	1.7433 5736.2 1.11E-01 1.6947 8.72E-02 (3.23E+02) 3.82E+02	2.1512 4648.6 8.30E-02 1.3431 1.83E-01 5.68E+02 5.26E+02	2.7920 3581.6 1.26E-02 1.2505 2.13E-01 5.29E+01 5.16E+01

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text)

Table 8. Radiative transition parameters for N_2 $w^1\Delta_u - a^1\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	3.6400 2747.3 6.77E-01 1.2493 2.12E-01 1.28E+03 1.28E+03	9.2512 1080.9 2.82E-01 1.3140 1.94E-01 2.71E+01 2.73E+01	-17.9347 -557.6 3.87E-02 1.3963 1.69E-01 -3.86E-01 -3.90E-01	-4.6118 -2168.3 1.95E-03 1.5138 1.32E-01 -7.09E-01 -7.04E-01	-2.6657 -3751.4 2.64E-05 1.7438 7.13E-02 (-1.44E-02) -9.27E-03	-1.8843 -5306.9 4.22E-10 11.7050 0.00E+00 (0.00E+00) -1.14E-03	-1.4631 -6834.8 2.84E-09 1.5962 1.09E-01 (-2.16E-05) -9.09E-06	-1.1997 -8335.3 2.06E-12 -.8297 1.05E-03 (-2.66E-12) -2.06E-06	-1.0195 -9808.5 3.83E-13 2.0385 2.42E-02 (-4.28E-10) -1.10E-08	-.8885 -11254.4 6.43E-15 1.3095 1.95E-01 (-7.07E-10) -6.41E-10	-.7891 -12673.1 2.20E-16 1.4561 1.50E-01 (-2.05E-11) -8.46E-13
1	2.3348 4283.0 2.44E-01 1.1897 2.28E-01 2.02E+03 2.03E+03	3.8217 2616.6 2.55E-01 1.2634 2.08E-01 4.02E+02 3.97E+02	10.2240 978.1 3.98E-01 1.3232 1.91E-01 2.75E+01 2.76E+01	-15.8060 -632.7 9.56E-02 1.4050 1.66E-01 -1.35E+00 -1.36E+00	-4.5131 -2215.7 6.78E-03 1.5241 1.29E-01 -2.50E+00 -2.48E+00	-2.6517 -3771.2 1.11E-04 1.7653 6.66E-02 (-5.36E-02) -3.14E-02	-1.8871 -5299.1 2.76E-09 -7.6412 0.00E+00 (0.00E+00) -6.95E-03	-1.4707 -6799.6 1.93E-08 1.6464 9.49E-02 (-1.11E-04) -3.57E-05	-1.2088 -8272.8 3.72E-11 .0045 6.03E-02 (-1.55E-07) -1.66E-05	-1.0289 -9718.7 2.89E-12 2.2033 1.15E-02 (-7.08E-10) -1.83E-07	-.8979 -11137.5 3.57E-14 1.5287 1.28E-01 (-1.64E-09) -7.86E-10
2	1.7256 5795.0 6.16E-02 1.1419 2.39E-01 1.38E+03 1.40E+03	2.4221 4128.7 2.87E-01 1.1976 2.26E-01 2.09E+03 2.08E+03	4.0158 2490.2 6.46E-02 1.2892 2.01E-01 8.16E+01 7.90E+01	11.3714 879.4 4.14E-01 1.3330 1.88E-01 2.02E+01 2.02E+01	-14.2110 -703.7 1.58E-01 1.4140 1.63E-01 -2.96E+00 -2.99E+00	-4.4265 -2259.1 1.47E-02 1.5346 1.26E-01 -5.49E+00 -5.42E+00	-2.6406 -3787.1 2.79E-04 1.7886 6.17E-02 (-1.17E-01) -5.98E-02	-1.8912 -5287.6 7.91E-08 -1.4596 8.94E-06 (-1.89E-12) -2.42E-02	-1.4791 -6760.7 7.39E-08 1.6985 8.18E-02 (-3.09E-04) -6.32E-05	-1.2185 -8206.6 3.09E-10 .4532 1.84E-01 (-1.17E-05) -7.38E-05	-1.0389 -9625.4 1.16E-11 2.4129 3.85E-03 (-3.10E-10) -1.44E-06
3	1.3729 7283.8 1.36E-02 1.1014 2.47E-01 6.48E+02 6.60E+02	1.7802 5617.4 1.23E-01 1.1684 2.37E-01 2.49E+03 2.51E+03	2.5133 3978.9 2.39E-01 1.2064 2.24E-01 1.53E+03 1.52E+03	4.2227 2368.1 3.46E-03 1.4228 1.60E-01 2.39E+00 2.04E+00	12.7379 785.1 3.77E-01 1.3438 1.85E-01 1.26E+01 1.26E+01	-12.9802 -770.4 2.17E-01 1.4232 1.60E-01 -5.17E+00 -5.21E+00	-4.3510 -2298.3 2.56E-02 1.5454 1.23E-01 -9.54E+00 -9.41E+00	-2.6324 -3798.8 5.41E-04 1.8142 5.67E-02 (-1.93E-01) -8.10E-02	-1.8968 -5272.0 5.50E-07 -1.812 3.06E-02 (-1.53E-04) -6.32E-02	-1.4886 -6717.9 2.08E-07 1.7536 6.91E-02 (-6.09E-04) -4.69E-05	-1.2290 -8136.7 1.66E-09 .7315 2.52E-01 (-1.15E-04) -2.37E-04
4	1.1429 8749.4 2.85E-03 1.0662 2.53E-01 2.47E+02 2.53E+02	1.4118 7083.1 3.84E-02 1.1075 2.46E-01 1.67E+03 1.70E+03	1.8367 5444.6 1.60E-01 1.1552 2.36E-01 2.65E+03 2.93E+03	2.6084 3833.8 1.65E-01 1.2166 2.21E-01 9.18E+02 9.06E+02	4.4430 2250.7 8.04E-03 1.1570 2.35E-01 1.03E+01 1.14E+01	14.3828 695.3 3.16E-01 1.3558 1.81E-01 7.07E+00 7.03E+00	-12.0097 -832.7 2.69E-01 1.4328 1.57E-01 -7.80E+00 -7.86E+00	-4.2860 -2333.2 3.90E-02 1.5565 1.20E-01 -1.44E+01 -1.42E+01	-2.6272 -3806.3 8.89E-04 1.8425 5.14E-02 (-2.63E-01) -8.17E-02	-1.9040 -5252.2 2.29E-06 .3789 1.61E-01 (-1.74E-02) -1.37E-01	-1.4990 -6671.0 4.74E-07 1.8139 5.67E-02 (-9.17E-04) -3.60E-09
5	.9811 10192.3 5.89E-04 1.0352 2.57E-01 8.35E+01 8.59E+01	1.1729 8526.0 1.04E-02 1.0721 2.52E-01 8.31E+02 8.49E+02	1.4519 6887.5 6.70E-02 1.1136 2.44E-01 2.65E+03 2.69E+03	1.8951 5276.7 1.70E-01 1.1624 2.34E-01 2.77E+03 2.77E+03	2.7074 3693.6 9.51E-02 1.2295 2.18E-01 4.60E+02 4.48E+02	4.6769 2138.2 3.96E-02 1.2236 1.81E-01 3.77E+01 3.91E+01	16.3871 610.2 2.49E-01 1.3696 1.57E-01 3.59E+00 3.56E+00	-11.2327 -890.3 3.13E-01 1.4427 1.77E-01 -1.06E+01 -1.07E+01	-4.2312 -2363.4 5.43E-02 1.5679 1.54E-01 -1.97E+01 -1.94E+01	-2.6252 -3809.3 1.30E-03 1.8742 4.60E-02 (-3.07E-01) -5.69E-02	-1.9127 -5228.1 7.10E-06 .6970 2.46E-01 (-1.25E-01) -2.59E-01
6	.8611 11612.7 1.23E-04 1.0078 2.60E-01 2.64E+01 2.72E+01	1.0054 9946.4 2.65E-03 1.0410 2.56E-01 3.48E+02 3.57E+02	1.2037 8307.9 2.27E-02 1.0780 2.51E-01 1.66E+03 1.69E+03	1.4932 6697.1 9.22E-02 1.1199 2.43E-01 3.32E+03 3.35E+03	1.9554 5114.0 1.56E-01 1.1700 2.32E-01 2.29E+03 2.28E+03	2.8101 3558.6 4.36E-02 1.2488 2.12E-01 1.80E+02 1.72E+02	4.9246 2030.6 7.65E-02 1.2446 2.14E-01 5.91E+01 6.03E+01	18.8635 530.1 1.86E-01 1.3860 1.72E-01 1.66E+00 1.64E+00	-10.6042 -943.0 3.47E-01 1.4529 1.51E-01 -1.35E+01 -1.36E+01	-4.1860 -2388.9 7.10E-02 1.5796 1.13E-01 -2.51E+01 -2.46E+01	-2.6263 -3807.7 1.74E-03 1.9102 4.03E-02 (-3.15E-01) -1.87E-02
7	.7686 13010.9 2.62E-05 .9837 2.63E-01 8.07E+00 8.35E+00	.8815 11344.5 6.57E-04 1.0136 2.60E-01 1.31E+02 1.35E+02	1.0303 9706.0 6.91E-03 1.0468 2.56E-01 8.36E+02 8.57E+02	1.2353 8095.2 3.80E-02 1.0839 2.50E-01 2.55E+03 2.60E+03	1.5356 6512.2 1.09E-01 1.1263 2.42E-01 3.57E+03 3.60E+03	2.0175 4956.7 1.29E-01 1.1782 2.31E-01 1.70E+03 1.68E+03	2.9165 3428.8 1.30E-02 1.2881 2.01E-01 4.32E+01 3.97E+01	5.1860 1928.3 1.07E-01 1.2576 2.10E-01 6.88E+01 6.95E+01	21.9722 455.1 1.31E-01 1.4061 1.66E-01 5.88E-01 6.78E-01	-10.0931 -990.8 3.73E-01 1.4635 1.48E-01 -1.61E+01 -1.62E+01	-4.1502 -2409.6 8.85E-02 1.5917 1.10E-01 -3.02E+01 -2.96E+01

Table 8. Radiative transition parameters for N_2 $w^1\Delta_u - a^1\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	- .7110 -14064.9 1.20E-15 1.1606 2.35E-01 (-3.72E-10) -2.96E-10*	- .6481 -15429.8 1.20E-15 1.1534 2.36E-01 (-4.97E-10) -4.65E-10*	- .5964 -16767.9 2.65E-16 1.0886 2.49E-01 (-1.57E-10) -1.52E-10*	- .5531 -18079.4 2.21E-17 1.6056 1.06E-01 (-2.97E-12) -5.17E-12*	- .5164 -19364.4 1.90E-16 1.2963 1.99E-01 (-1.11E-10) -1.17E-10*	- .4849 -20623.1 8.24E-17 1.2379 2.15E-01 (-6.79E-11) -7.11E-11*	- .4575 -21855.6 1.97E-18 1.5063 1.35E-01 (-7.58E-13) -6.50E-13*	- .4336 -23062.1 7.35E-17 1.2736 2.05E-01 (-7.71E-11) -7.64E-11*	- .4125 -24242.8 7.24E-17 1.2397 2.15E-01 (-9.64E-11) -9.66E-11*	- .3937 -25397.7 9.51E-18 1.1672 2.33E-01 (-1.71E-11) -1.78E-11*	- .3770 -26526.8 9.96E-18 1.3105 1.95E-01 (-1.43E-11) -1.38E-11*
1	- .7981 -12529.2 8.32E-15 1.3186 1.92E-01 (-1.23E-09) -3.08E-10*	- .7197 -13894.1 6.39E-15 1.0968 2.48E-01 (-2.13E-09) -1.53E-09*	- .6565 -15232.2 2.85E-15 1.0415 2.56E-01 (-1.34E-09) -1.22E-09*	- .6045 -16543.7 7.38E-16 .9941 2.62E-01 (-4.64E-10) -4.44E-10*	- .5609 -17828.7 2.02E-17 .3451 1.50E-01 (-5.26E-12) -3.06E-11*	- .5239 -19087.4 5.15E-17 1.5566 1.20E-01 (-1.04E-11) -1.97E-11*	- .4921 -20320.0 4.50E-17 1.3845 1.72E-01 (-2.27E-11) -2.98E-11*	- .4645 -21526.5 2.43E-20 1.7536 6.91E-02 (-2.34E-15) -1.34E-13*	- .4404 -22707.1 2.54E-17 1.3159 1.93E-01 (-2.25E-11) -2.22E-11*	- .4191 -23862.0 2.64E-17 1.3513 1.82E-01 (-2.42E-11) -2.65E-11*	- .4001 -24991.1 7.45E-19 2.0731 2.09E-02 (-1.02E-14) -9.35E-14*
2	- .9077 -11017.2 2.65E-13 1.6888 8.41E-02 (-5.09E-09) -2.95E-10*	- .8076 -12382.0 4.02E-14 1.3113 1.95E-01 (-5.85E-09) -1.38E-09*	- .7289 -13720.1 3.29E-14 1.1059 2.46E-01 (-1.04E-08) -6.79E-09*	- .6653 -15031.7 1.22E-14 1.0055 2.61E-01 (-5.72E-09) -5.08E-09*	- .6129 -16316.7 3.21E-15 .9294 2.66E-01 (-1.99E-09) -2.01E-09*	- .5690 -17575.4 3.92E-16 .7070 2.48E-01 (-2.66E-10) -3.98E-10*	- .5317 -18807.9 1.84E-19 1.1370 0.00E+00 (0.00E+00) -1.05E-11*	- .4996 -20014.4 3.37E-17 1.5052 1.35E-01 (-9.99E-12) -2.17E-11*	- .4718 -21165.0 4.00E-17 1.0964 2.48E-01 (-4.73E-11) -5.52E-11*	- .4474 -22349.9 4.52E-17 .8822 2.66E-01 (-7.23E-11) -9.11E-11*	- .4259 -23479.1 8.51E-17 .8671 2.65E-01 (-1.57E-10) -1.91E-10*
3	-1.0495 -9528.4 3.13E-11 2.7026 6.52E-04 (-2.33E-11) -7.44E-06*	- .9180 -10893.3 1.40E-12 1.8185 5.59E-02 (-1.15E-08) -4.38E-09*	- .8176 -12231.4 1.38E-13 1.2876 2.01E-01 (-2.07E-08) -5.20E-09*	- .7384 -13542.9 1.34E-13 1.1181 2.44E-01 (-4.00E-08) -2.41E-08*	- .6744 -14827.9 4.21E-14 .9719 2.63E-01 (-1.93E-08) -1.69E-08*	- .6216 -16086.6 9.85E-15 .8602 2.65E-01 (-5.84E-09) -6.39E-09*	- .5774 -17319.2 1.80E-15 .7754 2.58E-01 (-1.27E-09) -1.56E-09*	- .5398 -18525.7 9.08E-17 .5457 2.11E-01 (-5.20E-11) -8.86E-11*	- .5075 -19706.3 2.64E-16 1.1498 2.37E-01 (-2.30E-10) -2.89E-10*	- .4794 -20861.2 1.45E-15 1.0746 2.51E-01 (-1.68E-09) -1.74E-09*	- .4547 -21990.3 2.77E-15 1.0548 2.54E-01 (-3.87E-09) -3.86E-09*
4	-1.2403 -8062.7 6.67E-09 .9251 2.66E-01 (-5.00E-04) -6.10E-04*	-1.0607 -9427.6 5.85E-11 3.1882 1.65E-05 (-2.71E-14) -2.97E-05*	- .9289 -10765.7 5.75E-12 1.9389 3.61E-02 (-1.90E-08) -1.02E-07*	- .8280 -12077.2 2.86E-13 1.2246 2.19E-01 (-4.89E-08) -1.26E-08*	- .7484 -13362.3 3.97E-13 1.1284 2.42E-01 (-1.12E-07) -6.09E-08*	- .6839 -14621.0 1.25E-13 .9723 2.63E-01 (-5.51E-08) -4.53E-08*	- .6308 -15853.5 2.78E-14 .8672 2.65E-01 (-1.58E-08) -1.63E-08*	- .5862 -17060.0 3.01E-15 .7588 2.56E-01 (-1.99E-09) -2.29E-09*	- .5482 -18240.6 7.74E-16 1.2849 2.02E-01 (-3.89E-10) -6.44E-10*	- .5156 -19395.5 9.36E-15 1.0941 2.48E-01 (-8.52E-09) -8.92E-09*	- .4872 -20524.6 2.10E-14 1.0743 2.51E-01 (-2.33E-08) -2.33E-08*
5	-1.5106 -6619.8 9.23E-07 1.8817 4.47E-02 (-1.09E-03) -2.54E-04*	-1.2524 -7984.7 2.19E-08 1.0713 2.52E-01 (-1.44E-03) -1.32E-03*	-1.0726 -9322.8 7.01E-11 4.2019 4.63E-10 (-2.47E-23) -9.70E-05*	- .9403 -10634.3 1.94E-11 2.0545 2.26E-02 (-2.41E-08) -7.97E-07*	- .8390 -11919.4 3.53E-13 1.0627 2.53E-01 (-7.78E-08) -2.46E-08*	- .7588 -13178.1 9.36E-13 1.1507 2.37E-01 (-2.43E-07) -1.14E-07*	- .6939 -14410.6 2.81E-13 .9896 2.62E-01 (-1.77E-07) -8.45E-08*	- .6403 -15617.1 3.53E-14 .8134 2.62E-01 (-1.88E-08) -1.87E-08*	- .5953 -16797.7 1.43E-15 1.7442 7.12E-02 (-6.95E-11) -6.28E-10*	- .5570 -17952.6 4.03E-14 1.1191 2.43E-01 (-2.80E-08) -2.98E-08*	- .5241 -19081.7 9.79E-14 1.0722 2.52E-01 (-8.73E-08) -8.83E-08*
6	-1.9233 -5199.5 1.82E-05 .9056 2.66E-01 (-3.67E-01) -4.42E-01*	-1.5234 -6564.3 1.58E-06 1.9606 3.32E-02 (-9.97E-04) -1.96E-03*	-1.2654 -7902.5 6.17E-08 1.1888 2.28E-01 (-3.20E-03) -2.48E-03*	-1.0853 -9214.0 3.22E-11 7.9958 9.36E-02 (0.00E+00) -2.71E-04*	- .9525 -10499.0 5.58E-11 2.1710 1.34E-02 (-2.35E-08) -4.01E-06*	- .8505 -11757.7 8.27E-14 .0002 5.95E-02 (-9.63E-10) -3.24E-08*	- .7698 -12990.2 1.51E-12 1.1879 2.28E-01 (-3.50E-07) -1.19E-07*	- .7044 -14196.7 3.49E-13 1.0057 2.61E-01 (-1.37E-07) -7.19E-08*	- .6503 -15377.3 5.92E-16 -1.4622 8.74E-06 (-3.33E-19) -1.28E-10*	- .6049 -16532.2 1.23E-13 1.1520 2.37E-01 (-6.29E-08) -7.10E-08*	- .5662 -17661.4 3.65E-13 1.0717 2.52E-01 (-2.58E-07) -2.65E-07*
7	-2.6307 -3801.3 2.15E-03 1.9516 3.44E-02 (-2.83E-01) -6.03E-04*	-1.9357 -5166.2 4.08E-05 1.0555 2.54E-01 (-7.37E-01) -6.91E-01*	-1.5374 -6504.3 2.40E-06 2.0566 2.24E-02 (-6.71E-04) -7.86E-03*	-1.2795 -7815.8 1.53E-07 1.2884 2.01E-01 (-5.99E-03) -4.07E-03*	-1.0988 -9100.8 1.36E-11 -13.7450 0.00E+00 (0.00E+00) -6.67E-04*	- .9653 -10359.5 1.41E-10 2.2879 7.54E-03 (-1.81E-08) -1.53E-05*	- .8627 -11592.0 7.94E-13 2.2527 9.01E-03 (-2.03E-10) -1.52E-08*	- .7813 -12798.6 1.27E-12 1.2791 2.04E-01 (-2.25E-07) -1.61E-08*	- .7153 -13979.2 1.19E-13 1.1032 2.46E-01 (-3.99E-08) -1.48E-10*	- .6608 -15134.1 2.57E-13 1.1641 2.34E-01 (-9.86E-08) -1.44E-07*	- .6149 -16263.2 1.18E-12 1.0785 2.51E-01 (-6.44E-07) -6.77E-07*

Table 8. Radiative transition parameters for N_2 $w^1\Delta_u - a^1\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.6951 14387.0 5.82E-06 .9631 2.64E-01 2.45E+00 2.53E+00*	.7861 12720.7 1.63E-04 .9895 2.62E-01 4.66E+01 4.81E+01*	.9023 11082.2 1.99E-03 1.0193 2.59E-01 3.69E+02 3.79E+02*	1.0558 9471.4 1.36E-02 1.0526 2.55E-01 1.52E+03 1.55E+03	1.2677 7888.3 5.40E-02 1.0900 2.49E-01 3.32E+03 3.37E+03	1.5791 6332.9 1.16E-01 1.1330 2.41E-01 3.45E+03 3.46E+03	2.0812 4804.9 9.69E-02 1.1876 2.28E-01 1.13E+03 1.12E+03	3.0262 3304.4 8.09E-04 1.5145 1.32E-01 (1.03E+00) 6.49E-01*	5.4606 1831.3 1.28E-01 1.2679 2.07E-01 6.84E+01 6.86E+01	25.9469 385.4 8.77E-02 1.4321 1.58E-01 2.53E-01 2.48E-01	-9.6771 -1033.4 3.92E-01 1.4746 1.44E-01 -1.83E+01 -1.85E+01
9	.6353 15741.5 1.36E-06 .9462 2.65E-01 7.53E-01 7.79E-01*	.7105 14075.2 4.11E-05 .9688 2.64E-01 1.61E+01 1.67E+01*	.8041 12436.7 5.64E-04 .9952 2.62E-01 1.50E+02 1.55E+02*	.9237 10825.9 4.50E-03 1.0251 2.58E-01 7.73E+02 7.94E+02*	1.0819 9242.8 2.24E-02 1.0585 2.54E-01 2.31E+03 2.35E+03	1.3008 7687.4 6.81E-02 1.0961 2.48E-01 3.85E+03 3.89E+03	1.6235 6159.4 1.13E-01 1.1399 2.39E-01 3.05E+03 3.05E+03	2.1464 4658.9 6.51E-02 1.1989 2.25E-01 6.78E+02 6.60E+02	3.1389 3185.8 2.17E-03 1.0484 2.55E-01 (9.25E+00) 1.18E+01*	5.7475 1739.9 1.38E-01 1.2769 2.05E-01 6.16E+01 6.15E+01	31.1413 321.1 5.48E-02 1.4679 1.46E-01 7.89E-02 7.75E-02
10	.5857 17074.6 3.38E-07 .9334 2.65E-01 2.40E-01 2.47E-01*	.6490 15408.3 1.08E-05 .9517 2.65E-01 5.59E+00 5.77E+00*	.7262 13769.7 1.60E-04 .9745 2.63E-01 5.87E+01 6.07E+01*	.8224 12159.0 1.44E-03 1.0010 2.61E-01 3.57E+02 3.67E+02*	.9455 10575.9 8.41E-03 1.0309 2.58E-01 1.34E+03 1.37E+03*	1.1086 9020.4 3.24E-02 1.0644 2.53E-01 3.09E+03 3.14E+03	1.3347 7492.5 7.85E-02 1.1023 2.47E-01 4.07E+03 4.10E+03	1.6689 5992.0 1.02E-01 1.1473 2.38E-01 2.51E+03 2.49E+03	2.2129 4518.9 3.83E-02 1.2136 2.22E-01 3.52E+02 3.38E+02	3.2542 3073.0 1.21E-02 1.1579 2.35E-01 3.93E+01 4.28E+01	6.0453 1654.2 1.38E-01 1.2852 2.02E-01 5.19E+01 5.15E+01
11	.5439 18386.5 9.04E-08 .9251 2.66E-01 8.04E-02 8.24E-02*	.5981 16720.2 2.96E-06 .9385 2.65E-01 1.97E+00 2.03E+00*	.6631 15081.7 4.66E-05 .9572 2.64E-01 2.26E+01 2.34E+01*	.7423 13470.9 4.55E-04 1.0068 2.63E-01 1.56E+02 1.61E+02*	.8412 11887.8 3.00E-03 1.0368 2.60E-01 6.93E+02 7.12E+02*	.9678 10332.4 1.37E-02 1.0368 2.57E-01 2.02E+03 2.07E+03	1.1358 8804.4 4.26E-02 1.0704 2.52E-01 3.74E+03 3.80E+03	1.3691 7303.9 8.39E-02 1.1087 2.45E-01 3.99E+03 4.01E+03	1.7150 5830.8 8.58E-02 1.1552 2.36E-01 1.92E+03 1.89E+03	2.2806 4384.9 1.84E-02 1.2362 2.16E-01 1.46E+02 1.37E+02	3.3714 2966.1 2.62E-02 1.1883 2.28E-01 7.21E+01 7.57E+01
12	.5082 19677.6 2.63E-08 .9212 2.66E-01 2.87E-02 2.92E-02*	.5552 18011.2 8.67E-07 .9295 2.66E-01 7.24E-01 7.43E-01*	.6108 16372.7 1.41E-05 .9437 2.65E-01 8.79E+00 9.06E+00*	.6774 14762.0 1.46E-04 .9628 2.64E-01 6.62E+01 6.83E+01*	.7588 13178.9 1.05E-03 .9859 2.62E-01 3.35E+02 3.45E+02*	.8603 11623.4 5.42E-03 1.0126 2.60E-01 1.16E+03 1.20E+03*	.9905 10095.5 2.01E-02 1.0426 2.56E-01 2.75E+03 2.61E+03	1.1635 8595.0 5.17E-02 1.0764 2.51E-01 4.19E+03 4.25E+03	1.4041 7121.8 8.42E-02 1.1153 2.44E-01 3.67E+03 3.68E+03	1.7618 5675.9 6.72E-02 1.1641 2.34E-01 1.36E+03 1.34E+03	2.3490 4257.2 6.03E-03 1.2830 2.03E-01 (3.88E+01) 3.45E+01*
13	.4774 20948.0 8.39E-09 .9211 2.66E-01 1.10E-02 1.12E-02*	.5186 19281.7 2.73E-07 .9248 2.66E-01 2.80E-01 2.86E-01*	.5668 17643.2 4.48E-06 .9342 2.65E-01 3.51E+00 3.61E+00*	.6237 16032.4 4.80E-05 .9489 2.65E-01 2.81E+01 2.89E+01*	.6921 14449.3 3.67E-04 .9683 2.64E-01 1.56E+02 1.61E+02*	.7756 12893.9 2.08E-03 .9917 2.62E-01 6.20E+02 6.37E+02*	.8798 11365.9 8.77E-03 1.0184 2.59E-01 1.75E+03 1.80E+03*	1.0136 9865.4 2.71E-02 1.0485 2.55E-01 3.44E+03 3.51E+03	1.1916 8392.3 5.87E-02 1.0825 2.50E-01 4.40E+03 4.44E+03	1.4396 6946.4 7.96E-02 1.1222 2.43E-01 3.19E+03 3.18E+03	1.8091 5527.6 4.87E-02 1.1744 2.31E-01 8.92E+02 8.68E+02
14	.4505 22198.2 2.93E-09 .9240 2.66E-01 4.59E-03 4.61E-03*	.4870 20531.8 9.34E-08 .9238 2.66E-01 1.16E-01 1.17E-01*	.5293 18893.3 1.52E-06 .9286 2.66E-01 1.47E+00 1.50E+00*	.5786 17282.5 1.65E-05 .9389 2.65E-01 1.22E+01 1.25E+01*	.6370 15699.5 1.31E-04 .9542 2.65E-01 7.20E+01 7.42E+01*	.7070 14144.0 7.92E-04 .9740 2.63E-01 3.15E+02 3.24E+02*	.7926 12616.1 3.67E-03 .9974 2.61E-01 1.02E+03 1.05E+03*	.8996 11115.6 1.30E-02 1.0242 2.59E-01 2.41E+03 2.47E+03	1.0371 9642.4 3.41E-02 1.0545 2.55E-01 4.02E+03 4.08E+03	1.2200 8196.5 6.30E-02 1.0888 2.49E-01 4.36E+03 4.39E+03	1.4754 6777.8 7.12E-02 1.1295 2.41E-01 2.62E+03 2.60E+03
15	.4268 23428.2 1.12E-09 .9288 2.66E-01 2.06E-03 2.06E-03*	.4595 21761.9 3.47E-08 .9257 2.66E-01 5.11E-02 5.15E-02*	.4969 20123.4 5.54E-07 .9266 2.66E-01 6.46E-01 6.55E-01*	.5402 18512.6 6.01E-06 .9326 2.65E-01 5.44E+00 5.56E+00*	.5907 16929.5 4.86E-05 .9437 2.65E-01 3.36E+01 3.45E+01*	.6504 15374.0 3.06E-04 .9596 2.64E-01 1.57E+02 1.62E+02*	.7222 13846.1 1.51E-03 .9796 2.63E-01 5.63E+02 5.79E+02*	.8100 12345.6 5.90E-03 1.0032 2.61E-01 1.53E+03 1.57E+03*	.9198 10872.5 1.78E-02 1.0301 2.58E-01 3.09E+03 3.15E+03	1.0608 9426.6 4.04E-02 1.0605 2.54E-01 4.41E+03 4.48E+03	1.2488 8007.8 6.41E-02 1.0952 2.48E-01 4.10E+03 4.11E+03

Table 8. Radiative transition parameters for N_2 $w^1\Delta_u - a^1\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	-4.1235 -2425.1 1.06E-01 1.6041 1.06E-01 -3.47E+01 -3.39E+01	-2.6385 -3790.0 2.49E-03 2.0005 2.83E-02 (-2.20E-01) -6.09E-02*	-1.9500 -5128.1 8.21E-05 1.1705 2.32E-01 (-1.21E+00) -1.00E+00*	-1.5529 -6439.6 3.24E-06 2.1802 1.28E-02 (-2.88E-04) -2.33E-02*	-1.2946 -7724.7 3.41E-07 1.3764 1.75E-01 (-9.74E-03) -5.86E-03*	-1.1132 -8983.4 5.80E-10 -1.8714 1.79E-07 (-2.74E-17) -1.46E-03*	-0.9789 -10215.9 3.16E-10 2.4129 3.85E-03 (-1.01E-08) -4.82E-05*	-0.8755 -11422.4 1.31E-11 1.7809 6.33E-02 (-1.59E-07) -3.69E-09*	-0.7935 -12603.0 3.95E-14 2.7810 3.82E-04 (-2.34E-14) -2.61E-07*	-0.7269 -13757.9 3.47E-13 .8241 2.63E-01 (-1.27E-07) -4.98E-07*	-0.6717 -14887.0 3.14E-12 1.0572 2.54E-01 (-1.35E-06) -1.62E-06*
9	-9.3402 -1070.6 4.04E-01 1.4861 1.41E-01 -2.00E+01 -2.02E+01	-4.1059 -2435.5 1.24E-01 1.6169 1.03E-01 -3.84E+01 -3.74E+01	-2.6500 -3773.6 2.71E-03 2.0597 2.21E-02 (-1.44E-01) -2.80E-01*	-1.9665 -5085.1 1.52E-04 1.2633 2.08E-01 (-1.76E+00) -1.37E+00*	-1.5698 -6370.2 3.83E-06 2.3516 5.39E-03 (-5.84E-05) -5.73E-02*	-1.3108 -7628.9 6.94E-07 1.4579 1.50E-01 (-1.40E-02) -7.29E-03*	-1.1285 -8861.4 3.78E-09 -3.022 1.83E-02 (-1.80E-06) -2.89E-03*	-0.9933 -10067.9 6.21E-10 2.5607 1.62E-03 (-3.36E-09) -1.31E-04*	-0.8890 -11248.5 7.98E-11 1.6724 8.82E-02 (-1.79E-06) -1.94E-07*	-0.8062 -12403.4 5.65E-12 .9060 2.66E-01 (-1.55E-06) -3.47E-06*	-0.7390 -13532.6 7.90E-12 .9222 2.66E-01 (-2.80E-06) -4.92E-06*
10	38.1060 262.4 3.14E-02 1.5209 1.30E-01 1.96E-02 1.91E-02	-9.0707 -1102.4 4.13E-01 1.4981 1.37E-01 -2.11E+01 -2.14E+01	-4.0974 -2440.6 1.41E-01 1.6301 9.92E-02 -4.10E+01 -3.99E+01	-2.6652 -3752.1 2.75E-03 2.1338 1.59E-02 (-7.46E-02) -7.56E-01*	-1.9853 -5037.1 2.62E-04 1.3413 1.86E-01 (-2.33E+00) -1.75E+00*	-1.5884 -6295.8 3.85E-06 2.6168 1.14E-03 (-2.53E-06) -1.23E-01*	-1.3283 -7528.3 1.30E-06 1.5363 1.26E-01 (-1.78E-02) -7.53E-03*	-1.1448 -8734.8 1.52E-08 .3383 1.48E-01 (-4.52E-04) -5.18E-03*	-1.0085 -9915.5 1.06E-09 2.7504 4.72E-04 (-4.68E-10) -3.18E-04*	-0.9033 -11070.3 3.28E-10 1.6310 9.90E-02 (-8.83E-06) -1.13E-06*	-0.8197 -12199.5 5.99E-11 1.0395 2.57E-01 (-1.45E-05) -1.83E-05*
11	6.3518 1574.4 1.31E-01 1.2931 2.00E-01 4.15E+01 4.10E+01	47.7377 209.5 1.60E-02 1.6079 1.05E-01 3.29E-03 3.12E-03	-8.8602 -1128.6 4.18E-01 1.5106 1.33E-01 -2.17E+01 -2.21E+01	-4.0981 -2440.1 1.58E-01 1.6438 9.56E-02 -4.24E+01 -4.13E+01	-2.6844 -3725.2 2.61E-03 2.2307 1.01E-02 (-2.76E-02) -1.60E+00*	-2.0065 -4983.9 4.25E-04 1.4092 1.65E-01 (-2.89E+00) -2.11E+00*	-1.6087 -6216.4 3.01E-06 3.1058 3.28E-05 (-1.57E-09) -2.39E-01*	-1.3472 -7422.9 2.25E-06 1.6151 1.03E-01 (-1.99E-02) -5.84E-03*	-1.1623 -8603.5 4.77E-08 .7013 2.47E-01 (-3.76E-03) -8.44E-03*	-1.0248 -9758.4 1.54E-09 3.0297 6.04E-05 (-1.05E-11) -6.95E-04*	-0.9185 -10887.6 1.05E-09 1.6175 1.03E-01 (-2.91E-05) -3.54E-06*
12	3.4899 2865.4 4.11E-02 1.2049 2.24E-01 9.84E+01 1.02E+02	6.6643 1500.5 1.20E-01 1.3007 1.98E-01 3.20E+01 3.14E+01	61.5707 162.4 6.63E-03 1.7750 6.45E-02 2.40E-04 1.59E-04*	-8.7025 -1149.1 4.21E-01 1.5237 1.30E-01 -2.17E+01 -2.22E+01	-4.1083 -2434.1 1.73E-01 1.6580 9.19E-02 -4.27E+01 -4.15E+01	-2.7080 -3692.8 2.26E-03 2.3655 5.00E-03 (-5.76E-03) -2.90E+00*	-2.0303 -4925.3 6.56E-04 1.4700 1.46E-01 (-3.38E+00) -2.40E+00*	-1.6308 -6131.8 1.40E-06 4.3941 4.13E-11 (-1.12E-21) -4.27E-01*	-1.3675 -7312.5 3.62E-06 1.6977 8.20E-02 (-1.93E-02) -2.43E-03*	-1.1810 -8467.4 1.27E-07 .9457 2.65E-01 (-1.10E-02) -1.25E-02*	-1.0420 -9596.5 1.71E-09 3.5372 6.87E-07 (-1.45E-15) -1.39E-03*
13	2.4179 4135.9 5.49E-04 1.5120 1.33E-01 (1.39E+00) 8.27E-01*	3.6088 2771.0 5.46E-02 1.2166 2.21E-01 1.15E+02 1.17E+02	6.9790 1432.9 1.05E-01 1.3082 1.95E-01 2.39E+01 2.33E+01	82.3968 121.4 1.83E-03 2.2061 1.13E-02 (8.50E-07) 3.74E-05*	-8.5936 -1163.7 4.23E-01 1.5373 1.25E-01 -2.13E+01 -2.19E+01	-4.1282 -2422.4 1.87E-01 1.6727 8.81E-02 -4.18E+01 -4.06E+01	-2.7361 -3654.9 1.73E-03 2.5704 1.52E-03 (-3.99E-04) -4.75E+00*	-2.0570 -4861.4 9.64E-04 1.5262 1.29E-01 (-3.72E+00) -2.56E+00*	-1.6551 -6042.0 4.57E-08 20.6440 0.00E+00 (0.00E+00) -7.08E-01*	-1.3895 -7196.9 5.38E-06 1.7885 6.17E-02 (-1.55E-02) -6.45E-11*	-1.2011 -8326.0 3.00E-07 1.1295 2.41E-01 (-2.04E-02) -1.66E-02*
14	1.8567 5386.0 3.20E-02 1.1872 2.28E-01 5.29E+02 5.09E+02	2.4869 4021.1 6.74E-04 .9086 2.66E-01 (6.28E+00) 1.01E+01*	3.7272 2683.0 6.55E-02 1.2259 2.19E-01 1.22E+02 1.24E+02	7.2914 1371.5 8.90E-02 1.3154 1.93E-01 1.74E+01 1.68E+01	115.6524 86.5 1.03E-04 5.1641 6.55E-16 (5.78E-35) 1.21E-04*	-8.5307 -1172.2 4.25E-01 1.5515 1.21E-01 -2.04E+01 -2.12E+01	-4.1584 -2404.8 1.99E-01 1.6881 8.43E-02 -3.99E+01 -3.86E+01	-2.7691 -3611.3 1.11E-03 2.9285 1.31E-04 (-1.82E-06) -7.20E+00*	-2.0869 -4791.9 1.35E-03 1.5794 1.13E-01 (-3.87E+00) -2.54E+00*	-1.6816 -5946.8 1.66E-06 -2.1756 6.68E-09 (-3.15E-17) -1.10E+00*	-1.4132 -7075.9 7.36E-06 1.8941 4.27E-02 (-9.65E-03) -5.92E-03*
15	1.5115 6616.0 6.02E-02 1.1374 2.40E-01 2.03E+03 2.01E+03	1.9043 5251.2 1.85E-02 1.2049 2.24E-01 2.72E+02 2.57E+02	2.5556 3913.0 4.87E-03 1.0952 2.48E-01 (3.63E+01) 4.16E+01*	3.8439 2601.5 7.25E-02 1.2339 2.16E-01 1.21E+02 1.22E+02	7.5958 1316.5 7.33E-02 1.3223 1.91E-01 1.24E+01 1.19E+01	172.9475 57.8 2.74E-04 -1.1354 1.25E-04 (1.67E-12) 8.75E-05*	-8.5128 -1174.7 4.29E-01 1.5662 1.17E-01 -1.93E+01 -2.02E+01	-4.1996 -2381.2 2.09E-01 1.7041 8.04E-02 (-3.70E+01) -3.58E+01	-2.8075 -3561.8 4.92E-04 3.7446 8.39E-08 (-3.17E-13) -1.02E+01*	-2.1201 -4716.7 1.82E-03 1.6312 9.89E-02 (-3.80E+00) -2.32E+00*	-1.7106 -5845.9 1.18E-05 -.0402 5.18E-02 (-1.28E-02) -1.62E+00*

Table 9. Radiative transition parameters for $N_2 C^3\Pi_u-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.3370 29671.2 4.54E-01 1.1843 7.40E-01 1.32E+07 1.31E+07	.3576 27965.8 3.27E-01 1.1466 7.81E-01 8.84E+06 8.84E+06	.3804 26289.6 1.45E-01 1.1135 8.12E-01 3.53E+06 3.56E+06	.4058 24642.3 5.12E-02 1.0830 8.37E-01 1.09E+06 1.10E+06	.4343 23024.0 1.58E-02 1.0545 8.56E-01 2.86E+05 2.92E+05	.4665 21434.7 4.50E-03 1.0277 8.70E-01 6.78E+04 6.98E+04*	.5032 19874.5 1.22E-03 1.0025 8.79E-01 1.50E+04 1.55E+04*	.5452 18343.4 3.23E-04 .9788 8.85E-01 3.16E+03 3.29E+03*	.5938 16841.6 8.44E-05 .9568 8.87E-01 6.42E+02 6.74E+02*	.6507 15369.2 2.20E-05 .9359 8.86E-01 1.27E+02 1.34E+02*	.7181 13926.3 5.71E-06 .9150 8.83E-01 2.44E+01 2.59E+01*
1	.3158 31665.6 3.92E-01 1.2285 6.87E-01 1.19E+07 1.19E+07	.3338 29960.2 3.42E-01 1.2098 7.10E-01 6.19E+05 5.87E+05	.3536 28284.0 2.05E-01 1.1550 7.72E-01 5.60E+06 5.54E+06	.3754 26636.7 1.98E-01 1.1211 8.05E-01 4.93E+06 4.93E+06	.3997 25018.4 1.10E-01 1.0904 8.31E-01 2.41E+06 2.43E+06	.4268 23429.1 4.68E-02 1.0619 8.51E-01 8.84E+05 8.98E+05	.4573 21868.9 1.71E-02 1.0354 8.66E-01 2.72E+05 2.78E+05	.4917 20337.8 5.68E-03 1.0103 8.76E-01 7.44E+04 7.68E+04*	.5309 18836.0 1.78E-03 .9864 8.83E-01 1.88E+04 1.95E+04*	.5759 17363.6 5.36E-04 .9639 8.86E-01 4.47E+03 4.68E+03*	.6281 15920.7 1.59E-04 .9428 8.87E-01 1.02E+03 1.07E+03*
2	.2976 33606.3 1.33E-01 1.2784 6.21E-01 3.94E+06 3.97E+06	.3135 31901.0 3.42E-01 1.2395 6.73E-01 1.02E+07 1.01E+07	.3309 30224.8 2.36E-02 1.1679 7.58E-01 7.58E+05 7.99E+05	.3499 28577.5 6.42E-02 1.1652 7.61E-01 1.76E+06 1.71E+06	.3709 26959.2 1.61E-01 1.1288 7.98E-01 4.07E+06 4.04E+06	.3942 25369.9 1.39E-01 1.0976 8.25E-01 3.13E+06 3.14E+06	.4200 23809.7 7.91E-02 1.0689 8.47E-01 1.55E+06 1.57E+06	.4489 22278.6 3.62E-02 1.0424 8.62E-01 6.02E+05 6.14E+05	.4813 20776.8 1.44E-02 1.0177 8.74E-01 2.30E+05 2.06E+05	.5180 19304.3 5.28E-03 .9940 8.81E-01 5.97E+04 6.19E+04*	.5599 17861.5 1.82E-03 .9711 8.86E-01 1.65E+04 1.72E+04*
3	.2818 35480.4 2.02E-02 1.3415 5.35E-01 5.23E+05 5.28E+05	.2961 33775.1 2.53E-01 1.2894 6.07E-01 7.25E+06 7.30E+06	.3115 32098.8 2.11E-01 1.2551 6.52E-01 6.01E+06 5.94E+06	.3284 30451.5 8.90E-02 1.1835 7.41E-01 2.79E+06 2.85E+06	.3468 28833.2 5.00E-03 1.1893 7.34E-01 1.31E+05 1.15E+05*	.3671 27243.9 9.36E-02 1.1362 7.91E-01 2.40E+06 2.35E+06	.3894 25683.7 1.31E-01 1.1047 8.20E-01 3.02E+06 3.00E+06	.4140 24152.6 9.87E-02 1.0755 8.42E-01 2.00E+06 2.01E+06	.4415 22650.8 5.53E-02 1.0487 8.59E-01 9.61E+05 9.76E+05	.4722 21178.4 2.61E-02 1.0243 8.71E-01 3.82E+05 3.91E+05	.5067 19735.5 1.10E-02 1.0012 8.79E-01 1.33E+05 1.37E+05
4	.2684 37261.7 9.50E-04 1.4568 3.80E-01 1.44E+04 1.38E+04*	.2812 35556.3 5.37E-02 1.3575 5.13E-01 1.29E+06 1.30E+06	.2952 33880.1 3.30E-01 1.3027 5.88E-01 8.99E+06 9.03E+06	.3102 32232.8 1.19E-01 1.2802 6.19E-01 3.09E+06 3.02E+06	.3266 30614.5 1.16E-01 1.1862 7.38E-01 3.66E+06 3.71E+06	.3445 29025.2 3.48E-03 1.1370 7.90E-01 1.08E+05 1.24E+05*	.3641 27465.0 4.02E-02 1.1423 7.85E-01 1.04E+06 9.98E+05	.3856 25933.9 1.01E-01 1.1110 8.14E-01 2.37E+06 2.33E+06	.4093 24432.1 1.01E-01 1.0818 8.38E-01 2.09E+06 2.09E+06	.4355 22959.7 6.80E-02 1.0543 8.56E-01 1.22E+06 1.23E+06	.4648 21516.8 3.72E-02 1.0295 8.69E-01 5.66E+05 5.78E+05

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 9. Radiative transition parameters for $N_2 C^3\Pi_u-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	.7992 12513.1 1.46E-06 .8925 8.77E-01 4.47E+00 4.80E+00*	.8985 11129.9 3.68E-07 .8670 8.67E-01 7.73E-01 8.44E-01*	1.0228 9776.8 8.99E-08 .8369 8.50E-01 (1.23E-01) 1.38E-01*	1.1828 8454.2 2.11E-08 .8004 8.24E-01 (1.75E-02) 2.06E-02*	1.3962 7162.4 4.65E-09 .7541 7.81E-01 (2.12E-03) 2.67E-03*	1.6944 5901.6 9.03E-10 .6853 7.04E-01 (1.86E-04) 2.71E-04*	2.1403 4672.3 1.19E-10 .5188 4.80E-01 (5.65E-06) 1.49E-05*	2.8779 3474.7 7.67E-13 -2.3476 2.31E-16 (3.48E-39) 1.14E-09*	4.3302 2309.3 2.08E-11 1.3805 4.81E-01 (1.20E-07) 5.27E-07*	8.4991 1176.6 5.49E-11 1.1507 7.77E-01 (1.09E-07) 1.54E-07*	129.9646 76.9 7.33E-11 1.0892 8.32E-01 (4.69E-11) 5.42E-11*
1	.6893 14507.5 4.62E-05 .9224 8.85E-01 2.24E+02 2.37E+02*	.7619 13124.3 1.33E-05 .9013 8.80E-01 4.71E+01 5.03E+01*	.8495 11771.2 3.74E-06 .8782 8.72E-01 9.39E+00 1.02E+01*	.9571 10448.6 1.02E-06 .8515 8.59E-01 1.74E+00 1.92E+00*	1.0921 9156.8 2.63E-07 .8176 8.37E-01 (2.87E-01) 3.29E-01*	1.2665 7896.0 6.18E-08 .7675 7.95E-01 (3.89E-02) 4.85E-02*	1.5000 6666.7 1.19E-08 .6761 6.92E-01 (3.42E-03) 5.42E-03*	1.8285 5469.1 1.38E-09 .4290 3.62E-01 (6.00E-05) 3.13E-04*	2.3236 4303.7 2.11E-12 -7.5517 0.00E+00 (0.00E+00) 1.60E-07*	3.1536 3171.0 2.39E-10 1.4627 3.73E-01 (2.14E-06) 1.59E-05*	4.8278 2071.3 5.17E-10 1.1828 7.42E-01 (5.12E-06) 8.44E-06*
2	.6080 16448.3 6.03E-04 .9497 8.87E-01 4.28E+03 4.49E+03*	.6638 15065.1 1.96E-04 .9295 8.86E-01 1.06E+03 1.12E+03*	.7293 13712.0 6.21E-05 .9092 8.82E-01 2.52E+02 2.68E+02*	.8071 12389.4 1.91E-05 .8866 8.75E-01 5.65E+01 6.08E+01*	.9011 11097.6 5.70E-06 .8604 8.64E-01 (1.18E+01) 1.29E+01*	1.0166 9836.8 1.61E-06 .8288 8.45E-01 (2.22E+00) 2.52E+00*	1.1618 8607.5 4.21E-07 .7860 8.12E-01 (3.58E-01) 4.32E-01*	1.3495 7409.9 9.26E-08 .7107 7.34E-01 (4.12E-02) 5.88E-02*	1.6014 6244.5 1.33E-08 .5141 4.74E-01 (1.48E-03) 4.80E-03*	1.9563 5111.8 2.81E-10 -1.1337 5.31E-07 (2.14E-17) 3.58E-05*	2.4924 4012.1 8.61E-10 1.7548 1.05E-01 (1.23E-06) 1.11E-04*
3	.5458 18322.3 4.30E-03 .9785 8.85E-01 4.19E+04 4.36E+04*	.5904 16939.1 1.58E-03 .9562 8.87E-01 1.23E+04 1.29E+04*	.6416 15586.1 5.64E-04 .9355 8.86E-01 3.40E+03 3.59E+03*	.7011 14263.5 1.96E-04 .9161 8.84E-01 9.00E+02 9.55E+02*	.7709 12971.6 6.62E-05 .8955 8.78E-01 2.26E+02 2.42E+02*	.8539 11710.8 2.14E-05 .8701 8.68E-01 5.25E+01 5.72E+01*	.9541 10481.5 6.51E-06 .8367 8.50E-01 (1.10E+01) 1.25E+01*	1.0771 9283.9 1.84E-06 .7939 8.18E-01 (2.00E+00) 2.43E+00*	1.2317 8118.6 4.71E-07 .7359 7.62E-01 (2.97E-01) 4.02E-01*	1.4315 6985.8 9.77E-08 .6319 6.35E-01 (2.72E-02) 4.96E-02*	1.6989 5886.2 1.09E-08 .2939 2.14E-01 (2.07E-04) 2.80E-03*
4	.4974 20103.6 1.79E-02 1.0071 8.78E-01 2.26E+05 2.32E+05	.5342 18720.4 7.80E-03 .9855 8.83E-01 8.09E+04 8.37E+04*	.5758 17367.3 3.17E-03 .9632 8.86E-01 2.65E+04 2.76E+04*	.6233 16044.7 1.22E-03 .9409 8.87E-01 8.05E+03 8.50E+03*	.6778 14752.9 4.58E-04 .9201 8.84E-01 2.33E+03 2.48E+03*	.7412 13492.1 1.68E-04 .9012 8.80E-01 6.47E+02 6.91E+02*	.8155 12262.8 5.96E-05 .8810 8.73E-01 1.70E+02 1.83E+02*	.9037 11065.2 2.00E-05 .8530 8.60E-01 4.06E+01 4.47E+01*	1.0101 9899.8 6.13E-06 .8099 8.31E-01 (8.33E+00) 9.85E+00*	1.1406 8767.1 1.69E-06 .7459 7.73E-01 (1.38E+00) 1.88E+00*	1.3042 7667.4 4.09E-07 .6554 6.66E-01 (1.66E-01) 2.97E-01*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 10. Radiative transition parameters for N_2 $E^3\Sigma_g^+ - A^3\Sigma_u^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.2173 46019.7 3.98E-03 1.1969 1.28E-02 (1.29E+02) 1.14E+02*	.2243 44586.8 1.72E-02 1.1845 1.10E-02 3.71E+02 3.59E+02	.2316 43181.6 4.02E-02 1.1727 9.16E-03 5.51E+02 5.77E+02	.2392 41804.1 6.78E-02 1.1615 7.52E-03 (5.67E+02) 6.32E+02	.2472 40454.5 9.24E-02 1.1508 6.07E-03 (4.57E+02) 5.28E+02	.2555 39132.8 1.08E-01 1.1406 4.84E-03 (3.08E+02) 3.58E+02	.2643 37839.2 1.13E-01 1.1309 3.82E-03 (1.82E+02) 2.04E+02	.2734 36574.0 1.08E-01 1.1216 2.99E-03 9.64E+01 9.95E+01	.2830 35337.4 9.71E-02 1.1127 2.33E-03 (4.71E+01) 4.22E+01	.2930 34129.7 8.24E-02 1.1042 1.80E-03 (2.16E+01) 1.56E+01	.3035 32951.4 6.70E-02 1.0960 1.39E-03 (9.34E+00) 4.96E+00
1	.2074 48204.7 2.67E-02 1.2159 1.53E-02 (1.42E+03) 1.19E+03	.2138 46771.8 7.81E-02 1.2027 1.36E-02 3.01E+03 2.75E+03	.2204 45366.6 1.18E-01 1.1901 1.18E-02 3.11E+03 3.07E+03	.2273 43989.1 1.18E-01 1.1782 1.00E-02 2.04E+03 2.12E+03	.2345 42639.5 8.55E-02 1.1666 8.25E-03 9.15E+02 9.54E+02	.2420 41317.8 4.27E-02 1.1553 6.66E-03 2.71E+02 2.48E+02	.2498 40024.2 1.14E-02 1.1431 5.13E-03 (3.91E+01) 1.73E+01	.2580 38759.0 9.06E-05 1.0924 1.23E-03 (1.62E-02) 8.68E+00*	.2665 37522.4 5.64E-03 1.1337 4.10E-03 (1.02E+01) 3.79E+01*	.2754 36314.7 2.00E-02 1.1221 3.03E-03 (1.79E+01) 4.52E+01	.2846 35136.4 3.56E-02 1.1128 2.33E-03 (1.71E+01) 3.43E+01

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 11. Radiative transition parameters for N_2 $E^3\Sigma_g^+ - B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.2742 36467.8 1.43E-01 1.1653 1.85E-03 9.63E+01	.2877 34762.5 2.43E-01 1.1431 1.85E-03 1.42E+02	.3022 33086.2 2.35E-01 1.1224 1.85E-03 1.18E+02	.3181 31438.9 1.70E-01 1.1031 1.85E-03 7.32E+01	.3353 29820.6 1.03E-01 1.0848 1.85E-03 3.78E+01	.3542 28231.3 5.54E-02 1.0675 1.85E-03 1.73E+01	.3749 26671.1 2.75E-02 1.0512 1.85E-03 7.23E+00	.3978 25140.0 1.29E-02 1.0357 1.85E-03 2.83E+00	.4230 23638.2 5.77E-03 1.0209 1.85E-03 1.06E+00*	.4511 22165.8 2.52E-03 1.0069 1.85E-03 3.80E-01*	.4826 20722.9 1.07E-03 .9934 1.85E-03 1.33E-01*
1	.2587 38652.8 3.11E-01 1.1937 1.85E-03 2.49E+02	.2707 36947.5 1.26E-01 1.1683 1.85E-03 8.80E+01	.2835 35271.2 7.28E-04 1.1115 1.85E-03 4.43E-01*	.2974 33623.9 4.83E-02 1.1324 1.85E-03 2.55E+01	.3124 32005.6 1.16E-01 1.1112 1.85E-03 5.26E+01	.3288 30416.3 1.31E-01 1.0924 1.85E-03 5.10E+01	.3465 28856.1 1.06E-01 1.0749 1.85E-03 3.54E+01	.3660 27325.0 7.16E-02 1.0585 1.85E-03 2.03E+01	.3872 25823.2 4.27E-02 1.0429 1.85E-03 1.02E+01	.4107 24350.8 2.34E-02 1.0282 1.85E-03 4.68E+00	.4365 22907.9 1.21E-02 1.0142 1.85E-03 2.01E+00

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 12. Radiative transition parameters for $N_2 E^3\Sigma_g^+-C^3\Pi_u$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4
0	1.4713 6796.6 7.75E-01 1.1359 4.14E-02 1.69E+03	2.0824 4802.2 1.87E-01 1.0720 4.14E-02 1.44E+02	3.4947 2861.4 3.20E-02 1.0185 4.14E-02 5.20E+00	10.1275 987.4 5.01E-03 .9741 4.14E-02 3.35E-02*	-12.5965 -793.9 7.94E-04 .9362 4.14E-02 -1.38E-03*
1	1.1134 8981.6 2.05E-01 1.2059 4.14E-02 1.03E+03	1.4312 6987.2 4.23E-01 1.1460 4.14E-02 1.00E+03	1.9816 5046.4 2.72E-01 1.0810 4.14E-02 2.43E+02	3.1522 3172.4 7.73E-02 1.0273 4.14E-02 1.71E+01	7.1884 1391.1 1.75E-02 .9838 4.14E-02 3.27E-01

*The Einstein coefficient for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 13. Radiative transition parameters for $N_2 D^3\Sigma_u^+-B^3\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.2259 44264.1 9.71E-02 1.1608 6.09E-01 1.27E+07 1.25E+07	.2350 42558.8 1.93E-01 1.1403 5.69E-01 1.95E+07 1.94E+07	.2446 40882.6 2.17E-01 1.1215 5.31E-01 1.70E+07 1.70E+07	.2549 39235.3 1.83E-01 1.1040 4.95E-01 1.10E+07 1.10E+07	.2658 37617.0 1.30E-01 1.0876 4.61E-01 5.95E+06 5.96E+06	.2776 36027.7 8.14E-02 1.0722 4.29E-01 2.84E+06 2.84E+06	.2901 34467.5 4.69E-02 1.0576 4.00E-01 1.24E+06 1.24E+06	.3036 32936.4 2.55E-02 1.0439 3.72E-01 5.11E+05 5.07E+05	.3181 31434.6 1.32E-02 1.0310 3.47E-01 2.01E+05 1.98E+05	.3338 29962.1 6.67E-03 1.0187 3.24E-01 7.63E+04 7.46E+04*	.3506 28519.3 3.29E-03 1.0071 3.03E-01 2.83E+04 2.74E+04*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 14. Radiative transition parameters for $N_2^+ A^2\Pi_u-X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.1092 9015.6 4.81E-01 1.1491 2.55E-01 4.65E+04 4.64E+04	1.4618 6840.7 3.78E-01 1.1924 2.46E-01 1.48E+04 1.48E+04	2.1284 4698.4 1.20E-01 1.2406 2.34E-01 1.38E+03 1.39E+03	3.8625 2589.0 1.95E-02 1.2954 2.20E-01 3.34E+01 3.36E+01	19.5110 512.5 1.73E-03 1.3612 2.02E-01 1.93E-02 1.95E-02*	-6.5328 -1530.7 7.89E-05 1.4468 1.78E-01 -3.64E-02 -3.67E-02*	-2.8244 -3540.5 1.54E-06 1.5782 1.41E-01 -5.50E-03 -5.42E-03*	-1.8127 -5516.6 5.96E-09 1.9443 5.72E-02 (-1.33E-05) -3.47E-06*	-1.3407 -7458.6 4.07E-11 1.0324 2.75E-01 (-5.19E-06) -6.07E-06*	-1.0677 -9366.2 1.63E-12 1.7225 1.03E-01 (-5.77E-08) -3.71E-08*	-1.8898 -11239.1 2.57E-14 .9275 2.86E-01 (-1.20E-08) -1.54E-08*
1	.9183 10889.2 3.24E-01 1.1118 2.63E-01 5.84E+04 5.85E+04	1.1475 8714.3 3.45E-02 1.1669 2.51E-01 2.93E+03 2.87E+03	1.5216 6572.0 3.41E-01 1.2010 2.44E-01 1.17E+04 1.16E+04	2.2409 4462.6 2.33E-01 1.2484 2.32E-01 2.27E+03 2.28E+03	4.1909 2386.1 5.94E-02 1.3033 2.18E-01 7.79E+01 7.84E+01	29.1662 342.9 7.10E-03 1.3696 2.00E-01 2.32E-02 2.34E-02*	-5.9990 -1666.9 4.01E-04 1.4569 1.75E-01 -2.31E-01 -2.33E-01*	-2.7450 -3643.0 8.92E-06 1.5946 1.36E-01 -3.25E-02 -3.17E-02*	-1.7905 -5585.0 3.08E-08 2.0361 4.31E-02 (-4.04E-05) -9.82E-08*	-1.3346 -7492.6 4.86E-10 1.1718 2.50E-01 -5.19E-05 -5.41E-05*	-1.0678 -9365.5 1.26E-11 1.8097 8.31E-02 (-2.90E-07) -1.26E-07*
2	.7854 12732.8 1.33E-01 1.0783 2.68E-01 4.02E+04 4.04E+04	.9472 10557.8 2.28E-01 1.1203 2.61E-01 3.70E+04 3.68E+04	1.1883 8415.6 1.87E-02 1.1401 2.57E-01 1.49E+03 1.53E+03	1.5858 6306.1 1.95E-01 1.2113 2.41E-01 5.77E+03 5.73E+03	2.3643 4229.7 2.95E-01 1.2567 2.30E-01 2.40E+03 2.40E+03	4.5737 2186.4 1.12E-01 1.3113 2.16E-01 1.11E+02 1.11E+02	56.6248 176.6 1.74E-02 1.3782 1.98E-01 7.60E-03 7.67E-03	-5.5572 -1799.5 1.18E-03 1.4674 1.72E-01 -8.27E-01 -8.34E-01*	-2.6728 -3741.5 2.91E-05 1.6126 1.31E-01 -1.07E-01 -1.03E-01*	-1.7702 -5649.1 8.11E-08 2.1725 2.72E-02 (-4.37E-05) -8.56E-05*	-1.3294 -7521.9 2.99E-09 1.2772 2.25E-01 -2.61E-04 -2.58E-04*
3	.6875 14546.3 4.39E-02 1.0480 2.73E-01 2.04E+04 2.06E+04	.8083 12371.3 1.97E-01 1.0858 2.67E-01 5.40E+04 5.41E+04	.9776 10229.1 8.34E-02 1.1315 2.59E-01 1.21E+04 1.20E+04	1.2316 8119.6 1.01E-01 1.1592 2.53E-01 6.99E+03 7.05E+03	1.6548 6043.2 2.95E-01 1.2258 2.38E-01 1.81E+03 1.78E+03	2.5001 3999.9 3.00E-01 1.2655 2.28E-01 2.02E+03 2.02E+03	5.0249 1990.1 1.68E-01 1.3197 2.14E-01 1.46E+03 1.23E+02	712.1493 14.0 3.32E-02 1.3871 1.95E-01 7.09E-06 7.15E-06	-5.1868 -1928.0 2.64E-03 1.4785 1.69E-01 -2.19E+00 -2.21E+00*	-2.6072 -3835.6 7.01E-05 1.6326 1.26E-01 -2.54E-01 -2.44E-01*	-1.7518 -5708.4 1.34E-07 2.4033 1.11E-02 (-1.25E-05) -1.13E-03*
4	.6124 16329.7 1.29E-02 1.0202 2.77E-01 8.70E+03 8.78E+03	.7065 14154.8 1.01E-01 1.0552 2.72E-01 4.30E+04 4.32E+04	.8325 12012.5 1.74E-01 1.0939 2.66E-01 4.33E+04 4.32E+04	1.0098 9903.1 8.57E-03 1.1601 2.53E-01 1.08E+03 1.03E+03*	1.2777 7826.6 1.54E-01 1.1694 2.51E-01 9.39E+03 9.41E+03	1.7291 5783.4 9.50E-03 1.2647 2.28E-01 1.94E+02 1.84E+02*	2.6500 3773.6 2.63E-01 1.2752 2.26E-01 1.46E+03 1.45E+03	5.5633 1797.5 2.18E-01 1.3285 2.11E-01 1.15E+02 1.15E+02	-69.2094 -144.5 5.41E-02 1.3964 1.92E-01 -2.45E-02 -2.47E-02	-4.8731 -2052.1 4.96E-03 1.4902 1.66E-01 -4.77E+00 -4.79E+00*	-2.5478 -3925.0 1.38E-04 1.6551 1.20E-01 -4.87E-01 -4.62E-01*
5	.5530 18083.2 3.53E-03 .9948 2.80E-01 3.32E+03 3.35E+03*	.6286 15908.2 4.04E-02 1.0273 2.76E-01 2.51E+04 2.53E+04	.7264 13766.0 1.37E-01 1.0627 2.71E-01 5.32E+04 5.33E+04	.8579 11656.5 1.09E-01 1.1032 2.64E-01 2.43E+04 2.41E+04	1.0438 9580.1 5.69E-03 1.0980 2.65E-01 7.12E+02 7.55E+02*	1.3268 7536.8 1.53E-01 1.1789 2.49E-01 8.24E+03 8.21E+03	1.8093 5527.0 2.57E-03 1.1286 2.59E-01 5.90E+01 6.57E+01*	2.8161 3551.0 2.04E-01 1.2860 2.23E-01 9.19E+02 9.13E+02	6.2152 1609.0 2.57E-01 1.3376 2.09E-01 9.47E+01 9.49E+01	-33.4835 -298.7 7.91E-02 1.4060 1.90E-01 -3.07E-01 -3.09E-01	-4.6051 -2171.5 8.23E-03 1.5025 1.62E-01 -8.98E+00 -9.02E+00*
6	.5049 19806.6 9.44E-04 .9717 2.82E-01 1.18E+03 1.20E+03*	.5672 17631.7 1.42E-02 1.0019 2.79E-01 1.23E+04 1.24E+04	.6456 15489.4 7.35E-02 1.0346 2.75E-01 4.19E+04 4.21E+04	.7474 13380.0 1.39E-01 1.0706 2.70E-01 4.89E+04 4.89E+04	.8847 11303.5 4.47E-02 1.1156 2.62E-01 8.97E+03 8.81E+03	1.0799 9260.2 4.03E-02 1.1298 2.59E-01 4.35E+03 4.43E+03	1.3792 7250.4 1.17E-01 1.1891 2.47E-01 5.48E+03 5.43E+03	1.8960 5274.4 2.87E-02 1.2030 2.43E-01 5.05E+02 5.19E+02	3.0009 3332.4 1.40E-01 1.2988 2.19E-01 5.07E+02 5.01E+02	7.0187 1424.8 2.83E-01 1.3473 2.06E-01 7.04E+01 7.05E+01	-22.3168 -448.1 1.07E-01 1.4160 1.87E-01 -1.36E+00 -1.37E+00
7	.4651 21500.0 2.52E-04 .9510 2.84E-01 4.09E+02 4.15E+02*	.5175 19325.1 4.62E-03 .9787 2.82E-01 5.36E+03 5.42E+03*	.5820 17182.8 3.22E-02 1.0091 2.78E-01 2.56E+04 2.59E+04	.6634 15073.4 9.93E-02 1.0421 2.74E-01 5.17E+04 5.19E+04	.7694 12996.9 1.11E-01 1.0791 2.68E-01 3.55E+04 3.53E+04	.9129 10953.7 7.41E-03 1.1434 2.56E-01 1.30E+03 1.23E+03*	1.1181 8943.9 7.86E-02 1.1620 2.57E-01 7.50E+03 7.57E+03	1.4352 6967.8 6.86E-02 1.2012 2.44E-01 2.80E+03 2.75E+03	1.9897 5025.8 6.58E-02 1.2209 2.39E-01 9.69E+02 9.83E+02	3.2070 3118.2 8.41E-02 1.3151 2.15E-01 2.39E+02 2.35E+02	8.0300 1245.3 2.94E-01 1.3574 2.03E-01 4.77E+01 4.77E+01

Table 14. Radiative transition parameters for $N_2^+ A^2\Pi_u-X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_i^* R_e(r) \psi_j dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	- .7647 -13076.8 7.61E-17 -1.2837 6.17E-04 (-2.62E-16) -5.40E-10*	- .6721 -14879.1 1.70E-18 4.2135 6.71E-08 (-1.02E-25) -3.11E-13*	- .6008 -16645.3 4.72E-17 1.4356 1.81E-01 (-2.90E-11) -4.83E-11*	- .5442 -18375.2 6.30E-19 3.0535 4.10E-04 (-2.66E-18) -4.15E-14*	- .4983 -20068.0 1.00E-16 1.0337 2.75E-01 -2.48E-10 -2.37E-10*	- .4603 -21723.1 2.41E-16 1.0886 2.67E-01 -7.12E-10 -6.93E-10*	- .4285 -23339.9 1.57E-16 1.0873 2.67E-01 -5.76E-10 -5.64E-10*	- .4013 -24917.5 1.80E-17 1.0171 2.77E-01 -8.69E-11 -8.53E-11*	- .3780 -26455.3 1.57E-17 1.2225 2.39E-01 -6.72E-11 -7.10E-11*	- .3578 -27952.5 7.02E-17 1.1519 2.55E-01 -4.03E-10 -4.08E-10*	- .3400 -29408.6 6.75E-17 1.1283 2.59E-01 -4.68E-10 -4.72E-10*
1	- .8926 -11203.2 3.28E-13 1.0566 2.72E-01 -1.38E-07 -1.49E-07*	- .7689 -13005.5 1.47E-16 -5.2039 9.37E-23 (0.00E+00) -4.79E-09*	- .6770 -14771.7 4.52E-16 .3229 1.98E-01 (-2.31E-10) -8.38E-10*	- .6060 -16501.6 1.06E-15 .8980 2.87E-01 -1.59E-09 -1.46E-09*	- .5496 -18194.4 1.16E-15 .9546 2.84E-01 -2.28E-09 -2.18E-09*	- .5038 -19849.5 9.23E-16 .9754 2.82E-01 -2.32E-09 -2.26E-09*	- .4658 -21466.3 4.87E-16 .9758 2.82E-01 -1.55E-09 -1.51E-09*	- .4340 -23043.9 1.33E-16 .9411 2.85E-01 -5.36E-10 -5.22E-10*	- .4068 -24581.7 2.68E-18 .4251 2.26E-01 (-8.23E-12) -1.67E-11*	- .3835 -26078.9 3.16E-17 1.2104 2.42E-01 (-1.33E-10) -1.52E-10*	- .3632 -27535.0 8.60E-17 1.1392 2.57E-01 -4.82E-10 -5.04E-10*
2	-1.0684 -9359.7 4.80E-11 1.9307 5.95E-02 (-5.65E-07) -4.05E-08*	- .8959 -11161.9 2.62E-12 1.1746 2.50E-01 -9.20E-07 -8.90E-07*	- .7735 -12928.2 1.69E-14 - .3734 3.82E-02 (-2.15E-10) -6.30E-08*	- .6822 -14658.0 1.21E-14 .6427 2.72E-01 (-1.14E-08) -1.79E-08*	- .6116 -16350.8 1.24E-14 .9225 2.86E-01 -1.79E-08 -1.67E-08*	- .5554 -18006.0 6.32E-15 .9056 2.87E-01 -1.23E-08 -1.20E-08*	- .5096 -19622.7 2.72E-15 .8734 2.88E-01 -6.90E-09 -7.00E-09*	- .4717 -21200.4 1.21E-15 .8827 2.88E-01 -3.86E-09 -3.83E-09*	- .4398 -22738.1 4.52E-16 .9032 2.87E-01 -1.77E-09 -1.67E-09*	- .4126 -24235.3 5.50E-17 .7732 2.86E-01 -2.59E-10 -2.45E-10*	- .3892 -25691.4 2.87E-17 1.4509 1.77E-01 (-6.16E-11) -1.15E-10*
3	-1.3252 -7546.2 1.25E-08 1.3634 2.02E-01 -8.89E-04 -8.53E-04*	-1.0697 -9348.4 1.14E-10 2.1111 3.36E-02 (-4.29E-07) -6.75E-07*	- .8997 -11114.7 1.44E-11 1.2696 2.27E-01 (-4.14E-06) -3.73E-06*	- .7785 -12844.5 2.28E-13 .2921 1.89E-01 (-7.01E-08) -4.47E-07*	- .6879 -14537.3 6.58E-14 .5871 2.62E-01 (-5.64E-08) -1.05E-07*	- .6176 -16192.5 5.11E-14 .8680 2.88E-01 -7.29E-08 -7.16E-08*	- .5615 -17809.2 2.62E-14 .8777 2.88E-01 -4.97E-08 -4.86E-08*	- .5158 -19386.9 1.24E-14 .8741 2.88E-01 -3.03E-08 -2.99E-08*	- .4779 -20924.6 5.30E-15 .8741 2.88E-01 -1.63E-08 -1.59E-08*	- .4460 -22421.8 1.47E-15 .8096 2.87E-01 -5.56E-09 -5.60E-09*	- .4188 -23877.9 1.01E-16 .2840 1.87E-01 (-1.94E-10) -6.39E-10*
4	-1.7353 -5762.7 1.35E-07 2.8971 1.01E-03 (-1.06E-07) -6.56E-03*	-1.3219 -7565.0 4.05E-08 1.4389 1.80E-01 -2.31E-03 -2.17E-03*	-1.0717 -9331.2 1.66E-10 2.4594 8.73E-03 (-4.15E-08) -1.31E-05*	- .9041 -11061.1 5.80E-11 1.3526 2.05E-01 (-1.33E-05) -1.14E-05*	- .7841 -12753.9 1.56E-12 .5781 2.61E-01 (-8.92E-07) -2.11E-06*	- .6940 -14409.0 2.61E-13 .5260 2.50E-01 -1.98E-07 -4.53E-07*	- .6240 -16025.8 1.81E-13 .8229 2.88E-01 -2.50E-07 -2.61E-07*	- .5681 -17603.4 9.95E-14 .8671 2.88E-01 -1.82E-07 -1.78E-07*	- .5224 -19141.2 4.78E-14 .8749 2.88E-01 -1.12E-07 -1.10E-07*	- .4845 -20638.4 1.92E-14 .8468 2.88E-01 -5.68E-08 -5.62E-08*	- .4526 -22094.5 5.16E-15 .7513 2.84E-01 -1.82E-08 -1.97E-08*
5	-2.4942 -4009.3 2.34E-04 1.6808 1.13E-01 -7.87E-01 -7.30E-01*	-1.7207 -5811.5 4.77E-08 4.8365 1.39E-10 (-7.29E-22) -2.54E-02*	-1.3196 -7577.8 1.07E-07 1.5095 1.60E-01 -4.82E-03 -4.41E-03*	-1.0744 -9307.6 9.55E-11 3.6226 8.96E-06 (-2.51E-14) -8.79E-05*	- .9091 -11000.4 1.82E-10 1.4312 1.83E-01 (-3.27E-05) -2.63E-05*	- .7902 -12655.5 7.86E-12 .7737 2.86E-01 (-5.27E-06) -7.76E-06*	- .7007 -14272.3 9.36E-13 .5022 2.45E-01 (-6.60E-07) -1.66E-06*	- .6309 -15850.0 5.69E-13 .7809 2.86E-01 (-7.51E-07) -8.47E-07*	- .5751 -17387.7 3.35E-13 .8611 2.88E-01 -5.92E-07 -5.77E-07*	- .5295 -18884.9 1.59E-13 .8601 2.88E-01 -3.61E-07 -3.52E-07*	- .4916 -20341.0 5.96E-14 .8176 2.88E-01 -1.68E-07 -1.70E-07*
6	-4.3747 -2285.8 1.24E-02 1.5156 1.58E-01 -1.51E+01 -1.51E+01*	-2.4461 -4088.1 3.51E-04 1.7108 1.06E-01 (-1.09E+00) -9.82E-01*	-1.7081 -5854.4 2.37E-08 -4.7547 1.10E-19 (-2.34E-40) -7.62E-02*	-1.3185 -7584.2 2.36E-07 1.5800 1.40E-01 (-8.21E-03) -7.25E-03*	-1.0779 -9277.0 1.71E-11 -6.0921 1.60E-29 0.00E+00 -3.77E-04*	- .9147 -10932.1 4.58E-10 1.5117 1.59E-01 (-6.16E-05) -4.55E-05*	- .7969 -12548.9 3.21E-11 .9278 2.86E-01 (-2.09E-05) -2.36E-05*	- .7079 -14126.5 3.27E-12 .5385 2.53E-01 (-2.39E-06) -5.51E-06*	- .6384 -15664.3 1.60E-12 .7371 2.83E-01 (-1.99E-06) -2.47E-06*	- .5827 -17161.5 9.45E-13 .8428 2.88E-01 -1.60E-06 -1.59E-06*	- .5371 -18617.6 4.47E-13 .8456 2.88E-01 -9.69E-07 -9.47E-07*
7	-16.8796 -592.4 1.36E-01 1.4265 1.84E-01 -3.88E+00 -3.90E+00*	-4.1759 -2394.7 1.74E-02 1.5296 1.54E-01 -2.31E+01 -2.32E+01*	-2.4033 -4160.9 4.73E-04 1.7467 9.73E-02 (-1.31E+00) -1.12E+00*	-1.6976 -5890.8 6.80E-07 .0566 1.23E-01 (-8.54E-03) -1.89E-01*	-1.3186 -7583.6 4.46E-07 1.6556 1.20E-01 (-1.13E-02) -9.35E-03*	-1.0824 -9238.7 1.29E-09 .3154 1.96E-01 (-1.59E-04) -1.20E-03*	- .9212 -10855.5 9.29E-10 1.6018 1.34E-01 (-8.68E-05) -5.47E-05*	- .8043 -12433.1 1.09E-10 1.0540 2.72E-01 -6.27E-05 -6.00E-05*	- .7158 -13970.9 1.09E-11 .6153 2.67E-01 (-8.61E-06) -1.63E-05*	- .6465 -15668.1 4.10E-12 .6963 2.79E-01 -4.78E-06 -6.56E-06*	- .5909 -16924.2 2.32E-12 .8128 2.87E-01 -3.76E-06 -3.89E-06*

Table 14. Radiative transition parameters for $N_2^+ A^2\Pi_u-X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.4317 23163.4 6.81E-05 .9328 2.85E-01 1.40E+02 1.42E+02*	.4765 20988.5 1.45E-03 .9579 2.84E-01 2.19E+03 2.22E+03*	.5306 18846.2 1.26E-02 .9859 2.81E-01 1.35E+04 1.36E+04	.5975 16736.8 5.39E-02 1.0165 2.77E-01 3.94E+04 3.97E+04	.6821 14660.3 1.09E-01 1.0499 2.73E-01 5.17E+04 5.18E+04	.7926 12617.1 6.99E-02 1.0889 2.67E-01 2.02E+04 2.00E+04	.9427 10607.3 9.28E-04 1.0196 2.77E-01 (1.72E+02) 2.01E+02*	1.1586 8631.2 1.01E-01 1.1519 2.55E-01 8.50E+03 8.52E+03	1.4949 6689.2 2.85E-02 1.2189 2.40E-01 9.93E+02 9.63E+02	2.0913 4781.6 9.83E-02 1.2330 2.36E-01 1.22E+03 1.23E+03	3.4379 2908.7 4.18E-02 1.3389 2.09E-01 9.06E+01 8.83E+01
9	.4033 24796.8 1.90E-05 .9172 2.86E-01 4.81E+01 4.89E+01*	.4420 22621.9 4.54E-04 .9394 2.85E-01 8.65E+02 8.78E+02*	.4883 20479.7 4.63E-03 .9649 2.83E-01 6.44E+03 6.52E+03*	.5444 18370.2 2.51E-02 .9932 2.80E-01 2.47E+04 2.49E+04	.6137 16293.8 7.33E-02 1.0241 2.76E-01 4.91E+04 4.93E+04	.7017 14250.5 1.00E-01 1.0582 2.72E-01 4.34E+04 4.33E+04	.8169 12240.7 3.19E-02 1.1019 2.64E-01 8.29E+03 8.12E+03	.9742 10264.6 1.64E-02 1.1013 2.64E-01 2.51E+03 2.59E+03	1.2015 8322.6 1.01E-01 1.1615 2.53E-01 7.55E+03 7.53E+03	1.5588 6415.0 5.45E-03 1.2623 2.29E-01 1.53E+02 1.42E+02*	2.2016 4542.2 1.18E-01 1.2435 2.34E-01 1.23E+03 1.23E+03
10	.3788 26400.3 5.52E-06 .9043 2.87E-01 1.69E+01 1.72E+01*	.4128 24225.4 1.43E-04 .9234 2.86E-01 3.37E+02 3.43E+02*	.4528 22083.1 1.65E-03 .9462 2.84E-01 2.91E+03 2.95E+03*	.5007 19973.7 1.06E-02 .9721 2.82E-01 1.37E+04 1.38E+04	.5587 17897.2 4.03E-02 1.0006 2.79E-01 3.65E+04 3.68E+04	.6308 15853.9 8.48E-02 1.0318 2.75E-01 5.19E+04 5.21E+04	.7223 13844.1 7.80E-02 1.0671 2.70E-01 3.06E+04 3.04E+04	.8426 11868.1 7.56E-03 1.1269 2.60E-01 1.73E+03 1.64E+03*	1.0074 9926.1 4.04E-02 1.1178 2.61E-01 5.47E+03 5.56E+03	1.2471 8018.5 8.49E-02 1.1714 2.51E-01 5.56E+03 5.52E+03	1.6272 6145.6 2.21E-04 .8923 2.87E-01 (8.58E+00) 1.36E+01*
11	.3575 27973.7 1.68E-06 .8937 2.87E-01 6.15E+00 6.24E+00*	.3876 25798.8 4.62E-05 .9097 2.87E-01 1.32E+02 1.34E+02*	.4227 23656.6 5.82E-04 .9297 2.86E-01 1.27E+03 1.29E+03*	.4641 21547.1 4.28E-03 .9531 2.84E-01 7.00E+03 7.09E+03*	.5136 19470.7 1.96E-02 .9794 2.82E-01 2.33E+04 2.35E+04	.5738 17427.4 5.51E-02 1.0082 2.78E-01 4.58E+04 4.61E+04	.6486 15417.6 8.53E-02 1.0399 2.74E-01 4.77E+04 4.76E+04	.7440 13441.5 5.02E-02 1.0774 2.69E-01 1.78E+04 1.76E+04	.8696 11499.5 2.24E-06 -.8789 5.09E-03 (1.79E+04) 7.07E+00*	1.0425 9591.9 6.15E-02 1.1290 2.59E-01 7.39E+03 7.46E+03	1.2955 7719.1 6.01E-02 1.1825 2.48E-01 3.44E+03 3.39E+03
12	.3388 29517.2 5.36E-07 .8851 2.88E-01 2.31E+00 2.34E+00*	.3657 27342.3 1.54E-05 .8984 2.87E-01 5.26E+01 5.33E+01*	.3968 25200.0 2.07E-04 .9155 2.86E-01 5.51E+02 5.59E+02*	.4331 23090.6 1.68E-03 .9363 2.85E-01 3.42E+03 3.46E+03*	.4759 21014.1 8.91E-03 .9602 2.83E-01 1.34E+04 1.36E+04*	.5271 18970.9 3.08E-02 .9868 2.81E-01 3.36E+04 3.39E+04	.5896 16961.1 6.61E-02 1.0159 2.77E-01 5.03E+04 5.05E+04	.6673 14985.0 7.52E-02 1.0484 2.73E-01 3.82E+04 3.81E+04	.7667 13043.0 2.48E-02 1.0905 2.66E-01 7.91E+03 7.73E+03	.8980 11135.4 6.37E-03 1.0713 2.70E-01 1.30E+03 1.37E+03*	1.0796 9262.5 7.31E-02 1.1389 2.57E-01 7.79E+03 7.81E+03
13	.3223 31030.7 1.79E-07 .8780 2.88E-01 8.95E-01 9.06E-01*	.3466 28855.8 5.31E-06 .8890 2.87E-01 2.14E+01 2.16E+01*	.3743 26713.6 7.52E-05 .9034 2.87E-01 2.39E+02 2.42E+02*	.4064 24604.1 6.58E-04 .9215 2.86E-01 1.63E+03 1.65E+03*	.4439 22527.6 3.88E-03 .9430 2.85E-01 7.28E+03 7.37E+03*	.4882 20484.4 1.57E-02 .9674 2.83E-01 2.18E+04 2.20E+04	.5413 18474.6 4.23E-02 .9943 2.80E-01 4.23E+04 4.26E+04	.6061 16498.5 7.05E-02 1.0239 2.76E-01 4.90E+04 4.91E+04	.6870 14556.5 5.78E-02 1.0576 2.72E-01 2.67E+04 2.65E+04	.7906 12648.9 7.47E-03 1.1133 2.62E-01 2.11E+03 2.01E+03*	.9280 10776.0 2.06E-02 1.0959 2.65E-01 3.68E+03 3.77E+03
14	.3076 32514.3 6.20E-08 .8715 2.88E-01 3.58E-01 3.62E-01*	.3296 30339.4 1.90E-06 .8810 2.88E-01 8.88E+00 9.00E+00*	.3546 28197.1 2.79E-05 .8932 2.87E-01 1.05E+02 1.06E+02*	.3833 26087.7 2.59E-04 .9088 2.87E-01 7.65E+02 7.76E+02*	.4165 24011.2 1.66E-03 .9278 2.86E-01 3.79E+03 3.84E+03*	.4552 21968.0 7.52E-03 .9499 2.84E-01 1.30E+04 1.32E+04*	.5010 19958.1 2.41E-02 .9747 2.82E-01 3.08E+04 3.11E+04	.5561 17982.1 5.19E-02 1.0020 2.79E-01 4.76E+04 4.79E+04	.6234 16040.1 6.74E-02 1.0322 2.75E-01 4.28E+04 4.27E+04	.7076 14132.5 3.79E-02 1.0681 2.70E-01 1.58E+04 1.56E+04	.8157 12259.6 2.83E-04 1.2589 2.30E-01 (5.58E+01) 4.37E+01*
15	.2944 33967.9 2.22E-08 .8651 2.88E-01 1.46E-01 1.48E-01*	.3145 31793.0 7.00E-07 .8739 2.88E-01 3.78E+00 3.82E+00*	.3373 29650.8 1.06E-05 .8844 2.88E-01 4.65E+01 4.71E+01*	.3631 27541.3 1.03E-04 .8978 2.87E-01 3.60E+02 3.65E+02*	.3927 25464.9 7.04E-04 .9144 2.86E-01 1.93E+03 1.96E+03*	.4270 23421.6 3.50E-03 .9342 2.85E-01 7.41E+03 7.51E+03*	.4670 21411.8 1.27E-02 .9569 2.84E-01 2.04E+04 2.06E+04	.5145 19435.7 3.31E-02 .9821 2.81E-01 3.89E+04 3.92E+04	.5716 17493.7 5.76E-02 1.0098 2.78E-01 4.84E+04 4.85E+04	.6416 15586.1 5.79E-02 1.0408 2.74E-01 3.34E+04 3.32E+04	.7292 13713.3 2.00E-02 1.0811 2.68E-01 7.50E+03 7.32E+03

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$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	9.3372	-13.6752	-4.0040	-2.3655	-1.6891	-1.3201	-1.0879	-.9285	-.8125	-.7244	-.6553
	1071.0	-731.3	-2497.5	-4227.4	-5920.1	-7575.3	-9192.0	-10769.7	-12307.5	-13804.6	-15260.8
	2.94E-01	1.65E-01	2.30E-02	5.75E-04	3.45E-06	7.21E-07	8.78E-09	1.48E-09	3.10E-10	3.43E-11	9.95E-12
	1.3683	1.4374	1.5446	1.7912	.7608	1.7437	.9535	1.7167	1.1627	.7175	.6642
	2.00E-01	1.81E-01	1.50E-01	8.71E-02	2.85E-01	9.80E-02	2.84E-01	1.04E-01	2.52E-01	2.81E-01	2.75E-01
	2.94E+01	-8.56E+00	-3.28E+01	(-1.34E+00)	(-2.35E-01)	(-1.22E-02)	(-2.23E-03)	(-8.15E-05)	(-1.49E-04)	(-2.89E-05)	(-1.08E-05)
	2.94E+01	-8.60E+00	-3.27E+01	-1.05E+00*	-4.04E-01*	-8.57E-03*	-3.08E-03*	-3.34E-05*	-1.28E-04*	-4.33E-05*	-1.63E-05*
9	3.6977	11.0844	-11.5727	-3.8552	-2.3328	-1.6830	-1.3230	-1.0945	-.9369	-.8216	-.7338
	2704.4	902.2	-864.1	-2593.9	-4286.7	-5941.9	-7558.6	-9136.3	-10674.0	-12171.2	-13627.3
	1.50E-02	2.85E-01	1.94E-01	2.88E-02	6.28E-04	1.08E-05	9.78E-07	3.39E-08	1.68E-09	7.50E-10	1.02E-10
	1.3833	1.3799	1.4489	1.5608	1.8491	1.0550	1.8577	1.2199	1.8971	1.2600	.8320
	1.96E-01	1.97E-01	1.77E-01	1.46E-01	7.48E-02	2.72E-01	7.31E-02	2.39E-01	6.55E-02	2.30E-01	2.88E-01
	2.31E+01	1.65E+01	-1.59E+01	-4.32E+01	(-1.12E+00)	(-6.82E-01)	(-9.15E-03)	-6.00E-03	(-3.55E-05)	(-2.89E-04)	(-8.64E-05)
	2.21E+01	1.65E+01	-1.60E+01	-4.31E+01	-7.33E-01*	-7.59E-01*	-3.89E-03*	-6.44E-03*	-6.58E-08*	-2.27E-04*	-1.04E-04*
10	2.3213	3.9911	13.5258	-10.0960	-3.7268	-2.3050	-1.6792	-1.3275	-1.1025	-.9463	-.8317
	4307.8	2505.6	739.3	-990.5	-2683.3	-4338.4	-5955.2	-7532.8	-9070.6	-10567.8	-12023.9
	1.24E-01	2.27E-03	2.70E-01	2.20E-01	3.44E-02	6.06E-04	2.63E-05	1.06E-06	9.59E-08	1.01E-09	1.53E-09
	1.2535	1.5362	1.3923	1.4609	1.5785	1.9293	1.2249	2.0287	1.3849	2.3294	1.3510
	2.31E-01	1.53E-01	1.94E-01	1.74E-01	1.41E-01	5.98E-02	2.38E-01	4.41E-02	1.96E-01	1.50E-02	2.05E-01
	1.07E+03	(1.68E+00)	8.29E+00	-2.63E+01	-5.33E+01	(-7.16E-01)	-1.28E+00	(-3.59E-03)	-1.11E-02	(-1.08E-06)	(-4.54E-04)
	1.07E+03	1.47E+00*	8.27E+00	-2.64E+01	-5.30E+01	-2.82E-01*	-1.27E+00*	-2.75E-05*	-1.10E-02*	-1.15E-04*	-3.24E-04*
11	1.7003	2.4515	4.3238	17.1539	-9.0103	-3.6167	-2.2822	-1.6780	-1.3338	-1.1118	-.9569
	5881.3	4079.1	2312.8	583.0	-1109.8	-2765.0	-4381.7	-5959.4	-7497.2	-8994.3	-10450.5
	8.46E-03	1.17E-01	3.29E-04	2.52E-01	2.45E-01	3.93E-02	4.99E-04	5.37E-05	8.16E-07	2.16E-07	8.16E-12
	1.1637	1.2636	.6776	1.4058	1.4736	1.5980	2.0524	1.3423	2.3559	1.5144	14.1990
	2.52E-01	2.29E-01	2.77E-01	1.90E-01	1.70E-01	1.35E-01	4.09E-02	2.08E-01	1.35E-02	1.59E-01	0.00E+00
	2.22E+02	8.42E+02	(6.32E-01)	3.65E+00	-3.94E+01	-6.17E+01	(-2.85E-01)	-1.98E+00	(-2.53E-04)	-1.60E-02	(0.00E+00)
	2.35E+02*	8.39E+02	1.45E+00*	3.64E+00	-3.96E+01	-6.12E+01	-9.33E-04*	-1.89E+00*	-1.46E-02*	-1.51E-02*	-7.83E-04*
12	1.3468	1.7786	2.5932	4.7027	23.0606	-8.1867	-3.5233	-2.2645	-1.6796	-1.3421	-1.1227
	7424.8	5622.5	3856.3	2126.4	433.6	-1221.5	-2838.3	-4415.9	-5933.7	-7450.9	-8907.0
	3.51E-02	2.40E-02	1.03E-01	5.44E-03	2.34E-01	2.68E-01	4.32E-02	3.22E-04	9.50E-05	2.73E-07	3.96E-07
	1.1960	1.1923	1.2739	1.1564	1.4203	1.4870	1.6196	2.2759	1.4344	3.4458	1.6373
	2.45E-01	2.46E-01	2.26E-01	2.54E-01	1.86E-01	1.67E-01	1.29E-01	1.85E-02	1.82E-01	3.23E-05	1.25E-01
	1.75E+03	5.22E+02	6.09E+02	6.83E+00	1.33E+00	-5.48E+01	-6.70E+01	(-3.85E-02)	-2.68E+00	(-4.77E-10)	(-1.76E-02)
	1.70E+03	5.38E+02	6.04E+02	7.49E+00*	1.33E+00	-5.51E+01	-6.61E+01	-4.21E-01*	-2.50E+00*	-8.45E-02*	-1.52E-02*
13	1.1188	1.4013	1.8623	2.7473	5.1357	34.2438	-7.5486	-3.4454	-2.2522	-1.6843	-1.3525
	8938.3	7136.1	5369.8	3640.0	1947.2	292.0	-1324.7	-2902.4	-4440.2	-5937.3	-7393.5
	7.35E-02	1.55E-02	4.11E-02	8.43E-02	1.42E-02	2.18E-01	2.88E-01	4.54E-02	1.26E-04	1.49E-04	3.68E-08
	1.1485	1.2159	1.2075	1.2849	1.2207	1.4361	1.5011	1.6441	2.8493	1.5149	-4.9646
	2.55E-01	2.40E-01	2.42E-01	2.23E-01	2.39E-01	1.81E-01	1.62E-01	1.23E-01	1.31E-03	1.59E-01	4.33E-21
	6.93E+03	6.61E+02	7.58E+02	4.10E+02	1.21E+01	3.62E-01	-7.17E+01	-6.80E+01	(-7.60E-05)	-3.17E+00	(-1.13E-42)
	6.92E+03	6.34E+02	7.72E+02	4.05E+02	1.27E+01	3.61E-01	-7.20E+01	-6.66E+01	-2.24E+00*	-2.90E+00*	-2.64E-01*
14	.9595	1.1601	1.4591	1.9518	2.9148	5.6319	62.9628	-7.0481	-3.3823	-2.2453	-1.6921
	10421.9	8619.6	6853.3	5123.5	3430.7	1775.6	158.8	-1418.8	-2956.6	-4453.8	-5909.9
	3.63E-02	6.48E-02	3.91E-03	5.59E-02	6.55E-02	2.38E-02	2.06E-01	3.07E-01	4.57E-02	4.33E-06	2.06E-04
	1.1093	1.1583	1.2597	1.2189	1.2966	1.2475	1.4529	1.5160	1.6723	9.0788	1.5924
	2.63E-01	2.53E-01	2.30E-01	2.40E-01	2.20E-01	2.33E-01	1.76E-01	1.58E-01	1.16E-01	5.75E-41	1.37E-01
	5.75E+03	5.40E+03	1.34E+02	8.74E+02	2.60E+02	1.46E+01	5.19E-02	-8.89E+01	-6.40E+01	(0.00E+00)	(-3.23E+00)
	5.84E+03	5.36E+03	1.23E+02*	8.85E+02	2.55E+02	1.51E+01	5.18E-02	-8.94E+01	-6.19E+01	-6.14E+00*	-2.85E+00*
15	.8421	.9927	1.2038	1.5204	2.0473	3.0967	6.2017	287.2655	-6.6535	-3.3332	-2.2440
	11875.5	10073.3	8307.0	6577.2	4884.4	3229.2	1612.5	34.8	-1503.0	-3000.1	-4456.3
	2.17E-03	4.86E-02	5.09E-02	2.28E-05	6.62E-02	4.86E-02	3.26E-02	1.98E-01	3.24E-01	4.38E-02	8.73E-05
	1.0341	1.1200	1.1688	2.1459	1.2288	1.3095	1.2619	1.4708	1.5317	1.7056	-.1720
	2.75E-01	2.61E-01	2.51E-01	2.98E-02	2.37E-01	2.17E-01	2.29E-01	1.71E-01	1.54E-01	1.07E-01	7.03E-02
	5.59E+02	6.85E+03	3.73E+03	(1.17E-02)	8.79E+02	1.56E+02	1.45E+01	4.95E-04	-1.05E+02	-5.50E+01	(-1.55E-01)
	6.13E+02*	6.91E+03	3.68E+03	1.71E-01*	8.86E+02	1.52E+02	1.49E+01	4.94E-04	-1.06E+02	-5.22E+01	-1.25E+01*

Table 14. Radiative transition parameters for $N_2^+ A^2\Pi_u-X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.2826 35391.7 8.12E-09 .8578 2.88E-01 6.05E-02 6.11E-02*	.3011 33216.8 2.65E-07 .8669 2.88E-01 1.63E+00 1.65E+00*	.3218 31074.5 4.16E-06 .8766 2.88E-01 2.09E+01 2.12E+01*	.3452 28965.1 4.18E-05 .8883 2.87E-01 1.70E+02 1.73E+02*	.3719 26888.6 3.00E-04 .9028 2.87E-01 9.73E+02 9.87E+02*	.4025 24845.3 1.60E-03 .9204 2.86E-01 4.07E+03 4.13E+03*	.4379 22835.5 6.43E-03 .9409 2.85E-01 1.26E+04 1.27E+04*	.4794 20859.5 1.92E-02 .9641 2.83E-01 2.83E+04 2.86E+04	.5286 18917.5 4.12E-02 .9897 2.81E-01 4.44E+04 4.47E+04	.5879 17009.9 5.83E-02 1.0179 2.77E-01 4.47E+04 4.47E+04	.6606 15137.0 4.44E-02 1.0501 2.73E-01 2.32E+04 2.30E+04
17	.2718 36785.6 2.99E-09 .8490 2.88E-01 2.50E-02 2.53E-02*	.2889 34610.6 1.02E-07 .8595 2.88E-01 7.09E-01 7.17E-01*	.3080 32468.4 1.66E-06 .8691 2.88E-01 9.51E+01 9.63E+00*	.3294 30358.9 1.72E-05 .8797 2.88E-01 8.09E+01 8.20E+01*	.3536 28282.5 1.29E-04 .8925 2.87E-01 4.88E+02 4.95E+02*	.3811 26239.2 7.28E-04 .9081 2.87E-01 2.19E+03 2.22E+03*	.4127 24229.4 3.16E-03 .9266 2.86E-01 7.44E+03 7.54E+03*	.4494 22253.3 1.05E-02 .9478 2.84E-01 1.90E+04 1.92E+04	.4923 20311.4 2.63E-02 .9714 2.82E-01 3.56E+04 3.59E+04	.5434 18403.7 4.70E-02 .9974 2.80E-01 4.64E+04 4.66E+04	.6049 16530.9 5.40E-02 1.0262 2.76E-01 3.77E+04 3.76E+04
18	.2621 38149.6 1.09E-09 .8375 2.88E-01 1.02E-02 1.03E-02*	.2780 35974.7 3.93E-08 .8506 2.88E-01 3.07E-01 3.11E-01*	.2956 33832.5 6.67E-07 .8612 2.88E-01 4.34E+00 4.39E+00*	.3152 31723.0 7.21E-06 .8716 2.88E-01 3.86E+01 3.91E+01*	.3373 29646.5 5.60E-05 .8833 2.88E-01 2.44E+02 2.48E+02*	.3623 27603.3 3.31E-04 .8971 2.87E-01 1.16E+03 1.18E+03*	.3907 25593.5 1.53E-03 .9137 2.86E-01 4.27E+03 4.33E+03*	.4234 23617.4 5.56E-03 .9330 2.85E-01 1.21E+04 1.22E+04*	.4614 21675.4 1.56E-02 .9548 2.84E-01 2.60E+04 2.63E+04	.5059 19767.8 3.31E-02 .9788 2.82E-01 4.11E+04 4.14E+04	.5588 17895.0 4.95E-02 1.0053 2.79E-01 4.47E+04 4.48E+04
19	.2533 39484.0 3.85E-10 .8211 2.88E-01 3.97E-03 4.06E-03*	.2680 37309.0 1.50E-08 .8391 2.88E-01 1.31E-01 1.33E-01*	.2844 35166.8 2.69E-07 .8521 2.88E-01 1.96E+00 1.99E+00*	.3025 33057.3 3.03E-06 .8633 2.88E-01 1.84E+01 1.86E+01*	.3228 30980.9 2.45E-05 .8745 2.88E-01 1.22E+02 1.24E+02*	.3456 28937.6 1.51E-04 .8872 2.87E-01 6.14E+02 6.22E+02*	.3714 26927.8 7.37E-04 .9021 2.87E-01 2.40E+03 2.44E+03*	.4008 24951.8 2.87E-03 .9196 2.86E-01 7.39E+03 7.49E+03*	.4346 23009.8 8.86E-03 .9396 2.85E-01 1.77E+04 1.80E+04*	.4739 21102.2 2.13E-02 .9619 2.83E-01 3.26E+04 3.28E+04	.5200 19229.3 3.85E-02 .9864 2.81E-01 4.38E+04 4.40E+04
20	.2452 40788.6 1.26E-10 .7957 2.87E-01 1.43E-03 1.47E-03*	.2590 38613.7 5.51E-09 .8231 2.88E-01 5.32E-02 5.43E-02*	.2742 36471.5 1.07E-07 .8407 2.88E-01 8.69E-01 8.83E-01*	.2910 34362.0 1.27E-06 .8539 2.88E-01 8.67E+00 8.79E+00*	.3097 32285.6 1.07E-05 .8657 2.88E-01 6.07E+01 6.15E+01*	.3307 30242.3 6.92E-05 .8778 2.88E-01 3.21E+02 3.25E+02*	.3542 28232.5 3.53E-04 .8915 2.87E-01 1.33E+03 1.35E+03*	.3809 26256.4 1.45E-03 .9074 2.87E-01 4.39E+03 4.45E+03*	.4113 24314.4 4.85E-03 .9258 2.86E-01 1.15E+04 1.17E+04*	.4463 22406.8 1.29E-02 .9464 2.84E-01 2.38E+04 2.41E+04	.4870 20534.0 2.69E-02 .9692 2.83E-01 3.77E+04 3.80E+04
21	.2377 42063.8 3.55E-11 .7501 2.84E-01 4.32E-04 4.61E-04*	.2507 39888.8 1.88E-09 .7983 2.87E-01 1.99E-02 2.06E-02*	.2649 37746.6 4.08E-08 .8249 2.88E-01 3.68E-01 3.76E-01*	.2806 35637.2 5.25E-07 .8424 2.88E-01 3.99E+00 4.05E+00*	.2980 33560.7 4.68E-06 .8559 2.88E-01 2.97E+01 3.02E+01*	.3173 31517.4 3.16E-05 .8684 2.88E-01 1.66E+02 1.68E+02*	.3389 29507.6 1.69E-04 .8815 2.88E-01 7.26E+02 7.36E+02*	.3632 27531.6 7.31E-04 .8962 2.87E-01 2.55E+03 2.59E+03*	.3908 25589.6 2.59E-03 .9131 2.86E-01 7.23E+03 7.33E+03*	.4223 23682.0 7.52E-03 .9321 2.85E-01 1.65E+04 1.67E+04*	.4585 21809.1 1.75E-02 .9533 2.84E-01 2.96E+04 2.99E+04

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 14. Radiative transition parameters for $N_2^+ A^2\Pi_u - X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	.7519 13299.2 7.22E-03 1.1016 2.64E-01 2.40E+03 2.30E+03*	.8698 11497.0 1.01E-02 1.0753 2.69E-01 2.25E+03 2.34E+03	1.0277 9730.7 5.50E-02 1.1298 2.59E-01 6.89E+03 6.91E+03	1.2499 8000.9 3.56E-02 1.1806 2.48E-01 2.28E+03 2.24E+03	1.5853 6308.1 2.13E-03 1.1035 2.64E-01 7.56E+01 8.53E+01*	2.1492 4653.0 7.16E-02 1.2379 2.35E-01 8.07E+02 8.10E+02	3.2936 3036.2 3.47E-02 1.3238 2.13E-01 8.91E+01 8.66E+01	6.8561 1458.6 3.92E-02 1.2695 2.27E-01 1.27E+01 1.30E+01	-126.2308 -79.2 1.95E-01 1.4896 1.66E-01 -1.08E-02 -1.08E-02	-6.3436 -1576.4 3.38E-01 1.5483 1.49E-01 -1.19E+02 -1.20E+02	-3.2976 -3032.5 3.94E-02 1.7465 9.73E-02 -4.22E+01 -3.87E+01
17	.6806 14693.1 2.97E-02 1.0605 2.71E-01 1.41E+04 1.38E+04	.7757 12890.9 8.71E-04 1.1686 2.51E-01 2.38E+02 2.08E+02*	.8989 11124.6 2.05E-02 1.0921 2.66E-01 4.05E+03 4.15E+03	1.0644 9394.8 5.53E-02 1.1394 2.57E-01 6.14E+03 6.13E+03	1.2984 7702.0 2.19E-02 1.1950 2.45E-01 1.22E+03 1.18E+03	1.6538 6046.9 7.93E-02 1.1582 2.53E-01 2.28E+02 2.41E+02*	2.2573 4430.1 7.27E-02 1.2465 2.33E-01 6.95E+02 6.95E+02	3.5058 2852.4 2.40E-02 1.3396 2.08E-01 4.90E+01 4.72E+01	7.6065 1314.7 4.33E-02 1.2719 2.26E-01 1.02E+01 1.04E+01	-54.7909 -182.5 1.97E-01 1.5089 1.60E-01 -1.25E-01 -1.25E-01	-6.1027 -1638.6 3.50E-01 1.5659 1.44E-01 -1.30E+02 -1.31E+02
18	.6228 16057.2 4.57E-02 1.0349 2.75E-01 2.90E+04 2.88E+04	.7015 14255.0 1.67E-02 1.0730 2.69E-01 7.11E+03 6.94E+03	.8007 12488.7 4.72E-04 1.0632 2.83E-01 1.49E+02 1.83E+02*	.9295 10758.9 3.03E-02 1.1041 2.64E-01 5.33E+03 5.41E+03	1.1030 9066.1 5.06E-02 1.1145 2.55E-01 4.98E+03 4.95E+03	1.3494 7410.9 1.13E-02 1.2146 2.41E-01 5.41E+02 5.17E+02	1.7259 5794.2 1.53E-02 1.1796 2.49E-01 3.72E+02 3.86E+02	2.3716 4216.5 7.07E-02 1.2547 2.31E-01 5.72E+02 5.71E+02	3.7331 2678.7 1.63E-02 1.3571 2.04E-01 2.62E+01 2.50E+01	8.4634 1181.6 4.46E-02 1.2688 2.27E-01 7.70E+00 7.81E+00	-36.4224 -274.6 2.06E-01 1.5283 1.55E-01 -4.14E-01 -4.17E-01
19	.5750 17391.5 4.84E-02 1.0133 2.78E-01 3.98E+04 3.98E+04	.6415 15589.3 3.52E-02 1.0441 2.74E-01 2.02E+04 2.00E+04	.7234 13823.0 7.10E-03 1.0906 2.66E-01 2.70E+03 2.58E+03*	.8269 12093.2 4.42E-03 1.0541 2.72E-01 1.17E+03 1.25E+03*	.9615 10400.4 3.75E-02 1.1145 2.62E-01 5.87E+03 5.92E+03	1.1435 8745.3 4.29E-02 1.1591 2.53E-01 3.73E+03 3.69E+03	1.4028 7128.5 4.46E-03 1.2476 2.33E-01 1.77E+02 1.65E+02*	1.8015 5550.8 2.25E-02 1.1932 2.46E-01 4.70E+02 4.83E+02	2.4919 4013.1 6.66E-02 1.2625 2.29E-01 4.57E+02 4.55E+02	3.9747 2515.9 1.09E-02 1.3757 1.98E-01 1.39E+01 1.31E+01	9.4359 1059.8 4.34E-02 1.2595 2.30E-01 5.52E+00 5.60E+00
20	.5349 18696.2 4.18E-02 .9941 2.80E-01 4.34E+04 4.35E+04	.5919 16894.0 4.39E-02 1.0216 2.77E-01 3.29E+04 3.27E+04	.6610 15127.7 2.43E-02 1.0541 2.72E-01 1.26E+04 1.24E+04	.7464 13397.9 1.62E-03 1.1290 2.59E-01 5.29E+02 4.81E+02*	.8543 11705.1 1.07E-02 1.0767 2.69E-01 2.51E+03 2.59E+03	.9950 10049.9 4.12E-02 1.1243 2.60E-01 5.74E+03 5.77E+03	1.1858 8433.2 3.40E-02 1.1698 2.51E-01 2.60E+03 2.56E+03	1.4587 6855.5 9.43E-04 1.3366 2.09E-01 2.69E+01 2.30E+01*	1.8805 5317.8 2.87E-02 1.2036 2.43E-01 5.17E+02 5.27E+02	2.6174 3820.6 6.16E-02 1.2698 2.27E-01 3.58E+02 3.56E+02	4.2293 2364.5 7.49E-03 1.3946 1.93E-01 7.47E+00 6.92E+00*
21	.5007 19971.3 3.17E-02 .9765 2.82E-01 4.07E+04 4.09E+04	.5504 18169.1 4.24E-02 1.0019 2.79E-01 4.02E+04 4.02E+04	.6097 16402.8 3.71E-02 1.0301 2.76E-01 2.52E+04 2.50E+04	.6815 14673.0 1.47E-02 1.0655 2.70E-01 6.89E+03 6.71E+03	.7704 12980.2 6.08E-07 -1.9170 9.34E-06 2.35E-10 5.72E+00*	.8830 11325.1 1.74E-02 1.0906 2.66E-01 3.64E+03 3.72E+03	1.0300 9708.3 4.17E-02 1.1337 2.58E-01 5.16E+03 5.17E+03	1.2299 8130.6 2.53E-02 1.1814 2.48E-01 1.70E+03 1.67E+03	1.5168 6592.9 7.32E-07 -4.2799 1.07E-16 4.89E-33 2.06E+00*	1.9624 5095.7 3.34E-02 1.2124 2.41E-01 5.20E+02 5.28E+02	2.7476 3639.6 5.62E-02 1.2764 2.25E-01 2.79E+02 2.76E+02

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 15. Radiative transition parameters for $N_2^+ B^2\Sigma_u^+ - X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.3912 25564.7 6.63E-01 1.0995 7.13E-01 1.14E+07 1.14E+07	.4275 23389.8 2.53E-01 1.0508 7.52E-01 3.71E+06 3.71E+06	.4706 21247.6 6.58E-02 1.0113 7.81E-01 7.81E+05 7.84E+05	.5225 19138.1 1.45E-02 .9762 8.07E-01 1.34E+05 1.35E+05	.5861 17061.7 2.98E-03 .9450 8.28E-01 2.06E+04 2.07E+04*	.6659 15018.4 6.04E-04 .9179 8.46E-01 2.97E+03 2.99E+03*	.7687 13008.6 1.26E-04 .8953 8.61E-01 4.15E+02 4.18E+02*	.9064 11032.5 2.78E-05 .8778 8.71E-01 5.74E+01 5.77E+01*	1.1000 9090.5 6.71E-06 .8659 8.79E-01 7.89E+00 7.93E+00*	1.3922 7182.9 1.82E-06 .8598 8.82E-01 1.06E+00 1.07E+00*	1.8832 5310.1 5.67E-07 .8593 8.83E-01 1.34E-01 1.34E-01*
1	.3580 27936.3 2.92E-01 1.1527 6.68E-01 5.75E+06 5.76E+06	.3882 25761.3 2.37E-01 1.1115 7.03E-01 4.06E+06 4.03E+06	.4234 23619.1 2.87E-01 1.0567 7.47E-01 4.27E+06 4.28E+06	.4649 21509.6 1.29E-01 1.0169 7.77E-01 1.57E+06 1.57E+06	.5146 19433.2 4.07E-02 .9818 8.03E-01 3.90E+05 3.92E+05	.5750 17389.9 1.10E-02 .9508 8.24E-01 7.94E+04 7.99E+04	.6502 15380.1 2.76E-03 .9238 8.42E-01 1.45E+04 1.46E+04*	.7460 13404.0 6.91E-04 .9012 8.57E-01 2.48E+03 2.49E+03*	.8724 11462.0 1.79E-04 .8836 8.68E-01 4.12E+02 4.14E+02*	1.0466 9554.4 4.99E-05 .8716 8.75E-01 6.76E+01 6.79E+01*	1.3018 7681.6 1.54E-05 .8653 8.79E-01 1.09E+01 1.10E+01*
2	.3305 30254.5 4.31E-02 1.2191 6.08E-01 8.94E+05 9.02E+05	.3561 28079.5 4.02E-01 1.1609 6.61E-01 7.88E+06 7.88E+06	.3855 25937.3 5.72E-02 1.1357 6.83E-01 9.43E+05 9.27E+05	.4197 23827.9 2.30E-01 1.0628 7.42E-01 3.48E+06 3.47E+06	.4597 21751.4 1.63E-01 1.0224 7.73E-01 2.04E+06 2.04E+06	.5074 19708.1 6.97E-02 .9873 7.99E-01 6.90E+05 6.93E+05	.5650 17698.3 2.37E-02 .9565 8.20E-01 1.79E+05 1.80E+05	.6360 15722.3 7.23E-03 .9297 8.38E-01 4.00E+04 4.02E+04*	.7257 13780.3 2.13E-03 .9072 8.53E-01 8.22E+03 8.27E+03*	.8423 11872.6 6.39E-04 .8897 8.64E-01 1.62E+03 1.63E+03*	1.0000 9999.8 2.03E-04 .8958 8.72E-01 3.12E+02 3.14E+02*
3	.3076 32514.1 2.14E-03 1.3210 5.09E-01 3.86E+04 3.98E+04*	.3296 30339.2 1.01E-01 1.2284 6.00E-01 2.06E+06 2.08E+06	.3546 28197.0 4.19E-01 1.1702 6.53E-01 8.10E+06 8.09E+06	.3833 26087.5 3.52E-03 1.2654 5.64E-01 4.03E+04 3.77E+04*	.4165 24011.0 1.53E-01 1.0689 7.37E-01 2.33E+06 2.32E+06	.4552 21967.8 1.67E-01 1.0279 7.69E-01 2.13E+06 2.13E+06	.5011 19958.0 9.32E-02 .9925 7.95E-01 9.49E+05 9.52E+05	.5561 17981.9 3.89E-02 .9620 8.17E-01 3.06E+05 3.07E+05	.6234 16039.9 1.41E-02 .9355 8.35E-01 8.22E+04 8.26E+04	.7076 14132.3 4.84E-03 .9132 8.49E-01 1.99E+04 2.01E+04*	.8157 12259.4 1.66E-03 .8958 8.60E-01 4.58E+03 4.61E+03*
4	.2881 34708.5 7.48E-06 1.8293 -1.32E-01 (1.10E+01) 2.21E-01*	.3074 32533.6 6.26E-03 1.3401 4.89E-01 1.04E+05 1.08E+05*	.3290 30391.3 1.60E-01 1.2386 5.90E-01 3.17E+06 3.19E+06	.3536 28281.9 3.95E-01 1.1808 6.43E-01 7.50E+06 7.46E+06	.3816 26205.4 4.21E-03 .9370 8.34E-01 1.07E+05 1.19E+05*	.4139 24162.2 8.62E-02 1.0751 7.33E-01 1.32E+06 1.31E+06	.4514 22152.4 1.50E-01 1.0335 7.65E-01 1.93E+06 1.93E+06	.4956 20176.3 1.07E-01 .9975 7.91E-01 1.11E+06 1.11E+06	.5484 18234.3 5.36E-02 .9673 8.13E-01 4.35E+05 4.37E+05	.6125 16326.7 2.28E-02 .9411 8.31E-01 1.39E+05 1.39E+05	.6919 14453.8 8.97E-03 .9192 8.45E-01 3.92E+04 3.94E+04*
5	.2715 36829.5 2.34E-06 1.1665 6.56E-01 1.02E+02 1.10E+02*	.2886 34654.6 3.94E-06 2.8861 -2.23E+00 (1.65E+03) 3.49E+02*	.3076 32512.4 1.10E-02 1.3640 4.64E-01 1.64E+05 1.72E+05	.3289 30402.9 2.13E-01 1.2496 5.80E-01 4.07E+06 4.09E+06	.3530 28326.4 3.63E-01 1.1932 6.32E-01 6.68E+06 6.63E+06	.3805 26283.2 2.07E-02 1.0168 7.77E-01 4.59E+05 4.83E+05	.4120 24273.4 3.99E-02 1.0807 7.28E-01 6.12E-05 6.07E+05	.4485 22297.3 1.21E-01 1.0394 7.60E-01 1.57E+06 1.56E+06	.4913 20355.3 1.08E-01 1.0021 7.88E-01 1.15E+06 1.15E+06	.5421 18447.7 6.50E-02 .9724 8.09E-01 5.42E+05 5.43E+05	.6033 16574.8 3.20E-02 .9465 8.27E-01 2.02E+05 2.03E+05
6	.2573 38867.8 8.84E-08 1.5229 2.83E-01 (8.43E-01) 1.13E+00*	.2725 36692.9 1.79E-05 1.2327 5.96E-01 6.35E+02 6.74E+02*	.2894 34550.6 1.34E-05 -0.0984 1.03E+00 (1.18E+03) 4.15E+03*	.3082 32441.2 1.43E-02 1.3958 4.30E-01 1.82E+05 1.94E+05	.3293 30364.7 2.56E-01 1.2617 5.68E-01 4.69E+06 4.72E+06	.3531 28321.5 3.39E-01 1.2077 6.19E-01 5.97E+06 5.90E+06	.3801 26311.7 3.44E-02 1.0192 7.76E-01 7.64E+05 8.01E+05	.4109 24335.6 1.32E-02 1.0817 7.27E-01 2.03E+05 2.01E+05	.4466 22393.6 8.91E-02 1.0467 7.55E-01 1.15E+06 1.15E+06	.4881 20486.0 1.00E-01 1.0062 7.85E-01 1.08E+06 1.08E+06	.5373 18613.1 7.11E-02 .9774 8.06E-01 6.03E+05 6.05E+05
7	.2450 40812.9 5.82E-09 1.0638 7.41E-01 (4.41E-01) 4.98E-01*	.2588 38637.9 2.53E-07 1.7456 -9.81E-03 (2.84E-03) 3.18E-01*	.2740 36495.7 6.98E-05 1.2920 5.38E-01 (1.99E+03) 2.11E+03*	.2908 34386.3 2.64E-04 .8674 8.78E-01 (1.68E+04) 2.04E+04*	.3095 32309.8 1.44E-02 1.4437 3.76E-01 1.39E+05 1.54E+05	.3304 30266.5 2.90E-01 1.2751 5.55E-01 5.02E+06 5.04E+06	.3539 28256.7 3.30E-01 1.2243 6.04E-01 5.50E+06 5.42E+06	.3805 26280.7 3.84E-02 .9936 7.94E-01 8.90E+05 9.44E+05	.4109 24338.7 1.56E-03 1.0398 7.60E-01 2.63E+04 2.64E+04*	.4458 22431.1 6.09E-02 1.0575 7.46E-01 7.76E+05 7.68E+05	.4864 20558.2 8.50E-02 1.0091 7.83E-01 9.18E+05 9.19E+05

Table 15. Radiative transition parameters for $N_2^+ B^2\Sigma_u^+ - X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. -Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	2.8799 3472.3 2.05E-07 .8633 8.80E-01 1.35E-02 1.35E-02*	5.9878 1670.1 8.58E-08 .8702 8.76E-01 6.21E-04 6.21E-04*	-103.9263 -96.2 4.12E-08 .8779 8.71E-01 -5.65E-08 -5.64E-08*	-5.4763 -1826.0 2.22E-08 .8851 8.67E-01 -2.06E-04 -2.06E-04*	-2.8418 -3518.8 1.31E-08 .8909 8.63E-01 -8.63E-04 -8.62E-04*	-1.9327 -5174.0 8.31E-09 .8951 8.61E-01 -1.73E-03 -1.73E-03*	-1.4726 -6790.8 5.55E-09 .8978 8.59E-01 -2.60E-03 -2.60E-03*	-1.1950 -8368.4 3.86E-09 .8994 8.58E-01 -3.37E-03 -3.37E-03*	-1.0095 -9906.2 2.77E-09 .9001 8.58E-01 -4.01E-03 -4.01E-03*	-.8769 -11403.4 2.04E-09 .9003 8.57E-01 -4.51E-03 -4.51E-03*	-.7776 -12859.5 1.54E-09 .9001 8.58E-01 -4.87E-03 -4.87E-03*
1	1.7112 5843.8 5.36E-06 .8643 8.80E-01 1.68E+00 1.68E+00*	2.4743 4041.6 2.14E-06 .8675 8.78E-01 2.20E-01 2.21E-01*	4.3950 2275.3 9.74E-07 .8732 8.74E-01 1.78E-02 1.78E-02*	18.3328 545.5 5.00E-07 .8797 8.70E-01 1.25E-04 1.24E-04*	-8.7159 -1147.3 2.85E-07 .8859 8.67E-01 -6.54E-04 -6.53E-04*	-3.5683 -2802.5 1.76E-07 .8908 8.63E-01 -5.84E-03 -5.83E-03*	-2.2628 -4419.2 1.15E-07 .8945 8.61E-01 -1.50E-02 -1.49E-02*	-1.6675 -5996.9 7.96E-08 .8970 8.60E-01 -2.57E-02 -2.57E-02*	-1.3272 -7534.7 5.69E-08 .8985 8.59E-01 -3.64E-02 -3.64E-02*	-1.1072 -9031.8 4.20E-08 .8993 8.58E-01 -4.61E-02 -4.61E-02*	-.9535 -10488.0 3.17E-08 .8996 8.58E-01 -5.46E-02 -5.45E-02*
2	1.2252 8162.0 7.04E-05 .8710 8.76E-01 5.94E+01 5.97E+01*	1.5724 6359.8 2.72E-05 .8694 8.77E-01 1.09E+01 1.09E+01*	2.1770 4593.5 1.19E-05 .8717 8.75E-01 1.79E+00 1.79E+00*	3.4920 2863.7 5.84E-06 .8763 8.72E-01 2.11E-01 2.11E-01*	8.5406 1170.9 3.19E-06 .8817 8.69E-01 7.83E-03 7.82E-03*	-20.6504 -484.3 1.90E-06 .8868 8.66E-01 -3.28E-04 -3.28E-04*	-4.7596 -2101.0 1.22E-06 .8910 8.63E-01 -1.71E-02 -1.71E-02*	-2.7184 -3678.7 8.30E-07 .8942 8.61E-01 -6.21E-02 -6.21E-02*	-1.9170 -5216.4 5.89E-07 .8964 8.60E-01 -1.25E-01 -1.25E-01*	-1.4895 -6713.6 4.33E-07 .8978 8.59E-01 -1.96E-01 -1.96E-01*	-1.2240 -8169.7 3.27E-07 .8987 8.58E-01 -2.66E-01 -2.66E-01*
3	.9595 10421.7 5.95E-04 .8837 8.68E-01 1.03E+03 1.03E+03*	1.1602 8619.4 2.30E-04 .8768 8.72E-01 2.27E+02 2.28E+02*	1.4592 6853.2 9.82E-05 .8746 8.73E-01 4.89E+01 4.90E+01*	1.9519 5123.3 4.66E-05 .8760 8.73E-01 9.66E+00 9.68E+00*	2.9150 3430.5 2.45E-05 .8795 8.70E-01 1.52E+00 1.52E+00*	5.6325 1775.4 1.41E-05 .8838 8.68E-01 1.21E-01 1.21E-01*	63.0382 158.6 8.83E-06 .8879 8.65E-01 5.35E-05 5.34E-05*	-7.0471 -1419.0 5.88E-06 .8914 8.63E-01 -2.54E-02 -2.53E-02*	-3.3820 -2956.8 4.12E-06 .8942 8.61E-01 -1.60E-01 -1.60E-01*	-2.2452 -4454.0 3.00E-06 .8961 8.60E-01 -3.97E-01 -3.97E-01*	-1.6920 -5910.1 2.26E-06 .8975 8.59E-01 -6.97E-01 -6.97E-01*
4	.7926 12616.1 3.49E-03 .9020 8.56E-01 1.04E+04 1.05E+04*	.9247 10813.8 1.40E-03 .8899 8.64E-01 2.69E+03 2.70E+03*	1.1053 9047.5 6.02E-04 .8827 8.68E-01 6.81E+02 6.84E+02*	1.3665 7317.7 2.81E-04 .8799 8.70E-01 1.69E+02 1.69E+02*	1.7778 5624.9 1.44E-04 .8804 8.70E-01 3.92E+01 3.93E+01*	2.5190 3969.8 8.06E-05 .8828 8.68E-01 7.70E+00 7.71E+00*	4.2499 2353.0 4.89E-05 .8861 8.66E-01 9.69E-01 9.70E-01*	12.8972 775.4 3.18E-05 .8893 8.64E-01 2.25E-02 2.25E-02*	-13.1163 -762.4 2.19E-05 .8922 8.63E-01 -1.46E-02 -1.46E-02*	-4.4256 -2259.6 1.58E-05 .8945 8.61E-01 -2.74E-01 -2.74E-01*	-2.6913 -3715.7 1.18E-05 .8961 8.60E-01 -9.06E-01 -9.06E-01*
5	.6786 14737.1 1.43E-02 .9251 8.41E-01 6.59E+04 6.62E+04	.7731 12934.8 6.29E-03 .9082 8.52E-01 2.00E+04 2.01E+04*	.8954 11168.6 2.82E-03 .8961 8.60E-01 5.88E+03 5.91E+03*	1.0595 9438.7 1.33E-03 .8887 8.65E-01 1.69E+03 1.70E+03*	1.2910 7745.9 6.75E-04 .8853 8.67E-01 4.77E+02 4.79E+02*	1.6418 6090.8 3.71E-04 .8849 8.67E-01 1.28E+02 1.28E+02*	2.2351 4474.0 2.20E-04 .8863 8.66E-01 3.00E+01 3.00E+01*	3.4526 2896.4 1.40E-04 .8886 8.65E-01 5.16E+00 5.16E+00*	7.3604 1358.6 9.47E-05 .8910 8.63E-01 3.59E-01 3.59E-01*	-72.1709 -138.6 6.72E-05 .8932 8.62E-01 -2.69E-04 -2.69E-04*	-6.2709 -1594.7 4.97E-05 .8950 8.61E-01 -3.03E-01 -3.02E-01*
6	.5961 16775.4 4.01E-02 .9517 8.24E-01 2.60E+05 2.61E+05	.6679 14973.1 2.04E-02 .9308 8.38E-01 9.72E+04 9.76E+04	.7572 13206.9 9.98E-03 .9143 8.49E-01 3.35E+04 3.37E+04*	.8713 11477.0 4.95E-03 .9023 8.56E-01 1.11E+04 1.12E+04*	1.0221 9784.2 2.56E-03 .8946 8.61E-01 3.60E+03 3.61E+03*	1.2301 8129.1 1.40E-03 .8907 8.64E-01 1.14E+03 1.14E+03*	1.5355 6512.3 8.23E-04 .8894 8.64E-01 3.44E+02 3.45E+02*	2.0265 4934.7 5.16E-04 .8899 8.64E-01 9.38E+01 9.39E+01*	2.9439 3396.9 3.43E-04 .8913 8.63E-01 2.03E+01 2.03E+01*	5.2639 1899.7 2.40E-04 .8929 8.62E-01 2.48E+00 2.48E+00*	22.5423 443.6 1.76E-04 .8945 8.61E-01 2.30E-02 2.30E-02*
7	.5342 18720.4 7.12E-02 .9822 8.02E-01 6.09E+05 6.10E+05	.5911 16918.2 4.56E-02 .9565 8.20E-01 3.01E+05 3.02E+05	.6600 15151.9 2.61E-02 .9363 8.34E-01 1.28E+05 1.28E+05	.7450 13422.1 1.42E-02 .9202 8.45E-01 4.96E+04 4.98E+04	.8526 11729.3 7.75E-03 .9083 8.52E-01 1.84E+04 1.85E+04*	.9926 10074.1 4.36E-03 .9005 8.57E-01 6.64E+03 6.66E+03*	1.1824 8457.4 2.57E-03 .8960 8.60E-01 2.33E+03 2.34E+03*	1.4535 6879.7 1.61E-03 .8940 8.61E-01 7.86E+02 7.88E+02*	1.8720 5342.0 1.06E-03 .8936 8.62E-01 2.43E+02 2.43E+02*	2.6009 3844.8 7.33E-04 .8941 8.61E-01 6.26E+01 6.27E+01*	4.1864 2388.7 5.31E-04 .8951 8.61E-01 1.09E+01 1.09E+01*

Table 15. Radiative transition parameters for $N_2^+ B^2\Sigma_u^+ - X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. -Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.2344 42653.3 3.03E-10 1.6528 1.18E-01 (6.61E-04) 2.15E-03*	.2470 40478.3 9.94E-08 1.1988 6.27E-01 5.25E+00 (1.23E+02) 5.68E+00*	.2609 38336.1 3.77E-08 3.9364 -5.35E+00 (1.88E+01*)	.2760 36226.7 1.77E-04 1.3553 4.73E-01 3.81E+03 4.11E+03*	.2928 34150.2 1.39E-03 1.0785 7.30E-01 6.00E+04 (5.07E+04) 6.49E+04*	.3115 32106.9 1.03E-02 1.5331 2.71E-01 5.07E+04 6.55E+04	.3323 30097.1 3.11E-01 1.2900 5.40E-01 5.02E+06 5.04E+06	.3556 28121.1 3.43E-01 1.2426 5.86E-01 5.31E+06 5.20E+06	.3820 26179.1 3.16E-02 .9262 8.41E-01 8.13E+05 8.96E+05	.4120 24271.4 7.97E-04 1.2930 5.37E-01 6.66E+03 6.36E+03*	.4465 22398.6 3.92E-02 1.0779 7.30E-01 4.76E+05 4.66E+05
9	.2253 44377.3 2.83E-11 1.2048 6.22E-01 (1.93E-03) 2.35E-03*	.2370 42202.3 5.02E-10 2.4759 -1.29E+00 (1.28E-01) 2.74E-02*	.2496 40060.1 6.81E-07 1.2983 5.32E-01 2.51E+01 (2.29E+02) 2.70E+01*	.2635 37950.6 2.21E-06 .6988 9.66E-01 (2.29E+02) 3.24E+02*	.2788 35874.2 2.93E-04 1.4415 3.79E-01 (3.93E+03) 4.51E+03*	.2956 33830.9 4.52E-03 1.1812 6.43E-01 1.47E+05 (2.77E+03) 1.53E+05*	.3143 31821.1 3.36E-03 1.8162 -1.12E-01 (2.77E+03) 1.90E+02*	.3351 29845.0 3.12E-01 1.3067 5.23E-01 4.60E+06 4.61E+06	.3584 27903.0 3.77E-01 1.2614 5.68E-01 5.35E+06 (5.55E+05) 5.23E+06	.3847 25995.4 1.75E-02 .7461 9.44E-01 (5.55E+05) 6.94E+05	.4145 24122.6 8.71E-03 1.2359 5.93E-01 8.70E+04 8.20E+04*
10	.2175 45975.1 3.47E-12 1.4757 3.39E-01 7.87E-05 (3.24E-02) 7.40E-05*	.2283 43800.2 8.65E-10 1.3592 4.69E-01 (3.24E-02) 3.90E-02*	.2401 41657.9 5.91E-09 .3943 1.06E+00 (9.70E-01) 1.81E+00*	.2529 39548.5 2.36E-06 1.4072 4.17E-01 (5.15E+01) 5.78E+01*	.2669 37472.0 3.23E-05 1.0955 7.16E-01 (5.36E+02) 1.95E+03*	.2823 35428.7 2.50E-04 1.6252 1.54E-01 (5.36E+02) 1.13E+03*	.2992 33418.9 1.06E-02 1.2510 5.78E-01 (9.03E+03) 2.76E+05	.3180 31442.9 3.01E-04 .6894 6.90E-01 (9.03E+03) 1.17E+05*	.3390 29500.9 2.79E-01 1.3262 5.03E-01 3.68E+06 3.69E+06	.3624 27593.3 4.27E-01 1.2791 5.51E-01 (1.40E+05) 5.37E+06	.3888 25720.4 3.74E-03 -.0365 1.04E+00 (1.40E+05) 4.23E+05*
11	.4864 20560.8 6.58E-02 1.0094 7.83E-01 7.10E+05 7.11E+05	.5331 18758.6 6.56E-02 .9876 7.99E-01 5.60E+05 5.59E+05	.5885 16992.3 4.75E-02 .9609 8.17E-01 3.15E+05 3.16E+05	.6552 15262.5 3.03E-02 .9414 8.31E-01 1.50E+05 1.51E+05	.7369 13569.7 1.82E-02 .9259 8.41E-01 6.53E+04 6.56E+04	.8393 11914.5 1.09E-02 .9142 8.49E-01 2.69E+04 2.70E+04	.9711 10297.8 6.63E-03 .9060 8.54E-01 1.07E+04 1.07E+04*	1.1468 8720.1 4.20E-03 .9011 8.57E-01 4.14E+03 4.15E+03*	1.3923 7182.4 2.77E-03 .8986 8.59E-01 1.53E+03 1.54E+03*	1.7590 5685.2 1.92E-03 .8974 8.59E-01 5.26E+02 5.27E+02*	2.3646 4229.1 1.38E-03 .8971 8.59E-01 1.56E+02 1.56E+02*
9	.4487 22284.8 2.47E-02 1.1218 6.94E-01 2.67E+05 2.57E+05	.4882 20482.6 4.56E-02 1.0034 7.87E-01 4.91E+05 4.95E+05	.5343 18716.3 5.58E-02 .9944 7.94E-01 4.67E+05 4.65E+05	.5887 16986.5 4.51E-02 .9647 8.15E-01 2.97E+05 2.98E+05	.6539 15293.7 3.20E-02 .9463 8.27E-01 1.59E+05 1.59E+05	.7332 13638.5 2.12E-02 .9310 8.38E-01 7.63E+04 7.66E+04	.8318 12021.8 1.38E-02 .9199 8.45E-01 3.46E+04 3.47E+04	.9575 10444.1 9.03E-03 .9115 8.50E-01 1.51E+04 1.51E+04*	1.1228 8906.3 6.08E-03 .9059 8.54E-01 6.35E+03 6.37E+03*	1.3497 7409.2 4.24E-03 .9029 8.56E-01 2.56E+03 2.57E+03*	1.6798 5953.0 3.07E-03 .9013 8.57E-01 9.63E+02 9.64E+02*
10	.4187 23882.6 2.61E-02 1.2595 5.70E-01 2.34E+05 2.18E+05	.4529 22080.4 1.68E-02 1.2100 6.17E-01 1.40E+05 1.30E+05	.4923 20314.1 2.70E-02 .9808 8.03E-01 2.96E+05 3.03E+05	.5381 18584.3 4.39E-02 1.0048 7.86E-01 3.53E+05 3.50E+05	.5920 16891.5 3.90E-02 .9675 8.13E-01 2.52E+05 2.52E+05	.6563 15236.4 3.07E-02 .9513 8.24E-01 1.49E+05 1.50E+05	.7342 13619.6 2.22E-02 .9354 8.35E-01 7.90E+04 7.93E+04	.8304 12041.9 1.56E-02 .9251 8.41E-01 3.92E+04 3.93E+04	.9520 10504.2 1.10E-02 .9169 8.47E-01 1.85E+04 1.86E+04	1.1102 9007.0 7.86E-03 .9107 8.51E-01 8.42E+03 8.44E+03*	1.3244 7550.9 5.76E-03 .9068 8.53E-01 3.66E+03 3.66E+03*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 16. Radiative transition parameters for $N_2^+ C^2\Sigma_u^+ - X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.1549 66540.1 1.19E-02 1.1948 1.31E-01 1.11E+05 1.13E+05	.1603 62365.2 7.15E-02 1.2126 1.47E-01 7.62E+05 7.71E+05	.1660 60223.0 1.87E-01 1.2318 1.66E-01 2.27E+06 2.28E+06	.1721 58113.5 2.77E-01 1.2527 1.86E-01 3.82E+06 3.81E+06	.1785 56037.1 2.52E-01 1.2762 2.10E-01 3.94E+06 3.93E+06	.1852 53993.8 1.43E-01 1.3037 2.36E-01 2.54E+06 2.54E+06	.1924 51984.0 4.86E-02 1.3384 2.66E-01 9.80E+05 1.00E+06	.2000 50007.9 8.65E-03 1.3889 3.00E-01 1.97E+05 2.16E+05*	.2080 48065.9 5.36E-04 1.4959 3.06E-01 (1.13E+04) 1.87E+04*	.2166 46158.3 9.97E-08 -2.6964 0.00E+00 (0.00E+00) 7.43E+01*	.2258 44285.5 5.24E-06 1.3347 2.63E-01 (6.40E+01) 1.27E+02*
1	.1502 66591.7 4.50E-02 1.1780 1.16E-01 3.63E+05 3.71E+05	.1552 64416.7 1.52E-01 1.1940 1.30E-01 1.39E+06 1.41E+06	.1606 62274.5 1.61E-01 1.2100 1.45E-01 1.65E+06 1.65E+06	.1662 60165.0 3.14E-02 1.2203 1.55E-01 3.31E+05 3.25E+05	.1722 58088.6 2.92E-02 1.2692 2.03E-01 4.75E+05 4.74E+05	.1784 56045.3 1.90E-01 1.2830 2.16E-01 3.17E+06 3.13E+06	.1851 54035.5 2.36E-01 1.3089 2.41E-01 4.38E+06 4.34E+06	.1921 52059.5 1.24E-01 1.3434 2.70E-01 2.60E+06 2.62E+06	.1995 50117.5 2.86E-02 1.3954 3.03E-01 6.67E+05 7.26E+05	.2074 48209.9 1.87E-03 1.5143 2.98E-01 (3.77E+04) 6.76E+04*	.2158 46337.0 8.17E-06 .4444 3.71E-07 (2.26E+10) 2.92E+01*
2	.1457 66620.8 9.10E-02 1.1626 1.03E-01 6.36E+05 6.49E+05	.1505 64445.9 1.55E-01 1.1772 1.15E-01 1.22E+06 1.22E+06	.1555 64303.6 3.09E-02 1.1884 1.25E-01 2.61E+05 2.48E+05	.1608 62194.2 3.44E-02 1.2184 1.53E-01 3.91E+05 4.07E+05	.1663 60117.7 1.19E-01 1.2299 1.64E-01 1.40E+06 1.41E+06	.1722 58074.5 1.94E-02 1.2281 1.62E-01 2.02E+05 2.06E+05	.1784 56064.7 5.97E-02 1.2990 2.32E-01 1.14E+06 1.10E+06	.1849 54088.6 2.35E-01 1.3160 2.47E-01 4.60E+06 4.48E+06	.1918 52146.6 1.96E-01 1.3493 2.75E-01 4.25E+06 4.23E+06	.1990 50239.0 5.67E-02 1.4026 3.06E-01 1.36E+06 1.47E+06	.2068 48366.2 3.77E-03 1.5363 2.85E-01 (7.01E+04) 1.41E+05*
3	.1416 70625.0 1.31E-01 1.1483 9.22E-02 7.92E+05 8.05E+05	.1461 68450.1 8.92E-02 1.1613 1.02E-01 6.06E+05 5.93E+05	.1508 66307.8 5.45E-03 1.1905 1.27E-01 5.18E+04 6.00E+04*	.1558 64198.4 9.61E-02 1.1950 1.31E-01 8.83E+05 8.90E+05	.1610 62121.9 1.49E-02 1.1994 1.35E-01 1.32E+05 1.23E+05	.1664 60078.7 5.40E-02 1.2373 1.71E-01 6.94E+05 7.13E+05	.1722 58068.9 8.17E-02 1.2445 1.78E-01 1.03E+06 1.05E+06	.1783 56092.8 2.72E-03 1.4128 3.09E-01 9.29E+04 9.32E+04*	.1847 54150.8 1.81E-01 1.3264 2.56E-01 3.84E+06 3.65E+06	.1914 52243.2 2.49E-01 1.3561 2.80E-01 5.62E+06 5.50E+06	.1985 50370.3 8.89E-02 1.4104 3.08E-01 2.19E+06 2.34E+06
4	.1377 72601.6 1.49E-01 1.1349 8.24E-02 7.86E+05 7.94E+05	.1420 70426.7 2.35E-02 1.1452 8.99E-02 1.34E+05 1.23E+05	.1464 68284.4 5.65E-02 1.1659 1.06E-01 4.09E+05 4.26E+05	.1511 66175.0 4.60E-02 1.1760 1.14E-01 3.53E+05 3.39E+05	.1560 64098.5 2.17E-02 1.2030 1.38E-01 2.21E+05 2.38E+05	.1611 62055.3 7.00E-02 1.2100 1.45E-01 7.10E+05 7.06E+05	.1665 60045.5 1.99E-03 1.2851 2.18E-01 (4.15E+04) 4.66E+04*	.1722 58069.4 9.04E-02 1.2506 1.84E-01 1.22E+06 1.25E+06	.1782 56127.4 9.01E-03 1.1950 1.31E-01 (5.53E+04) 7.87E+04*	.1844 54219.8 1.20E-01 1.3422 2.69E-01 2.80E+06 2.57E+06	.1910 52347.0 2.82E-01 1.3642 2.85E-01 6.67E+06 6.38E+06
5	.1341 74548.1 1.45E-01 1.1224 7.40E-02 6.64E+05 6.64E+05	.1382 72373.2 6.38E-06 .8947 4.90E-03 (1.18E-01) 5.99E+02*	.1424 70230.9 8.10E-02 1.1503 9.37E-02 4.99E+05 5.03E+05	.1468 68121.5 6.82E-04 1.1309 7.97E-02 (2.77E+03) 9.40E+02*	.1514 66045.0 6.79E-02 1.1807 1.18E-01 5.55E+05 5.63E+05	.1562 64001.8 3.76E-03 1.1738 1.12E-01 (2.53E+04) 1.96E+04*	.1613 61992.0 6.22E-02 1.2151 1.50E-01 6.71E+05 6.87E+05	.1666 60015.9 1.27E-02 1.2100 1.45E-01 1.16E+05 1.10E+05	.1722 58073.9 5.76E-02 1.2570 1.91E-01 8.29E+05 8.68E+05	.1780 56166.3 3.59E-02 1.2359 1.70E-01 (3.71E+05) 4.53E+05	.1842 54293.4 6.99E-02 1.3676 2.87E-01 (1.87E+06) 1.63E+06
6	.1308 76461.8 1.24E-01 1.1105 6.65E-02 4.96E+05 4.91E+05	.1346 74286.9 1.51E-02 1.1283 7.79E-02 (7.61E+04) 8.58E+04	.1386 72144.6 5.60E-02 1.1361 8.33E-02 2.96E+05 2.86E+05	.1428 70035.2 1.98E-02 1.1562 9.82E-02 1.33E+05 1.47E+05	.1471 67958.7 4.14E-02 1.1632 1.04E-01 2.83E+05 2.72E+05	.1517 65915.5 2.17E-02 1.1872 1.24E-01 1.94E+05 2.10E+05	.1565 63905.7 3.80E-02 1.1921 1.28E-01 3.31E+05 3.20E+05	.1615 61929.6 2.23E-02 1.2231 1.57E-01 2.65E+05 2.83E+05	.1667 59987.6 4.23E-02 1.2230 1.57E-01 4.57E+05 4.54E+05	.1722 58080.0 2.20E-02 1.2683 2.02E-01 3.56E+05 3.84E+05	.1779 56207.2 5.71E-02 1.2460 1.80E-01 (6.63E+05) 8.02E+05
7	.1276 78340.2 9.68E-02 1.0994 5.99E-02 3.39E+05 3.31E+05	.1313 76165.2 4.40E-02 1.1145 6.89E-02 1.87E+05 1.98E+05	.1351 74023.0 1.86E-02 1.1215 7.34E-02 (8.23E+04) 7.29E+04	.1391 71913.5 5.25E-02 1.1401 8.61E-02 2.93E+05 3.04E+05	.1432 69837.1 3.37E-03 1.1386 8.51E-02 (1.68E+04) 1.16E+04*	.1475 67793.8 5.35E-02 1.1676 1.07E-01 3.89E+05 3.95E+05	.1520 65784.0 6.24E-05 1.0304 2.92E-02 (3.08E+01) 5.77E+02*	.1567 63808.0 5.35E-02 1.1969 1.33E-01 4.95E+05 5.00E+05	.1616 61866.0 7.55E-04 1.2831 2.16E-01 (1.69E+04) 2.16E+04*	.1668 59958.4 5.63E-02 1.2284 1.62E-01 6.47E+05 6.56E+05	.1722 58085.5 2.93E-03 1.3110 2.43E-01 (6.86E+04) 8.21E+04*

Table 16. Radiative transition parameters for $N_2^+ C^2\Sigma_u^+-X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	.2356 42447.7 8.84E-08 1.8639 3.12E-02 (1.33E-02) 9.91E+00*	.2460 40645.5 7.47E-08 1.2661 2.00E-01 (4.05E-01) 1.02E+00*	.2572 38879.2 2.11E-09 1.8420 3.96E-02 (3.93E-04) 2.26E-01*	.2692 37149.4 2.09E-09 1.2832 2.16E-01 (1.01E-02) 2.41E-02*	.2820 35456.6 6.29E-12 3.0950 4.29E-17 (1.05E-36) 3.80E-03*	.2958 33801.5 8.02E-11 1.3673 2.87E-01 (5.18E-04) 1.23E-03*	.3107 32184.7 2.92E-12 .8451 2.25E-03 (1.00E-09) 1.38E-05*	.3267 30607.1 1.98E-12 1.5553 2.71E-01 (8.45E-06) 5.81E-05*	.3440 29069.3 9.11E-13 1.2447 1.78E-01 (1.44E-06) 3.25E-06*	.3627 27572.2 8.54E-15 .1006 6.66E-12 (1.61E-29) 7.80E-07*	.3829 26116.0 4.93E-14 1.4748 3.12E-01 (1.74E-07) 6.58E-07*
1	.2247 44499.3 2.89E-05 1.3717 2.90E-01 (4.00E+00) 8.21E+02*	.2342 42697.0 6.40E-08 2.8880 2.37E-13 (5.66E-25) 3.07E+01*	.2443 40930.7 5.96E-07 1.3324 2.61E-01 (5.65E+00) 1.22E+01*	.2551 39200.9 3.02E-10 5.1741 0.00E+00 (0.00E+00) 7.66E-01*	.2666 37508.2 1.84E-08 1.3707 2.89E-01 (1.65E-01) 3.76E-01*	.2789 35853.0 3.67E-10 .6924 1.36E-04 (6.34E-10) 5.31E-03*	.2921 34236.3 5.18E-10 1.4987 3.05E-01 (3.92E-03) 1.58E-02*	.3062 32658.6 1.14E-10 1.1816 1.19E-01 (1.15E-04) 3.18E-04*	.3213 31120.8 1.91E-12 2.3779 2.82E-06 (9.29E-16) 4.00E-04*	.3376 29623.7 9.68E-12 1.3969 3.03E-01 (4.69E-05) 1.26E-04*	.3550 28167.6 1.19E-12 1.0780 4.86E-02 (1.28E-07) 8.58E-08*
2	.2149 46528.4 6.81E-05 .8790 3.86E-03 (2.08E-01) 1.91E+02*	.2236 44726.2 8.46E-05 1.4098 3.08E-01 (1.46E+03) 2.79E+03*	.2328 42959.9 2.14E-07 -.1624 1.80E-16 (1.12E-30) 2.86E+01*	.2425 41230.1 2.22E-06 1.3949 3.02E-01 (2.88E+01) 6.26E+01*	.2529 39537.3 3.75E-08 .6878 1.24E-04 (7.18E-08) 4.30E-01*	.2640 37882.2 6.47E-08 1.4674 3.14E-01 (7.01E-01) 2.14E+00*	.2757 36265.4 8.93E-09 1.1254 7.60E-02 (4.98E-03) 1.75E-02*	.2883 34687.8 8.00E-10 1.7946 6.34E-02 (2.72E-04) 6.63E-02*	.3017 33150.0 9.94E-10 1.3270 2.57E-01 (4.84E-03) 1.13E-02*	.3159 31623.8 3.70E-11 .7837 7.86E-04 (1.47E-09) 3.00E-04*	.3312 30196.7 2.71E-11 1.6247 2.09E-01 (6.59E-05) 1.01E-03*
3	.2060 48532.6 5.68E-03 1.5633 2.65E-01 (9.23E+04) 2.20E+05*	.2140 46730.4 2.82E-04 1.0571 3.92E-02 (8.97E+01) 2.83E+03*	.2224 44964.1 1.71E-04 1.4522 3.15E-01 (3.13E+03) 6.57E+03*	.2313 43234.3 4.86E-06 .8914 4.66E-03 (1.73E-02) 2.90E-02*	.2407 41541.5 5.00E-06 1.4663 3.14E-01 (7.15E+01) 1.92E+02*	.2507 39886.4 4.93E-07 1.0903 5.49E-02 (1.91E-01) 1.12E+00*	.2613 38269.6 1.04E-07 1.6273 2.06E-01 (5.00E-01) 6.26E+00*	.2725 36692.0 5.82E-08 1.2714 2.05E-01 (2.44E-01) 6.03E-01*	.2845 35154.2 4.20E-11 -2.9573 0.00E+00 (0.00E+00) 9.40E-02*	.2971 33657.0 3.23E-09 1.4612 3.14E-01 (2.46E-02) 8.08E-02*	.3106 32200.9 7.93E-10 1.1886 1.25E-01 (8.42E-04) 2.25E-03*
4	.1980 50509.2 1.22E-01 1.4191 3.11E-01 3.07E+06 3.23E+06	.2053 48707.0 7.06E-03 1.5975 2.35E-01 (9.11E+04) 2.82E+05*	.2130 46940.7 8.04E-04 1.1574 9.92E-02 (1.66E+03) 1.30E+04*	.2212 45210.9 2.61E-04 1.5040 3.03E-01 (4.48E+03) 1.18E+04*	.2298 43518.1 2.67E-05 1.1152 6.94E-02 (2.14E+01) 1.79E+02*	.2389 41863.0 7.12E-06 1.5688 2.60E-01 (7.17E+01) 3.94E+02*	.2485 40246.2 2.40E-06 1.2318 1.66E-01 (8.69E+00) 2.58E+01*	.2586 38668.6 4.20E-08 2.2272 9.05E-05 (4.03E-08) 9.64E+00*	.2693 37130.8 1.87E-07 1.3751 2.92E-01 (1.66E+00) 3.88E+00*	.2806 35633.7 1.42E-08 .9937 1.89E-02 (4.67E-04) 9.54E-04*	.2926 34177.5 3.52E-09 1.7252 1.13E-01 (3.66E-03) 2.37E-01*
5	.1906 52455.7 3.01E-01 1.3735 2.91E-01 7.47E+06 6.96E+06	.1974 50653.5 1.53E-01 1.4285 3.13E-01 3.94E+06 4.09E+06	.2046 48887.2 7.51E-03 1.6426 1.91E-01 (6.48E+04) 3.09E+05*	.2121 47157.4 1.79E-03 1.2243 1.58E-01 (9.54E+03) 3.79E+04*	.2200 45464.6 3.05E-04 1.5754 2.55E-01 (3.77E+03) 1.67E+04*	.2283 43809.5 8.57E-05 1.2231 1.57E-01 (3.61E+02) 1.25E+03*	.2370 42192.7 5.54E-06 1.7815 7.15E-02 (4.30E+00) 5.44E+02*	.2462 40615.1 6.92E-06 1.3212 2.52E-01 (5.96E+01) 1.35E+02*	.2559 39077.3 5.92E-08 .2081 2.85E-10 (5.82E-19) 5.19E+00*	.2661 37580.1 3.28E-07 1.4935 3.07E-01 (3.32E+00) 1.21E+01*	.2768 36124.0 1.04E-07 1.2249 1.59E-01 (2.51E-01) 6.96E-01*
6	.1839 54369.4 3.65E-02 1.4108 3.09E-01 (1.13E+06) 9.59E+05	.1902 52567.2 3.12E-01 1.3842 2.97E-01 (8.10E+06) 7.32E+06	.1968 50800.9 1.81E-01 1.4388 3.14E-01 (4.76E+06) 4.86E+06	.2038 49071.1 6.92E-03 1.7055 1.30E-01 (2.82E+04) 2.93E+05*	.2111 47378.3 3.34E-03 1.2742 2.08E-01 (3.10E+04) 8.45E+04*	.2187 45723.2 2.61E-04 1.6929 1.42E-01 (1.02E+03) 1.86E+04*	.2267 44106.4 1.98E-04 1.2945 2.27E-01 (1.78E+03) 4.28E+03*	.2351 42528.8 7.76E-07 3.0289 7.63E-16 (7.04E-29) 4.51E+02*	.2440 40991.0 1.35E-05 1.3998 3.04E-01 (1.74E+02) 3.96E+02*	.2532 39493.8 1.22E-06 1.0457 3.47E-02 (1.83E-01) 1.04E+00*	.2629 38037.7 2.54E-07 1.7345 1.06E-01 (3.16E-01) 2.12E+01*
7	.1778 56247.8 6.51E-02 1.2502 1.84E-01 (7.92E+05) 9.83E+05	.1837 54445.5 1.69E-02 1.4893 3.09E-01 (5.25E+05) 5.20E+05	.1898 52679.3 3.18E-01 1.3962 3.03E-01 (8.65E+06) 7.55E+06	.1963 50949.5 2.06E-01 1.4499 3.15E-01 (5.48E+06) 5.50E+06	.2030 49256.7 5.46E-03 1.8004 6.00E-02 (4.76E+03) 2.35E+05*	.2101 47601.5 5.42E-03 1.3148 2.46E-01 (7.17E+04) 1.56E+05*	.2175 45984.8 1.36E-04 1.9604 9.35E-03 (2.34E+00) 1.55E+04*	.2252 44407.1 3.56E-04 1.3521 2.77E-01 (4.83E+03) 1.00E+04*	.2333 42869.4 3.98E-06 .4211 1.96E-07 (2.44E-11) 1.13E+02*	.2417 41372.2 1.79E-05 1.4921 3.08E-01 (2.43E+02) 7.73E+02*	.2505 39916.1 5.34E-06 1.2238 1.58E-01 (1.72E+01) 5.39E+01*

Table 16. Radiative transition parameters for $N_2^+ C^2\Sigma_u^+-X^2\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.1247 80180.5 7.04E-02 1.0888 5.41E-02 2.15E+05 2.09E+05	.1282 78005.6 6.65E-02 1.1028 6.19E-02 2.45E+05 2.52E+05	.1318 75863.4 5.37E-04 1.0869 5.31E-02 1.34E+03 2.58E+02*	.1356 73753.9 5.49E-02 1.1267 7.68E-02 2.63E+05 2.61E+05	.1395 71677.4 7.68E-03 1.1486 9.24E-02 4.89E+04 5.89E+04*	.1436 69634.2 3.43E-02 1.1514 9.45E-02 2.10E+05 1.99E+05	.1479 67624.4 2.33E-02 1.1729 1.12E-01 1.82E+05 1.99E+05	.1523 65648.3 1.72E-02 1.1752 1.14E-01 1.27E+05 1.16E+05	.1570 63706.3 3.75E-02 1.2017 1.37E-01 3.68E+05 3.85E+05	.1618 61798.7 6.14E-03 1.1905 1.27E-01 4.73E+04 4.04E+04*	.1669 59925.9 4.96E-02 1.2330 1.67E-01 6.02E+05 6.20E+05
9	.1220 81980.3 4.85E-02 1.0789 4.91E-02 1.30E+05 1.25E+05	.1253 79805.4 7.51E-02 1.0921 5.59E-02 2.41E+05 2.44E+05	.1288 77663.1 5.90E-03 1.1116 6.71E-02 2.52E+04 3.12E+04*	.1324 75553.7 3.25E-02 1.1138 6.85E-02 1.33E+05 1.24E+05	.1361 73477.2 3.31E-02 1.1312 7.99E-02 1.70E+05 1.81E+05	.1400 71434.0 4.66E-03 1.1306 7.95E-02 2.17E+04 1.57E+04*	.1440 69424.2 4.40E-02 1.1557 9.78E-02 2.86E+05 2.90E+05	.1483 67448.1 1.08E-03 1.2010 1.36E-01 1.25E+04 1.80E+04*	.1527 65506.1 3.75E-02 1.1813 1.19E-01 3.01E+05 2.96E+05	.1572 63598.5 1.33E-02 1.2099 1.45E-01 1.45E+05 1.60E+05	.1620 61725.6 2.29E-02 1.2051 1.40E-01 2.15E+05 2.06E+05
10	.1194 83737.1 3.21E-02 1.0696 4.47E-02 7.62E+04 7.21E+04	.1226 81562.2 7.17E-02 1.0822 5.07E-02 2.03E+05 2.01E+05	.1259 79420.0 2.29E-02 1.0971 5.86E-02 7.99E+04 8.81E+04	.1293 77310.5 9.49E-03 1.0997 6.01E-02 3.21E+04 2.59E+04*	.1329 75234.1 4.50E-03 1.1183 7.13E-02 1.98E+05 2.00E+05	.1366 73190.8 3.05E-03 1.1441 8.91E-02 1.92E+04 2.58E+04*	.1405 71181.0 2.83E-02 1.1407 8.66E-02 1.55E+05 1.46E+05	.1445 69204.9 2.39E-02 1.1607 1.02E-01 1.66E+05 1.80E+05	.1487 67262.9 6.04E-03 1.1578 9.95E-02 3.69E+04 2.92E+04*	.1530 65355.3 3.87E-02 1.1856 1.23E-01 3.29E+05 3.37E+05	.1575 63482.5 6.54E-04 1.2602 1.94E-01 1.27E+04 1.75E+04*
$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	.1722 58088.1 8.08E-04 1.1275 7.74E-02 (1.92E+03) 1.67E+02*	.1777 56285.9 6.18E-02 1.2119 1.85E-01 (7.68E+05) 1.00E+06	.1834 54519.6 6.59E-03 1.6474 1.86E-01 (7.50E+04) 2.55E+05*	.1894 52789.8 3.24E-01 1.4095 3.08E-01 (9.15E+06) 7.69E+06	.1957 51097.0 2.27E-01 1.4619 3.14E-01 (6.08E+06) 5.99E+06	.2023 49441.9 3.51E-03 1.9625 9.09E-03 (7.10E+01) 1.53E+05*	.2091 47825.1 7.81E-03 1.3500 2.75E-01 (1.31E+05) 2.50E+05*	.2162 46247.5 1.40E-05 3.6013 2.31E-28 (0.00E+00) 8.14E+03*	.2237 44709.7 5.14E-04 1.4065 3.07E-01 (8.78E+03) 1.81E+04*	.2314 43212.6 3.89E-05 1.0314 2.96E-02 (5.56E+00) 1.01E+02*	.2395 41756.4 1.47E-05 1.6456 1.88E-01 (7.67E+01) 1.04E+03*
9	.1670 59887.9 3.23E-02 1.2384 1.72E-01 4.16E+05 4.37E+05	.1722 58085.7 8.72E-03 1.2140 1.49E-01 (7.64E+04) 6.49E+04*	.1776 56319.4 5.19E-02 1.2521 1.86E-01 (6.48E+05) 9.12E+05	.1832 54589.6 1.92E-03 2.0316 3.27E-03 (6.79E+00) 1.06E+05*	.1890 52896.8 3.29E-01 1.4238 3.12E-01 (9.61E+06) 7.75E+06	.1952 51241.7 2.45E-01 1.4747 3.12E-01 (6.52E+06) 6.31E+06	.2015 49624.9 1.61E-03 2.3096 1.47E-05 (8.58E-05) 6.87E+04*	.2081 48047.3 1.02E-02 1.3826 2.96E-01 (2.01E+05) 3.54E+05	.2150 46509.5 5.25E-05 0.0716 2.28E-12 (5.58E-20) 1.05E+03*	.2222 45012.3 5.99E-04 1.4660 3.14E-01 (1.09E+04) 2.59E+04*	.2296 43556.2 1.30E-04 1.1973 1.33E-01 (3.86E+02) 1.62E+03*
10	.1622 61644.7 3.57E-02 1.2109 1.46E-01 3.59E+05 3.56E+05	.1671 59842.5 1.50E-02 1.2469 1.80E-01 2.12E+05 2.30E+05	.1722 58076.2 1.95E-02 1.2281 1.62E-01 2.03E+05 1.87E+05	.1775 56346.4 3.98E-02 1.2511 1.85E-01 (4.91E+05) 7.74E+05	.1830 54653.6 2.63E-04 3.5337 1.10E-26 (0.00E+00) 3.04E+04*	.1887 52998.5 3.35E-01 1.4392 3.15E-01 (1.00E+07) 7.75E+06	.1946 51381.7 2.59E-01 1.4883 3.09E-01 (6.78E+06) 6.44E+06	.2008 49804.1 2.99E-04 3.6530 1.11E-29 (0.00E+00) 1.07E+04*	.2072 48266.3 1.22E-02 1.4147 3.10E-01 (2.67E+05) 4.53E+05	.2138 46769.2 4.19E-04 0.8852 4.25E-03 (1.56E+00) 2.15E+03*	.2207 45313.1 5.48E-04 1.5437 2.80E-01 (8.09E+03) 3.01E+04*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 17. Radiative transition parameters for $O_2^+ A^2\Pi_u - X^2\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.2496 40068.1 1.60E-06 1.2432 1.92E-01 7.69E+00 7.76E+00*	.2618 38195.0 3.00E-05 1.2583 1.97E-01 1.31E+02 1.32E+02*	.2751 36354.7 2.66E-04 1.2738 2.01E-01 1.05E+03 1.06E+03*	.2895 34547.2 1.50E-03 1.2897 2.07E-01 5.33E+03 5.37E+03*	.3051 32772.4 5.96E-03 1.3061 2.12E-01 1.91E+04 1.93E+04*	.3223 31030.3 1.79E-02 1.3230 2.18E-01 5.17E+04 5.19E+04	.3411 29320.7 4.22E-02 1.3405 2.25E-01 1.09E+05 1.10E+05	.3617 27643.7 7.98E-02 1.3585 2.32E-01 1.84E+05 1.85E+05	.3846 25999.3 1.23E-01 1.3772 2.40E-01 2.54E+05 2.55E+05	.4100 24387.4 1.58E-01 1.3967 2.49E-01 2.89E+05 2.89E+05	.4384 22808.2 1.69E-01 1.4169 2.59E-01 2.72E+05 2.72E+05
1	.2443 40939.7 1.31E-05 1.2362 1.90E-01 6.57E+01 6.62E+01*	.2560 39066.6 2.13E-04 1.2510 1.94E-01 9.70E+02 9.76E+02*	.2686 37226.3 1.60E-03 1.2661 1.99E-01 6.64E+03 6.68E+03*	.2823 35418.9 7.44E-03 1.2816 2.04E-01 2.78E+04 2.80E+04*	.2972 33644.1 2.36E-02 1.2975 2.09E-01 7.97E+04 8.01E+04	.3135 31901.9 5.37E-02 1.3139 2.15E-01 1.63E+05 1.64E+05	.3312 30192.3 8.90E-02 1.3307 2.21E-01 2.43E+05 2.44E+05	.3507 28515.3 1.06E-01 1.3480 2.28E-01 2.59E+05 2.59E+05	.3721 26870.9 8.43E-02 1.3656 2.35E-01 1.84E+05 1.83E+05	.3959 25259.1 3.51E-02 1.3829 2.43E-01 6.77E+04 6.70E+04	.4223 23679.8 1.18E-03 1.3855 2.44E-01 1.88E+03 1.75E+03*
2	.2393 41784.0 5.67E-05 1.2296 1.88E-01 2.97E+02 2.99E+02*	.2506 39910.9 7.99E-04 1.2440 1.92E-01 3.80E+03 3.83E+03*	.2627 38070.6 5.11E-03 1.2588 1.97E-01 2.21E+04 2.22E+04*	.2758 36263.1 1.94E-02 1.2739 2.01E-01 7.60E+04 7.63E+04	.2900 34488.3 4.80E-02 1.2894 2.06E-01 1.70E+05 1.71E+05	.3054 32746.2 7.91E-02 1.3052 2.12E-01 2.53E+05 2.53E+05	.3222 31036.6 8.32E-02 1.3213 2.18E-01 2.39E+05 2.39E+05	.3406 29359.6 4.64E-02 1.3373 2.24E-01 1.19E+05 1.19E+05	.3608 27715.2 4.84E-03 1.3486 2.28E-01 1.09E+04 1.06E+04*	.3831 26103.3 1.09E-02 1.3812 2.42E-01 2.30E+04 2.35E+04	.4078 24524.1 5.75E-02 1.3962 2.49E-01 1.06E+05 1.07E+05
3	.2347 42600.9 1.73E-04 1.2232 1.86E-01 9.44E+02 9.50E+02*	.2455 40727.8 2.12E-03 1.2374 1.90E-01 1.05E+04 1.06E+04*	.2572 38887.6 1.14E-02 1.2518 1.95E-01 5.15E+04 5.18E+04	.2697 37080.1 3.52E-02 1.2665 1.99E-01 1.44E+05 1.44E+05	.2832 35305.3 6.60E-02 1.2816 2.04E-01 2.45E+05 2.45E+05	.2979 33563.1 7.30E-02 1.2968 2.09E-01 2.44E+05 2.44E+05	.3139 31853.5 3.80E-02 1.3118 2.14E-01 1.14E+05 1.14E+05	.3314 30176.5 1.64E-03 1.3172 2.16E-01 4.26E+03 4.05E+03*	.3505 28532.1 1.76E-02 1.3516 2.30E-01 4.37E+04 4.43E+04	.3715 26920.3 5.71E-02 1.3666 2.36E-01 1.25E+05 1.26E+05	.3946 25341.0 4.69E-02 1.3829 2.43E-01 9.13E+04 9.08E+04
4	.2305 43390.6 4.20E-04 1.2172 1.85E-01 2.37E+03 2.39E+03*	.2409 41517.5 4.45E-03 1.2311 1.89E-01 2.30E+04 2.31E+04*	.2520 39677.3 2.02E-02 1.2452 1.93E-01 9.47E+04 9.51E+04	.2641 37869.8 4.96E-02 1.2596 1.97E-01 2.11E+05 2.12E+05	.2770 36095.0 6.77E-02 1.2741 2.01E-01 2.62E+05 2.62E+05	.2911 34352.8 4.34E-02 1.2886 2.06E-01 1.52E+05 1.51E+05	.3063 32643.3 4.08E-03 1.2985 2.10E-01 1.26E+04 1.23E+04*	.3229 30966.3 1.26E-02 1.3265 2.20E-01 3.66E+04 3.72E+04	.3410 29321.8 4.86E-02 1.3400 2.25E-01 1.26E+05 1.26E+05	.3609 27710.0 3.53E-02 1.3550 2.31E-01 8.11E+04 8.05E+04	.3827 26130.7 8.16E-04 1.3502 2.29E-01 1.55E+03 1.40E+03*
5	.2265 44153.1 8.59E-04 1.2115 1.83E-01 5.04E+03 5.06E+03*	.2365 42280.0 7.89E-03 1.2252 1.87E-01 4.23E+04 4.24E+04*	.2473 40439.8 2.99E-02 1.2390 1.91E-01 1.46E+05 1.46E+05	.2589 38632.3 5.75E-02 1.2530 1.95E-01 2.55E+05 2.56E+05	.2713 36857.5 5.34E-02 1.2669 1.99E-01 2.15E+05 2.15E+05	.2848 35115.3 1.37E-02 1.2796 2.03E-01 4.97E+04 4.92E+04	.2993 33405.8 3.55E-03 1.3062 2.12E-01 1.21E+04 1.24E+04*	.3152 31728.8 3.76E-02 1.3158 2.16E-01 9.65E+04 1.14E+05	.3324 30084.3 3.58E-02 1.3299 2.21E-01 3.97E+03 9.60E+04	.3512 28472.5 1.72E-03 1.3332 2.22E-01 3.97E+03 3.75E+03*	.3718 26893.2 1.98E-02 1.3699 2.37E-01 4.39E+04 4.45E+04
6	.2228 44888.5 1.54E-03 1.2060 1.82E-01 9.37E+03 9.42E+03*	.2325 43015.4 1.23E-02 1.2195 1.85E-01 6.82E+04 6.85E+04	.2429 41175.2 3.87E-02 1.2331 1.89E-01 1.96E+05 1.96E+05	.2540 39367.7 5.68E-02 1.2466 1.93E-01 2.62E+05 2.62E+05	.2660 37592.9 3.18E-02 1.2598 1.97E-01 1.33E+05 1.32E+05	.2789 35850.7 4.03E-04 1.2550 1.96E-01 1.44E+03 1.33E+03*	.2929 34141.1 2.13E-02 1.2939 2.08E-01 7.44E+04 7.50E+04	.3080 32464.1 3.91E-02 1.3071 2.13E-01 1.22E+05 1.22E+05	.3245 30819.7 7.63E-03 1.3179 2.16E-01 2.12E+04 2.07E+04*	.3424 29207.9 9.66E-03 1.3461 2.27E-01 2.52E+04 2.57E+04*	.3619 27628.6 3.91E-02 1.3580 2.32E-01 9.01E+04 9.02E+04
7	.2193 45596.8 2.51E-03 1.2009 1.81E-01 1.57E+04 1.58E+04*	.2287 43723.7 1.73E-02 1.2142 1.84E-01 9.91E+04 9.95E+04	.2388 41883.5 4.48E-02 1.2274 1.88E-01 2.35E+05 2.35E+05	.2495 40076.0 4.85E-02 1.2406 1.91E-01 2.31E+05 2.31E+05	.2611 38301.2 1.27E-02 1.2523 1.95E-01 5.49E+04 5.44E+04	.2735 36559.0 4.16E-03 1.2762 2.02E-01 1.68E+04 1.72E+04*	.2869 34849.4 3.41E-02 1.2859 2.05E-01 1.23E+05 1.23E+05	.3015 33172.4 2.06E-02 1.2984 2.10E-01 6.70E+04 6.64E+04	.3172 31528.0 7.94E-04 1.3363 2.23E-01 2.52E+03 2.69E+03*	.3343 29916.2 2.98E-02 1.3344 2.23E-01 8.02E+04 8.06E+04	.3529 28336.9 2.16E-02 1.3472 2.28E-01 5.17E+04 5.12E+04

Table 17. Radiative transition parameters for $O_2^+ A^2\Pi_u - X^2\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	.4703	.5064	.5474	.5946	.6492	.7132	.7891	.8805	.9925	1.1328	1.3134
	21261.6	19747.7	18266.6	16818.4	15403.2	14021.2	12672.5	11357.2	10075.5	8827.7	7614.0
	1.51E-01	1.14E-01	7.22E-02	3.84E-02	1.72E-02	6.39E-03	1.97E-03	4.96E-04	1.01E-04	1.64E-05	2.05E-06
	1.4379	1.4600	1.4831	1.5075	1.5333	1.5608	1.5903	1.6220	1.6567	1.6949	1.7379
	2.70E-01	2.82E-01	2.95E-01	3.10E-01	3.27E-01	3.46E-01	3.68E-01	3.94E-01	4.24E-01	4.59E-01	5.03E-01
	2.14E+05	1.41E+05	7.75E+04	3.56E+04	1.36E+04	4.27E+03	1.10E+03	2.28E+02	3.76E+01	4.81E+00	4.64E-01
	2.14E+05	1.41E+05	7.72E+04	3.54E+04	1.35E+04	4.23E+03*	1.08E+03*	2.25E+02*	3.69E+01*	4.70E+00*	4.51E-01*
1	.4518	.4850	.5225	.5653	.6144	.6715	.7383	.8177	.9135	1.0310	1.1785
	22133.2	20619.3	19138.2	17690.0	16274.9	14892.8	13544.1	12228.8	10947.1	9699.3	8485.6
	1.77E-02	7.51E-02	1.28E-01	1.41E-01	1.13E-01	7.01E-02	3.41E-02	1.32E-02	4.04E-03	9.76E-04	1.83E-04
	1.4314	1.4498	1.4712	1.4941	1.5185	1.5444	1.5721	1.6017	1.6338	1.6689	1.7076
	2.66E-01	2.76E-01	2.88E-01	3.02E-01	3.17E-01	3.34E-01	3.54E-01	3.77E-01	4.03E-01	4.35E-01	4.72E-01
	2.76E+04	1.02E+05	1.51E+05	1.44E+05	9.94E+04	5.24E+04	2.15E+04	6.94E+03	1.75E+03	3.41E+02	5.05E+01
	2.81E+04	1.02E+05	1.51E+05	1.44E+05	9.91E+04	5.22E+04	2.14E+04	6.87E+03	1.72E+03*	3.35E+02*	4.94E+01*
2	.4352	.4659	.5004	.5395	.5841	.6354	.6950	.7649	.8481	.9484	1.0718
	22977.5	21463.6	19982.5	18534.3	17119.1	15737.1	14388.3	13073.0	11791.4	10543.6	9329.8
	7.77E-02	4.11E-02	1.64E-03	2.15E-02	8.72E-02	1.35E-01	1.29E-01	8.66E-02	4.33E-02	1.65E-02	4.77E-03
	1.4143	1.4326	1.4345	1.4866	1.5065	1.5302	1.5560	1.5837	1.6136	1.6460	1.6814
	2.58E-01	2.67E-01	2.68E-01	2.97E-01	3.09E-01	3.25E-01	3.43E-01	3.63E-01	3.87E-01	4.14E-01	4.46E-01
	1.27E+05	5.86E+04	1.90E+03	2.45E+04	8.48E+04	1.12E+05	9.10E+04	5.16E+04	2.15E+04	6.70E+03	1.56E+03
	1.27E+05	5.81E+04	1.74E+03*	2.50E+04	8.54E+04	1.12E+05	9.09E+04	5.14E+04	2.13E+04	6.63E+03	1.54E+03*
3	.4203	.4488	.4808	.5168	.5575	.6041	.6577	.7199	.7931	.8802	.9855
	23794.4	22280.5	20799.5	19351.3	17936.1	16554.0	15205.3	13890.0	12608.3	11360.5	10146.8
	5.23E-03	1.39E-02	6.27E-02	6.38E-02	1.52E-02	5.65E-03	6.59E-02	1.29E-01	1.34E-01	9.13E-02	4.42E-02
	1.3935	1.4307	1.4465	1.4656	1.4821	1.5308	1.5439	1.5685	1.5960	1.6260	1.6586
	2.48E-01	2.66E-01	2.74E-01	2.85E-01	2.94E-01	3.25E-01	3.34E-01	3.52E-01	3.72E-01	3.97E-01	4.25E-01
	8.76E+03	2.21E+04	8.59E+04	7.60E+04	1.54E+04	5.49E+03	5.24E+04	8.64E+04	7.53E+04	4.27E+04	1.69E+04
	8.43E+03*	2.26E+04	8.63E+04	7.57E+04	1.50E+04	5.77E+03*	5.31E+04	8.68E+04	7.52E+04	4.25E+04	1.68E+04
4	.4068	.4335	.4632	.4965	.5340	.5766	.6252	.6812	.7464	.8230	.9144
	24584.1	23070.2	21589.2	20141.0	18725.8	17343.7	15995.0	14679.7	13398.0	12150.2	10936.5
	2.37E-02	5.50E-02	2.37E-02	1.38E-03	4.56E-02	6.87E-02	2.34E-02	2.74E-03	6.28E-02	1.31E-01	1.35E-01
	1.3977	1.4134	1.4291	1.4824	1.4802	1.4995	1.5177	1.5792	1.5833	1.6093	1.6390
	2.50E-01	2.57E-01	2.65E-01	2.94E-01	2.93E-01	3.05E-01	3.16E-01	3.60E-01	3.63E-01	3.83E-01	4.08E-01
	4.45E+04	9.05E+04	3.39E+04	1.98E+03	5.21E+04	6.75E+04	1.94E+04	2.27E+03	4.03E+04	7.01E+04	5.94E+04
	4.52E+04	9.05E+04	3.34E+04	2.16E+03*	5.27E+04	6.74E+04	1.90E+04	2.46E+03*	4.09E+04	7.04E+04	5.93E+04
5	.3945	.4196	.4474	.4784	.5131	.5523	.5967	.6476	.7062	.7744	.8548
	25346.6	23832.8	22351.7	20903.5	19488.3	18106.3	16757.5	15442.2	14160.6	12912.8	11699.0
	4.52E-02	1.25E-02	7.19E-03	4.84E-02	3.34E-02	5.45E-06	3.91E-02	6.87E-02	2.26E-02	4.66E-03	7.45E-02
	1.3842	1.3971	1.4332	1.4448	1.4613	2.0027	1.5152	1.5348	1.5530	1.6157	1.6245
	2.44E-01	2.49E-01	2.67E-01	2.73E-01	2.82E-01	8.46E-01	3.15E-01	3.28E-01	3.40E-01	3.88E-01	3.96E-01
	8.85E+04	2.14E+04	1.16E+04	6.69E+04	3.99E+04	4.70E+01	3.70E+04	5.51E+04	1.50E+04	3.06E+03	3.78E+04
	8.84E+04	2.09E+04	1.20E+04*	6.72E+04	3.94E+04	4.89E+01*	3.75E+04	5.50E+04	1.46E+04	3.28E+03*	3.84E+04
6	.3834	.4070	.4331	.4621	.4945	.5307	.5717	.6181	.6713	.7327	.8042
	26082.0	24568.1	23087.1	21638.9	20223.7	18841.6	17492.9	16177.6	14895.9	13648.1	12434.4
	1.38E-02	5.49E-03	4.09E-02	2.09E-02	2.64E-03	4.40E-02	3.48E-02	1.36E-05	4.23E-02	6.67E-02	1.45E-02
	1.3705	1.4043	1.4141	1.4282	1.4739	1.4772	1.4939	1.9035	1.5511	1.5714	1.5870
	2.37E-01	2.53E-01	2.58E-01	2.65E-01	2.90E-01	2.91E-01	3.01E-01	7.03E-01	3.39E-01	3.54E-01	3.66E-01
	2.81E+04	1.05E+04	6.76E+04	3.00E+04	3.71E+03	5.07E+04	3.43E+04	(5.76E+01)	3.25E+04	4.30E+04	7.53E+03
	2.75E+04	1.09E+04*	6.78E+04	2.95E+04	3.95E+03*	5.10E+04	3.39E+04	6.83E+01*	3.30E+04	4.28E+04	7.22E+03
7	.3733	.3956	.4203	.4475	.4777	.5115	.5494	.5922	.6409	.6966	.7609
	26790.3	25276.4	23795.4	22347.2	20932.0	19549.9	18201.2	16885.9	15604.2	14356.4	13142.7
	8.04E-04	3.18E-02	2.13E-02	1.65E-03	3.70E-02	2.25E-02	2.48E-03	4.47E-02	3.02E-02	1.21E-03	5.28E-02
	1.3927	1.3869	1.4001	1.4458	1.4448	1.4589	1.5097	1.5105	1.5269	1.6050	1.5882
	2.47E-01	2.45E-01	2.51E-01	2.74E-01	2.73E-01	2.81E-01	3.11E-01	3.12E-01	3.22E-01	3.80E-01	3.66E-01
	1.92E+03	6.22E+04	3.66E+04	2.80E+03	5.13E+04	2.69E+04	2.94E+03	4.24E+04	2.42E+04	(1.04E+03)	3.26E+04
	2.08E+03*	6.26E+04	3.61E+04	3.01E+03*	5.16E+04	2.65E+04	3.16E+03*	4.27E+04	2.37E+04	1.17E+03*	3.30E+04

Table 17. Radiative transition parameters for $O_2^+ A^2\Pi_u - X^2\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v'v''$	0	1	2	3	4	5	6	7	8	9	10
8	.2161 46278.1 3.75E-03 1.1959 1.79E-01 2.43E+04 2.44E+04*	.2252 44405.0 2.23E-02 1.2091 1.83E-01 1.32E+05 1.33E+05	.2349 42564.7 4.72E-02 1.2221 1.86E-01 2.56E+05 2.56E+05	.2454 40757.2 3.57E-02 1.2347 1.90E-01 1.76E+05 1.76E+05	.2565 38982.4 2.00E-03 1.2412 1.91E-01 8.78E+03 8.53E+03*	.2685 37240.3 1.58E-02 1.2666 1.99E-01 6.54E+04 6.60E+04	.2814 35530.7 3.21E-02 1.2786 2.03E-01 1.20E+05 1.20E+05	.2954 33853.7 3.79E-03 1.2868 2.06E-01 1.26E+04 1.22E+04*	.3105 32209.3 1.35E-02 1.3135 2.15E-01 4.23E+04 4.29E+04	.3268 30597.4 2.95E-02 1.3253 2.19E-01 8.22E+04 8.20E+04	.3446 29018.2 1.74E-03 1.3275 2.20E-01 4.17E+03 3.93E+03*
9	.2131 46932.4 5.24E-03 1.1913 1.78E-01 3.49E+04 3.51E+04*	.2219 45059.3 2.69E-02 1.2043 1.82E-01 1.65E+05 1.65E+05	.2314 43219.0 4.60E-02 1.2170 1.85E-01 2.57E+05 2.57E+05	.2415 41411.5 2.23E-02 1.2290 1.88E-01 1.13E+05 1.13E+05	.2523 39636.7 3.19E-04 1.2660 1.99E-01 1.59E+03 1.70E+03*	.2639 37894.5 2.55E-02 1.2598 1.97E-01 1.09E+05 1.09E+05	.2764 36185.0 2.02E-02 1.2714 2.01E-01 7.80E+04 7.75E+04	.2898 34508.0 4.76E-04 1.3101 2.14E-01 1.81E+03 1.95E+03*	.3043 32863.6 2.54E-02 1.3047 2.12E-01 8.20E+04 8.23E+04	.3200 31251.7 1.35E-02 1.3159 2.16E-01 3.88E+04 3.83E+04	.3370 29672.5 3.90E-03 1.3450 2.27E-01 1.06E+04 1.10E+04*
10	.2103 47559.7 6.93E-03 1.1868 1.77E-01 4.75E+04 4.77E+04*	.2189 45686.6 3.07E-02 1.1998 1.80E-01 1.93E+05 1.94E+05	.2281 43846.3 4.16E-02 1.2123 1.84E-01 2.40E+05 2.39E+05	.2379 42038.8 1.12E-02 1.2231 1.86E-01 5.84E+04 5.79E+04	.2484 40264.0 4.84E-03 1.2445 1.92E-01 2.37E+04 2.41E+04*	.2596 38521.9 2.83E-02 1.2536 1.95E-01 1.25E+05 1.25E+05	.2716 36812.3 7.66E-03 1.2635 1.98E-01 3.04E+04 2.99E+04*	.2846 35135.3 7.83E-03 1.2870 2.06E-01 2.91E+04 2.95E+04*	.2986 33490.9 2.51E-02 1.2972 2.09E-01 8.35E+04 8.33E+04	.3137 31879.0 1.35E-03 1.2987 2.10E-01 3.88E+03 3.67E+03*	.3300 30299.8 1.70E-02 1.3233 2.22E-01 4.72E+04 4.77E+04
11	.2076 48160.2 8.75E-03 1.1826 1.76E-01 6.15E+04 6.17E+04*	.2160 46287.0 3.34E-02 1.1955 1.79E-01 2.16E+05 2.16E+05	.2250 44446.8 3.52E-02 1.2077 1.82E-01 2.09E+05 2.08E+05	.2345 42639.3 3.83E-03 1.2162 1.85E-01 2.05E+04 2.02E+04*	.2447 40864.5 1.16E-02 1.2375 1.90E-01 5.83E+04 5.87E+04	.2556 39122.3 2.45E-02 1.2479 1.93E-01 1.11E+05 1.11E+05	.2673 37412.8 8.00E-04 1.2474 1.93E-01 3.17E+03 3.00E+03*	.2798 35735.8 1.69E-02 1.2791 2.03E-01 6.44E+04 6.49E+04	.2933 34091.3 1.55E-02 1.2898 2.07E-01 5.32E+04 5.28E+04	.3079 32479.5 1.59E-03 1.3200 2.17E-01 5.22E+03 5.46E+03*	.3236 30900.2 2.31E-02 1.3233 2.18E-01 6.58E+04 6.59E+04
12	.2052 48733.8 1.06E-02 1.1786 1.75E-01 7.65E+04 7.68E+04	.2134 46860.7 3.47E-02 1.1914 1.78E-01 2.31E+05 2.31E+05	.2221 45020.4 2.79E-02 1.2034 1.81E-01 1.70E+05 1.69E+05	.2314 43212.9 4.28E-04 1.2014 1.81E-01 2.29E+03 2.17E+03*	.2413 41438.1 1.75E-02 1.2320 1.89E-01 8.99E+04 9.03E+04	.2519 39696.0 1.71E-02 1.2422 1.92E-01 7.95E+04 7.91E+04	.2633 37986.4 6.79E-04 1.2742 2.01E-01 3.06E+03 3.22E+03*	.2754 36309.4 2.12E-02 1.2726 2.01E-01 8.32E+04 8.33E+04	.2885 34665.0 5.35E-03 1.2812 2.04E-01 1.87E+04 1.83E+04*	.3025 33053.1 9.40E-03 1.3057 2.12E-01 3.09E+04 3.14E+04*	.3177 31473.9 1.77E-02 1.3156 2.16E-01 5.20E+04 5.17E+04
13	.2029 49280.6 1.24E-02 1.1747 1.74E-01 9.18E+04 9.21E+04	.2109 47407.5 3.49E-02 1.1876 1.77E-01 2.38E+05 2.38E+05	.2195 45567.3 2.07E-02 1.1993 1.80E-01 1.29E+05 1.28E+05	.2285 43759.8 2.52E-04 1.2329 1.89E-01 1.53E+03 1.62E+03*	.2382 41985.0 2.07E-02 1.2271 1.88E-01 1.09E+05 1.10E+05	.2485 40242.8 9.31E-03 1.2364 1.90E-01 4.44E+04 4.40E+04*	.2595 38533.2 4.88E-03 1.2587 1.97E-01 2.19E+04 2.22E+04*	.2713 36856.2 1.95E-02 1.2667 1.99E-01 7.83E+04 7.82E+04	.2840 35211.8 3.01E-04 1.2555 1.96E-01 1.02E+03 9.16E+02*	.2976 33600.0 1.63E-02 1.2981 2.09E-01 5.51E+04 5.54E+04	.3123 32020.7 7.87E-03 1.3073 2.13E-01 2.37E+04 2.33E+04*
14	.2008 49800.8 1.42E-02 1.1711 1.74E-01 1.07E+05 1.07E+05	.2086 47927.7 3.40E-02 1.1840 1.77E-01 2.37E+05 2.37E+05	.2170 46087.4 1.42E-02 1.1955 1.79E-01 9.07E+04 9.02E+04	.2258 44279.9 2.18E-03 1.2156 1.84E-01 1.31E+04 1.33E+04*	.2353 42505.1 2.10E-02 1.2227 1.86E-01 1.14E+05 1.14E+05	.2453 40763.0 3.52E-03 1.2295 1.88E-01 1.71E+04 1.68E+04*	.2561 39053.4 1.01E-02 1.2520 1.95E-01 4.62E+04 4.66E+04	.2675 37376.4 1.39E-02 1.2610 1.97E-01 5.71E+04 5.68E+04	.2799 35732.0 1.09E-03 1.2903 2.07E-01 4.30E+03 4.49E+03*	.2931 34120.1 1.79E-02 1.2918 2.07E-01 6.18E+04 6.18E+04	.3073 32540.9 1.18E-03 1.2928 2.08E-01 3.54E+03 3.34E+03*
15	.1988 50294.3 1.57E-02 1.1677 1.73E-01 1.21E+05 1.22E+05	.2065 48421.2 3.23E-02 1.1806 1.76E-01 2.30E+05 2.30E+05	.2147 46581.0 8.93E-03 1.1918 1.78E-01 5.82E+04 5.78E+04*	.2233 44773.5 5.10E-03 1.2094 1.83E-01 3.10E+04 3.13E+04*	.2326 42998.7 1.89E-02 1.2185 1.85E-01 1.05E+05 1.05E+05	.2424 41256.5 5.35E-04 1.2151 1.84E-01 2.59E+03 2.46E+03*	.2529 39547.0 1.40E-02 1.2467 1.93E-01 6.52E+04 6.55E+04	.2641 37870.0 7.52E-03 1.2550 1.96E-01 3.16E+04 3.13E+04*	.2760 36225.5 5.20E-03 1.2778 2.03E-01 2.06E+04 2.09E+04*	.2889 34613.7 1.44E-02 1.2858 2.05E-01 5.09E+04 5.06E+04	.3027 33034.4 3.20E-04 1.3283 2.20E-01 1.13E+03 1.24E+03*

Table 17. Radiative transition parameters for $O_2^+ A^2\Pi_u-X^2\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	.3640 27471.6 1.85E-02 1.3629 2.34E-01 4.27E+04 4.32E+04	.3852 25957.7 2.69E-02 1.3752 2.40E-01 5.46E+04 5.43E+04	.4086 24476.6 3.21E-05 1.2496 1.94E-01 3.58E+01 1.28E+01*	.4342 23028.4 2.69E-02 1.4165 2.59E-01 4.46E+04 4.50E+04	.4627 21613.2 2.28E-02 1.4296 2.65E-01 3.29E+04 3.24E+04	.4943 20231.2 1.33E-03 1.4825 2.95E-01 1.94E+03 2.12E+03*	.5296 18882.4 3.67E-02 1.4763 2.91E-01 4.24E+04 4.26E+04	.5692 17567.1 1.89E-02 1.4896 2.99E-01 1.86E+04 1.82E+04	.6140 16285.5 5.51E-03 1.5374 3.30E-01 5.23E+03 5.53E+03*	.6650 15037.7 4.82E-02 1.5447 3.35E-01 3.72E+04 3.74E+04	.7234 13824.0 1.99E-02 1.5594 3.45E-01 1.27E+04 1.23E+04
9	.3555 28125.9 2.84E-02 1.3524 2.30E-01 6.76E+04 6.77E+04	.3758 26612.0 5.22E-03 1.3602 2.33E-01 1.08E+04 1.05E+04*	.3979 25130.9 1.32E-02 1.3923 2.47E-01 2.59E+04 2.64E+04	.4222 23682.7 2.72E-02 1.4037 2.53E-01 4.67E+04 4.65E+04	.4491 22267.5 1.32E-04 1.3431 2.26E-01 1.51E+02 1.00E+02*	.4788 20885.5 2.64E-02 1.4467 2.74E-01 3.67E+04 3.70E+04	.5119 19536.7 2.01E-02 1.4591 2.81E-01 2.40E+04 2.36E+04	.5488 18221.4 3.16E-03 1.5063 3.09E-01 3.70E+03 3.94E+03*	.5903 16939.8 3.86E-02 1.5084 3.10E-01 3.66E+04 3.67E+04	.6373 15692.0 1.13E-02 1.5188 3.17E-01 8.87E+03 8.53E+03	.6907 14478.2 1.40E-02 1.5668 3.50E-01 1.06E+04 1.10E+04
10	.3478 28753.2 1.79E-02 1.3428 2.26E-01 4.40E+04 4.35E+04	.3671 27239.3 1.26E-03 1.3818 2.42E-01 3.02E+03 3.22E+03*	.3882 25758.2 2.62E-02 1.3801 2.42E-01 5.29E+04 5.30E+04	.4114 24310.0 6.06E-03 1.3880 2.45E-01 1.06E+04 1.02E+04*	.4368 22894.8 1.26E-02 1.4217 2.61E-01 2.09E+04 2.13E+04	.4648 21512.8 2.54E-02 1.4326 2.67E-01 3.64E+04 3.62E+04	.4959 20164.0 2.14E-05 1.6854 4.50E-01 7.20E+01 9.46E+01*	.5305 18848.8 2.90E-02 1.4774 2.92E-01 3.34E+04 3.37E+04	.5692 17567.1 1.38E-02 1.4881 2.98E-01 1.35E+04 1.31E+04	.6128 16319.3 8.88E-03 1.5318 3.26E-01 8.29E+03 8.64E+03*	.6620 15105.6 3.85E-02 1.5412 3.32E-01 2.97E+04 2.96E+04
11	.3407 29353.6 3.77E-03 1.3297 2.21E-01 9.41E+03 9.09E+03*	.3592 27839.8 1.29E-02 1.3596 2.33E-01 3.07E+04 3.11E+04	.3794 26358.7 1.83E-02 1.3697 2.37E-01 3.81E+04 3.78E+04	.4014 24910.5 9.84E-04 1.4146 2.58E-01 2.05E+03 2.22E+03*	.4256 23495.3 2.51E-02 1.4084 2.55E-01 4.29E+04 4.30E+04	.4522 22113.3 4.32E-03 1.4135 2.57E-01 6.26E+03 5.97E+03*	.4816 20764.5 1.54E-02 1.4511 2.77E-01 2.14E+04 2.18E+04	.5142 19449.2 2.12E-02 1.4617 2.83E-01 2.52E+04 2.49E+04	.5504 18167.6 1.53E-03 1.5166 3.16E-01 1.85E+03 2.02E+03*	.5910 16919.8 3.18E-02 1.5086 3.11E-01 3.01E+04 3.02E+04	.6367 15706.0 5.41E-03 1.5123 3.13E-01 4.16E+03 3.91E+03*
12	.3341 29927.3 2.99E-04 1.3675 2.36E-01 (9.07E+02) 1.01E+03*	.3519 28413.4 2.09E-02 1.3500 2.29E-01 5.09E+04 5.10E+04	.3713 26932.3 4.21E-03 1.3559 2.31E-01 8.91E+03 8.59E+03*	.3924 25484.1 1.24E-02 1.3874 2.45E-01 2.50E+04 2.54E+04	.4155 24068.9 1.63E-02 1.3969 2.49E-01 2.87E+04 2.84E+04	.4408 22686.9 2.05E-03 1.4372 2.69E-01 3.51E+03 3.74E+03*	.4686 21338.1 2.46E-02 1.4372 2.69E-01 3.51E+04 3.51E+04	.4994 20022.8 1.41E-03 1.4295 2.65E-01 1.61E+03 1.45E+03*	.5336 18741.2 2.06E-02 1.4808 2.94E-01 2.37E+04 2.40E+04	.5716 17493.4 1.38E-02 1.4901 2.99E-01 1.34E+04 1.31E+04	.6143 16279.6 7.60E-03 1.5333 3.27E-01 7.09E+03 7.39E+03*
13	.3281 30474.1 6.44E-03 1.3332 2.22E-01 1.82E+04 1.86E+04*	.3453 28960.2 1.72E-02 1.3416 2.26E-01 4.31E+04 4.29E+04	.3639 27479.2 2.18E-04 1.4057 2.53E-01 (5.90E+02) 6.75E+02*	.3842 26031.0 1.99E-02 1.3770 2.40E-01 4.11E+04 4.12E+04	.4062 24615.8 2.83E-03 1.3796 2.41E-01 4.99E+03 4.74E+03*	.4304 23233.7 1.44E-02 1.4153 2.58E-01 2.43E+04 2.47E+04	.4569 21885.0 1.24E-02 1.4241 2.63E-01 1.81E+04 1.78E+04	.4862 20569.7 5.26E-03 1.4606 2.82E-01 7.37E+03 7.67E+03*	.5185 19288.0 2.24E-02 1.4662 2.85E-01 2.64E+04 2.63E+04	.5543 18040.2 4.32E-05 1.6704 4.36E-01 (9.76E+01) 1.27E+02*	.5943 16826.5 2.58E-02 1.5111 3.12E-01 2.42E+04 2.44E+04
14	.3226 30994.3 1.37E-02 1.3243 2.19E-01 3.97E+04 4.00E+04	.3392 29480.4 7.90E-03 1.3328 2.22E-01 2.02E+04 1.99E+04*	.3572 27999.3 6.19E-03 1.3605 2.33E-01 1.50E+04 1.53E+04*	.3766 26551.1 1.56E-02 1.3679 2.36E-01 3.30E+04 3.27E+04	.3978 25135.9 7.59E-04 1.4141 2.58E-01 1.62E+03 1.76E+03*	.4210 23753.9 1.95E-02 1.4044 2.53E-01 3.38E+04 3.38E+04	.4463 22405.1 7.92E-04 1.3921 2.47E-01 (1.10E+03) 9.74E+02*	.4742 21089.8 1.77E-02 1.4437 2.73E-01 2.50E+04 2.52E+04	.5048 19808.2 6.67E-03 1.4496 2.76E-01 8.00E+03 7.70E+03*	.5388 18560.4 1.14E-02 1.4873 2.97E-01 1.31E+04 1.34E+04	.5765 17346.7 1.62E-02 1.4949 3.02E-01 1.56E+04 1.53E+04
15	.3176 31487.8 1.62E-02 1.3174 2.16E-01 4.80E+04 4.80E+04	.3336 29974.0 1.18E-03 1.3169 2.16E-01 3.01E+03 2.83E+03*	.3510 28492.9 1.32E-02 1.3508 2.29E-01 3.26E+04 3.28E+04	.3698 27044.7 6.21E-03 1.3577 2.32E-01 1.34E+04 1.31E+04*	.3902 25629.5 7.80E-03 1.3872 2.45E-01 1.59E+04 1.63E+04*	.4124 24247.4 1.26E-02 1.3943 2.48E-01 2.24E+04 2.21E+04	.4367 22898.7 2.69E-03 1.4304 2.66E-01 4.62E+03 4.86E+03*	.4633 21583.4 1.78E-02 1.4323 2.67E-01 2.58E+04 2.57E+04	.4926 20301.8 9.03E-05 1.5544 3.41E-01 (1.78E+02) 2.24E+02*	.5248 19053.9 2.01E-02 1.4726 2.89E-01 2.35E+04 2.36E+04	.5605 17840.2 1.27E-03 1.4600 2.82E-01 (1.16E+03) 1.03E+03*

Table 17. Radiative transition parameters for $O_2^+ A^2\Pi_u - X^2\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
16	.1970	.2045	.2125	.2210	.2301	.2397	.2499	.2608	.2725	.2851	.2985
	50761.4	48888.3	47048.0	45240.5	43465.7	41723.6	40014.0	38337.0	36692.6	35080.7	33501.5
	1.71E-02	2.99E-02	4.97E-03	8.10E-03	1.54E-02	9.05E-05	1.54E-02	2.72E-03	9.60E-03	8.69E-03	3.60E-03
	1.1644	1.1775	1.1882	1.2050	1.2147	1.2684	1.2421	1.2473	1.2714	1.2797	1.3041
	1.72E-01	1.75E-01	1.78E-01	1.82E-01	1.84E-01	2.00E-01	1.92E-01	1.93E-01	2.01E-01	2.03E-01	2.11E-01
	1.34E+05	2.17E+05	3.30E+04	5.02E+04	8.72E+04	5.31E+02	7.35E+04	1.16E+04	3.87E+04	3.14E+04	1.23E+04
	1.35E+05	2.17E+05	3.27E+04*	5.06E+04*	8.69E+04	5.85E+02*	7.36E+04	1.13E+04*	3.90E+04*	3.10E+04*	1.26E+04*
17	.1953	.2027	.2106	.2189	.2278	.2372	.2472	.2579	.2693	.2815	.2946
	51202.0	49328.9	47488.6	45681.1	43906.3	42164.2	40454.6	38777.6	37133.2	35521.3	33901.5
	1.82E-02	2.70E-02	2.29E-03	1.06E-02	1.15E-02	1.37E-03	1.46E-02	3.34E-04	1.23E-02	3.64E-03	7.87E-03
	1.1614	1.1745	1.1847	1.2012	1.2110	1.2346	1.2379	1.2282	1.2662	1.2726	1.2965
	1.72E-01	1.74E-01	1.77E-01	1.81E-01	1.83E-01	1.90E-01	1.91E-01	1.88E-01	1.99E-01	2.01E-01	2.09E-01
	1.46E+05	2.00E+05	1.55E+04	6.69E+04	6.60E+04	7.49E+03	7.09E+04	1.39E+03	5.05E+04	1.33E+04	2.72E+04
	1.46E+05	2.00E+05	1.53E+04*	6.72E+04	6.56E+04	7.68E+03*	7.09E+04	1.29E+03*	5.08E+04	1.30E+04*	2.75E+04*
18	.1937	.2010	.2088	.2169	.2256	.2349	.2447	.2552	.2663	.2783	.2911
	51616.3	49743.2	47902.9	46095.5	44320.7	42578.5	40868.9	39191.9	37547.5	35935.7	34356.4
	1.91E-02	2.40E-02	7.39E-04	1.23E-02	7.71E-03	3.45E-03	1.22E-02	1.44E-04	1.27E-02	7.03E-04	1.08E-02
	1.1585	1.1717	1.1810	1.1979	1.2074	1.2274	1.2340	1.2828	1.2617	1.2593	1.2909
	1.71E-01	1.74E-01	1.76E-01	1.80E-01	1.82E-01	1.88E-01	1.89E-01	2.04E-01	1.98E-01	1.97E-01	2.07E-01
	1.55E+05	1.81E+05	5.09E+03	7.89E+04	4.52E+04	1.90E+04	6.05E+04	7.32E+02	5.33E+04	2.56E+03	3.78E+04
	1.55E+05	1.80E+05	4.95E+03*	7.92E+04	4.48E+04*	1.93E+04*	6.03E+04	7.99E+02*	5.33E+04	2.42E+03*	3.81E+04
19	.1923	.1995	.2071	.2151	.2237	.2327	.2424	.2527	.2636	.2753	.2878
	52004.5	50131.3	48291.1	46483.6	44708.8	42966.6	41257.1	39580.1	37935.6	36323.8	34744.5
	1.96E-02	2.09E-02	7.57E-05	1.31E-02	4.62E-03	5.57E-03	9.15E-03	1.37E-03	1.13E-02	1.94E-05	1.14E-02
	1.1558	1.1692	1.1742	1.1949	1.2039	1.2227	1.2302	1.2554	1.2575	1.3683	1.2861
	1.70E-01	1.73E-01	1.74E-01	1.79E-01	1.81E-01	1.86E-01	1.88E-01	1.96E-01	1.96E-01	2.37E-01	2.05E-01
	1.62E+05	1.60E+05	5.25E+02	8.55E+04	2.76E+04	3.11E+04	4.62E+04	6.59E+03	4.81E+04	1.05E+02	4.08E+04
	1.62E+05	1.60E+05	4.82E+02*	8.57E+04	2.73E+04*	3.14E+04*	4.59E+04*	6.78E+03*	4.80E+04	1.30E+02*	4.09E+04
20	.1910	.1980	.2055	.2135	.2219	.2308	.2403	.2504	.2611	.2726	.2848
	52366.5	50493.4	48653.1	46845.6	45070.8	43328.7	41619.1	39942.1	38297.7	36685.8	35106.6
	1.98E-02	1.78E-02	5.45E-05	1.31E-02	2.38E-03	7.24E-03	6.16E-03	3.16E-03	8.81E-03	9.15E-04	1.01E-02
	1.1533	1.1669	1.1846	1.1922	1.2003	1.2191	1.2264	1.2482	1.2534	1.2818	1.2817
	1.70E-01	1.73E-01	1.77E-01	1.79E-01	1.81E-01	1.85E-01	1.87E-01	1.94E-01	1.95E-01	2.04E-01	2.04E-01
	1.66E+05	1.39E+05	3.97E+02	8.68E+04	1.44E+04	4.10E+04	3.16E+04	1.53E+04	3.81E+04	3.81E+03	3.69E+04
	1.66E+05	1.38E+05	4.35E+02*	8.69E+04	1.42E+04*	4.13E+04*	3.13E+04*	1.55E+04*	3.79E+04*	3.96E+03*	3.68E+04
21	.1897	.1967	.2041	.2119	.2202	.2290	.2384	.2483	.2588	.2701	.2822
	52702.0	50828.8	48988.6	47181.1	45406.3	43664.1	41954.6	40277.6	38633.1	37021.3	35442.0
	1.96E-02	1.49E-02	4.39E-04	1.24E-02	9.60E-04	8.21E-03	3.67E-03	4.81E-03	6.09E-03	2.49E-03	7.77E-03
	1.1509	1.1647	1.1777	1.1897	1.1959	1.2160	1.2226	1.2436	1.2495	1.2728	1.2775
	1.69E-01	1.72E-01	1.75E-01	1.78E-01	1.79E-01	1.85E-01	1.86E-01	1.92E-01	1.94E-01	2.01E-01	2.03E-01
	1.67E+05	1.18E+05	3.21E+03	8.34E+04	5.86E+03	4.72E+04	1.90E+04	2.35E+04	2.68E+04	1.04E+04	2.88E+04
	1.67E+05	1.18E+05	3.31E+03*	8.34E+04	5.71E+03*	4.74E+04*	1.88E+04*	2.38E+04*	2.65E+04*	1.06E+04*	2.86E+04*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 17. Radiative transition parameters for $O_2^+ A^2\Pi_u - X^2\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{v',v''}$ (μm), $\nu_{v',v''}$ (cm^{-1}), $q_{v',v''}$, $\bar{r}_{v',v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v',v''})$ (electric dipole moment atomic units), $A_{v',v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v',v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
16	.3129 31954.9 1.34E-02 1.3111 2.14E-01 4.06E+04 4.03E+04	.3285 30441.0 3.36E-04 1.3564 2.31E-01 1.03E+03 1.13E+03*	.3453 28959.9 1.51E-02 1.3435 2.26E-01 3.81E+04 3.81E+04	.3635 27511.7 4.97E-04 1.3308 2.21E-01 1.03E+03 9.16E+02*	.3832 26096.5 1.40E-02 1.3775 2.41E-01 2.91E+04 2.93E+04	.4046 24714.5 3.47E-03 1.3809 2.42E-01 6.22E+03 5.97E+03*	.4280 23365.7 1.08E-02 1.4139 2.57E-01 1.86E+04 1.88E+04	.4535 22050.4 8.13E-03 1.4204 2.61E-01 1.20E+04 1.17E+04*	.4815 20768.8 6.86E-03 1.4542 2.78E-01 9.65E+03 9.94E+03*	.5123 19521.0 1.34E-02 1.4601 2.82E-01 1.60E+04 1.57E+04	.5462 18307.2 3.17E-03 1.5019 3.06E-01 3.70E+03 3.91E+03*
17	.3087 32395.5 8.06E-03 1.3047 2.12E-01 2.49E+04 2.46E+04*	.3238 30481.6 3.65E-03 1.3303 2.21E-01 1.07E+04 1.09E+04*	.3401 29400.5 1.18E-02 1.3367 2.24E-01 3.03E+04 3.01E+04	.3578 27952.3 9.02E-04 1.3741 2.39E-01 2.28E+03 2.43E+03*	.3768 26537.1 1.40E-02 1.3697 2.37E-01 2.99E+04 2.98E+04	.3975 25155.1 6.26E-11 92.5600 1.20E-01 2.91E-05 1.30E+01*	.4201 23806.3 1.48E-02 1.4044 2.53E-01 2.58E+04 2.59E+04	.4446 22491.0 8.03E-04 1.3932 2.48E-01 1.14E+03 1.01E+03*	.4715 21209.4 1.42E-02 1.4415 2.72E-01 2.02E+04 2.04E+04	.5010 19961.6 2.98E-03 1.4421 2.72E-01 3.55E+03 3.35E+03*	.5334 18747.9 1.27E-02 1.4816 2.94E-01 1.46E+04 1.48E+04
18	.3048 32809.8 3.23E-03 1.2972 2.09E-01 1.01E+04 9.84E+03*	.3195 31295.9 7.76E-03 1.3223 2.18E-01 2.29E+04 2.32E+04*	.3354 29814.8 6.39E-03 1.3297 2.21E-01 1.67E+04 1.64E+04*	.3525 28366.6 4.82E-03 1.3564 2.31E-01 1.19E+04 1.22E+04*	.3710 26951.5 9.43E-03 1.3623 2.34E-01 2.05E+04 2.02E+04*	.3911 25569.4 2.48E-03 1.3943 2.48E-01 5.18E+03 5.39E+03*	.4129 24220.7 1.20E-02 1.3961 2.49E-01 2.14E+04 2.12E+04	.4366 22905.4 9.35E-04 1.4401 2.71E-01 1.67E+03 1.81E+03*	.4625 21623.7 1.39E-02 1.4224 2.67E-01 2.03E+04 2.02E+04	.4908 20375.9 1.50E-04 1.5236 3.20E-01 2.64E+02 3.18E+02*	.5219 19162.2 1.54E-02 1.4700 2.87E-01 1.81E+04 1.81E+04
19	.3012 33197.9 5.23E-04 1.2818 2.04E-01 1.61E+03 1.49E+03*	.3156 31684.1 1.03E-02 1.3165 2.16E-01 3.08E+04 3.10E+04	.3311 30203.0 2.05E-03 1.3204 2.17E-01 5.42E+03 5.21E+03*	.3478 28754.8 8.61E-03 1.3486 2.28E-01 2.16E+04 2.18E+04*	.3658 27339.6 4.06E-03 1.3537 2.30E-01 8.91E+03 8.66E+03*	.3852 25957.6 6.92E-03 1.3824 2.43E-01 1.44E+04 1.47E+04*	.4064 24608.8 6.17E-03 1.3872 2.45E-01 1.12E+04 1.09E+04*	.4293 23293.5 5.44E-03 1.4180 2.59E-01 9.38E+03 9.62E+03*	.4543 22011.9 8.21E-03 1.4224 2.62E-01 1.22E+04 1.19E+04*	.4816 20764.1 4.25E-03 1.4563 2.80E-01 6.02E+03 6.24E+03*	.5115 19550.3 1.01E-02 1.4593 2.81E-01 1.21E+04 1.19E+04
20	.2980 33560.0 6.25E-05 1.3495 2.29E-01 (2.50E+02) 2.94E+02*	.3121 32046.1 1.04E-02 1.3115 2.14E-01 3.19E+04 3.19E+04	.3272 30565.0 1.22E-04 1.2850 2.05E-01 (2.97E+02) 2.45E+02*	.3434 29116.8 1.02E-02 1.3427 2.26E-01 2.60E+04 2.61E+04	.3610 27701.6 7.26E-04 1.3371 2.24E-01 1.57E+03 1.45E+03*	.3799 26319.6 9.76E-03 1.3751 2.39E-01 2.07E+04 2.08E+04*	.4005 24970.8 1.60E-03 1.3735 2.39E-01 2.87E+03 2.71E+03*	.4227 23655.5 9.37E-03 1.4088 2.55E-01 1.63E+04 1.65E+04*	.4469 22373.9 2.52E-03 1.4093 2.55E-01 3.73E+03 3.55E+03*	.4733 21126.1 9.14E-03 1.4444 2.73E-01 1.30E+04 1.32E+04*	.5022 19912.3 3.38E-03 1.4458 2.74E-01 4.05E+03 3.87E+03*
21	.2950 33895.4 1.09E-03 1.3051 2.12E-01 3.86E+03 4.02E+03*	.3088 32381.6 8.79E-03 1.3069 2.12E-01 2.73E+04 2.72E+04*	.3236 30900.5 3.48E-04 1.3458 2.27E-01 1.07E+03 1.16E+03*	.3395 29452.3 9.38E-03 1.3375 2.24E-01 2.44E+04 2.43E+04*	.3567 28037.1 4.65E-05 1.4302 2.66E-01 (1.47E+02) 1.80E+02*	.3752 26655.1 9.81E-03 1.3691 2.37E-01 2.11E+04 2.11E+04*	.3952 25306.3 5.21E-06 1.1067 1.61E-01 (4.42E+00) 4.80E-04*	.4168 23991.0 1.02E-02 1.4017 2.52E-01 1.81E+04 1.81E+04	.4403 22709.4 7.20E-05 1.3335 2.22E-01 (8.45E+01) 5.50E+01*	.4659 21461.6 1.07E-02 1.4361 2.69E-01 1.55E+04 1.56E+04	.4939 20247.8 1.39E-04 1.3850 2.44E-01 (1.39E+02) 9.99E+01*

*The Einstein coefficients for this band may have limited accuracy, since the Franck-Condon factor is less than 0.01 (see text).

Table 18. Radiative transition parameters for $O_2^+ b^4\Sigma_g^- - a^4\Pi_u$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$.

$v' \backslash v''$	0	1	2	3	4	5	6	7	8	9	10
0	.6000 16666.4 2.65E-01 1.3375 2.05E-01 2.09E+05 2.08E+05	.6389 15651.7 2.92E-01 1.3013 2.19E-01 2.17E+05 2.16E+05	.6822 14657.4 2.06E-01 1.2716 2.29E-01 1.38E+05 1.38E+05	.7308 13683.9 1.19E-01 1.2460 2.38E-01 6.99E+04 7.01E+04	.7855 12731.2 6.19E-02 1.2235 2.45E-01 3.10E+04 3.12E+04	.8475 11799.6 3.01E-02 1.2034 2.51E-01 1.26E+04 1.27E+04	.9183 10889.2 1.41E-02 1.1851 2.56E-01 4.86E+03 4.91E+03	1.0000 10000.2 6.50E-03 1.1684 2.61E-01 1.79E+03 1.81E+03*	1.0950 9132.6 2.96E-03 1.1531 2.65E-01 6.40E+02 6.48E+02*	1.2067 8286.8 1.34E-03 1.1390 2.68E-01 2.23E+02 2.26E+02*	1.3400 7462.8 6.15E-04 1.1260 2.71E-01 7.62E+01 7.73E+01*
1	.5609 17829.1 4.28E-01 1.3791 1.89E-01 3.52E+05 3.52E+05	.5947 16814.4 2.34E-02 1.3083 2.16E-01 2.10E+04 2.13E+04	.6321 15820.2 3.96E-02 1.3220 2.11E-01 2.83E+04 2.78E+04	.6736 14846.6 1.20E-01 1.2819 2.25E-01 8.10E+04 8.05E+04	.7197 13893.9 1.33E-01 1.2540 2.35E-01 7.98E+04 7.97E+04	.7715 12962.3 1.03E-01 1.2305 2.43E-01 5.37E+04 5.38E+04	.8297 12051.9 6.73E-02 1.2099 2.49E-01 2.96E+04 2.98E+04	.8958 11162.9 3.96E-02 1.1914 2.55E-01 1.45E+04 1.46E+04	.9713 10295.4 2.18E-02 1.1747 2.59E-01 6.49E+03 6.55E+03	1.0583 9449.5 1.16E-02 1.1594 2.63E-01 2.75E+03 2.78E+03	1.1594 8625.5 6.04E-03 1.1453 2.67E-01 1.12E+03 1.13E+03*
2	.5275 18957.6 2.44E-01 1.4296 1.70E-01 1.94E+05 1.95E+05	.5573 17942.9 1.77E-01 1.3980 1.82E-01 1.37E+05 1.37E+05	.5900 16948.6 1.40E-01 1.3361 2.06E-01 1.17E+05 1.17E+05	.6260 15975.1 7.27E-03 1.2629 2.32E-01 6.47E+03 6.72E+03*	.6657 15022.4 2.24E-02 1.3022 2.18E-01 1.47E+04 1.43E+04	.7097 14090.8 7.38E-02 1.2638 2.32E-01 4.49E+04 4.45E+04	.7587 13180.4 9.29E-02 1.2382 2.40E-01 4.98E+04 4.96E+04	.8136 12291.3 8.23E-02 1.2168 2.47E-01 3.78E+04 3.78E+04	.8754 11423.8 6.06E-02 1.1979 2.53E-01 2.34E+04 2.35E+04	.9454 10578.0 4.00E-02 1.1810 2.58E-01 1.27E+04 1.28E+04	1.0252 9753.9 2.47E-02 1.1657 2.62E-01 6.35E+03 6.40E+03
3	.4987 20051.8 5.81E-02 1.4965 1.44E-01 3.94E+04 3.92E+04	.5253 19037.0 3.48E-01 1.4425 1.65E-01 2.64E+05 2.65E+05	.5542 18042.8 2.46E-02 1.4514 1.61E-01 1.52E+04 1.51E+04	.5858 17069.3 1.42E-01 1.3490 2.01E-01 1.15E+05 1.15E+05	.6205 16116.6 5.98E-02 1.3018 2.18E-01 4.84E+04 4.88E+04	.6585 15185.0 8.45E-04 1.1661 2.62E-01 (8.21E+02) 9.43E+02*	.7005 14274.6 1.95E-02 1.2810 2.26E-01 1.17E+04 1.15E+04	.7471 13385.5 5.43E-02 1.2475 2.37E-01 2.97E+04 2.94E+04	.7988 12518.0 6.98E-02 1.2243 2.45E-01 3.32E+04 3.31E+04	.8567 11672.2 6.56E-02 1.2047 2.51E-01 2.66E+04 2.66E+04	.9218 10848.1 5.20E-02 1.1875 2.56E-01 1.76E+04 1.76E+04
4	.4737 21111.7 4.97E-03 1.6041 1.06E-01 2.12E+03 1.98E+03*	.4976 20097.0 1.43E-01 1.5093 1.39E-01 9.12E+04 9.10E+04	.5235 19102.7 3.32E-01 1.4578 1.59E-01 2.36E+05 2.38E+05	.5516 18129.2 2.23E-03 1.1443 2.67E-01 3.84E+03 4.20E+03*	.5822 17176.5 8.20E-02 1.3638 1.95E-01 6.41E+04 6.34E+04	.6156 16244.9 9.02E-02 1.3140 2.14E-01 7.17E+04 7.17E+04	.6521 15334.5 2.39E-02 1.2705 2.29E-01 1.84E+04 1.87E+04	.6923 14445.4 1.56E-04 1.5118 2.24E-01 (3.65E+01) 2.39E+01*	.7365 13577.9 1.89E-02 1.2620 2.32E-01 1.03E+04 1.01E+04	.7854 12732.1 4.33E-02 1.2331 2.42E-01 2.12E+04 2.10E+04	.8398 11908.0 5.46E-02 1.2121 2.49E-01 2.31E+04 2.30E+04
5	.4517 22137.3 5.90E-05 1.9562 2.60E-02 1.75E+00 1.81E+00*	.4734 21122.5 1.60E-02 1.6230 9.97E-02 6.06E+03 5.61E+03	.4968 20128.3 2.26E-01 1.5229 1.34E-01 1.35E+05 1.35E+05	.5221 19154.8 2.66E-01 1.4767 1.52E-01 1.74E+05 1.76E+05	.5494 18202.1 3.29E-02 1.3295 2.08E-01 3.48E+04 3.46E+04	.5790 17270.5 2.89E-02 1.3881 1.86E-01 2.08E+04 2.04E+04	.6112 16360.1 8.31E-02 1.3244 2.10E-01 6.50E+04 6.47E+04	.6464 15471.0 5.01E-02 1.2848 2.24E-01 3.78E+04 3.81E+04	.6848 14603.5 7.92E-03 1.2371 2.41E-01 5.79E+03 6.02E+03*	.7269 13757.7 1.68E-03 1.3160 2.13E-01 8.04E+02 7.35E+02*	.7732 12933.6 1.81E-02 1.2459 2.38E-01 8.99E+03 8.79E+03
6	.4324 23128.5 3.10E-06 1.2975 2.20E-01 (7.52E+00) 6.00E+00*	.4522 22113.8 1.51E-04 2.0951 1.27E-02 (1.06E+00) 3.57E+01*	.4735 21119.5 3.11E-02 1.6435 9.32E-02 1.03E+04 9.42E+03	.4964 20146.0 2.96E-01 1.5375 1.29E-01 1.63E+05 1.64E+05	.5210 19193.3 1.95E-01 1.5013 1.42E-01 1.13E+05 1.16E+05	.5476 18261.7 6.62E-02 1.3538 1.99E-01 6.47E+04 6.38E+04	.5763 17351.3 3.64E-03 1.4702 1.54E-01 1.83E+03 1.69E+03*	.6075 16462.2 5.72E-02 1.3356 2.06E-01 4.38E+04 4.33E+04	.6412 15594.7 6.11E-02 1.2942 2.21E-01 4.59E+04 4.59E+04	.6780 14748.9 2.50E-02 1.2586 2.34E-01 1.77E+04 1.80E+04	.7181 13924.8 1.82E-03 1.1874 2.56E-01 1.30E+03 1.42E+03*
7	.4152 24085.2 1.14E-07 2.0022 2.07E-02 (2.76E-03) 3.50E-02*	.4335 23070.5 2.33E-05 1.4032 1.80E-01 (3.75E+01) 2.89E+01*	.4530 22076.3 1.77E-04 2.3657 2.38E-03 (4.38E-02) 2.08E+02*	.4739 21102.7 4.75E-02 1.6660 8.64E-02 (1.35E+04) 1.21E+04	.4963 20150.1 3.50E-01 1.5532 1.23E-01 1.77E+05 1.79E+05	.5203 19218.4 1.39E-01 1.5337 1.30E-01 6.79E+04 7.03E+04	.5462 18308.0 8.47E-02 1.3633 1.9E-01 8.04E+04 7.87E+04	.5741 17419.0 8.91E-04 1.1262 2.71E-01 (1.40E+03) 1.70E+03*	.6042 16551.5 3.05E-02 1.3502 2.00E-01 2.25E+04 2.20E+04	.6367 15705.6 5.66E-02 1.3026 2.18E-01 4.23E+04 4.20E+04	.6720 14881.6 3.85E-02 1.2689 2.30E-01 2.72E+04 2.74E+04

Table 18. Radiative transition parameters for $O_2^+ b^4\Sigma_g^- - a^4\Pi_u$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
0	1.5014 6660.7 2.84E-04 1.1141 2.74E-01 2.55E+01 2.59E+01*	1.7005 5880.6 1.34E-04 1.1031 2.76E-01 8.38E+00 8.53E+00*	1.9521 5122.8 6.42E-05 1.0933 2.78E-01 2.70E+00 2.75E+00*	2.2793 4387.3 3.16E-05 1.0845 2.79E-01 8.44E-01 8.60E-01*	2.7216 3674.4 1.61E-05 1.0769 2.81E-01 2.54E-01 2.59E-01*	3.3511 2984.1 8.47E-06 1.0705 2.82E-01 7.23E-02 7.36E-02*	4.3164 2316.7 4.64E-06 1.0654 2.82E-01 1.86E-02 1.90E-02*	5.9790 1672.5 2.65E-06 1.0616 2.83E-01 4.02E-03 4.08E-03*	9.5088 1051.7 1.58E-06 1.0590 2.83E-01 5.97E-04 6.06E-04*	22.0363 454.4 9.85E-07 1.0575 2.83E-01 3.01E-05 3.05E-05*	-84.2112 -118.7 6.40E-07 1.0570 2.83E-01 -1.74E-07 -1.76E-07*
1	1.2782 7823.4 3.11E-03 1.1324 2.70E-01 4.39E+02 4.45E+02*	1.4198 7043.3 1.60E-03 1.1206 2.72E-01 1.68E+02 1.70E+02*	1.5910 6285.5 8.27E-04 1.1098 2.75E-01 6.27E+01 6.37E+01*	1.8018 5550.0 4.34E-04 1.1001 2.76E-01 2.30E+01 2.34E+01*	2.0674 4837.1 2.32E-04 1.0915 2.78E-01 8.22E+00 8.37E+00*	2.4115 4146.8 1.27E-04 1.0839 2.79E-01 2.87E+00 2.92E+00*	2.8740 3479.5 7.17E-05 1.0776 2.80E-01 9.62E-01 9.79E-01*	3.5270 2835.2 4.18E-05 1.0723 2.81E-01 3.05E-01 3.10E-01*	4.5159 2214.4 2.52E-05 1.0683 2.82E-01 8.81E-02 8.96E-02*	6.1838 1617.1 1.58E-05 1.0653 2.82E-01 2.16E-02 2.19E-02*	9.5788 1044.0 1.02E-05 1.0633 2.83E-01 3.77E-03 3.82E-03*
2	1.1171 8951.8 1.46E-02 1.1517 2.65E-01 2.98E+03 3.01E+03	1.2237 8171.8 8.38E-03 1.1388 2.68E-01 1.33E+03 1.35E+03*	1.3488 7414.0 4.76E-03 1.1272 2.71E-01 5.78E+02 5.85E+02*	1.4973 6678.5 2.70E-03 1.1165 2.73E-01 2.43E+02 2.47E+02*	1.6763 5965.5 1.54E-03 1.1070 2.75E-01 1.00E+02 1.02E+02*	1.8956 5275.3 8.89E-04 1.0985 2.77E-01 4.05E+01 4.12E+01*	2.1702 4607.9 5.23E-04 1.0910 2.78E-01 1.60E+01 1.63E+01*	2.5229 3963.7 3.14E-04 1.0846 2.79E-01 6.19E+00 6.28E+00*	2.9915 3342.8 1.94E-04 1.0793 2.80E-01 2.31E+00 2.34E+00*	3.6422 2745.6 1.23E-04 1.0750 2.81E-01 8.16E-01 8.28E-01*	4.6031 2172.4 8.08E-05 1.0717 2.81E-01 2.66E-01 2.69E-01*
3	.9954 10046.0 3.71E-02 1.1721 2.60E-01 1.03E+04 1.04E+04	1.0792 9266.0 2.48E-02 1.1581 2.64E-01 5.56E+03 5.61E+03	1.1753 8508.2 1.59E-02 1.1454 2.67E-01 2.83E+03 2.86E+03	1.2866 7772.7 9.97E-03 1.1338 2.69E-01 1.38E+03 1.39E+03*	1.4165 7059.7 6.17E-03 1.1233 2.72E-01 6.49E+02 6.57E+02*	1.5700 6369.5 3.80E-03 1.1139 2.74E-01 2.99E+02 3.03E+02*	1.7537 5702.1 2.36E-03 1.1055 2.75E-01 1.35E+02 1.36E+02*	1.9771 5057.9 1.48E-03 1.0982 2.77E-01 5.96E+01 6.04E+01*	2.2538 4437.0 9.47E-04 1.0918 2.78E-01 2.59E+01 2.63E+01*	2.6043 3839.8 6.17E-04 1.0864 2.79E-01 1.10E+01 1.12E+01*	3.0613 3266.6 4.11E-04 1.0819 2.80E-01 4.55E+00 4.61E+00*
4	.9004 11105.9 5.29E-02 1.1944 2.54E-01 1.89E+04 1.89E+04	.9684 10325.9 4.40E-02 1.1788 2.58E-01 1.31E+04 1.31E+04	1.0451 9568.1 3.33E-02 1.1647 2.62E-01 8.11E+03 8.15E+03	1.1322 8832.6 2.37E-02 1.1521 2.65E-01 4.66E+03 4.70E+03	1.2316 8119.6 1.63E-02 1.1406 2.68E-01 2.54E+03 2.56E+03	1.3460 7429.4 1.10E-02 1.1303 2.70E-01 1.33E+03 1.34E+03	1.4788 6762.0 7.30E-03 1.1210 2.72E-01 6.78E+02 6.86E+02*	1.6346 6117.8 4.85E-03 1.1127 2.74E-01 3.38E+02 3.42E+02*	1.8192 5496.9 3.24E-03 1.1054 2.75E-01 1.66E+02 1.68E+02*	2.0409 4899.7 2.19E-03 1.0990 2.77E-01 7.99E+01 8.10E+01*	2.3113 4326.5 1.50E-03 1.0936 2.78E-01 3.80E+01 3.85E+01*
5	.8243 12131.5 3.53E-02 1.2209 2.46E-01 1.54E+04 1.53E+04	.8809 11351.5 4.35E-02 1.2019 2.52E-01 1.63E+04 1.62E+04	.9440 10593.7 4.27E-02 1.1859 2.56E-01 1.35E+04 1.35E+04	1.0144 9858.2 3.68E-02 1.1717 2.60E-01 9.67E+03 9.69E+03	1.0935 9145.2 2.92E-02 1.1590 2.63E-01 6.29E+03 6.32E+03	1.1827 8455.0 2.20E-02 1.1476 2.66E-01 3.82E+03 3.85E+03	1.2841 7787.6 1.61E-02 1.1374 2.69E-01 2.22E+03 2.24E+03	1.3999 7143.4 1.15E-02 1.1282 2.71E-01 1.24E+03 1.26E+03	1.5331 6522.5 8.16E-03 1.1200 2.73E-01 6.82E+02 6.89E+02*	1.6877 5925.3 5.79E-03 1.1127 2.74E-01 3.67E+02 3.71E+02*	1.8684 5352.1 4.13E-03 1.1064 2.75E-01 1.94E+02 1.97E+02*
6	.7620 13122.7 3.39E-03 1.2776 2.27E-01 1.60E+03 1.51E+03*	.8102 12342.7 1.67E-02 1.2330 2.42E-01 7.43E+03 7.28E+03	.8632 11584.9 2.87E-02 1.2108 2.49E-01 1.12E+04 1.11E+04	.9217 10849.4 3.45E-02 1.1937 2.54E-01 1.15E+04 1.15E+04	.9865 10136.4 3.43E-02 1.1791 2.58E-01 9.65E+03 9.64E+03	1.0586 9446.2 3.05E-02 1.1663 2.62E-01 7.13E+03 7.14E+03	1.1391 8778.8 2.53E-02 1.1549 2.64E-01 4.84E+03 4.86E+03	1.2293 8134.6 2.00E-02 1.1447 2.67E-01 3.11E+03 3.13E+03	1.3309 7513.7 1.54E-02 1.1356 2.69E-01 1.91E+03 1.93E+03	1.4458 6916.5 1.16E-02 1.1274 2.71E-01 1.14E+03 1.15E+03	1.5765 6343.3 8.74E-03 1.1202 2.72E-01 6.71E+02 6.77E+02*
7	.7103 14079.5 1.14E-02 1.2327 2.42E-01 7.55E+03 7.76E+03	.7519 13299.4 1.41E-04 1.0127 2.88E-01 1.11E+02 1.63E+02*	.7973 12541.6 4.37E-03 1.2579 2.34E-01 1.91E+03 1.82E+03*	.8470 11806.1 1.44E-02 1.2230 2.45E-01 5.77E+03 5.65E+03	.9015 11093.2 2.29E-02 1.2031 2.51E-01 7.98E+03 7.89E+03	.9613 10402.9 2.70E-02 1.1875 2.56E-01 8.06E+03 8.02E+03	1.0272 9735.6 2.73E-02 1.1743 2.59E-01 6.86E+03 6.85E+03	1.0999 9091.4 2.49E-02 1.1627 2.62E-01 5.23E+03 5.24E+03	1.1806 8470.5 2.15E-02 1.1524 2.65E-01 3.71E+03 3.73E+03	1.2701 7873.2 1.77E-02 1.1433 2.67E-01 2.51E+03 2.52E+03	1.3698 7300.1 1.43E-02 1.1352 2.69E-01 1.63E+03 1.64E+03

Table 18. Radiative transition parameters for $O_2^+ b^4\Sigma_g^- a^4\Pi_u$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r-centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v'\backslash v''$	0	1	2	3	4	5	6	7	8	9	10
8	.3999 25007.4 1.48E-08 1.3868 1.86E-01 (3.24E-02) 2.37E-02*	.4168 23992.7 3.28E-07 2.3385 2.86E-03 (1.50E-04) 7.34E-01*	.4348 22998.4 9.09E-05 1.4872 1.48E-01 (9.76E+01) 7.32E+01*	.4540 22024.9 8.15E-05 3.2179 1.21E-06 (5.15E-09) 7.13E+02*	.4746 21072.2 6.23E-02 1.6910 7.92E-02 (1.48E+04) 1.29E+04	.4965 20140.6 3.93E-01 1.5700 1.17E-01 (1.80E+05) 1.83E+05	.5200 19230.2 1.00E-01 1.5761 1.15E-01 (3.84E+04) 4.06E+04	.5452 18341.1 8.77E-02 1.3659 1.94E-01 (8.28E+04) 8.03E+04	.5723 17473.6 9.55E-03 1.2967 2.20E-01 (1.00E+04) 1.04E+04*	.6014 16627.8 1.18E-02 1.3750 1.91E-01 (8.01E+03) 7.73E+03	.6328 15803.8 4.36E-02 1.3110 2.15E-01 (3.22E+04) 3.18E+04
9	.3862 25894.9 3.89E-12 8.5735 0.00E+00 (0.00E+00) 2.21E-03*	.4019 24880.1 1.43E-07 1.5064 1.40E-01 (1.76E-01) 1.11E-01*	.4187 23885.9 1.88E-07 3.7136 2.89E-09 (8.65E-17) 5.32E+00*	.4364 22912.3 2.45E-04 1.5616 1.20E-01 (1.73E+02) 1.23E+02*	.4554 21959.7 3.07E-06 -9.1323 0.00E+00 (0.00E+00) 1.79E+03*	.4756 21028.0 7.29E-02 1.7196 7.14E-02 (1.40E+04) 1.17E+04	.4971 20117.6 4.30E-01 1.5880 1.11E-01 (1.75E+05) 1.81E+05	.5201 19228.6 7.67E-02 1.6291 9.77E-02 (2.11E+04) 2.29E+04	.5446 18361.1 7.99E-02 1.3618 1.96E-01 (7.69E+04) 7.35E+04	.5709 17515.2 2.11E-02 1.3283 2.09E-01 (2.00E+04) 2.05E+04	.5991 16691.2 2.36E-03 1.4441 1.64E-01 (1.20E+03) 1.10E+03*
10	.3739 26747.4 9.18E-11 1.6990 7.69E-02 (4.21E-05) 3.00E-06*	.3886 25732.7 9.03E-10 .1548 6.00E-02 (2.24E-04) 2.78E-02*	.4042 24738.5 6.60E-07 1.6192 1.01E-01 (4.12E-01) 1.84E-01*	.4208 23764.9 2.92E-07 -1.3590 6.12E-07 (5.95E-12) 2.24E+01*	.4384 22812.2 5.07E-04 1.6343 9.61E-02 (2.25E+02) 1.41E+02*	.4570 21880.6 3.92E-04 .4800 1.66E-01 (4.57E+02) 3.63E+03*	.4769 20970.2 7.75E-02 1.7533 6.28E-02 (1.14E+04) 8.82E+03	.4980 20081.2 4.63E-01 1.6070 1.05E-01 (1.67E+05) 1.75E+05	.5205 19213.7 6.49E-02 1.6894 7.96E-02 (1.18E+04) 1.29E+04	.5444 18367.8 6.65E-02 1.3483 2.01E-01 (6.74E+04) 6.31E+04	.5700 17543.8 3.10E-02 1.3464 2.02E-01 (2.76E+04) 2.83E+04
11	.3628 27565.0 7.76E-12 1.2261 2.44E-01 (3.92E-05) 3.37E-05*	.3766 26550.2 6.41E-10 1.9175 3.13E-02 (4.75E-05) 2.54E-04*	.3913 25556.0 2.24E-08 .9925 2.89E-01 (1.27E-01) 1.55E-01*	.4068 24582.4 1.86E-06 1.7465 6.45E-02 (4.67E-01) 3.84E-02*	.4232 23629.8 8.23E-06 .7787 2.68E-01 (3.16E+01) 6.59E+01*	.4406 22698.1 8.36E-04 1.7134 7.30E-02 (2.11E+02) 9.56E+01*	.4590 21787.7 2.05E-03 1.0710 2.81E-01 (6.82E+03) 5.16E+03	.4785 20898.7 7.46E-02 1.7947 5.33E-02 (7.85E+03) 1.66E+05	.4992 20031.2 4.93E-01 1.6269 9.84E-02 (1.56E+05) 7.69E+03	.5212 19185.3 6.25E-02 1.7496 6.37E-02 (7.26E+03) 7.69E+03	.5446 18361.3 5.09E-02 1.3189 2.12E-01 (5.74E+04) 5.19E+04
12	.3528 28347.3 8.75E-15 -3.7600 8.94E-25 (0.00E+00) 5.09E-06*	.3659 27332.5 1.41E-10 1.4233 1.72E-01 (3.45E-04) 2.22E-04*	.3797 26338.3 1.38E-09 2.3996 1.88E-03 (3.64E-07) 7.75E-03*	.3942 25364.7 1.86E-07 1.2767 2.27E-01 (6.35E-01) 5.03E-01*	.4096 24412.1 3.35E-06 1.9274 2.98E-02 (1.76E-01) 4.96E-01*	.4259 23480.4 4.91E-05 1.1775 2.59E-01 (1.72E+02) 1.46E+02*	.4431 22570.0 1.10E-03 1.8115 4.98E-02 (1.27E+02) 1.34E+01*	.4612 21681.0 6.04E-03 1.2987 2.19E-01 (1.20E+04) 9.44E+03*	.4805 20813.5 6.38E-02 1.8493 4.24E-02 (4.20E+03) 1.80E+03	.5008 19967.6 5.21E-01 1.6476 9.19E-02 (1.42E+05) 1.55E+05	.5224 19143.6 6.83E-02 1.8019 5.18E-02 (5.21E+03) 5.12E+03
13	.3437 29094.1 7.80E-14 1.9524 2.65E-02 (5.46E-09) 9.11E-08*	.3561 28079.4 4.36E-12 .6856 2.42E-01 (2.28E-05) 8.71E-05*	.3692 27085.1 1.03E-09 1.5946 1.09E-01 (9.88E-04) 3.33E-04*	.3830 26111.6 9.08E-11 9.5421 0.00E+00 (0.00E+00) 7.05E-02*	.3975 25158.9 8.78E-07 1.4485 1.62E-01 (1.49E+00) 1.00E+00*	.4128 24227.3 3.27E-06 2.3031 3.62E-03 (2.47E-03) 6.92E+00*	.4289 23316.9 1.73E-04 1.3678 1.94E-01 (3.33E+02) 2.52E+02*	.4459 22427.9 1.08E-03 1.9584 2.57E-02 (3.27E+01) 5.23E+01*	.4638 21560.3 1.33E-02 1.4287 1.70E-01 (1.56E+04) 1.25E+04	.4828 20714.5 4.61E-02 1.9303 2.94E-02 (1.44E+03) 4.32E+01	.5028 19890.5 5.43E-01 1.6688 8.55E-02 (1.27E+05) 1.42E+05
14	.3355 29805.4 2.40E-14 1.4872 1.48E-01 (5.61E-08) 3.24E-08*	.3473 28790.6 2.56E-13 2.8883 3.45E-05 (2.95E-14) 7.35E-06*	.3598 27796.4 9.92E-11 1.1640 2.62E-01 (5.93E-04) 5.55E-04*	.3728 26822.8 3.85E-09 1.8020 5.18E-02 (8.07E-04) 1.99E-04*	.3865 25870.2 1.62E-08 .4353 1.49E-01 (2.51E-02) 3.48E-01*	.4010 24938.6 2.75E-06 1.5906 3.62E-03 (2.11E+00) 1.02E+00*	.4162 24028.1 4.71E-07 4.7919 1.94E-01 (2.27E-31) 3.38E+01*	.4322 23139.1 4.40E-04 1.4960 1.44E-01 (4.60E+02) 3.31E+02*	.4490 22271.6 6.58E-04 2.2675 4.55E-03 (6.11E-01) 5.35E+02*	.4667 21425.8 2.42E-02 1.5198 1.35E-01 (1.77E+04) 1.47E+04	.4854 20601.7 2.49E-02 2.0793 1.38E-02 (1.69E+02) 1.18E+03
15	.3281 30480.8 1.92E-15 1.0276 2.87E-01 (1.81E-08) 2.49E-08*	.3394 29466.1 3.53E-13 1.7013 7.63E-02 (2.13E-07) 6.58E-10*	.3512 28471.8 2.17E-13 -3.2691 3.87E-20 (3.08E-44) 1.07E-04*	.3637 27498.3 8.91E-10 1.4086 1.78E-01 (2.37E-03) 1.55E-03*	.3767 26545.6 6.56E-09 2.2017 6.84E-03 (2.33E-05) 1.89E-02*	.3904 25614.0 2.23E-07 1.1167 2.73E-01 (1.13E+00) 1.09E+00*	.4048 24703.6 5.90E-06 1.7443 6.50E-02 (1.52E+00) 1.14E-01*	.4199 23814.5 5.13E-06 .1876 6.80E-02 (1.30E+00) 1.04E+02*	.4358 22947.0 8.63E-04 1.6040 1.06E-01 (4.73E+02) 3.04E+02*	.4525 22101.2 8.07E-05 4.0614 2.05E-11 (1.48E-18) 1.88E+03*	.4700 21277.1 3.73E-02 1.5933 1.09E-01 (1.74E+04) 1.49E+04

Table 18. Radiative transition parameters for $O_2^+ b^4\Sigma_g^- - a^4\Pi_u$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm), $\nu_{v'v''}$ (cm^{-1}), $q_{v'v''}$, $\bar{r}_{v'v''}$ ($\text{\AA}$), $R_e(\bar{r}_{v'v''})$ (electric dipole moment atomic units), $A_{v'v''}$ (s^{-1}) calculated by the r -centroid method, and $A_{v'v''}$ (s^{-1}) calculated by integrating $\int \psi_{v'}^* R_e(r) \psi_{v''} dr$. - Continued

$v' \backslash v''$	11	12	13	14	15	16	17	18	19	20	21
8	.6666 15001.7 4.37E-02 1.2767 2.27E-01 3.09E+04 3.09E+04	.7032 14221.6 2.24E-02 1.2461 2.38E-01 1.48E+04 1.50E+04	.7427 13463.8 4.86E-03 1.2046 2.51E-01 3.02E+03 3.16E+03*	.7857 12728.3 3.88E-05 1.6442 9.30E-02 2.80E+00 8.01E-01*	.8323 12015.3 4.41E-03 1.2463 2.38E-01 1.75E+03 1.68E+03*	.8830 11325.1 1.16E-02 1.2160 2.47E-01 4.19E+03 4.11E+03	.9383 10657.7 1.75E-02 1.1977 2.53E-01 5.49E+03 5.44E+03	.9987 10013.5 2.06E-02 1.1833 2.57E-01 5.54E+03 5.51E+03	1.0647 9392.7 2.12E-02 1.1712 2.60E-01 4.82E+03 4.80E+03	1.1370 8795.4 2.00E-02 1.1607 2.63E-01 3.80E+03 3.81E+03	1.2162 8222.2 1.78E-02 1.1515 2.65E-01 2.82E+03 2.83E+03
9	.6294 15889.1 2.86E-02 1.3205 2.11E-01 2.08E+04 2.04E+04	.6619 15109.1 4.10E-02 1.2837 2.25E-01 2.90E+04 2.88E+04	.6968 14351.2 3.00E-02 1.2545 2.35E-01 1.98E+04 2.00E+04	.7344 13615.7 1.27E-02 1.2247 2.45E-01 7.80E+03 7.97E+03	.7750 12902.8 2.08E-03 1.1718 2.60E-01 1.23E+03 1.31E+03*	.8188 12212.5 2.05E-04 1.3953 1.83E-01 5.06E+01 4.22E+01*	.8662 11545.2 3.71E-03 1.2405 2.40E-01 1.33E+03 1.28E+03*	.9174 10901.0 8.71E-03 1.2120 2.49E-01 2.82E+03 2.77E+03*	.9728 10280.1 1.28E-02 1.1946 2.54E-01 3.63E+03 3.59E+03	1.0328 9682.9 1.52E-02 1.1812 2.57E-01 3.71E+03 3.68E+03	1.0977 9109.7 1.59E-02 1.1701 2.61E-01 3.31E+03 3.30E+03
10	.5973 16741.7 4.82E-06 -1.2754 1.54E-06 (2.19E-10) 1.65E+02*	.6265 15961.6 1.59E-02 1.3326 2.07E-01 1.12E+04 1.09E+04	.6577 15203.8 3.36E-02 1.2905 2.22E-01 2.37E+04 2.34E+04	.6912 14468.3 3.25E-02 1.2614 2.33E-01 2.16E+04 2.16E+04	.7270 13755.4 1.99E-02 1.2349 2.41E-01 1.22E+04 1.23E+04	.7654 13065.1 7.51E-03 1.2044 2.51E-01 4.27E+03 4.40E+03*	.8066 12397.8 1.03E-03 1.1366 2.69E-01 5.74E+02 6.33E+02*	.8508 11753.5 2.22E-04 1.3784 1.90E-01 5.26E+01 4.57E+01*	.8983 11132.7 2.63E-03 1.2407 2.39E-01 8.44E+02 8.11E+02*	.9492 10535.4 5.95E-03 1.2115 2.49E-01 1.74E+03 1.71E+03*	1.0038 9962.3 8.78E-03 1.1942 2.54E-01 2.27E+03 2.24E+03*
11	.5695 17559.2 3.80E-02 1.3625 1.96E-01 3.19E+04 3.29E+04	.5960 16779.2 1.82E-03 1.1963 2.53E-01 2.23E+03 2.43E+03*	.6242 16021.3 7.00E-03 1.3511 2.00E-01 4.66E+03 4.43E+03*	.6542 15285.8 2.44E-02 1.2977 2.20E-01 1.71E+04 1.67E+04	.6862 14572.9 3.05E-02 1.2675 2.30E-01 2.03E+04 2.02E+04	.7203 13882.6 2.41E-02 1.2424 2.39E-01 1.49E+04 1.50E+04	.7567 13215.3 1.34E-02 1.2176 2.47E-01 7.63E+03 7.75E+03	.7955 12571.1 4.90E-03 1.1865 2.56E-01 2.58E+03 2.68E+03*	.8368 11950.2 7.03E-04 1.1114 2.74E-01 (3.66E+02)(4.11E+02*	.8808 11353.0 1.06E-04 1.4459 1.63E-01 1.68E+01 1.44E+01*	.9277 10779.8 1.52E-03 1.2495 2.37E-01 4.33E+02 4.14E+02*
12	.5452 18341.5 3.53E-02 1.2598 2.33E-01 (4.80E+04) 4.16E+04	.5694 17561.5 4.21E-02 1.3809 1.89E-01 3.29E+04 3.44E+04	.5951 16803.6 5.34E-03 1.2508 2.36E-01 5.73E+03 5.89E+03*	.6223 16068.1 2.02E-03 1.3904 1.85E-01 (1.16E+03) 1.04E+03*	.6512 15355.2 1.57E-02 1.3063 2.17E-01 1.08E+04 1.05E+04	.6819 14664.9 2.54E-02 1.2736 2.28E-01 1.70E+04 1.67E+04	.7144 13997.6 2.48E-02 1.2489 2.37E-01 1.55E+04 1.54E+04	.7489 13353.4 1.77E-02 1.2264 2.44E-01 1.02E+04 1.02E+04	.7854 12732.5 9.60E-03 1.2031 2.51E-01 5.07E+03 5.16E+03*	.8240 12135.3 3.70E-03 1.1729 2.60E-01 1.81E+03 1.88E+03*	.8649 11562.1 7.05E-04 1.1068 2.75E-01 (3.35E+02) 3.72E+02*
13	.5239 19088.4 8.27E-02 1.8421 4.38E-02 (4.47E+03)(4.00E+03	.5462 18308.3 2.12E-02 1.1365 2.69E-01 3.81E+04 3.28E+04	.5698 17550.5 4.46E-02 1.4053 1.79E-01 3.13E+04 3.38E+04	.5947 16815.0 8.92E-03 1.2631 2.32E-01 9.25E+03 9.27E+03*	.6210 16102.1 1.19E-04 1.6226 9.98E-02 (2.01E+01) 6.25E+00*	.6489 15411.8 8.71E-03 1.3179 2.12E-01 5.83E+03 5.61E+03*	.6782 14744.5 1.91E-02 1.2800 2.26E-01 1.27E+04 1.24E+04	.7092 14100.2 2.26E-02 1.2550 2.35E-01 1.41E+04 1.40E+04	.7419 13479.4 1.95E-02 1.2336 2.42E-01 1.13E+04 1.13E+04	.7763 12882.1 1.34E-02 1.2133 2.48E-01 7.13E+03 7.20E+03	.8124 12309.0 7.47E-03 1.1919 2.54E-01 3.65E+03 3.73E+03*
14	.5051 19799.6 5.52E-01 1.6903 7.94E-02 (1.09E+05)(1.27E+05	.5258 19019.6 1.07E-01 1.8713 3.85E-02 4.42E+03 3.71E+03	.5476 18261.7 9.58E-03 .8343 2.79E-01 1.84E+04 2.55E+04*	.5706 17526.3 4.65E-02 1.4393 1.66E-01 (2.79E+04) 3.18E+04	.5948 16813.3 1.16E-02 1.2582 2.34E-01 1.22E+04 1.19E+04	.6202 16123.0 3.22E-04 1.1518 2.65E-01 (3.84E+02) 5.01E+02*	.6470 15455.7 3.92E-03 1.3374 2.05E-01 2.47E+03 2.32E+03*	.6752 14811.5 1.28E-02 1.2874 2.23E-01 8.43E+03 8.21E+03	.7047 14190.6 1.85E-02 1.2611 2.33E-01 1.16E+04 1.14E+04	.7357 13593.4 1.87E-02 1.2401 2.40E-01 1.09E+04 1.09E+04	.7680 13020.2 1.53E-02 1.2214 2.46E-01 8.24E+03 8.26E+03
15	.4884 20475.0 6.60E-03 2.5309 7.21E-04 (1.19E-01)(6.14E+03*	.5077 19695.0 5.41E-01 1.7117 7.35E-02 (9.03E+04)(1.09E+05	.5281 18937.2 1.41E-01 1.8928 3.50E-02 4.74E+03 3.93E+03	.5494 18201.7 1.91E-03 .3950 3.35E-03 5.22E-01 1.97E+04	.5718 17488.7 4.92E-02 1.4865 1.48E-01 (2.33E+04) 2.91E+04	.5953 16798.5 1.29E-02 1.2360 2.41E-01 1.44E+04 1.37E+04	.6199 16131.1 1.75E-03 1.2673 2.31E-01 (1.58E+03)(1.80E+03*	.6457 15486.9 1.18E-03 1.3839 1.87E-01 6.22E+02 5.61E+02*	.6727 14866.0 7.56E-03 1.2968 2.20E-01 4.88E+03 4.69E+03*	.7008 14268.8 1.36E-02 1.2678 2.30E-01 8.50E+03 8.33E+03	.7302 13695.6 1.61E-02 1.2465 2.38E-01 9.43E+03 9.33E+03

Table 19. Calculated radiative lifetimes (s) of N_2 , N_2^+ , and O_2^+ states as a function of vibrational level.

v	$N_2 A^3\Sigma_u^+$	$N_2 B^3\Pi_g$	$N_2 W^3\Delta_u$	$N_2 B'^3\Sigma_u^-$	$N_2 a^1\Pi_g$	$N_2 w^1\Delta_u$	$N_2 C^3\Pi_u$
0	2.05	1.13(-5)*	>1†	4.54(-5)	5.77(-5)	7.67(-4)	3.71(-8)
1	2.09	9.26(-6)	4.53(-3)	3.57(-5)	5.68(-5)	4.08(-4)	3.75(-8)
2	2.12	7.87(-6)	1.22(-3)	2.98(-5)	5.58(-5)	2.79(-4)	3.81(-8)
3	2.14	6.90(-6)	6.04(-4)	2.58(-5)	5.50(-5)	2.13(-4)	3.90(-8)
4	2.14	6.17(-6)	3.78(-4)	2.29(-5)	5.42(-5)	1.72(-4)	4.04(-8)
5	2.14	5.62(-6)	2.66(-4)	2.07(-5)	5.36(-5)	1.45(-4)	
6	2.16	5.19(-6)	2.02(-4)	1.90(-5)	5.32(-5)	1.26(-4)	
7	2.36	4.85(-6)	1.61(-4)	1.76(-5)	5.29(-5)§	1.11(-4)	
8	1.99	4.58(-6)	1.34(-4)	1.65(-5)	5.28(-5)§	1.00(-4)	
9	1.07	4.36(-6)	1.14(-4)	1.56(-5)	5.29(-5)§	9.09(-5)	
10	4.61(-1)	4.18(-6)	9.89(-5)	1.49(-5)	5.35(-5)§	8.35(-5)	
11	2.16(-1)	4.04(-6)	8.76(-5)	1.42(-5)	5.58(-5)§	7.74(-5)	
12	1.19(-1)	3.93(-6)	7.87(-5)	1.36(-5)	5.98(-5)§	7.22(-5)	
13	6.92(-2)	3.85(-6)‡	7.16(-5)	1.32(-5)	6.10(-5)§	6.77(-5)	
14	4.36(-2)	3.78(-6)‡	6.58(-5)	1.28(-5)	6.30(-5)§	6.39(-5)	
15	2.98(-2)	3.74(-6)‡	6.11(-5)	1.24(-5)	6.49(-5)§	6.05(-5)	
16	2.11(-2)	3.72(-6)‡	5.72(-5)	1.21(-5)	6.73(-5)§	5.75(-5)	
17	1.58(-2)	3.72(-6)‡	5.39(-5)	1.18(-5)	6.88(-5)§	5.49(-5)	
18	1.24(-2)	3.73(-6)‡	5.12(-5)§	1.16(-5)§	7.20(-5)§	5.25(-5)	
19	1.00(-2)	3.76(-6)‡	4.89(-5)§	1.14(-5)§	7.37(-5)§	5.03(-5)§	
20	8.44(-3)	3.80(-6)‡	4.71(-5)§	1.13(-5)§	7.62(-5)§	4.83(-5)§	
21	7.32(-3)	3.84(-6)‡	4.56(-5)§	1.11(-5)§	7.99(-5)§	4.65(-5)§	

*Read as 1.13×10^{-5} .

† Value depends considerably on the spin component and rotational level, and also on the unknown (but slow)

rate of radiative decay to the ground state.

‡ Actual lifetime shorter due to predissociation.

§ Value may be significantly too large due to omission of transitions to high vibrational levels of lower electronic states.

Table 19. Calculated radiative lifetimes (s) of N_2 , N_2^+ , and O_2^+ states as a function of vibrational level. - Continued

v	$N_2 E^3\Sigma_g^+$	$N_2 D^3\Sigma_u^+$	$N_2^+ A^2\Pi_u$	$N_2^+ B^2\Sigma_u^+$	$N_2^+ C^2\Sigma_u^+$	$O_2^+ A^2\Pi_u$	$O_2^+ b^4\Sigma_g^-$
0	1.90(-4)*	1.41(-8)	1.60(-5)	6.23(-8)	6.81(-8)	5.97(-7)	1.46(-6)
1	7.49(-5)		1.33(-5)	6.20(-8)	6.62(-8)	6.09(-7)	1.49(-6)
2			1.15(-5)	6.19(-8)	6.42(-8)	6.23(-7)	1.54(-6)
3			1.03(-5)	6.23(-8)	6.23(-8)†	6.37(-7)	1.60(-6)
4			9.32(-6)	6.30(-8)	6.06(-8)†	6.53(-7)	1.69(-6)†
5			8.61(-6)	6.44(-8)	5.91(-8)†	6.71(-7)	1.79(-6)†
6			8.05(-6)	6.64(-8)	5.79(-8)†	6.90(-7)	1.91(-6)†
7			7.59(-6)	6.94(-8)	5.70(-8)†	7.11(-7)	2.07(-6)†
8			7.22(-6)	7.36(-8)	5.65(-8)†	7.34(-7)	2.25(-6)†
9			6.91(-6)	7.95(-8)	5.64(-8)†	7.58(-7)	2.47(-6)†
10			6.66(-6)	8.75(-8)	5.69(-8)†	7.85(-7)	2.70(-6)†
11			6.44(-6)			8.18(-7)	2.94(-6)†
12			6.25(-6)			8.67(-7)†	3.18(-6)†
13			6.10(-6)			9.15(-7)†	3.46(-6)†
14			5.96(-6)			9.54(-7)†	3.88(-6)†
15			5.85(-6)			1.01(-6)†	4.48(-6)†
16			5.75(-6)			1.06(-6)†	
17			5.67(-6)			1.11(-6)†	
18			5.61(-6)†			1.18(-6)†	
19			5.56(-6)†			1.25(-6)†	
20			5.53(-6)†			1.33(-6)†	
21			5.50(-6)†			1.42(-6)†	

*Read as 1.90×10^{-4} .

† Value may be significantly too large due to omission of transitions to high vibrational levels of lower electronic states.

‡ Actual lifetime shorter due to predissociation.

Table 20. Franck-Condon factors for $N_2 B^3\Pi_g-X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	6.11(-2)*	1.91(-1)	2.74(-1)	2.41(-1)	1.44(-1)	6.24(-2)	2.03(-2)	5.02(-3)	9.65(-4)	1.44(-4)	1.68(-5)
1	1.47(-1)	1.93(-1)	4.50(-2)	1.59(-2)	1.42(-1)	2.05(-1)	1.51(-1)	7.14(-2)	2.37(-2)	5.76(-3)	1.05(-3)
2	1.95(-1)	6.54(-2)	2.39(-2)	1.30(-1)	4.81(-2)	9.67(-3)	1.24(-1)	1.86(-1)	1.34(-1)	6.02(-2)	1.86(-2)
3	1.90(-1)	7.17(-4)	1.05(-1)	3.60(-2)	3.09(-2)	1.11(-1)	2.50(-2)	2.43(-2)	1.41(-1)	1.72(-1)	1.08(-1)
4	1.51(-1)	2.58(-2)	8.38(-2)	7.32(-3)	9.25(-2)	6.91(-3)	5.99(-2)	8.84(-2)	3.07(-3)	5.97(-2)	1.62(-1)
5	1.05(-1)	7.60(-2)	2.07(-2)	6.56(-2)	2.61(-2)	4.12(-2)	6.26(-2)	3.07(-3)	8.95(-2)	4.75(-2)	5.91(-3)
6	6.65(-2)	1.04(-1)	5.33(-4)	7.50(-2)	3.74(-3)	7.11(-2)	4.31(-5)	7.35(-2)	1.72(-2)	3.77(-2)	8.79(-2)
7	3.90(-2)	1.03(-1)	2.49(-2)	3.34(-2)	4.62(-2)	1.87(-2)	4.58(-2)	2.77(-2)	2.91(-2)	5.98(-2)	1.36(-3)
8	2.16(-2)	8.39(-2)	5.85(-2)	2.39(-3)	6.37(-2)	2.54(-3)	5.61(-2)	4.27(-3)	6.02(-2)	1.75(-4)	6.72(-2)
9	1.15(-2)	6.04(-2)	7.72(-2)	6.14(-3)	3.82(-2)	3.48(-2)	1.36(-2)	4.60(-2)	9.13(-3)	4.67(-2)	1.79(-2)
10	5.92(-3)	3.98(-2)	7.73(-2)	3.00(-2)	8.13(-3)	5.38(-2)	1.89(-3)	4.50(-2)	1.03(-2)	4.06(-2)	1.15(-2)
11	2.98(-3)	2.46(-2)	6.55(-2)	5.24(-2)	4.98(-4)	3.91(-2)	2.70(-2)	1.05(-2)	4.35(-2)	1.75(-3)	4.88(-2)
12	1.48(-3)	1.45(-2)	4.96(-2)	6.29(-2)	1.35(-2)	1.35(-2)	4.55(-2)	1.33(-3)	3.70(-2)	1.48(-2)	2.47(-2)
13	7.25(-4)	8.27(-3)	3.47(-2)	6.13(-2)	3.29(-2)	3.86(-4)	3.82(-2)	2.09(-2)	8.78(-3)	3.97(-2)	1.91(-5)
14	3.54(-4)	4.59(-3)	2.29(-2)	5.22(-2)	4.72(-2)	4.70(-3)	1.78(-2)	3.82(-2)	7.58(-4)	3.14(-2)	1.70(-2)
15	1.72(-4)	2.51(-3)	1.45(-2)	4.06(-2)	5.23(-2)	1.86(-2)	2.80(-3)	3.63(-2)	1.57(-2)	8.10(-3)	3.56(-2)
16	8.39(-5)	1.35(-3)	8.87(-3)	2.95(-2)	4.97(-2)	3.27(-2)	7.20(-4)	2.13(-2)	3.15(-2)	2.54(-4)	2.76(-2)
17	4.12(-5)	7.26(-4)	5.31(-3)	2.05(-2)	4.25(-2)	4.14(-2)	8.77(-3)	6.44(-3)	3.37(-2)	1.10(-2)	8.26(-3)
18	2.04(-5)	3.88(-4)	3.14(-3)	1.37(-2)	3.38(-2)	4.37(-2)	2.03(-2)	1.08(-4)	2.37(-2)	2.51(-2)	1.87(-6)
19	1.02(-5)	2.09(-4)	1.83(-3)	8.91(-3)	2.54(-2)	4.09(-2)	3.00(-2)	2.77(-3)	1.06(-2)	3.02(-2)	6.80(-3)
20	5.17(-6)	1.12(-4)	1.07(-3)	5.70(-3)	1.84(-2)	3.53(-2)	3.54(-2)	1.06(-2)	1.92(-3)	2.49(-2)	1.87(-2)
21	2.67(-6)	6.11(-5)	6.20(-4)	3.60(-3)	1.29(-2)	2.87(-2)	3.64(-2)	1.93(-2)	1.75(-4)	1.46(-2)	2.57(-2)

*Read as 6.11×10^{-2} .

Table 21. Franck-Condon factors for $N_2 W^3\Delta_u-X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.46(-3)*	1.15(-2)	4.26(-2)	9.90(-2)	1.62(-1)	1.98(-1)	1.88(-1)	1.42(-1)	8.66(-2)	4.32(-2)	1.77(-2)
1	7.46(-3)	4.25(-2)	1.04(-1)	1.38(-1)	9.47(-2)	2.00(-2)	5.18(-3)	6.77(-2)	1.38(-1)	1.54(-1)	1.18(-1)
2	2.04(-2)	8.14(-2)	1.20(-1)	6.49(-2)	1.39(-3)	3.66(-2)	9.31(-2)	6.18(-2)	3.82(-3)	2.50(-2)	1.02(-1)
3	3.97(-2)	1.06(-1)	7.80(-2)	3.31(-3)	3.56(-2)	7.72(-2)	2.25(-2)	8.07(-3)	7.07(-2)	7.01(-2)	9.81(-3)
4	6.18(-2)	1.03(-1)	2.41(-2)	1.51(-2)	6.90(-2)	2.05(-2)	1.21(-2)	6.61(-2)	2.93(-2)	4.04(-3)	6.36(-2)
5	8.18(-2)	7.73(-2)	2.40(-4)	5.17(-2)	3.75(-2)	3.44(-3)	5.62(-2)	2.26(-2)	9.58(-3)	6.10(-2)	2.41(-2)
6	9.60(-2)	4.32(-2)	1.13(-2)	5.85(-2)	2.62(-3)	3.83(-2)	3.32(-2)	3.80(-3)	5.22(-2)	1.53(-2)	1.55(-2)
7	1.02(-1)	1.53(-2)	3.60(-2)	3.41(-2)	8.17(-3)	4.76(-2)	7.60(-4)	3.93(-2)	2.23(-2)	9.91(-3)	4.96(-2)
8	1.01(-1)	1.44(-3)	5.23(-2)	7.76(-3)	3.33(-2)	2.10(-2)	1.44(-2)	3.74(-2)	6.99(-4)	4.31(-2)	8.68(-3)
9	9.43(-2)	1.69(-3)	5.15(-2)	2.67(-4)	4.36(-2)	7.12(-4)	3.77(-2)	7.15(-3)	2.63(-2)	2.22(-2)	9.33(-3)
10	8.34(-2)	1.16(-2)	3.76(-2)	1.11(-2)	3.14(-2)	7.39(-3)	3.28(-2)	2.62(-3)	3.63(-2)	4.57(-6)	3.64(-2)
11	7.07(-2)	2.55(-2)	1.99(-2)	2.74(-2)	1.17(-2)	2.58(-2)	1.11(-2)	2.23(-2)	1.48(-2)	1.64(-2)	2.23(-2)
12	5.79(-2)	3.85(-2)	6.14(-3)	3.75(-2)	5.84(-4)	3.44(-2)	2.57(-5)	3.26(-2)	5.32(-5)	3.19(-2)	7.34(-4)
13	4.61(-2)	4.79(-2)	2.14(-4)	3.70(-2)	3.05(-3)	2.72(-2)	7.38(-3)	2.20(-2)	9.42(-3)	2.06(-2)	9.04(-3)
14	3.58(-2)	5.27(-2)	1.95(-3)	2.82(-2)	1.38(-2)	1.28(-2)	2.13(-2)	5.69(-3)	2.45(-2)	3.00(-3)	2.58(-2)
15	2.72(-2)	5.33(-2)	8.92(-3)	1.63(-2)	2.47(-2)	2.08(-3)	2.80(-2)	9.71(-5)	2.61(-2)	1.95(-3)	2.36(-2)
16	2.03(-2)	5.05(-2)	1.81(-2)	6.24(-3)	2.98(-2)	5.18(-4)	2.36(-2)	7.11(-3)	1.47(-2)	1.41(-2)	8.31(-3)
17	1.50(-2)	4.56(-2)	2.69(-2)	7.81(-4)	2.79(-2)	6.63(-3)	1.29(-2)	1.78(-2)	2.96(-3)	2.31(-2)	2.62(-5)
18	1.09(-2)	3.96(-2)	3.36(-2)	4.37(-4)	2.11(-2)	1.54(-2)	3.48(-3)	2.33(-2)	3.27(-4)	2.03(-2)	5.47(-3)
19	7.83(-3)	3.33(-2)	3.77(-2)	4.16(-3)	1.25(-2)	2.21(-2)	6.80(-7)	2.06(-2)	6.41(-3)	1.01(-2)	1.58(-2)
20	5.57(-3)	2.73(-2)	3.91(-2)	1.02(-2)	5.19(-3)	2.41(-2)	2.74(-3)	1.27(-2)	1.48(-2)	1.70(-3)	2.02(-2)
21	3.92(-3)	2.18(-2)	3.81(-2)	1.69(-2)	9.17(-4)	2.16(-2)	8.98(-3)	4.73(-3)	1.94(-2)	4.20(-4)	1.59(-2)

*Read as 1.46×10^{-3} .

Table 22. Franck-Condon factors for $N_2 B' {}^3\Sigma_u^- - X {}^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.58(-3)*	1.23(-2)	4.50(-2)	1.03(-1)	1.66(-1)	2.00(-1)	1.87(-1)	1.38(-1)	8.26(-2)	4.02(-2)	1.61(-2)
1	8.02(-3)	4.49(-2)	1.08(-1)	1.38(-1)	9.07(-2)	1.64(-2)	7.75(-3)	7.49(-2)	1.43(-1)	1.54(-1)	1.13(-1)
2	2.18(-2)	8.48(-2)	1.20(-1)	6.08(-2)	4.97(-4)	4.19(-2)	9.49(-2)	5.66(-2)	1.76(-3)	3.18(-2)	1.11(-1)
3	4.20(-2)	1.08(-1)	7.49(-2)	1.86(-3)	4.05(-2)	7.66(-2)	1.80(-2)	1.20(-2)	7.56(-2)	6.52(-2)	5.76(-3)
4	6.49(-2)	1.03(-1)	2.07(-2)	1.88(-2)	6.97(-2)	1.62(-2)	1.66(-2)	6.76(-2)	2.36(-2)	7.74(-3)	6.95(-2)
5	8.52(-2)	7.50(-2)	8.05(-7)	5.53(-2)	3.33(-2)	6.06(-3)	5.83(-2)	1.75(-2)	1.45(-2)	6.25(-2)	1.78(-2)
6	9.91(-2)	3.98(-2)	1.45(-2)	5.78(-2)	1.08(-3)	4.28(-2)	2.85(-2)	7.13(-3)	5.36(-2)	1.02(-2)	2.22(-2)
7	1.05(-1)	1.26(-2)	4.01(-2)	3.04(-2)	1.17(-2)	4.62(-2)	2.48(-5)	4.33(-2)	1.69(-2)	1.54(-2)	4.81(-2)
8	1.02(-1)	5.92(-4)	5.45(-2)	5.12(-3)	3.74(-2)	1.66(-2)	1.93(-2)	3.38(-2)	2.81(-3)	4.46(-2)	4.28(-3)
9	9.44(-2)	3.05(-3)	5.09(-2)	1.22(-3)	4.38(-2)	2.17(-5)	4.01(-2)	3.74(-3)	3.16(-2)	1.66(-2)	1.52(-2)
10	8.25(-2)	1.47(-2)	3.48(-2)	1.48(-2)	2.80(-2)	1.13(-2)	2.96(-2)	5.82(-3)	3.45(-2)	7.66(-4)	3.81(-2)
11	6.92(-2)	2.93(-2)	1.66(-2)	3.14(-2)	8.19(-3)	3.00(-2)	7.17(-3)	2.71(-2)	9.87(-3)	2.23(-2)	1.66(-2)
12	5.60(-2)	4.22(-2)	3.98(-3)	3.96(-2)	8.97(-6)	3.49(-2)	4.06(-4)	3.25(-2)	4.66(-4)	3.24(-2)	3.01(-5)
13	4.40(-2)	5.08(-2)	4.29(-6)	3.63(-2)	5.77(-3)	2.42(-2)	1.17(-2)	1.77(-2)	1.46(-2)	1.56(-2)	1.48(-2)
14	3.38(-2)	5.45(-2)	3.69(-3)	2.55(-2)	1.81(-2)	9.02(-3)	2.54(-2)	2.54(-3)	2.78(-2)	6.00(-4)	2.85(-2)
15	2.54(-2)	5.39(-2)	1.20(-2)	1.31(-2)	2.82(-2)	5.20(-4)	2.88(-2)	1.41(-3)	2.41(-2)	5.53(-3)	1.97(-2)
16	1.87(-2)	5.01(-2)	2.17(-2)	3.92(-3)	3.11(-2)	2.14(-3)	2.09(-2)	1.16(-2)	1.01(-2)	1.93(-2)	3.87(-3)
17	1.36(-2)	4.44(-2)	3.02(-2)	1.01(-4)	2.68(-2)	1.04(-2)	9.10(-3)	2.19(-2)	6.71(-4)	2.44(-2)	8.44(-4)
18	9.78(-3)	3.79(-2)	3.62(-2)	1.50(-3)	1.84(-2)	1.95(-2)	1.25(-3)	2.42(-2)	2.28(-3)	1.70(-2)	1.05(-2)
19	6.95(-3)	3.13(-2)	3.93(-2)	6.58(-3)	9.56(-3)	2.47(-2)	5.97(-4)	1.83(-2)	1.10(-2)	5.79(-3)	2.00(-2)
20	4.89(-3)	2.53(-2)	3.95(-2)	1.33(-2)	3.04(-3)	2.47(-2)	5.75(-3)	9.07(-3)	1.88(-2)	1.05(-4)	2.00(-2)
21	3.42(-3)	2.00(-2)	3.77(-2)	2.00(-2)	1.44(-4)	2.02(-2)	1.30(-2)	2.05(-3)	2.06(-2)	2.67(-3)	1.21(-2)

*Read as 1.58×10^{-3} .

Table 23. Franck-Condon factors for $N_2 \alpha' {}^1\Sigma_u^- - X {}^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.89(-3)*	1.42(-2)	5.06(-2)	1.12(-1)	1.75(-1)	2.04(-1)	1.83(-1)	1.31(-1)	7.48(-2)	3.49(-2)	1.33(-2)
1	9.35(-3)	5.03(-2)	1.15(-1)	1.39(-1)	8.17(-2)	9.91(-3)	1.44(-2)	8.91(-2)	1.51(-1)	1.51(-1)	1.04(-1)
2	2.48(-2)	9.16(-2)	1.20(-1)	5.18(-2)	7.48(-5)	5.27(-2)	9.62(-2)	4.59(-2)	1.26(-5)	4.57(-2)	1.24(-1)
3	4.69(-2)	1.12(-1)	6.75(-2)	1.88(-4)	5.00(-2)	7.33(-2)	1.02(-2)	2.12(-2)	8.24(-2)	5.48(-2)	1.11(-3)
4	7.10(-2)	1.02(-1)	1.43(-2)	2.66(-2)	6.90(-2)	9.18(-3)	2.60(-2)	6.78(-2)	1.41(-2)	1.68(-2)	7.71(-2)
5	9.14(-2)	6.93(-2)	7.37(-4)	6.09(-2)	2.52(-2)	1.25(-2)	5.97(-2)	9.44(-3)	2.46(-2)	6.16(-2)	8.48(-3)
6	1.04(-1)	3.30(-2)	2.11(-2)*	5.47(-2)	1.29(-6)	4.93(-2)	1.98(-2)	1.49(-2)	5.29(-2)	3.42(-3)	3.41(-2)
7	1.08(-1)	7.99(-3)	4.65(-2)	2.32(-2)	1.90(-2)	4.17(-2)	1.17(-3)	4.78(-2)	8.70(-3)	2.58(-2)	4.23(-2)
8	1.04(-1)	5.02(-7)	5.70(-2)	1.68(-3)	4.32(-2)	9.68(-3)	2.79(-2)	2.61(-2)	8.94(-3)	4.34(-2)	3.35(-4)
9	9.36(-2)	6.40(-3)	4.81(-2)	4.40(-3)	4.20(-2)	1.05(-3)	4.15(-2)	4.23(-4)	3.81(-2)	8.27(-3)	2.54(-2)
10	8.03(-2)	2.06(-2)	2.91(-2)	2.18(-2)	2.14(-2)	1.86(-2)	2.27(-2)	1.28(-2)	2.89(-2)	5.28(-3)	3.68(-2)
11	6.60(-2)	3.60(-2)	1.12(-2)	3.72(-2)	3.48(-3)	3.51(-2)	2.33(-3)	3.30(-2)	3.63(-3)	3.01(-2)	8.19(-3)
12	5.24(-2)	4.82(-2)	1.28(-3)	4.10(-2)	9.99(-4)	3.33(-2)	3.47(-3)	2.95(-2)	4.16(-3)	2.94(-2)	2.86(-3)
13	4.04(-2)	5.51(-2)	9.26(-4)	3.34(-2)	1.14(-2)	1.81(-2)	1.90(-2)	1.06(-2)	2.24(-2)	7.98(-3)	2.33(-2)
14	3.03(-2)	5.68(-2)	7.70(-3)	2.02(-2)	2.47(-2)	3.94(-3)	2.98(-2)	9.51(-5)	2.94(-2)	4.59(-4)	2.83(-2)
15	2.23(-2)	5.42(-2)	1.78(-2)	8.10(-3)	3.21(-2)	1.89(-4)	2.70(-2)	5.94(-3)	1.85(-2)	1.27(-2)	1.22(-2)
16	1.61(-2)	4.88(-2)	2.79(-2)	1.16(-3)	3.10(-2)	6.53(-3)	1.51(-2)	1.86(-2)	4.12(-3)	2.48(-2)	2.60(-4)
17	1.15(-2)	4.20(-2)	3.56(-2)	3.94(-4)	2.33(-2)	1.68(-2)	3.95(-3)	2.57(-2)	3.01(-4)	2.26(-2)	5.57(-3)
18	8.10(-3)	3.49(-2)	4.00(-2)	4.57(-3)	1.34(-2)	2.47(-2)	5.40(-6)	2.25(-2)	7.62(-3)	1.06(-2)	1.78(-2)
19	5.64(-3)	2.81(-2)	4.13(-2)	1.15(-2)	5.15(-3)	2.68(-2)	3.77(-3)	1.30(-2)	1.76(-2)	1.23(-3)	2.24(-2)
20	3.90(-3)	2.21(-2)	3.99(-2)	1.89(-2)	6.61(-4)	2.32(-2)	1.15(-2)	3.95(-3)	2.22(-2)	1.20(-3)	1.60(-2)
21	2.68(-3)	1.71(-2)	3.67(-2)	2.53(-2)	3.39(-4)	1.63(-2)	1.87(-2)	4.98(-5)	1.91(-2)	8.33(-3)	5.88(-3)

*Read as 1.89×10^{-3} .

Table 24. Franck-Condon factors for N_2 w ${}^1\Delta_u - X$ ${}^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	2.91(-3)*	2.04(-2)	6.67(-2)	1.37(-1)	1.95(-1)	2.07(-1)	1.70(-1)	1.10(-1)	5.67(-2)	2.37(-2)	8.04(-3)
1	1.36(-2)	6.58(-2)	1.33(-1)	1.34(-1)	5.70(-2)	5.53(-4)	3.91(-2)	1.23(-1)	1.63(-1)	1.36(-1)	8.14(-2)
2	3.40(-2)	1.09(-1)	1.15(-1)	2.95(-2)	7.59(-3)	7.88(-2)	8.88(-2)	1.99(-2)	8.76(-3)	8.49(-2)	1.48(-1)
3	6.06(-2)	1.19(-1)	4.70(-2)	3.81(-3)	7.14(-2)	5.65(-2)	1.22(-4)	5.00(-2)	8.56(-2)	2.57(-2)	5.82(-3)
4	8.66(-2)	9.43(-2)	2.88(-3)	4.82(-2)	5.82(-2)	7.88(-5)	5.15(-2)	5.51(-2)	3.77(-4)	4.73(-2)	7.88(-2)
5	1.05(-1)	5.27(-2)	9.19(-3)	6.77(-2)	7.58(-3)	3.43(-2)	5.07(-2)	4.13(-7)	5.13(-2)	4.44(-2)	4.34(-4)
6	1.14(-1)	1.74(-2)	3.95(-2)	4.05(-2)	7.11(-3)	5.56(-2)	3.17(-3)	3.87(-2)	3.74(-2)	2.71(-3)	5.78(-2)
7	1.12(-1)	9.90(-4)	5.95(-2)	7.73(-3)	3.83(-2)	2.41(-2)	1.53(-2)	4.50(-2)	8.13(-5)	4.80(-2)	1.84(-2)
8	1.02(-1)	3.50(-3)	5.61(-2)	1.19(-3)	4.90(-2)	2.08(-4)	4.40(-2)	7.05(-3)	3.08(-2)	2.67(-2)	8.94(-3)
9	8.77(-2)	1.76(-2)	3.67(-2)	1.78(-2)	3.01(-2)	1.30(-2)	3.33(-2)	5.79(-3)	4.01(-2)	1.85(-4)	4.30(-2)
10	7.18(-2)	3.47(-2)	1.55(-2)	3.71(-2)	6.98(-3)	3.50(-2)	6.50(-3)	3.15(-2)	1.05(-2)	2.51(-2)	2.00(-2)
11	5.65(-2)	4.87(-2)	2.45(-3)	4.43(-2)	2.63(-4)	3.79(-2)	1.56(-3)	3.52(-2)	1.40(-3)	3.59(-2)	2.12(-4)
12	4.30(-2)	5.66(-2)	4.87(-4)	3.74(-2)	1.03(-2)	2.22(-2)	1.77(-2)	1.51(-2)	2.07(-2)	1.33(-2)	2.04(-2)
13	3.19(-2)	5.85(-2)	7.00(-3)	2.31(-2)	2.53(-2)	5.40(-3)	3.17(-2)	5.01(-4)	3.23(-2)	2.17(-5)	3.22(-2)
14	2.31(-2)	5.56(-2)	1.75(-2)	9.48(-3)	3.42(-2)	8.47(-5)	3.00(-2)	5.50(-3)	2.16(-2)	1.21(-2)	1.58(-2)
15	1.65(-2)	4.96(-2)	2.78(-2)	1.51(-3)	3.34(-2)	6.68(-3)	1.69(-2)	1.98(-2)	5.01(-3)	2.66(-2)	5.86(-4)

*Read as 2.91×10^{-3} .

Table 25. Franck-Condon factors for $N_2 C^3\Pi_u-X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	5.45(-1)*	3.47(-1)	9.28(-2)	1.39(-2)	1.34(-3)	9.78(-5)	6.49(-6)	4.30(-7)	3.19(-8)	3.59(-9)	1.09(-9)
1	3.08(-1)	7.92(-2)	3.59(-1)	1.99(-1)	4.77(-2)	6.68(-3)	6.84(-4)	6.24(-5)	5.82(-6)	6.99(-7)	7.82(-8)
2	1.06(-1)	2.67(-1)	2.68(-3)	2.31(-1)	2.68(-1)	1.00(-1)	2.02(-2)	2.89(-3)	3.72(-4)	4.83(-5)	7.25(-6)
3	3.00(-2)	1.83(-1)	1.28(-1)	7.49(-2)	8.80(-2)	2.73(-1)	1.63(-1)	4.78(-2)	9.74(-3)	1.76(-3)	3.05(-4)
4	7.74(-3)	7.94(-2)	1.84(-1)	2.25(-2)	1.50(-1)	5.91(-3)	2.04(-1)	2.15(-1)	9.49(-2)	2.78(-2)	6.86(-3)

*Read as 5.45×10^{-1} .

Table 26. Franck-Condon factors for $N_2 E^3\Sigma_g^+-X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	9.29(-1)*	6.93(-2)	1.86(-3)	2.31(-5)	2.01(-7)	7.69(-9)	4.47(-13)	8.00(-11)	1.51(-11)	1.50(-11)	1.59(-11)
1	6.76(-2)	7.93(-1)	1.33(-1)	5.75(-3)	1.07(-4)	1.38(-6)	7.07(-8)	4.09(-11)	1.20(-12)	4.71(-11)	2.12(-11)

*Read as 9.29×10^{-1} .

Table 27. Franck-Condon factors for $N_2 D^3\Sigma_u^+-X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	9.84(-1)*	1.54(-2)	4.60(-4)	2.24(-6)	2.18(-7)	2.59(-8)	5.97(-9)	4.81(-12)	3.17(-10)	5.84(-11)	2.06(-16)

*Read as 9.84×10^{-1} .

Table 28. Franck-Condon factors for $N_2^+ X^2\Sigma_g^+-N_2 X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	9.17(-1)*	8.02(-2)	2.53(-3)	4.47(-5)	4.17(-7)	1.26(-8)	2.10(-10)	1.01(-10)	2.09(-11)	5.10(-12)	1.35(-12)
1	7.79(-2)	7.60(-1)	1.54(-1)	7.91(-3)	2.04(-4)	2.57(-6)	9.23(-8)	1.28(-9)	8.14(-10)	1.83(-10)	5.16(-11)
2	4.65(-3)	1.45(-1)	6.12(-1)	2.21(-1)	1.65(-2)	5.84(-4)	9.55(-6)	3.96(-7)	4.23(-9)	3.74(-9)	9.13(-10)
3	2.68(-4)	1.38(-2)	2.01(-1)	4.75(-1)	2.80(-1)	2.86(-2)	1.34(-3)	2.78(-5)	1.31(-6)	9.68(-9)	1.28(-8)
4	1.76(-5)	1.12(-3)	2.72(-2)	2.44(-1)	3.51(-1)	3.29(-1)	4.46(-2)	2.68(-3)	6.99(-5)	3.66(-6)	1.63(-8)
5	1.55(-6)	9.62(-5)	2.89(-3)	4.45(-2)	2.74(-1)	2.42(-1)	3.67(-1)	6.46(-2)	4.91(-3)	1.59(-4)	9.21(-6)
6	2.13(-7)	1.06(-5)	3.14(-4)	6.00(-3)	6.50(-2)	2.90(-1)	1.50(-1)	3.91(-1)	8.87(-2)	8.42(-3)	3.34(-4)
7	4.74(-8)	1.71(-6)	4.18(-5)	7.97(-4)	1.08(-2)	8.78(-2)	2.91(-1)	7.83(-2)	4.01(-1)	1.17(-1)	1.37(-2)
8	1.47(-8)	4.21(-7)	7.79(-6)	1.25(-4)	1.72(-3)	1.78(-2)	1.11(-1)	2.76(-1)	2.90(-2)	3.94(-1)	1.48(-1)
9	5.49(-9)	1.42(-7)	2.11(-6)	2.65(-5)	3.16(-4)	3.34(-3)	2.71(-2)	1.34(-1)	2.47(-1)	3.68(-3)	3.70(-1)
10	2.24(-9)	5.67(-8)	7.58(-7)	7.79(-6)	7.48(-5)	7.01(-4)	5.94(-3)	3.89(-2)	1.54(-1)	2.05(-1)	2.24(-3)
11	9.69(-10)	2.50(-8)	3.24(-7)	2.98(-6)	2.37(-5)	1.84(-4)	1.42(-3)	9.88(-3)	5.30(-2)	1.67(-1)	1.55(-1)
12	4.42(-10)	1.17(-8)	1.53(-7)	1.35(-6)	9.59(-6)	6.28(-5)	4.11(-4)	2.66(-3)	1.55(-2)	6.86(-2)	1.71(-1)
13	2.13(-10)	5.77(-9)	7.65(-8)	6.73(-7)	4.56(-6)	2.67(-5)	1.50(-4)	8.41(-4)	4.66(-3)	2.30(-2)	8.44(-2)
14	1.10(-10)	2.99(-9)	4.03(-8)	3.59(-7)	2.40(-6)	1.33(-5)	6.67(-5)	3.26(-4)	1.61(-3)	7.71(-3)	3.24(-2)
15	6.01(-11)	1.64(-9)	2.23(-8)	2.01(-7)	1.35(-6)	7.33(-6)	3.46(-5)	1.52(-4)	6.61(-4)	2.88(-3)	1.21(-2)
16	3.50(-11)	9.50(-10)	1.30(-8)	1.18(-7)	7.97(-7)	4.31(-6)	1.98(-5)	8.17(-5)	3.21(-4)	1.26(-3)	4.88(-3)
17	2.15(-11)	5.81(-10)	7.95(-9)	7.24(-8)	4.92(-7)	2.67(-6)	1.21(-5)	4.85(-5)	1.78(-4)	6.35(-4)	2.24(-3)
18	1.38(-11)	3.74(-10)	5.10(-9)	4.64(-8)	3.17(-7)	1.72(-6)	7.82(-6)	3.07(-5)	1.09(-4)	3.62(-4)	1.18(-3)
19	9.28(-12)	2.52(-10)	3.42(-9)	3.10(-8)	2.12(-7)	1.15(-6)	5.24(-6)	2.05(-5)	7.11(-5)	2.27(-4)	6.91(-4)
20	6.50(-12)	1.77(-10)	2.39(-9)	2.16(-8)	1.47(-7)	8.01(-7)	3.64(-6)	1.42(-5)	4.88(-5)	1.52(-4)	4.42(-4)
21	4.74(-12)	1.29(-10)	1.73(-9)	1.56(-8)	1.06(-7)	5.74(-7)	2.61(-6)	1.02(-5)	3.47(-5)	1.07(-4)	3.02(-4)

*Read as 9.17×10^{-1} .

Table 29. Franck-Condon factors for $N_2^+ A^2\Pi_u - N_2 X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	2.64(-1)*	3.79(-1)	2.41(-1)	8.98(-2)	2.19(-2)	3.68(-3)	4.39(-4)	3.78(-5)	2.37(-6)	1.08(-7)	3.50(-9)
1	3.18(-1)	2.97(-2)	1.03(-1)	2.67(-1)	1.92(-1)	7.15(-2)	1.64(-2)	2.52(-3)	2.68(-4)	2.01(-5)	1.07(-6)
2	2.19(-1)	5.01(-2)	1.60(-1)	5.57(-5)	1.49(-1)	2.35(-1)	1.35(-1)	4.20(-2)	8.16(-3)	1.06(-3)	9.39(-5)
3	1.15(-1)	1.57(-1)	1.02(-2)	1.30(-1)	5.76(-2)	3.60(-2)	2.04(-1)	1.89(-1)	7.97(-2)	1.95(-2)	3.06(-3)
4	5.09(-2)	1.62(-1)	3.45(-2)	8.45(-2)	3.70(-2)	1.21(-1)	1.44(-4)	1.27(-1)	2.12(-1)	1.24(-1)	3.83(-2)
5	2.04(-2)	1.11(-1)	1.09(-1)	1.39(-3)	1.13(-1)	3.09(-5)	1.18(-1)	3.21(-2)	4.98(-2)	1.98(-1)	1.65(-1)
6	7.70(-3)	6.07(-2)	1.25(-1)	3.31(-2)	4.20(-2)	7.32(-2)	2.94(-2)	6.62(-2)	8.35(-2)	5.41(-3)	1.52(-1)
7	2.80(-3)	2.92(-2)	9.57(-2)	8.74(-2)	1.29(-4)	8.27(-2)	1.95(-2)	7.43(-2)	1.54(-2)	1.11(-1)	4.94(-3)
8	1.00(-3)	1.30(-2)	5.92(-2)	1.01(-1)	3.34(-2)	1.88(-2)	8.08(-2)	1.25(-4)	8.95(-2)	4.48(-4)	9.89(-2)
9	3.58(-4)	5.51(-3)	3.21(-2)	8.22(-2)	7.35(-2)	2.05(-3)	5.47(-2)	4.49(-2)	2.06(-2)	6.64(-2)	2.22(-2)
10	1.29(-4)	2.28(-3)	1.61(-2)	5.50(-2)	8.41(-2)	3.28(-2)	7.38(-3)	7.12(-2)	9.57(-3)	5.39(-2)	2.78(-2)
11	4.76(-5)	9.33(-4)	7.66(-3)	3.26(-2)	7.11(-2)	6.31(-2)	4.46(-3)	3.44(-2)	5.65(-2)	7.75(-4)	6.98(-2)
12	1.80(-5)	3.84(-4)	3.55(-3)	1.79(-2)	5.05(-2)	7.14(-2)	3.11(-2)	2.43(-3)	5.66(-2)	2.57(-2)	1.90(-2)
13	7.03(-6)	1.60(-4)	1.62(-3)	9.36(-3)	3.21(-2)	6.22(-2)	5.44(-2)	6.20(-3)	2.14(-2)	5.65(-2)	3.07(-3)
14	2.84(-6)	6.79(-5)	7.44(-4)	4.76(-3)	1.90(-2)	4.63(-2)	6.13(-2)	2.85(-2)	6.08(-4)	4.32(-2)	3.61(-2)
15	1.18(-6)	2.95(-5)	3.43(-4)	2.39(-3)	1.08(-2)	3.13(-2)	5.49(-2)	4.70(-2)	6.98(-3)	1.35(-2)	5.09(-2)
16	5.10(-7)	1.32(-5)	1.60(-4)	1.20(-3)	5.93(-3)	1.98(-2)	4.28(-2)	5.30(-2)	2.55(-2)	8.57(-5)	3.28(-2)
17	2.26(-7)	6.01(-6)	7.62(-5)	6.01(-4)	3.22(-3)	1.20(-2)	3.04(-2)	4.89(-2)	4.05(-2)	6.94(-3)	8.97(-3)
18	1.03(-7)	2.81(-6)	3.69(-5)	3.04(-4)	1.74(-3)	7.08(-3)	2.04(-2)	3.97(-2)	4.62(-2)	2.22(-2)	6.74(-7)
19	4.75(-8)	1.34(-6)	1.81(-5)	1.56(-4)	9.38(-4)	4.11(-3)	1.31(-2)	2.96(-2)	4.38(-2)	3.47(-2)	6.32(-3)
20	2.23(-8)	6.48(-7)	9.06(-6)	8.07(-5)	5.08(-4)	2.37(-3)	8.21(-3)	2.09(-2)	3.69(-2)	4.03(-2)	1.89(-2)
21	1.05(-8)	3.17(-7)	4.58(-6)	4.22(-5)	2.77(-4)	1.36(-3)	5.05(-3)	1.42(-2)	2.88(-2)	3.93(-2)	2.96(-2)

*Read as 2.64×10^{-1} .

Table 30. Franck-Condon factors for $N_2^+ B^2\Sigma_u^+-N_2 X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	8.83(-1)*	1.04(-1)	1.18(-2)	1.21(-3)	1.27(-4)	1.35(-5)	1.48(-6)	1.64(-7)	1.99(-8)	3.43(-9)	1.25(-9)
1	1.14(-1)	6.91(-1)	1.61(-1)	2.86(-2)	3.93(-3)	5.17(-4)	6.63(-5)	8.64(-6)	1.18(-6)	1.89(-7)	4.56(-8)
2	2.31(-3)	2.00(-1)	5.57(-1)	1.86(-1)	4.59(-2)	7.81(-3)	1.25(-3)	1.88(-4)	2.91(-5)	4.86(-6)	1.01(-6)
3	1.41(-5)	4.85(-3)	2.64(-1)	4.69(-1)	1.87(-1)	6.12(-2)	1.22(-2)	2.33(-3)	4.08(-4)	7.46(-5)	1.52(-5)
4	4.32(-6)	1.32(-4)	6.01(-3)	3.09(-1)	4.19(-1)	1.71(-1)	7.37(-2)	1.65(-2)	3.74(-3)	7.46(-4)	1.62(-4)
5	8.23(-10)	1.97(-5)	5.92(-4)	4.91(-3)	3.39(-1)	4.00(-1)	1.45(-1)	8.41(-2)	2.00(-2)	5.44(-3)	1.22(-3)
6	1.27(-8)	2.28(-7)	4.48(-5)	1.81(-3)	1.99(-3)	3.51(-1)	4.09(-1)	1.10(-1)	9.41(-2)	2.18(-2)	7.48(-3)
7	1.25(-11)	8.34(-8)	3.13(-6)	5.44(-5)	4.25(-3)	5.49(-6)	3.41(-1)	4.41(-1)	7.14(-2)	1.07(-1)	2.12(-2)
8	1.59(-10)	1.80(-9)	1.99(-7)	1.92(-5)	1.59(-5)	7.92(-3)	5.47(-3)	3.01(-1)	4.88(-1)	3.43(-2)	1.26(-1)
9	4.98(-11)	1.47(-9)	3.08(-8)	5.59(-8)	7.07(-5)	4.91(-5)	1.14(-2)	2.93(-2)	2.23(-1)	5.32(-1)	7.61(-3)
10	1.50(-11)	7.92(-10)	4.18(-9)	2.10(-7)	1.24(-6)	1.62(-4)	8.63(-4)	1.12(-2)	8.25(-2)	1.17(-1)	5.36(-1)

*Read as 8.83×10^{-1} .

Table 31. Franck-Condon factors for $N_2^+ C^2\Sigma_u^+-N_2 X^1\Sigma_g^+$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	2.75(-3)*	2.17(-2)	7.78(-2)	1.66(-1)	2.35(-1)	2.30(-1)	1.59(-1)	7.68(-2)	2.53(-2)	5.34(-3)	6.29(-4)
1	1.40(-2)	7.33(-2)	1.50(-1)	1.36(-1)	3.42(-2)	8.96(-3)	1.15(-1)	2.01(-1)	1.66(-1)	7.77(-2)	2.09(-2)
2	3.73(-2)	1.22(-1)	1.18(-1)	1.53(-2)	3.04(-2)	1.07(-1)	4.67(-2)	5.85(-3)	1.21(-1)	2.01(-1)	1.39(-1)
3	6.87(-2)	1.30(-1)	3.56(-2)	1.71(-2)	8.75(-2)	2.08(-2)	2.63(-2)	9.44(-2)	2.07(-2)	3.40(-2)	1.77(-1)
4	9.91(-2)	9.35(-2)	3.38(-7)	6.96(-2)	3.24(-2)	1.70(-2)	7.22(-2)	3.99(-3)	5.41(-2)	7.01(-2)	2.51(-4)
5	1.19(-1)	4.32(-2)	2.39(-2)	6.27(-2)	6.86(-4)	6.27(-2)	9.42(-3)	4.03(-2)	4.46(-2)	7.09(-3)	8.25(-2)
6	1.25(-1)	8.42(-3)	5.81(-2)	1.90(-2)	3.39(-2)	3.30(-2)	1.52(-2)	4.89(-2)	1.94(-3)	6.08(-2)	4.28(-3)
7	1.18(-1)	3.92(-4)	6.53(-2)	3.59(-5)	5.43(-2)	3.63(-4)	4.93(-2)	3.08(-3)	4.46(-2)	1.12(-2)	3.65(-2)
8	1.03(-1)	1.26(-2)	4.58(-2)	1.61(-2)	3.33(-2)	1.66(-2)	2.99(-2)	1.52(-2)	3.16(-2)	1.21(-2)	3.80(-2)
9	8.35(-2)	3.23(-2)	1.97(-2)	3.93(-2)	6.08(-3)	4.06(-2)	1.83(-3)	4.05(-2)	5.99(-4)	4.11(-2)	4.08(-4)
10	6.46(-2)	4.92(-2)	3.12(-3)	4.69(-2)	1.18(-3)	3.66(-2)	7.73(-3)	2.69(-2)	1.47(-2)	2.00(-2)	2.04(-2)

*Read as 2.75×10^{-3} .

Table 32. Franck-Condon factors for $O_2^+ X^2\Pi_g - O_2 X^3\Sigma_g^-$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	1.86(-1)*	2.71(-1)	2.30(-1)	1.50(-1)	8.40(-2)	4.24(-2)	2.00(-2)	9.02(-3)	3.94(-3)	1.69(-3)	7.15(-4)
1	3.62(-1)	8.32(-2)	4.96(-3)	8.33(-2)	1.34(-1)	1.25(-1)	8.98(-2)	5.53(-2)	3.09(-2)	1.61(-2)	8.02(-3)
2	2.91(-1)	4.27(-2)	1.65(-1)	5.34(-2)	5.55(-4)	4.41(-2)	8.95(-2)	9.82(-2)	8.08(-2)	5.61(-2)	3.49(-2)
3	1.25(-1)	2.57(-1)	1.65(-2)	7.24(-2)	1.09(-1)	3.10(-2)	6.16(-4)	3.16(-2)	6.73(-2)	7.91(-2)	7.03(-2)
4	3.07(-2)	2.36(-1)	1.10(-1)	9.65(-2)	4.15(-3)	8.21(-2)	7.44(-2)	1.64(-2)	1.38(-3)	2.65(-2)	5.45(-2)
5	4.33(-3)	9.10(-2)	2.67(-1)	1.57(-2)	1.28(-1)	1.32(-2)	2.82(-2)	7.66(-2)	4.89(-2)	7.60(-3)	2.61(-3)
6	3.26(-4)	1.73(-2)	1.61(-1)	2.25(-1)	3.47(-3)	9.76(-2)	5.42(-2)	8.73(-4)	4.67(-2)	6.33(-2)	3.07(-2)
7	1.07(-5)	1.60(-3)	4.06(-2)	2.20(-1)	1.51(-1)	3.89(-2)	4.65(-2)	8.08(-2)	8.67(-3)	1.48(-2)	5.28(-2)
8	7.14(-8)	5.94(-5)	4.53(-3)	7.29(-2)	2.57(-1)	7.87(-2)	8.09(-2)	1.00(-2)	7.83(-2)	3.31(-2)	3.60(-4)
9	7.16(-10)	3.47(-7)	1.85(-4)	9.65(-3)	1.11(-1)	2.67(-1)	2.80(-2)	1.06(-1)	1.33(-4)	5.54(-2)	5.37(-2)
10	4.25(-11)	8.65(-9)	8.54(-7)	4.22(-4)	1.72(-2)	1.51(-1)	2.57(-1)	3.57(-3)	1.07(-1)	1.14(-2)	2.80(-2)
11	2.46(-13)	3.23(-10)	5.21(-8)	1.32(-6)	7.91(-4)	2.70(-2)	1.91(-1)	2.31(-1)	1.23(-3)	9.15(-2)	3.18(-2)
12	2.10(-14)	6.10(-12)	1.19(-9)	2.13(-7)	1.21(-6)	1.28(-3)	3.89(-2)	2.26(-1)	1.98(-1)	1.30(-2)	6.71(-2)
13	7.65(-16)	2.04(-13)	5.31(-11)	2.68(-9)	6.66(-7)	3.72(-7)	1.84(-3)	5.21(-2)	2.58(-1)	1.62(-1)	3.10(-2)
14	8.53(-16)	1.66(-14)	7.48(-13)	3.02(-10)	3.67(-9)	1.70(-6)	2.56(-7)	2.40(-3)	6.62(-2)	2.84(-1)	1.30(-1)
15	6.53(-16)	4.35(-17)	1.35(-13)	8.80(-13)	1.23(-9)	1.96(-9)	3.70(-6)	5.83(-6)	2.86(-3)	8.03(-2)	3.07(-1)
16	2.09(-15)	1.28(-17)	6.77(-17)	8.09(-13)	4.23(-17)	3.90(-9)	4.34(-10)	6.94(-6)	2.76(-5)	3.12(-3)	9.38(-2)
17	3.66(-16)	1.93(-18)	5.85(-16)	1.34(-14)	3.46(-12)	1.32(-11)	9.97(-9)	2.74(-8)	1.14(-5)	8.32(-5)	3.07(-3)
18	4.26(-16)	4.23(-17)	7.54(-17)	6.24(-17)	1.28(-13)	9.64(-12)	1.55(-10)	2.07(-8)	1.80(-7)	1.62(-5)	1.97(-4)
19	1.44(-15)	8.81(-17)	4.29(-16)	9.12(-19)	2.47(-15)	7.26(-13)	1.94(-11)	8.78(-10)	3.40(-8)	6.92(-7)	1.97(-5)
20	5.52(-16)	1.88(-17)	1.82(-16)	1.13(-18)	3.38(-15)	5.89(-16)	3.52(-12)	2.30(-11)	3.47(-9)	4.17(-8)	1.99(-6)
21	3.76(-17)	1.38(-17)	3.02(-18)	5.31(-17)	3.47(-16)	6.02(-15)	2.49(-14)	1.22(-11)	5.30(-12)	1.06(-8)	3.01(-8)

*Read as 1.86×10^{-1} .

Table 33. Franck-Condon factors for $O_2^+ a^4\Pi_u-O_2 X^3\Sigma_g^-$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	9.87(-3)*	5.44(-2)	1.38(-1)	2.15(-1)	2.30(-1)	1.78(-1)	1.05(-1)	4.72(-2)	1.67(-2)	4.64(-3)	1.02(-3)
1	3.60(-2)	1.24(-1)	1.58(-1)	7.32(-2)	5.34(-4)	5.30(-2)	1.52(-1)	1.79(-1)	1.29(-1)	6.44(-2)	2.36(-2)
2	7.20(-2)	1.42(-1)	6.01(-2)	2.33(-3)	8.29(-2)	9.51(-2)	1.32(-2)	2.37(-2)	1.23(-1)	1.68(-1)	1.26(-1)
3	1.05(-1)	1.02(-1)	1.25(-3)	6.30(-2)	6.98(-2)	2.02(-4)	6.16(-2)	8.79(-2)	1.21(-2)	2.59(-2)	1.25(-1)
4	1.24(-1)	4.61(-2)	1.98(-2)	7.67(-2)	3.27(-3)	5.10(-2)	5.84(-2)	1.05(-4)	6.65(-2)	7.39(-2)	3.35(-3)
5	1.28(-1)	8.65(-3)	5.79(-2)	3.11(-2)	2.03(-2)	6.08(-2)	8.72(-5)	5.84(-2)	3.89(-2)	6.08(-3)	7.94(-2)
6	1.18(-1)	4.45(-4)	6.88(-2)	8.06(-4)	5.57(-2)	1.17(-2)	3.51(-2)	4.08(-2)	5.33(-3)	6.58(-2)	1.44(-2)
7	1.01(-1)	1.30(-2)	5.05(-2)	1.08(-2)	4.68(-2)	4.05(-3)	5.21(-2)	1.12(-4)	5.15(-2)	1.48(-2)	2.72(-2)
8	8.17(-2)	3.27(-2)	2.34(-2)	3.57(-2)	1.54(-2)	3.24(-2)	1.90(-2)	2.44(-2)	3.15(-2)	1.05(-2)	5.02(-2)
9	6.29(-2)	4.94(-2)	4.83(-3)	4.86(-2)	9.09(-5)	4.46(-2)	6.92(-6)	4.40(-2)	3.33(-4)	4.43(-2)	5.12(-3)
10	4.67(-2)	5.87(-2)	1.05(-4)	4.30(-2)	8.32(-3)	2.92(-2)	1.47(-2)	2.43(-2)	1.61(-2)	2.68(-2)	1.25(-2)
11	3.38(-2)	6.05(-2)	5.99(-3)	2.72(-2)	2.53(-2)	8.21(-3)	3.33(-2)	2.22(-3)	3.60(-2)	1.03(-3)	3.79(-2)
12	2.40(-2)	5.67(-2)	1.64(-2)	1.16(-2)	3.61(-2)	5.45(-7)	3.38(-2)	3.93(-3)	2.77(-2)	9.12(-3)	2.48(-2)
13	1.68(-2)	4.97(-2)	2.65(-2)	2.28(-3)	3.59(-2)	5.95(-3)	1.99(-2)	1.94(-2)	7.79(-3)	2.75(-2)	2.63(-3)
14	1.16(-2)	4.16(-2)	3.34(-2)	5.70(-5)	2.76(-2)	1.75(-2)	5.73(-3)	2.92(-2)	2.88(-5)	2.84(-2)	3.65(-3)
15	8.05(-3)	3.36(-2)	3.66(-2)	2.90(-3)	1.68(-2)	2.64(-2)	3.90(-5)	2.65(-2)	7.24(-3)	1.45(-2)	1.84(-2)
16	5.58(-3)	2.66(-2)	3.66(-2)	8.05(-3)	7.76(-3)	2.90(-2)	2.99(-3)	1.62(-2)	1.85(-2)	2.36(-3)	2.57(-2)
17	3.88(-3)	2.07(-2)	3.44(-2)	1.33(-2)	2.19(-3)	2.61(-2)	1.01(-2)	6.04(-3)	2.43(-2)	5.91(-4)	1.99(-2)
18	2.72(-3)	1.60(-2)	3.10(-2)	1.75(-2)	9.01(-5)	2.02(-2)	1.70(-2)	6.51(-4)	2.24(-2)	6.90(-3)	8.90(-3)
19	1.93(-3)	1.22(-2)	2.71(-2)	2.01(-2)	4.92(-4)	1.36(-2)	2.10(-2)	4.82(-4)	1.57(-2)	1.47(-2)	1.36(-3)
20	1.38(-3)	9.41(-3)	2.31(-2)	2.12(-2)	2.27(-3)	7.89(-3)	2.17(-2)	3.68(-3)	8.32(-3)	1.93(-2)	3.43(-4)
21	1.00(-3)	7.24(-3)	1.95(-2)	2.11(-2)	4.51(-3)	3.82(-3)	1.99(-2)	7.94(-3)	2.92(-3)	1.93(-2)	4.09(-3)

*Read as 9.87×10^{-3} .

Table 34. Franck-Condon factors for $O_2^+ A^2\Pi_u - O_2 X^3\Sigma_g^-$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	2.84(-3)*	1.95(-2)	6.34(-2)	1.29(-1)	1.86(-1)	2.02(-1)	1.71(-1)	1.16(-1)	6.43(-2)	2.96(-2)	1.14(-2)
1	1.23(-2)	6.00(-2)	1.23(-1)	1.31(-1)	6.34(-2)	3.00(-3)	2.49(-2)	1.01(-1)	1.53(-1)	1.44(-1)	9.88(-2)
2	2.91(-2)	9.71(-2)	1.12(-1)	3.73(-2)	2.21(-3)	6.22(-2)	9.25(-2)	3.75(-2)	1.83(-4)	4.74(-2)	1.20(-1)
3	5.00(-2)	1.09(-1)	5.50(-2)	2.40(-4)	5.50(-2)	6.71(-2)	6.89(-3)	2.34(-2)	8.04(-2)	5.52(-2)	2.58(-3)
4	6.97(-2)	9.23(-2)	9.74(-3)	2.92(-2)	6.44(-2)	7.34(-3)	2.56(-2)	6.55(-2)	1.65(-2)	1.11(-2)	6.95(-2)
5	8.43(-2)	6.11(-2)	1.01(-3)	5.70(-2)	2.39(-2)	1.05(-2)	5.65(-2)	1.30(-2)	1.64(-2)	6.05(-2)	1.90(-2)
6	9.18(-2)	3.04(-2)	1.75(-2)	5.14(-2)	2.34(-4)	4.23(-2)	2.51(-2)	6.96(-3)	5.10(-2)	1.26(-2)	1.54(-2)
7	9.25(-2)	9.51(-3)	3.75(-2)	2.65(-2)	1.10(-2)	4.30(-2)	1.92(-4)	3.82(-2)	2.10(-2)	8.24(-3)	4.78(-2)
8	8.78(-2)	6.28(-4)	4.74(-2)	5.82(-3)	3.12(-2)	1.89(-2)	1.27(-2)	3.60(-2)	7.87(-5)	3.83(-2)	1.45(-2)
9	7.97(-2)	1.43(-3)	4.49(-2)	8.80(-5)	3.87(-2)	1.54(-3)	3.19(-2)	1.08(-2)	1.77(-2)	2.84(-2)	1.83(-3)
10	6.98(-2)	7.88(-3)	3.44(-2)	6.46(-3)	3.09(-2)	2.85(-3)	3.26(-2)	3.67(-5)	3.27(-2)	3.84(-3)	2.41(-2)
11	5.96(-2)	1.63(-2)	2.15(-2)	1.70(-2)	1.67(-2)	1.46(-2)	1.85(-2)	9.44(-3)	2.43(-2)	2.90(-3)	3.06(-2)
12	4.99(-2)	2.42(-2)	1.06(-2)	2.54(-2)	5.10(-3)	2.46(-2)	4.77(-3)	2.23(-2)	7.55(-3)	1.76(-2)	1.43(-2)
13	4.12(-2)	3.03(-2)	3.48(-3)	2.88(-2)	1.90(-4)	2.68(-2)	6.14(-7)	2.58(-2)	3.10(-5)	2.54(-2)	9.47(-4)
14	3.36(-2)	3.40(-2)	3.24(-4)	2.73(-2)	1.35(-3)	2.21(-2)	3.62(-3)	1.96(-2)	4.21(-3)	1.98(-2)	2.89(-3)
15	2.72(-2)	3.57(-2)	3.30(-4)	2.26(-2)	5.86(-3)	1.42(-2)	1.05(-2)	9.97(-3)	1.27(-2)	8.77(-3)	1.25(-2)
16	2.19(-2)	3.56(-2)	2.37(-3)	1.67(-2)	1.10(-2)	6.91(-3)	1.61(-2)	2.70(-3)	1.82(-2)	1.30(-3)	1.88(-2)
17	1.76(-2)	3.42(-2)	5.40(-3)	1.09(-2)	1.49(-2)	2.07(-3)	1.82(-2)	2.64(-5)	1.83(-2)	3.51(-4)	1.77(-2)
18	1.41(-2)	3.19(-2)	8.62(-3)	6.18(-3)	1.68(-2)	1.07(-4)	1.69(-2)	1.23(-3)	1.42(-2)	3.92(-3)	1.17(-2)
19	1.13(-2)	2.92(-2)	1.15(-2)	2.87(-3)	1.69(-2)	4.03(-4)	1.36(-2)	4.35(-3)	8.80(-3)	8.51(-3)	5.34(-3)
20	9.07(-3)	2.62(-2)	1.37(-2)	9.25(-4)	1.55(-2)	2.00(-3)	9.53(-3)	7.56(-3)	4.12(-3)	1.16(-2)	1.23(-3)
21	7.24(-3)	2.31(-2)	1.51(-2)	9.62(-5)	1.32(-2)	3.98(-3)	5.81(-3)	9.72(-3)	1.19(-3)	1.24(-2)	3.85(-8)

*Read as 2.84×10^{-3} .

Table 35. Franck-Condon factors for $O_2^+ b^4\Sigma_g^- - O_2 X^3\Sigma_g^-$.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10
0	4.11(-1)*	3.76(-1)	1.61(-1)	4.31(-2)	8.21(-3)	1.19(-3)	1.36(-4)	1.26(-5)	9.81(-7)	6.34(-8)	3.54(-9)
1	3.36(-1)	2.78(-3)	2.34(-1)	2.61(-1)	1.23(-1)	3.49(-2)	6.96(-3)	1.05(-3)	1.24(-4)	1.20(-5)	9.46(-7)
2	1.62(-1)	1.69(-1)	8.18(-2)	4.85(-2)	2.31(-1)	1.96(-1)	8.31(-2)	2.26(-2)	4.43(-3)	6.62(-4)	7.88(-5)
3	6.13(-2)	2.09(-1)	1.69(-2)	1.62(-1)	2.55(-3)	1.20(-1)	2.18(-1)	1.41(-1)	5.28(-2)	1.34(-2)	2.52(-3)
4	2.04(-2)	1.35(-1)	1.28(-1)	1.65(-2)	1.19(-1)	6.44(-2)	2.25(-2)	1.72(-1)	1.85(-1)	9.65(-2)	3.20(-2)
5	6.36(-3)	6.53(-2)	1.54(-1)	2.90(-2)	8.59(-2)	3.20(-2)	1.22(-1)	3.27(-3)	8.54(-2)	1.87(-1)	1.43(-1)
6	1.93(-3)	2.72(-2)	1.11(-1)	1.05(-1)	1.43(-3)	1.12(-1)	6.48(-4)	1.06(-1)	5.10(-2)	1.50(-2)	1.40(-1)
7	5.83(-4)	1.04(-2)	6.15(-2)	1.22(-1)	3.39(-2)	4.24(-2)	6.72(-2)	3.97(-2)	4.17(-2)	1.00(-1)	3.59(-3)
8	1.79(-4)	3.83(-3)	2.97(-2)	9.34(-2)	8.80(-2)	1.07(-4)	8.40(-2)	1.09(-2)	8.46(-2)	8.29(-4)	9.49(-2)
9	5.60(-5)	1.38(-3)	1.32(-2)	5.74(-2)	1.00(-1)	3.29(-2)	2.21(-2)	7.33(-2)	5.35(-3)	7.60(-2)	2.03(-2)
10	1.80(-5)	5.01(-4)	5.63(-3)	3.11(-2)	8.12(-2)	7.29(-2)	9.22(-4)	6.11(-2)	2.59(-2)	4.48(-2)	2.71(-2)
11	5.96(-6)	1.83(-4)	2.35(-3)	1.56(-2)	5.44(-2)	8.41(-2)	2.82(-2)	1.36(-2)	6.61(-2)	2.73(-6)	6.94(-2)
12	2.00(-6)	6.74(-5)	9.68(-4)	7.52(-3)	3.25(-2)	7.21(-2)	5.91(-2)	9.75(-4)	4.70(-2)	3.11(-2)	2.21(-2)
13	6.79(-7)	2.51(-5)	3.99(-4)	3.52(-3)	1.81(-2)	5.23(-2)	7.06(-2)	2.14(-2)	1.10(-2)	5.61(-2)	1.18(-3)
14	2.27(-7)	9.39(-6)	1.65(-4)	1.62(-3)	9.66(-3)	3.42(-2)	6.46(-2)	4.60(-2)	3.30(-4)	3.93(-2)	2.86(-2)
15	7.20(-8)	3.47(-6)	6.78(-5)	7.42(-4)	5.00(-3)	2.09(-2)	5.07(-2)	5.83(-2)	1.38(-2)	1.15(-2)	4.66(-2)

*Read as 4.11×10^{-1} .

Table 36. Band origin wavelengths and Einstein coefficients for $N_2\ b\ ^1\Pi_u-X\ ^1\Sigma_g^+$. For each $v'-v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm) and $A_{v'v''}$ (s^{-1}). Band origins from Carroll and Collins (1969) and Roncin *et al.* (1987). Einstein coefficients calculated by normalizing relative band intensities measured by James *et al.* (1990) to the $v' = 1$ lifetime of 1.75 ns measured by Oertel *et al.* (1981), corrected to a radiative lifetime of 1.96 ns by allowing for 10.5% predissociation as determined by James *et al.* The other levels of the $b\ ^1\Pi_u$ state are strongly predissociated and give little emission.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0986	0.1009	0.1033	0.1058	0.1083	0.1110	0.1138	0.1166	0.1196	0.1227	0.1259	0.1292	0.1326
	1.04(8)*	1.04(8)	1.21(8)	7.1(7)	3.9(7)	1.5(7)	†	†	1.4(7)	1.4(7)	1.05(7)	1.05(7)	8(6)

*Read as 1.04×10^8 .

†These bands were too weak to be measured by James *et al.* (1990).

Table 37. Band origin wavelengths and Einstein coefficients for N_2 c'_4 ${}^1\Sigma_u^+ - X$ ${}^1\Sigma_g^+$. For each $v' - v''$ band, the listed quantities are $\lambda_{v'v''}$ (μm) and $A_{v'v''}$ (s^{-1}). Band origins from Yoshino and Tanaka (1977) and Roncin *et al.* (1987), or calculated from data therein. Einstein coefficients for $v'' = 0$ from Table VII of Ajello *et al.* (1989). Einstein coefficients for $v'' > 0$ from relative band intensities, $I_{v'v''}/I_{v'0}$, measured by Ajello *et al.* and James *et al.* (1990), except for $v' = 1$ and 2, where $A_{v'0}$ were too small to be measured, so $A_{2v''}$ were normalized to the $v' = 2$ radiative lifetime (0.65 ns) measured by Oertel *et al.* (1981), while $A_{1v''}$ were normalized to the average of the radiative lifetimes for $v' = 0$ (0.74 ns) deduced by Ajello *et al.* and $v' = 2$ measured by Oertel *et al.* Bands from $v' = 5$ are weak and their intensities have not been measured.

$v' \setminus v''$	0	1	2	3	4	5	6	7	8
0	0.0959 1.14(9)*	0.0980 1.88(8)	0.1003 1.85(7)	0.1026 7.9(6)	0.1051 3.4(6)	0.1076 ~1.5(6)	0.1102 <5.3(6)	0.1128 <3.0(6)	0.1156 <2.9(6)
1	0.0940 2.9(7)	0.0961 ~4.2(8)	0.0983 ~4.0(8)	0.1005 ~6.0(7)	0.1029 <6(7)	0.1053 ~5(7)	0.1077 ~3(8)	0.1103 <2.1(8)	0.1130 <1.0(8)
2	0.0921 2.1(7)	0.0941 2.5(8)	0.0962 2.8(8)	0.0984 ~9.3(7)	0.1006 ~9.3(7)	0.1029 <9(7)	0.1053 ~1.3(8)	0.1077 ~4.6(8)	0.1102 <3.2(8)
3	0.0904 1.11(8)	0.0923 1.2(8)	0.0943 ~5.7(8)	0.0964 6.1(8)	0.0985 3.4(8)	0.1007 4.7(7)†	0.1030 <2(7)	0.1053 ~3.9(7)	0.1077 <5(7)
4	0.0887 2.43(8)	0.0905 ~1.5(8)	0.0925 ~9.7(6)	0.0945 ~3.37(8)	0.0965 ~2.9(8)	0.0986 ~2.8(8)	0.1008 ~1.04(8)†	0.1030 <1(7)	0.1053 <1(7)
6	0.0856 1.63(8)	0.0874 2.0(8)	0.0891 <1.4(8)†	0.0910 <2(7)†	0.0929 2.0(8)	0.0948 4.35(8)	0.0968 <1.5(8)†	0.0989 2.84(8)	0.1010 2.5(8)‡

*Read as 1.14×10^9 .

†Based on the upper limit value of the electron-impact emission cross section given in Table II of Ajello *et al.* (1989), less estimated contributions from overlapping features.

‡Based on a revised value of the electron-impact emission cross section, $0.55 \times 10^{-19} \text{ cm}^2$ (Ajello, private communication, September 1990).

Table 38. Band head wavelengths and Einstein coefficients for N_2 c'_4 $^1\Sigma_u^+-a$ $^1\Pi_g$. For each $v'-v''$ band, the listed quantities are $\lambda_{Hv'v''}$ (μm) and $A_{v'v''}$ (s^{-1}). Band heads from Lofthus and Krupenie (1977) (band origins not available). Einstein coefficients calculated from the electron-impact band intensities of Filippelli *et al.* (1984) relative to that of the c'_4-X 0-0 band of Ajello *et al.* (1989), normalized to the $A_{00}(c'_4-X)$ value of the latter.

$v' \setminus v''$	0	1	2	3	4	5
0	0.2827 1.98(6)*	0.2967 4.82(6)	0.3119 3.40(6)	0.3283 2.37(6)	0.3463 1.37(6)	0.3661 9.0(5)

*Read as 1.98×10^6 .

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