

UNCLASSIFIED

AD 4 6 4 5 3 5

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

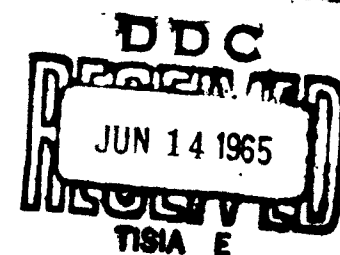
RECEIVED BY: DDC
461535

TECHNICAL INFORMATION SERIES

R65SD15

4 6 4 5 3 5

FREE-BOUND RADIATION FROM NITROGEN,
OXYGEN, AND AIR



M. P. SHERMAN
J. L. KULANDER

SPACE SCIENCES
LABORATORY

MISSILE AND SPACE DIVISION

GENERAL  ELECTRIC

SPACE SCIENCES LABORATORY

THEORETICAL FLUID PHYSICS SECTION

FREE-BOUND RADIATION FROM NITROGEN, OXYGEN, AND AIR

By

M. P. Sherman

J. L. Kulander

**This work was supported by the Office of Naval Research on
Contract No. Nonr-4188(00).**

**R65SD15
May, 1965**

MISSILE AND SPACE DIVISION

GENERAL  ELECTRIC

CONTENTS	PAGE
SUMMARY	iii
LIST OF FIGURES	iv
LIST OF TABLES	v
LIST OF SYMBOLS	vi
INTRODUCTION	1
CALCULATION OF THE PHOTOIONIZATION CROSS SECTION	3
SPONTANEOUS AND STIMULATED EMISSION	4
INTERNAL AND CHEMICAL EQUILIBRIUM	5
INTERNAL EQUILIBRIUM AND CHEMICAL NONEQUILIBRIUM	6
PRESENTATION OF RESULTS	8
ACKNOWLEDGEMENTS	9
REFERENCES	10
TABLES	11
FIGURES	26

SUMMARY

Photoabsorption cross sections for nitrogen and oxygen atoms are computed using the Method of Burgess and Seaton [2]. Results are presented for the radiative recombination of singly ionized nitrogen and oxygen applicable for equilibrium air, for chemical nonequilibrium with internal equilibrium, and internal nonequilibrium.

LIST OF FIGURES

1. Photoabsorption cross section for the 8-1 transition of N (D wave portion)
2. Absorption Coefficient per Nitrogen Atom - 5000 K
3. Absorption Coefficient per Nitrogen Atom - 10,000 K
4. Absorption Coefficient per Nitrogen Atom - 15,000 K
5. Absorption Coefficient per Oxygen Atom - 5,000 K
6. Absorption Coefficient per Oxygen Atom - 10,000 K
7. Absorption Coefficient per Oxygen Atom - 15,000 K
8. Bound-Free Absorption Coefficient of Equilibrium Air - 5,000 K
9. Bound-Free Absorption Coefficient of Equilibrium Air - 10,000 K
10. Total Rate of N^+ and O^+ Free-Bound Emission of Equilibrium Air
11. Planck Mean Absorption Coefficient per Atom of Nitrogen and Oxygen

LIST OF TABLES

- I. Nitrogen Levels and Transitions
- II. Oxygen Levels and Transitions
- III. Nitrogen Atom Photoionization Cross Sections
- IV. Oxygen Atom Photoionization Cross Sections
- V. Mean Absorption Coefficient per Nitrogen Atom
- VI. Mean Absorption Coefficient per Oxygen Atom
- VII. Bound-Free Absorption Coefficient of Air - 10^{-4} Atm
- VIII. Bound-Free Absorption Coefficient of Air - 10^{-2} Atm
- IX. Bound-Free Absorption Coefficient of Air - 1 Atm
- X. Bound-Free Absorption Coefficient of Air - 10^2 Atm

LIST OF SYMBOLS

A	= Angstrom unit
B	= Total equilibrium intensity
B_ν	= Equilibrium intensity per unit frequency interval
c	= Speed of light
E	= Electron kinetic energy
ΔE_{ij}	= Energy difference between state j of the ion and state i of the atom
f_e	= Electron distribution function - assumed Maxwellian
h	= Planck constant
k	= Boltzmann constant
K_ν	= Equilibrium spectral absorption coefficient
$K_{\nu s}$	= s species contribution to spectral absorption coefficient
K_P	= Equilibrium Planck mean absorption coefficient
K_{Ps}	= s species contribution to Planck mean absorption coefficient
m_e	= Electron mass
n_p	= Photon density per unit frequency interval
n_s	= Particle density of species s
n_{si}	= Particle density of energy level i of species s
T	= Temperature
ϵ	= Rate of spontaneous emission per unit volume
ϵ_ν	= Rate of spontaneous emission per unit volume per unit frequency interval

γ = Wavelength

ν = Frequency

$\bar{\sigma}_s$ = Mean absorption cross section of species s at frequency ν

σ_{sij} = Photoabsorption cross section for a transition from state i of the atom s to state j of the ion a frequency ν

σ_{sij}^+ = Radiative recombination cross section for a transition from state j of the ion s^+ to state i of the atom for an electron energy corresponding to emission of frequency ν

ϕ_{sji}^+ = Quantity related to the stimulated emission of frequency ν from an ion of species s^+

ω_s Statistical weight of energy level i of species s

INTRODUCTION

This report considers the absorption of radiation due to the photoionization of nitrogen and oxygen atoms, and the reverse process, the radiative recombination of singly ionized nitrogen and oxygen ions with electrons. Eighteen allowed radiative transitions between states of the atom and ion were considered for the nitrogen and twelve for the oxygen. This list of transitions can be found in Tables I and II.

The radiative recombination of singly ionized nitrogen and oxygen ions with electrons will be the principal source of radiation from air in the temperature range of ten to fifteen thousand degrees Kelvin. Other processes which contribute to the radiation are free-free radiative transitions (Bremsstrahlung), atomic line radiation, molecular bound-bound transitions, and radiative recombination of molecular ions and negative ions.

Results are presented for three possible conditions of nonequilibrium. If the population of the internal states concerned with the emission and possibly the absorption of radiation are not in a Boltzmann equilibrium distribution it is necessary to explicitly consider each radiative transition. If the internal states are in a Boltzmann distribution and the mole fractions of the various species are in equilibrium then the spontaneous emission of radiation per unit volume will be the equilibrium value. This is true whether the radiant intensity is the equilibrium value or if it is not, as in an optically thin gas. In this case it is possible to sum over all the

transitions of all the species and obtain an absorption coefficient for the gas and a corresponding rate of emission. There is a third possibility. The internal states may be in a Boltzmann distribution, but the mole fractions of the chemical species may be far from equilibrium. In this case it is possible to sum over all transitions involving a given species, but one can not add these results to obtain a value for the gas without knowing the composition of the gas.

As long as the gas is not in complete thermodynamic equilibrium, the material particles and the radiation, one can not expect to find the chemical composition or the internal distribution function to be in equilibrium because of the failure of the detailed balancing of individual processes. However, if the collisional processes are dominant the chemical composition and internal distribution can be very near equilibrium even if the radiation is not in equilibrium. Kulander (1) has shown for nitrogen and presumably for oxygen that there is a wide domain in which the internal states are near equilibrium even though the chemical composition and radiation are far from equilibrium. This results from the fact that the lower lying levels in N and O, which are the only levels significantly populated for the temperatures under consideration, do not have any allowed radiative transitions between them. Hence, the two partial equilibrium conditions considered do approximate many real situations.

If the absorption of radiation is negligible, as for an optically thin gas with small background radiation, then for internal and chemical equilibrium it is useful to integrate the absorption coefficient over the spectrum and obtain the Planck mean absorption coefficient. The total rate of emission per unit volume is then easily obtained. A slight generalization of these results permits application to the case of chemical nonequilibrium but internal equilibrium.

CALCULATION OF THE PHOTOIONIZATION CROSS SECTION

The photoionization cross sections are calculated using the "quantum defect" method of Burgess and Seaton (2). This method utilizes the empirically known energies of the bound atomic states to obtain the correct asymptotic forms for the bound and free wave functions. In other respects the wave function calculations are based on a central field approximation. The method obviously fails if no known energy levels are available. Further, since the wave functions are only approximate, their positive and negative contributions in obtaining the matrix elements sometimes cancel severely, yielding a near zero cross section. When this occurs, the result is described as highly sensitive and is of low accuracy. In frequency regimes where the sensitivity is high a hydrogenic value is fitted to the quantum defect result. Such problems affect about 30% of the cross sections at one frequency or another. An example of the procedures used is shown in Fig. 1.

SPONTANEOUS AND STIMULATED EMISSION

The spontaneous emission cross section and the stimulated emission are obtained from the photoionization cross section by detailed balancing at equilibrium. The volumetric rate of absorption for a given transition by a photon in frequency interval $d\nu$ is,

$$1) \quad n_s \sigma_{sij} c n_p d\nu$$

while the corresponding rate of spontaneous and stimulated emission is,

$$2) \quad f_e n_s + \left[\frac{2E}{m_e} \right]^{1/2} \left\{ \sigma_{sji}^+ + n_p \phi_{sji}^+ \right\} h d\nu$$

At equilibrium the photon density is

$$3) \quad n_p = \frac{8\pi\nu^2}{c^3} \left[\exp(h\nu/kT) - 1 \right]^{-1}$$

Equating absorption and emission we find

$$4) \quad \sigma_{sij} = \frac{2\omega_s + \frac{m_e c^2}{\nu^2 h^2}}{\omega_s} E \sigma_{sji}^+$$

$$5) \quad \sigma_{sji}^+ = \frac{8\pi\nu^2}{c^3} \phi_{sji}^+$$

INTERNAL AND CHEMICAL EQUILIBRIUM

The mean absorption cross section per particle of species s is,

$$6) \quad \bar{\sigma}_s = \sum_i \sum_j \frac{n_{si}}{n_s} \sigma_{sij}$$

where the summation is carried over all significant transitions for which

$$7) \quad E = h\nu - \Delta E_{ij} \geq 0$$

A graph of $\bar{\sigma}_s$ versus frequency will have jumps or "edges" at frequencies where additional terms enter the summation. The absorption coefficient including stimulated emission is defined

$$8) \quad K_\nu = \sum_s n_s \bar{\sigma}_s \left[1 - \exp(-h\nu/kT) \right]$$

The rate of emission is

$$9) \quad \epsilon_\nu = 4\pi K_\nu B_\nu$$

$$10) \quad \text{where } B_\nu = \frac{2h\nu^3}{c^2} \left[\exp(h\nu/kT) - 1 \right]$$

Integrating over frequency

$$11) \quad \epsilon = \int_0^\infty \epsilon_\nu d\nu = 4\pi B K_P$$

$$12) \quad K_P = \frac{\int_0^{\infty} K_{\nu} B_{\nu} d\nu}{B}$$

$$13) \quad B = \int_0^{\infty} B_{\nu} d\nu$$

INTERNAL EQUILIBRIUM AND CHEMICAL NONEQUILIBRIUM

The following relations are readily obtained from eqs. 1-7. The mean absorption cross section per particle is defined as before. The absorption coefficient including stimulated emission is

$$14) \quad K_{\nu} = \sum_s n_s \bar{\sigma}_s \left[1 - F_s \exp(-h\nu/kT) \right]$$

where

$$15) \quad F_s = \left(\frac{n_s + n_e}{n_s} \right) / \left(\frac{n_s + n_e}{n_s} \right)_{eq.}$$

The subscript eq. indicates equilibrium value.

The spontaneous emission is

$$\begin{aligned}
 16) \quad \epsilon_{\nu} &= 4\pi B_{\nu} \sum_s F_s n_s \bar{\sigma}_s \left[1 - \exp(-h\nu/kT) \right] \\
 &= 4\pi B_{\nu} \sum_s F_s K_{\nu s}
 \end{aligned}$$

where we have defined species absorption coefficients.

$$17) \quad K_{\nu s} = n_s \bar{\sigma}_s \left[1 - \exp(-h\nu/kT) \right]$$

We can integrate each species over frequency to obtain species Planck mean absorption coefficients.

$$18) \quad K_{Ps} = \int_0^{\infty} B_{\nu} K_{\nu s} d\nu / B$$

$$19) \quad \epsilon = 4\pi B \sum_s F_s K_{Ps}$$

Note that at chemical equilibrium as the F_s equal unity and the formulas become identical to those of the previous section.

PRESENTATION OF THE RESULTS

Since the various cross section are functions of frequency and temperature it is not practical to present all the results in graphical form. The figures used are for illustrative purposes. The tables present sufficient data so that more detailed graphs can be made and interpolation can be used. It is possible to use tables since the curves can be adequately described by the values at the edges and just before the edges.

The results are presented using three significant figures. However, the results are obtained from initial calculations of the photoionization cross sections which may be in error by as much as 50%.

For internal nonequilibrium the individual transition photoionization cross sections are presented. For internal equilibrium and chemical nonequilibrium the mean absorption coefficient per nitrogen and per oxygen atom are given. These are integrated over frequency to give Planck mean absorption coefficient per nitrogen and oxygen atom. For internal and chemical equilibrium the absorption coefficient is given. This is integrated over frequency to obtain total emission per unit volume.

The results are presented as functions of wave number. The relation between wavenumber (cm^{-1}), frequency (sec^{-1}), wavelength (cm), and wavelength ($\text{\AA}$) is

$$\begin{aligned}\text{wave number} &= \nu/c \\ &= 1/\lambda \\ &= 10^8/\text{\AA}\end{aligned}$$

ACKNOWLEDGEMENTS

The numerical results were obtained on an IBM 7094 digital computer by Mr. V. Kirk. The manuscript was typed by Mrs. M. F. Riba.

This work was supported by the Office of Naval Research on contract Nonr-4188(00).

REFERENCES

1. Kulander, J. L. "Departures from the Saha Equation in an Optically Thin Nitrogen Gas", GE-MSD TIS R64SD62, 1964 and J. Q. S. R. T., 5, 253, 1965.
2. Burgess, A. and Seaton, M. F., "A General Formula for the Calculation of Atomic Photo-ionization Cross Sections, "Monthly Notices Royal Astronomical Soc., V. 120, 1960, p. 9.

TABLE I
NITROGEN LEVELS AND TRANSITIONS

Level No.	Spectroscopic Designation	Mean energy above G. S. of Atom (cm ⁻¹)	Degeneracy	Transitions Atom → ion	ΔE (cm ⁻¹)
N					
1	⁴ S	0	4	1-1	117, 345
2	² D	19, 226	10	2-2 2-1	98, 118 113, 434
3	² P	28, 840	6	3-3 3-2 3-1	88, 505 103, 821 121, 198
4	⁴ P	83, 320	12	4-1	34, 026
5	² P	86, 200	6	5-1	31, 165
6	⁴ P	88, 140	12	6-7 6-6 6-5 6-4	73, 360 121, 442 138, 413 184, 322
7	² S	93, 582	2	7-1	23, 763
8	⁴ D	94, 830	20	8-1	22, 545
9	⁴ P	95, 500	12	9-1	21, 845
10	⁴ S	96, 752	4	10-1	20, 593
11	² D	96, 820	10	11-1	20, 525
12	² D	97, 790	6	12-1	19, 563
N⁺					
1	³ P	117, 345	9		
2	¹ D	132, 661	5		
3	¹ S	150, 038	1		
4	⁵ S	161, 513	5		
5	³ D	209, 545	15		
6	³ P	226, 566	9		
7	¹ D	272, 475	5		

TABLE II
OXYGEN LEVELS AND TRANSITIONS

	Level No.	Spectroscopic Designation	Mean energy above G. S. of Atom (cm^{-1})	Degeneracy	Transitions Atom $\rightarrow$ ion	ΔE
O	1	^3P	0	9	1-1 1-2 1-3	109, 837 136, 656 150, 304
	2	^1D	15, 868	5	2-2 2-3	120, 788 134, 436
	3	^1S	33, 792	1	3-3	116, 512
	4	^5S	73, 768	5	4-1	36, 069
	5	^3S	76, 795	3	5-1	33, 042
	6	^5P	86, 627	15	6-1	23, 210
	7	^3P	88, 630	9	7-1	21, 202
	8	^5S	95, 476	5	8-1	14, 361
	9	^3S	96, 226	3	9-1	13, 611
O^+	1	^4S	109, 837	4		
	2	^2D	136, 656	10		
	3	^2P	150, 304	6		

TABLE III
NITROGEN ATOM PHOTOIONIZATION CROSS SECTIONS

cm ⁻¹	A°	CROSS SECTION (cm ²)							
		12-1	11-1	10-1	9-1	8-1	7-1	5-1	4-1
19563.	5111.69	0.239-17*	0.	0.	0.	0.	0.	0.	0.
20525.	4872.11	0.246-17	0.320-17	0.	0.	0.	0.	0.	0.
20593.	4856.02	0.247-17	0.302-17	0.589-17	0.	0.	0.	0.	0.
21845.	4577.71	0.254-17	0.306-17	0.528-17	0.294-17	0.	0.	0.	0.
22545.	4435.57	0.256-17	0.307-17	0.496-17	0.250-17	0.439-17	0.	0.	0.
23763.	4208.22	0.257-17	0.306-17	0.447-17	0.190-17	0.345-17	0.291-17	0.	0.
31165.	3208.73	0.233-17	0.269-17	0.231-17	0.111-17	0.111-17	0.161-17	0.148-17	0.
34026.	2938.93	0.217-17	0.249-17	0.174-17	0.952-18	0.956-17	0.136-17	0.154-17	0.659-17
73360.	1363.14	0.718-18	0.801-18	0.288-18	0.147-18	0.195-18	0.218-18	0.887-18	0.192-17
88505.	1129.88	0.503-18	0.558-18	0.231-18	0.132-18	0.101-18	0.184-18	0.676-18	0.133-17
98118.	1019.18	0.411-18	0.454-18	0.200-18	0.120-18	0.848-19	0.164-18	0.574-18	0.108-17
103821.	963.20	0.366-18	0.405-18	0.184-18	0.113-18	0.810-19	0.153-18	0.523-18	0.963-18
113434.	881.57	0.306-18	0.337-18	0.160-18	0.102-18	0.746-19	0.136-18	0.450-18	0.801-18
117345.	825.19	0.285-18	0.314-18	0.152-18	0.979-19	0.720-19	0.130-18	0.424-18	0.746-18
121198.	825.10	0.266-18	0.293-18	0.144-18	0.938-19	0.695-19	0.124-18	0.401-18	0.697-18
121442.	823.44	0.265-18	0.292-18	0.143-18	0.936-19	0.694-19	0.124-18	0.399-18	0.694-18
138413.	722.48	0.201-18	0.221-18	0.114-18	0.778-19	0.592-19	0.102-18	0.315-18	0.525-18
184322.	542.53	0.108-18	0.118-18	0.674-19	0.489-19	0.389-19	0.628-19	0.183-18	0.281-18
200000.	500.00	0.904-19	0.985-19	0.575-19	0.424-19	0.340-19	0.541-19	0.156-18	0.235-18

*.993-17 is .993 x 10⁻¹⁷

TABLE III (Cont'd)

CROSS SECTION (cm ²)									
6-4	3-1	2-1	3-2	2-2	1-1	3-3	6-5	6-6	6-7
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.993-17	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.842-17	0.705-17	0.	0.	0.	0.	0.	0.	0.	0.
0.718-17	0.673-17	0.339-17	0.	0.	0.	0.	0.	0.	0.
0.648-17	0.637-17	0.326-17	0.322-17	0.	0.	0.	0.	0.	0.
0.543-17	0.564-17	0.293-17	0.302-17	0.231-17	0.	0.	0.	0.	0.
0.505-17	0.533-17	0.278-17	0.290-17	0.231-17	0.848-17	0.	0.	0.	0.
0.470-17	0.504-17	0.263-17	0.277-17	0.228-17	0.878-17	0.141-17	0.	0.	0.
0.468-17	0.502-17	0.262-17	0.276-17	0.228-17	0.879-17	0.141-17	0.192-17	0.	0.
0.344-17	0.385-17	0.200-17	0.217-17	0.199-17	0.865-17	0.141-17	0.212-17	0.995-18	0.
0.163-17	0.192-17	0.964-18	0.105-17	0.112-17	0.525-17	0.861-18	0.135-17	0.118-17	0.979-18
0.130-17	0.154-17	0.766-18	0.837-18	0.918-18	0.429-17	0.703-18	0.110-17	0.102-17	0.989-18

TABLE IV
OXYGEN ATOM PHOTOIONIZATION CROSS SECTIONS
(CROSS SECTION- cm^2)

cm^{-1}	A°	TRANSITIONS											
		9-1	8-1	7-1	6-1	5-1	4-1	1-1	3-3	2-2	2-3	1-2	1-3
13611.	7347.00	0.928-18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14361.	6963.30	0.903-18	0.874-18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21207.	4715.42	0.660-18	0.726-18	0.638-17	0.	0.	0.	0.	0.	0.	0.	0.	0.
23210.	4308.49	0.598-18	0.676-18	0.536-17	0.463-17	0.	0.	0.	0.	0.	0.	0.	0.
33042.	3026.45	0.378-18	0.470-18	0.235-17	0.123-17	0.533-18	0.	0.	0.	0.	0.	0.	0.
36069.	2772.46	0.332-18	0.421-18	0.178-17	0.105-17	0.552-18	0.523-18	0.	0.	0.	0.	0.	0.
109837.	910.44	0.414-19	0.678-19	0.195-18	0.877-19	0.185-18	0.208-18	0.352-17	0.	0.	0.	0.	0.
116516.	858.25	0.365-19	0.606-19	0.177-18	0.819-19	0.167-18	0.189-18	0.353-17	0.864-17	0.	0.	0.	0.
120788.	827.90	0.338-19	0.565-19	0.167-18	0.784-19	0.157-18	0.178-18	0.346-17	0.916-17	0.825-17	0.	0.	0.
134436.	743.85	0.268-19	0.458-19	0.139-18	0.682-19	0.130-18	0.147-18	0.306-17	0.943-17	0.843-17	0.134-17	0.	0.
136656.	731.76	0.259-19	0.444-19	0.135-18	0.667-19	0.126-18	0.143-18	0.298-17	0.934-17	0.835-17	0.140-17	0.222-17	0.
150304.	665.32	0.210-19	0.367-19	0.113-18	0.581-19	0.106-18	0.120-18	0.248-17	0.839-17	0.748-17	0.159-17	0.261-17	0.112-17
180000.	555.56	0.141-19	0.256-19	0.810-19	0.438-19	0.752-19	0.858-19	0.160-17	0.580-17	0.517-17	0.136-17	0.236-17	0.133-17
200000.	500.00	0.111-19	0.206-19	0.659-19	0.367-19	0.612-19	0.698-19	0.119-17	0.439-17	0.393-17	0.109-17	0.195-17	0.117-17

TABLE V. MEAN ABSORPTION COEFFICIENT PER NITROGEN ATOM

cm ⁻¹	$\overset{\circ}{\text{A}}$	Temperature in $\overset{\circ}{\text{K}}$							
		6000	8000	1000	12000	14000	16000	18000	20000
19500.	5128.21	0	0	0	0	0	0	0	0
19563.	5111.69	.229-27	.742-25	.222-23	.203-22	.945-22	.289-21	.673-21	.129-20
20500.	4878.05	.236-27	.770-25	.231-23	.212-22	.989-22	.303-21	.708-21	.136-20
20525.	4872.11	.846-27	.264-24	.776-23	.699-22	.322-21	.981-21	.227-20	.436-20
20593.	4856.02	.133-26	.412-24	.120-22	.108-21	.498-21	.151-20	.350-20	.672-20
21800.	4587.16	.129-26	.403-24	.118-22	.107-21	.493-21	.150-20	.349-20	.672-20
21845.	4577.71	.227-26	.681-24	.196-22	.174-21	.797-21	.241-20	.557-20	.106-19
22500.	4444.44	.211-26	.637-24	.184-22	.164-21	.752-21	.228-20	.528-20	.101-19
22545.	4435.57	.499-26	.142-23	.397-22	.347-21	.156-20	.470-20	.108-19	.205-19
23700.	4219.41	.417-26	.120-23	.337-22	.296-21	.134-20	.405-20	.932-20	.177-19
23763.	4208.22	.439-26	.125-23	.351-22	.308-21	.139-20	.420-20	.966-20	.184-19
31100.	3215.43	.221-26	.652-24	.187-22	.168-21	.777-21	.238-20	.557-20	.107-19
31165.	3208.73	.452-26	.103-23	.264-22	.222-21	.989-21	.295-20	.678-20	.129-19
34000.	2941.18	.433-26	.965-24	.244-22	.205-21	.911-21	.272-20	.626-20	.119-19
34026.	2938.93	.451-25	.663-23	.128-21	.895-21	.348-20	.946-20	.202-19	.364-19
73000.	1369.86	.138-25	.203-23	.394-22	.276-21	.108-20	.299-20	.648-20	.119-19
73360.	1363.14	.330-25	.561-23	.117-21	.866-21	.351-20	.985-20	.216-19	.401-19
88000.	1136.36	.262-25	.450-23	.949-22	.701-21	.285-20	.800-20	.176-19	.327-19
88505.	1129.88	.102-19	.545-19	.141-18	.257-18	.386-18	.514-18	.637-18	.751-18
98000.	1020.41	.980-20	.521-19	.135-18	.246-18	.369-18	.491-18	.607-18	.715-18
98118.	1019.18	.921-19	.298-18	.587-18	.898-18	.119-17	.145-17	.167-17	.186-17
103000.	970.87	.891-19	.288-18	.567-18	.867-18	.115-17	.140-17	.161-17	.179-17
103821.	963.20	.932-19	.311-18	.627-18	.978-18	.131-17	.162-17	.188-17	.211-17
113000.	884.96	.843-19	.281-18	.568-18	.886-18	.119-17	.147-17	.171-17	.191-17
113434.	881.57	.140-18	.448-18	.874-18	.132-17	.175-17	.212-17	.243-17	.269-17
117000.	854.70	.136-18	.435-18	.848-18	.128-17	.696-17	.205-17	.235-17	.260-17
117345.	852.19	.840-17	.824-17	.803-17	.782-17	.764-17	.748-17	.733-17	.719-17
121000.	826.45	.868-17	.848-17	.824-17	.799-17	.777-17	.758-17	.741-17	.724-17
121198.	825.10	.869-17	.850-17	.828-17	.805-17	.786-17	.769-17	.753-17	.739-17
121442.	823.44	.870-17	.852-17	.828-17	.806-17	.786-17	.769-17	.754-17	.740-17
138000.	724.64	.856-17	.833-17	.803-17	.773-17	.747-17	.724-17	.704-17	.685-17
138413.	722.48	.854-17	.830-17	.801-17	.771-17	.745-17	.722-17	.701-17	.683-17
184000.	543.48	.519-17	.503-17	.482-17	.461-17	.442-17	.425-17	.410-17	.397-17
184322.	542.53	.517-17	.501-17	.480-17	.459-17	.440-17	.423-17	.409-17	.396-17
200000.	500.00	.423-17	.409-17	.392-17	.374-17	.359-17	.345-17	.333-17	.323-17

TABLE VI. MEAN ABSORPTION COEFFICIENT PER OXYGEN ATOM

cm^{-1}	λ Å	Temperature in °K									
		6000.	8000.	10000.	12000.	14000.	16000.	18000.	20000.		
13600.	7352.94	0	0	0	0	0	0	0	0		
13611.	7347.00	.282-28	.840-26	.245-24	.224-23	.106-22	.335-22	.803-22	.159-21		
14300.	6993.01	.227-28	.828-26	.242-24	.223-23	.106-22	.335-22	.805-22	.160-21		
14361.	6963.30	.810-28	.235-25	.679-24	.617-23	.291-22	.913-22	.218-21	.432-21		
21200.	4716.98	.663-28	.198-25	.589-24	.550-23	.266-22	.852-22	.207-21	.417-21		
21207.	4715.42	.378-26	.747-24	.173-22	.137-21	.591-21	.173-20	.395-20	.753-20		
23200.	4310.34	.319-26	.634-24	.148-22	.118-21	.511-21	.151-20	.345-20	.661-20		
23210.	4308.49	.104-25	.190-23	.421-22	.325-21	.137-20	.387-20	.895-20	.169-19		
33000.	3030.30	.338-26	.631-24	.143-22	.113-21	.491-21	.145-20	.334-20	.644-20		
33042.	3026.45	.515-26	.803-24	.169-22	.129-21	.547-21	.159-20	.364-20	.696-20		
36000.	2777.78	.460-26	.695-24	.144-22	.109-21	.463-21	.135-20	.308-20	.590-20		
36069.	2772.46	.106-25	.118-23	.211-22	.147-21	.591-21	.167-20	.371-20	.699-20		
109000.	917.43	.331-26	.308-24	.482-23	.306-22	.115-21	.313-21	.680-21	.126-20		
109837.	910.44	.348-17	.341-17	.333-17	.325-17	.317-17	.309-17	.301-17	.294-17		
116000.	862.07	.349-17	.343-17	.334-17	.326-17	.318-17	.310-17	.303-17	.295-17		
116516.	858.25	.349-17	.342-17	.335-17	.327-17	.320-17	.314-17	.308-17	.302-17		
120000.	833.33	.344-17	.337-17	.330-17	.322-17	.315-17	.309-17	.304-17	.298-17		
120788.	827.90	.352-17	.361-17	.373-17	.384-17	.395-17	.404-17	.413-17	.419-17		
134000.	746.27	.314-17	.324-17	.337-17	.349-17	.361-17	.372-17	.382-17	.390-17		
134436.	743.85	.314-17	.327-17	.342-17	.358-17	.373-17	.387-17	.398-17	.408-17		
136000.	735.29	.308-17	.321-17	.337-17	.353-17	.368-17	.382-17	.393-17	.403-17		
136656.	731.76	.526-17	.535-17	.545-17	.556-17	.566-17	.575-17	.582-17	.587-17		
150000.	666.67	.515-17	.523-17	.532-17	.542-17	.550-17	.558-17	.564-17	.568-17		
150304.	665.32	.626-17	.631-17	.638-17	.644-17	.650-17	.655-17	.659-17	.661-17		
180000.	555.56	.531-17	.534-17	.536-17	.539-17	.542-17	.543-17	.544-17	.544-17		
200000.	500.00	.433-17	.434-17	.436-17	.437-17	.439-17	.440-17	.440-17	.439-17		

TABLE VII. BOUND-FREE ABSORPTION COEFFICIENT OF AIR - 10^{-4} ATM

PRESSURE = 0.0001		Temperature - °K									
cm ⁻¹	Å	6000	8000	10000	12000	14000	16000	18000	20000		
13600.	7352.94	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13611.	7347.00	0.7251E-11	0.1173E-08	0.2113E-04	0.7900E-09	0.3201E-07	0.1504E-09	0.7723E-10	0.4106E-10		
14300.	6993.01	0.7114E-11	0.1054E-08	0.2073E-08	0.7861E-09	0.3241E-07	0.1504E-09	0.7736E-10	0.4125E-10		
14361.	6963.30	0.2082E-10	0.3077E-08	0.5849E-08	0.2173E-08	0.1484E-07	0.4099E-09	0.2099E-09	0.1114E-09		
19500.	5128.21	0.1812E-10	0.2681E-08	0.5344E-08	0.2222E-08	0.1439E-07	0.3966E-09	0.2059E-09	0.1106E-09		
19563.	5111.69	0.2364E-09	0.3625E-07	0.5228E-07	0.1705E-07	0.0935E-08	0.3209E-08	0.1671E-08	0.9457E-09		
20500.	4878.05	0.2432E-09	0.3740E-07	0.5431E-07	0.1817E-07	0.1197E-08	0.3340E-08	0.1743E-08	0.9889E-09		
20525.	4872.11	0.8240E-09	0.1220E-06	0.1686E-06	0.5532E-07	0.2158E-07	0.9921E-08	0.5146E-08	0.2918E-08		
20573.	4856.02	0.1285E-08	0.1889E-06	0.2591E-06	0.8463E-07	0.3293E-07	0.1511E-07	0.7827E-08	0.4437E-08		
21200.	4716.98	0.1270E-08	0.1870E-06	0.2571E-06	0.8413E-07	0.3279E-07	0.1507E-07	0.7820E-08	0.4439E-08		
21207.	4715.42	0.2225E-08	0.2758E-06	0.4013E-06	0.1306E-06	0.5033E-07	0.2248E-07	0.1142E-07	0.6272E-08		
21800.	4587.16	0.2161E-08	0.2733E-06	0.3922E-06	0.1279E-06	0.4910E-07	0.2211E-07	0.1125E-07	0.6136E-08		
21845.	4577.71	0.3071E-08	0.3988E-06	0.5552E-06	0.1793E-06	0.6863E-07	0.3093E-07	0.1577E-07	0.8733E-08		
22500.	4444.44	0.2890E-08	0.3740E-06	0.5224E-06	0.1692E-06	0.6493E-07	0.2932E-07	0.1497E-07	0.8307E-08		
22545.	4435.57	0.5626E-08	0.7287E-06	0.9721E-06	0.3303E-06	0.1175E-06	0.5287E-07	0.2696E-07	0.1502E-07		
23200.	4310.34	0.5114E-08	0.6639E-06	0.8894E-06	0.2835E-06	0.1081E-06	0.4873E-07	0.2489E-07	0.1388E-07		
23210.	4308.49	0.6986E-08	0.8259E-06	0.1125E-05	0.3562E-06	0.1363E-06	0.5977E-07	0.3017E-07	0.1654E-07		
23700.	4210.41	0.6479E-08	0.7682E-06	0.1049E-05	0.3328E-06	0.1257E-06	0.5605E-07	0.2833E-07	0.1558E-07		
23763.	4208.22	0.6586E-08	0.7929E-06	0.1079E-05	0.3418E-06	0.1270E-06	0.5751E-07	0.2907E-07	0.1596E-07		
31100.	3215.43	0.3103E-08	0.3865E-06	0.5354E-06	0.1736E-06	0.0703E-07	0.3053E-07	0.1574E-07	0.8812E-08		
31165.	3208.73	0.5302E-08	0.5579E-06	0.6988E-06	0.2150E-06	0.8068E-07	0.3609E-07	0.1837E-07	0.1021E-07		
33000.	3030.30	0.5067E-08	0.5275E-06	0.6532E-06	0.2010E-06	0.7563E-07	0.3378E-07	0.1722E-07	0.9593E-08		
33042.	3026.45	0.5520E-08	0.5494E-06	0.6758E-06	0.2066E-06	0.7715E-07	0.3443E-07	0.1751E-07	0.9727E-08		
34000.	2941.18	0.5405E-08	0.5341E-06	0.6541E-06	0.1996E-06	0.7452E-07	0.3326E-07	0.1693E-07	0.9413E-08		
34026.	2938.03	0.4432E-07	0.3097E-05	0.2842E-05	0.7262E-06	0.2406E-06	0.9878E-07	0.4724E-07	0.2517E-07		
36000.	2777.78	0.4140E-07	0.2892E-05	0.2653E-05	0.6732E-06	0.2250E-06	0.9250E-07	0.4491E-07	0.2366E-07		
36069.	2772.46	0.4294E-07	0.2955E-05	0.2710E-05	0.6915E-06	0.2289E-06	0.9373E-07	0.4492E-07	0.2394E-07		
73000.	1369.86	0.1477E-07	0.9949E-06	0.9105E-06	0.2319E-06	0.7700E-07	0.3183E-07	0.1538E-07	0.8308E-08		
73360.	1363.14	0.3305E-07	0.2610E-05	0.2500E-05	0.6821E-06	0.2334E-06	0.9856E-07	0.4839E-07	0.2651E-07		
88000.	1136.36	0.2519E-07	0.2090E-05	0.2059E-05	0.5502E-06	0.1806E-06	0.7977E-07	0.3924E-07	0.2154E-07		

88505.	1129.88	0.9769E-02	0.2464E-01	0.2983E-02	0.1968E-03	0.2648E-04	0.5002E-05	0.1387E-05	0.4846E-06
98000.	1020.41	0.9341E-02	0.2356E-01	0.2852E-02	0.1881E-03	0.2377E-04	0.4775E-05	0.1322E-05	0.4615E-06
98118.	1019.18	0.8777E-01	0.1347E-00	0.1237E-01	0.6859E-03	0.7690E-04	0.1414E-04	0.3651E-05	0.1203E-05
103000.	970.87	0.8495E-01	0.1302E-00	0.1195E-01	0.6622E-03	0.7418E-04	0.1363E-04	0.3518E-05	0.1159E-05
103821.	963.20	0.8881E-01	0.1406E-00	0.1322E-01	0.7467E-03	0.8490E-04	0.1577E-04	0.4107E-05	0.1362E-05
109000.	917.43	0.8432E-01	0.1335E-00	0.1256E-01	0.7093E-03	0.8965E-04	0.1498E-04	0.3901E-05	0.1293E-05
109837.	910.44	0.9794E-00	0.5699E-00	0.4130E-01	0.1853E-02	0.1773E-03	0.2886E-04	0.6801E-05	0.2052E-05
113000.	884.96	0.9815E-00	0.5667E-00	0.4091E-01	0.1828E-02	0.1743E-03	0.2826E-04	0.6640E-05	0.1797E-05
113434.	881.57	0.1035E-01	0.6419E-00	0.4736E-01	0.2165E-02	0.2102E-03	0.3458E-04	0.8212E-05	0.2498E-05
116000.	862.07	0.1029E-01	0.6363E-00	0.4687E-01	0.2139E-02	0.2073E-03	0.3407E-04	0.8082E-05	0.2455E-05
116516.	858.25	0.1028E-01	0.6360E-00	0.4689E-01	0.2143E-02	0.2080E-03	0.3423E-04	0.8131E-05	0.2472E-05
117000.	854.70	0.1025E-01	0.6336E-00	0.4669E-01	0.2139E-02	0.2068E-03	0.3402E-04	0.8077E-05	0.2455E-05
117345.	852.19	0.8904E-01	0.4162E-01	0.1980E-00	0.7121E-02	0.5899E-03	0.8674E-04	0.1890E-04	0.5410E-05
120000.	833.33	0.9095E-01	0.4243E-01	0.2011E-00	0.7211E-02	0.5958E-03	0.8741E-04	0.1901E-04	0.5433E-05
120788.	827.90	0.9117E-01	0.4274E-01	0.2048E-00	0.7428E-02	0.6200E-03	0.9168E-04	0.2006E-04	0.5744E-05
121000.	826.45	0.9174E-01	0.4298E-01	0.2057E-00	0.7454E-02	0.6216E-03	0.9186E-04	0.2008E-04	0.5749E-05
121198.	825.10	0.9187E-01	0.4308E-01	0.2065E-00	0.7499E-02	0.6269E-03	0.9288E-04	0.2036E-04	0.5842E-05
121442.	823.44	0.9199E-01	0.4313E-01	0.2067E-00	0.7504E-02	0.6273E-03	0.9292E-04	0.2037E-04	0.5846E-05
134000.	746.27	0.9133E-01	0.4261E-01	0.2021E-00	0.7248E-02	0.6045E-03	0.8906E-04	0.1943E-04	0.5555E-05
134436.	743.85	0.9133E-01	0.4264E-01	0.2026E-00	0.7311E-02	0.6081E-03	0.8970E-04	0.1959E-04	0.5603E-05
136000.	735.29	0.9043E-01	0.4220E-01	0.2004E-00	0.7224E-02	0.6005E-03	0.8853E-04	0.1932E-04	0.5524E-05
136656.	731.76	0.9602E-01	0.4493E-01	0.2183E-00	0.7939E-02	0.6600E-03	0.9720E-04	0.2113E-04	0.5998E-05
138000.	724.64	0.9514E-01	0.4450E-01	0.2163E-00	0.7864E-02	0.6544E-03	0.9619E-04	0.2090E-04	0.5929E-05
138413.	722.48	0.9493E-01	0.4440E-01	0.2159E-00	0.7847E-02	0.6527E-03	0.9597E-04	0.2086E-04	0.5915E-05
150000.	666.67	0.8728E-01	0.4079E-01	0.1987E-00	0.7219E-02	0.5996E-03	0.8793E-04	0.1906E-04	0.5389E-05
150304.	665.32	0.9011E-01	0.4217E-01	0.2078E-00	0.7580E-02	0.6301E-03	0.9231E-04	0.1998E-04	0.5629E-05
179000.	558.66	0.6555E-01	0.3114E-01	0.1550E-00	0.5669E-02	0.4707E-03	0.6874E-04	0.1482E-04	0.4152E-05
180000.	555.56	0.6576E-01	0.3077E-01	0.1532E-00	0.5603E-02	0.4652E-03	0.6793E-04	0.1465E-04	0.4103E-05
184322.	542.53	0.6245E-01	0.2922E-01	0.1457E-00	0.5330E-02	0.4425E-03	0.6461E-04	0.1393E-04	0.3971E-05
199000.	502.51	0.5208E-01	0.2437E-01	0.1217E-00	0.4455E-02	0.3698E-03	0.5395E-04	0.1162E-04	0.3252E-05
200000.	500.00	0.5143E-01	0.2407E-01	0.1202E-00	0.4400E-02	0.3653E-03	0.5329E-04	0.1148E-04	0.3212E-05

TABLE VIII. BOUND-FREE ABSORPTION COEFFICIENT OF AIR - 10^{-2} ATM

PRESSURE = 0.0100

cm^{-1}	$\text{\AA}$	Temperature - $^{\circ}\text{K}$					16000					18000					20000				
		12000	14000	16000	18000	20000															
13600.	7352.94	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13611.	7347.00	0.7922E-11	0.1567E-08	0.2531E-07	0.5304E-07	0.3985E-07	0.1491E-07	0.7706E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08	0.4103E-08
14300.	6993.01	0.7771E-11	0.1545E-08	0.2526E-07	0.5272E-07	0.3776E-07	0.1490E-07	0.7719E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08	0.4117E-08
14361.	6963.30	0.2274E-10	0.4393E-08	0.7661E-07	0.1457E-06	0.8435E-07	0.4062E-07	0.2095E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07	0.1113E-07
19500.	5128.21	0.1980E-10	0.3917E-08	0.6450E-07	0.1361E-06	0.8228E-07	0.3930E-07	0.2055E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07	0.1103E-07
19563.	5111.69	0.2117E-09	0.5507E-07	0.8462E-06	0.1335E-05	0.5711E-05	0.3191E-05	0.1669E-05	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07	0.7453E-07
20500.	4878.05	0.2175E-09	0.5683E-07	0.8758E-06	0.1384E-05	0.5368E-05	0.3321E-05	0.1740E-05	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07	0.9884E-07
20525.	4872.11	0.7282E-09	0.1857E-06	0.2785E-05	0.4254E-05	0.2592E-05	0.9867E-06	0.5139E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06	0.2916E-06
20593.	4856.72	0.1134E-08	0.2877E-06	0.4232E-05	0.6519E-05	0.3193E-05	0.1503E-05	0.7816E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06	0.4435E-06
21200.	4716.78	0.1120E-03	0.2849E-06	0.4258E-05	0.6480E-05	0.3180E-05	0.1499E-05	0.7809E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06	0.4437E-06
21207.	4715.42	0.2163E-08	0.4204E-06	0.5999E-05	0.9596E-05	0.4816E-05	0.2233E-05	0.1143E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05	0.6289E-05
21800.	4587.16	0.2097E-03	0.4107E-06	0.5879E-05	0.9409E-05	0.4727E-05	0.2197E-05	0.1123E-05	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06	0.6191E-06
21845.	4577.71	0.2915E-08	0.6021E-06	0.8933E-05	0.1338E-04	0.6622E-05	0.3074E-05	0.1574E-05	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06	0.8728E-06
22500.	4444.44	0.2726E-08	0.5645E-06	0.8983E-05	0.1262E-04	0.6265E-05	0.2914E-05	0.1495E-05	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06	0.8333E-06
22545.	4435.57	0.5132E-08	0.1105E-05	0.1557E-04	0.2342E-04	0.1136E-04	0.5256E-05	0.2692E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05	0.1501E-05
23200.	4310.34	0.4577E-08	0.1007E-05	0.1423E-04	0.2148E-04	0.1045E-04	0.4844E-05	0.2486E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05	0.1389E-05
23210.	4308.49	0.6716E-08	0.1243E-05	0.1707E-04	0.2635E-04	0.1294E-04	0.5938E-05	0.3012E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05	0.1633E-05
23700.	4219.41	0.6229E-08	0.1156E-05	0.1592E-04	0.2463E-04	0.1212E-04	0.5569E-05	0.2829E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05	0.1554E-05
23763.	4208.22	0.6411E-08	0.1194E-05	0.1641E-04	0.2532E-04	0.1244E-04	0.5715E-05	0.2903E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05	0.1596E-05
31100.	3215.43	0.2739E-08	0.5832E-06	0.8272E-05	0.1295E-04	0.6467E-05	0.3034E-05	0.1571E-05	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06	0.8808E-06
31165.	3203.73	0.4873E-08	0.8444E-06	0.1396E-04	0.1615E-04	0.7792E-05	0.3587E-05	0.1834E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05	0.1020E-05
33000.	3035.30	0.4640E-08	0.7980E-06	0.1031E-04	0.1512E-04	0.7287E-05	0.3357E-05	0.1720E-05	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06	0.9589E-06
33042.	3026.45	0.5135E-08	0.8308E-06	0.1058E-04	0.1550E-04	0.7450E-05	0.3422E-05	0.1748E-05	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06	0.9723E-06
34000.	2941.18	0.5024E-08	0.8070E-06	0.1026E-04	0.1498E-04	0.7197E-05	0.3306E-05	0.1690E-05	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06	0.9409E-06
34026.	2938.93	0.3924E-07	0.4714E-05	0.4669E-04	0.5566E-04	0.2331E-04	0.9824E-05	0.4717E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05	0.2516E-05
36000.	2777.78	0.3665E-07	0.4402E-05	0.4361E-04	0.5201E-04	0.2180E-04	0.9199E-05	0.4425E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05	0.2365E-05
36069.	2772.46	0.3834E-07	0.4493E-05	0.4430E-04	0.5290E-04	0.2217E-04	0.9349E-05	0.4486E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05	0.2393E-05
73000.	1369.86	0.1331E-07	0.1512E-05	0.1480E-04	0.1771E-04	0.7457E-05	0.3165E-05	0.1536E-05	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06	0.8306E-06
73360.	1363.14	0.2339E-07	0.3972E-05	0.4227E-04	0.5249E-04	0.2263E-04	0.9803E-05	0.4833E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05	0.2650E-05
88000.	1136.36	0.2328E-07	0.3181E-05	0.3403E-04	0.4233E-04	0.1829E-04	0.7933E-05	0.3918E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05	0.2153E-05

88505.	1129.88	0.8588E-02	0.3754E-01	0.4968E-01	0.1521E-01	0.2414E-02	0.4975E-03	0.1385E-03	0.4844E-04
98000.	1020.41	0.8213E-02	0.3503E-01	0.4750E-01	0.1454E-01	0.2307E-02	0.4750E-03	0.1321E-03	0.4612E-04
98118.	1010.18	0.7717E-01	0.2053E-00	0.2060E-00	0.5299E-01	0.7461E-02	0.1406E-02	0.3646E-03	0.1202E-03
103000.	970.87	0.7468E-01	0.1985E-00	0.1990E-00	0.5115E-01	0.7197E-02	0.1356E-02	0.3513E-03	0.1158E-03
103821.	963.20	0.7808E-01	0.2142E-00	0.2202E-00	0.5769E-01	0.8238E-02	0.1569E-02	0.4102E-03	0.1361E-03
109000.	917.43	0.7413E-01	0.2034E-00	0.2092E-00	0.5490E-01	0.7825E-02	0.1491E-02	0.3896E-03	0.1293E-03
109837.	910.44	0.1252E 01	0.8410E 00	0.5561E 00	0.1315E-00	0.1700E-01	0.2865E-02	0.6790E-03	0.2051E-03
113000.	884.96	0.1055E 01	0.8358E 00	0.5487E 00	0.1295E-00	0.1670E-01	0.2806E-02	0.6629E-03	0.1996E-03
113434.	881.57	0.1102E 01	0.9506E 00	0.6560E 00	0.1555E-00	0.2201E-01	0.3435E-02	0.8199E-03	0.2497E-03
116000.	862.07	0.1096E 01	0.9421E 00	0.6484E 00	0.1535E-00	0.1991E-01	0.3384E-02	0.8069E-03	0.2454E-03
116516.	858.25	0.1075E 01	0.9416E 00	0.6486E 00	0.1538E-00	0.1998E-01	0.3400E-02	0.8118E-03	0.2471E-03
117000.	854.70	0.1093E 01	0.9380E 00	0.6454E 00	0.1530E-00	0.1986E-01	0.3379E-02	0.8064E-03	0.2454E-03
117345.	852.19	0.8019E 01	0.6314E 01	0.3165E 01	0.5385E 00	0.5703E-01	0.8623E-02	0.1887E-02	0.5408E-03
120000.	833.33	0.8185E 01	0.6439E 01	0.3219E 01	0.5456E 00	0.5760E-01	0.8690E-02	0.1898E-02	0.5430E-03
120788.	827.90	0.8209E 01	0.6484E 01	0.3264E 01	0.5601E 00	0.5990E-01	0.9113E-02	0.2003E-02	0.5742E-03
121000.	826.45	0.8259E 01	0.6521E 01	0.3279E 01	0.5622E 00	0.6006E-01	0.9130E-02	0.2005E-02	0.5746E-03
121198.	825.10	0.8270E 01	0.6530E 01	0.3292E 01	0.5636E 00	0.6057E-01	0.9232E-02	0.2033E-02	0.5839E-03
121442.	823.44	0.8281E 01	0.6543E 01	0.3295E 01	0.5660E 00	0.6061E-01	0.9236E-02	0.2034E-02	0.5843E-03
136000.	746.27	0.8202E 01	0.6467E 01	0.3234E 01	0.5499E 00	0.5842E-01	0.8853E-02	0.1940E-02	0.5552E-03
136436.	743.85	0.8202E 01	0.6472E 01	0.3239E 01	0.5523E 00	0.5876E-01	0.8916E-02	0.1956E-02	0.5600E-03
136000.	735.29	0.8119E 01	0.6405E 01	0.3204E 01	0.5455E 00	0.5802E-01	0.8800E-02	0.1929E-02	0.5522E-03
136656.	731.76	0.8730E 01	0.6803E 01	0.3421E 01	0.5934E 00	0.5376E-01	0.9659E-02	0.2110E-02	0.5995E-03
138000.	724.64	0.8653E 01	0.6739E 01	0.3387E 01	0.5876E 00	0.6313E-01	0.9559E-02	0.2087E-02	0.5926E-03
138413.	722.48	0.8535E 01	0.6724E 01	0.3379E 01	0.5863E 00	0.6299E-01	0.9537E-02	0.2082E-02	0.5913E-03
150000.	666.67	0.7956E 01	0.6173E 01	0.3099E 01	0.5383E 00	0.5782E-01	0.8737E-02	0.1903E-02	0.5387E-03
150304.	665.32	0.8265E 01	0.6375E 01	0.3208E 01	0.5625E 00	0.6072E-01	0.9171E-02	0.1994E-02	0.5626E-03
179000.	558.66	0.6145E 01	0.4702E 01	0.2368E 01	0.4185E-00	0.4532E-01	0.6828E-02	0.1480E-02	0.4150E-03
180000.	555.56	0.6073E 01	0.4644E 01	0.2340E 01	0.4135E-00	0.4479E-01	0.6748E-02	0.1462E-02	0.4101E-03
184322.	542.53	0.5771E 01	0.4412E 01	0.2222E 01	0.3932E-00	0.4260E-01	0.6418E-02	0.1390E-02	0.3899E-03
199000.	502.51	0.4918E 01	0.3678E 01	0.1853E 01	0.3283E-00	0.3559E-01	0.5359E-02	0.1160E-02	0.3250E-03
200000.	500.00	0.4759E 01	0.3633E 01	0.1830E 01	0.3243E-00	0.3516E-01	0.5294E-02	0.1146E-02	0.3210E-03

TABLE IX. BOUND-FREE ABSORPTION COEFFICIENT OF AIR - 1 ATM

PRESSURE = 1.0000

cm^{-1}	$\text{\AA}$	Temperature $^{\circ}\text{K}$						
		6000	8000	10000	12000	14000	16000	18000 20000
13600.	7352.94	0.	0.	0.	0.	0.	0.	0.
13611.	7347.06	0.1081E-10	0.1716E-08	0.3672E-07	0.2399E-06	0.6439E-05	0.8306E-06	0.6368E-06 0.3854E-06
14300.	6993.01	0.1061E-10	0.1692E-08	0.3636E-07	0.2384E-06	0.6469E-05	0.8302E-06	0.6378E-06 0.3868E-06
14361.	6963.30	0.3104E-10	0.4810E-08	0.1016E-06	0.6591E-06	0.1774E-05	0.2263E-05	0.1731E-05 0.1046E-05
19500.	5128.21	0.2702E-10	0.4289E-08	0.2286E-07	0.6154E-06	0.1633E-05	0.2189E-05	0.1698E-05 0.1038E-05
19563.	5111.69	0.7417E-10	0.5287E-07	0.1313E-05	0.8242E-05	0.1957E-04	0.2107E-04	0.1465E-04 0.3037E-05
20500.	4878.05	0.7481E-10	0.5452E-07	0.1359E-05	0.8559E-05	0.2036E-04	0.2196E-04	0.1529E-04 0.9451E-05
20525.	4872.11	0.2003E-09	0.1769E-06	0.4333E-05	0.2682E-04	0.5266E-04	0.6615E-04	0.4536E-04 0.2792E-04
20593.	4856.02	0.2999E-09	0.2737E-06	0.6690E-05	0.4123E-04	0.9589E-04	0.1010E-03	0.6904E-04 0.4248E-04
21200.	4716.98	0.2960E-09	0.2710E-06	0.6638E-05	0.4099E-04	0.9552E-04	0.1007E-03	0.6900E-04 0.4250E-04
21207.	4715.42	0.1720E-08	0.4195E-06	0.9144E-05	0.5508E-04	0.1299E-03	0.1417E-03	0.9868E-04 0.5971E-04
21800.	4587.16	0.1645E-08	0.4093E-06	0.8967E-05	0.5415E-04	0.1279E-03	0.1395E-03	0.9730E-04 0.5897E-04
21845.	4577.71	0.1846E-08	0.5911E-06	0.1320E-04	0.7941E-04	0.1853E-03	0.1987E-03	0.1372E-03 0.8329E-04
22500.	4444.44	0.1734E-08	0.5543E-06	0.1242E-04	0.7490E-04	0.1752E-03	0.1884E-03	0.1303E-03 0.7922E-04
22545.	4435.57	0.2325E-08	0.1068E-05	0.2410E-04	0.1436E-03	0.3299E-03	0.3465E-03	0.2363E-03 0.1435E-03
23200.	4310.34	0.2152E-08	0.9731E-06	0.2202E-04	0.1315E-03	0.3026E-03	0.3191E-03	0.2181E-03 0.1327E-03
23210.	4308.49	0.4742E-08	0.1232E-05	0.2611E-04	0.1536E-03	0.3550E-03	0.3800E-03	0.2616E-03 0.1576E-03
23700.	4219.41	0.4585E-08	0.1146E-05	0.2435E-04	0.1435E-03	0.3323E-03	0.3564E-03	0.2457E-03 0.1482E-03
23763.	4208.22	0.4630E-08	0.1182E-05	0.2512E-04	0.1479E-03	0.3421E-03	0.3662E-03	0.2522E-03 0.1521E-03
31100.	3215.43	0.1932E-08	0.5734E-06	0.1270E-04	0.7678E-04	0.1809E-03	0.1962E-03	0.1369E-03 0.8405E-04
31165.	3208.73	0.2437E-08	0.8214E-06	0.1690E-04	0.9714E-04	0.2203E-03	0.2335E-03	0.1602E-03 0.9742E-04
33000.	3030.30	0.2202E-08	0.7757E-06	0.1591E-04	0.9129E-04	0.2074E-03	0.2190E-03	0.1503E-03 0.9157E-04
33042.	3026.45	0.2979E-08	0.8108E-06	0.1630E-04	0.9298E-04	0.2108E-03	0.2226E-03	0.1527E-03 0.9283E-04
34000.	2941.18	0.2794E-08	0.7879E-06	0.1580E-04	0.9000E-04	0.2039E-03	0.2152E-03	0.1477E-03 0.8984E-04
34026.	2938.93	0.1120E-07	0.4498E-05	0.7266E-04	0.3488E-03	0.6910E-03	0.6552E-03	0.4156E-03 0.2408E-03
36000.	2777.78	0.1045E-07	0.4179E-05	0.6787E-04	0.3261E-03	0.6473E-03	0.6139E-03	0.3899E-03 0.2263E-03
36069.	2772.46	0.1275E-07	0.4299E-05	0.6887E-04	0.3301E-03	0.6551E-03	0.6217E-03	0.3949E-03 0.2289E-03
73000.	1369.86	0.5175E-08	0.1451E-05	0.2298E-04	0.1101E-03	0.2197E-03	0.2104E-03	0.1352E-03 0.7945E-04
73360.	1363.14	0.9125E-08	0.3788E-05	0.6585E-04	0.3314E-03	0.6788E-03	0.6585E-03	0.4270E-03 0.2538E-03
88000.	1136.36	0.7174E-08	0.3033E-05	0.5302E-04	0.2676E-03	0.5490E-03	0.5333E-03	0.3463E-03 0.2762E-03

98505.	1129.38	0.2110E-02	0.3545E-01	0.7752E-01	0.0673E-01	0.7305E-01	0.3358E-01	0.1226E-01	0.4641E-02
98000.	1023.41	0.2018E-02	0.3409E-01	0.7412E-01	0.0247E-01	0.6980E-01	0.3206E-01	0.1169E-01	0.4420E-02
98118.	1019.18	0.1996E-01	0.1950E-00	0.3215E-00	0.3371E-00	0.2258E-00	0.9491E-01	0.3227E-01	0.1152E-01
103000.	976.87	0.1935E-01	0.1885E-00	0.3106E-00	0.3254E-00	0.2178E-00	0.9151E-01	0.3110E-01	0.1110E-01
103821.	963.20	0.1918E-01	0.2034E-00	0.3437E-00	0.3670E-00	0.2493E-00	0.1059E-00	0.3630E-01	0.1304E-01
109000.	917.43	0.1921E-01	0.1932E-00	0.3264E-00	0.3486E-00	0.2368E-00	0.1006E-00	0.3449E-01	0.1239E-01
109837.	910.44	0.1353E-01	0.8914E-00	0.8259E-00	0.6936E-00	0.4298E-00	0.1772E-00	0.5840E-01	0.1951E-01
113000.	884.96	0.1361E-01	0.8871E-00	0.8141E-00	0.6818E-00	0.4201E-00	0.1731E-00	0.5696E-01	0.1698E-01
113434.	881.57	0.1372E-01	0.9960E-00	0.9815E-00	0.8472E-00	0.5255E-00	0.2155E-00	0.7086E-01	0.2378E-01
116000.	862.07	0.1367E-01	0.9877E-00	0.9697E-00	0.8352E-00	0.5175E-00	0.2121E-00	0.6971E-01	0.2337E-01
116516.	858.25	0.1366E-01	0.9872E-00	0.9701E-00	0.8364E-00	0.5189E-00	0.2130E-00	0.7012E-01	0.2353E-01
117000.	854.70	0.1363E-01	0.9836E-00	0.9651E-00	0.8314E-00	0.5156E-00	0.2116E-00	0.6964E-01	0.2337E-01
117345.	852.19	0.3365E-01	0.6089E-01	0.6878E-01	0.3284E-01	0.1640E-01	0.5656E-00	0.1653E-00	0.5167E-01
120000.	833.33	0.3370E-01	0.6207E-01	0.6982E-01	0.3331E-01	0.1659E-01	0.5703E-00	0.1663E-00	0.5189E-01
129788.	827.90	0.3124E-01	0.6256E-01	0.5046E-01	0.3336E-01	0.1707E-01	0.5939E-00	0.1749E-00	0.5481E-01
121000.	826.45	0.3135E-01	0.6291E-01	0.5070E-01	0.3410E-01	0.1712E-01	0.5951E-00	0.1752E-00	0.5685E-01
121198.	825.10	0.3138E-01	0.6304E-01	0.5090E-01	0.3431E-01	0.1727E-01	0.6019E-00	0.1776E-00	0.5575E-01
121442.	823.44	0.3140E-01	0.6312E-01	0.5096E-01	0.3434E-01	0.1728E-01	0.6023E-00	0.1777E-00	0.5579E-01
134000.	746.27	0.3001E-01	0.6230E-01	0.5004E-01	0.3347E-01	0.1671E-01	0.5781E-00	0.1696E-00	0.5302E-01
134436.	743.85	0.3002E-01	0.6235E-01	0.5012E-01	0.3356E-01	0.1678E-01	0.5816E-00	0.1709E-00	0.5346E-01
136000.	735.29	0.2964E-01	0.6170E-01	0.4957E-01	0.3317E-01	0.1657E-01	0.5740E-00	0.1686E-00	0.5271E-01
136656.	731.76	0.3798E-01	0.6606E-01	0.5269E-01	0.3534E-01	0.1778E-01	0.6218E-00	0.1835E-00	0.5716E-01
138000.	724.64	0.3783E-01	0.6545E-01	0.5216E-01	0.3496E-01	0.1759E-01	0.6150E-00	0.1814E-00	0.5650E-01
138413.	722.48	0.3778E-01	0.6531E-01	0.5204E-01	0.3488E-01	0.1754E-01	0.6136E-00	0.1813E-00	0.5637E-01
150000.	666.67	0.3574E-01	0.6034E-01	0.4768E-01	0.3189E-01	0.1603E-01	0.5605E-00	0.1653E-00	0.5134E-01
150304.	665.32	0.3996E-01	0.6225E-01	0.4726E-01	0.3299E-01	0.1664E-01	0.5847E-00	0.1728E-00	0.5359E-01
179000.	558.66	0.3174E-01	0.4611E-01	0.3627E-01	0.2426E-01	0.1225E-01	0.4321E-00	0.1279E-00	0.3950E-01
180000.	555.56	0.3161E-01	0.4557E-01	0.3583E-01	0.2397E-01	0.1211E-01	0.4270E-00	0.1263E-00	0.3903E-01
184322.	542.53	0.3325E-01	0.4329E-01	0.3403E-01	0.2276E-01	0.1150E-01	0.4058E-00	0.1201E-00	0.3711E-01
199000.	502.51	0.2559E-01	0.3612E-01	0.2736E-01	0.1836E-01	0.9584E-00	0.3384E-00	0.1052E-00	0.3093E-01
200000.	500.00	0.2530E-01	0.3568E-01	0.2801E-01	0.1873E-01	0.9465E-00	0.3343E-00	0.9896E-01	0.3055E-01

TABLE X. BOUND-FREE ABSORPTION COEFFICIENT OF AIR - 10^2 ATM

PRESSURE = 100.0000		Temperature - °K									
cm ⁻¹	Å	6000	8000	10000	12000	14000	16000	18000	20000		
13600.	7352.34	0.	0.	0.	0.	0.	0.	0.	0.		
13611.	7347.00	0.8866E-11	0.2220E-08	0.4301E-07	0.2918E-06	0.1116E-05	0.2806E-05	0.5129E-05	0.7179E-05		
14300.	6993.01	0.8538E-11	0.2175E-08	0.4229E-07	0.2700E-06	0.1113E-05	0.2804E-05	0.5137E-05	0.7204E-05		
14361.	6963.30	0.2546E-10	0.6183E-08	0.1170E-06	0.2801E-06	0.3051E-05	0.7645E-05	0.1394E-04	0.1948E-04		
19500.	5128.21	0.2216E-10	0.5513E-08	0.1037E-06	0.7484E-06	0.2004E-05	0.7395E-05	0.1368E-04	0.1934E-04		
19563.	5111.69	0.2741E-10	0.1936E-07	0.1055E-05	0.4836E-05	0.3857E-04	0.9347E-04	0.1613E-03	0.2134E-03		
20500.	4878.05	0.2680E-10	0.1969E-07	0.1090E-05	0.1021E-04	0.4017E-04	0.9757E-04	0.1687E-03	0.2236E-03		
20525.	4872.11	0.4077E-10	0.5459E-07	0.3401E-05	0.1197E-04	0.1244E-03	0.2989E-03	0.5115E-03	0.6718E-03		
20593.	4856.02	0.5187E-10	0.8219E-07	0.5226E-05	0.4914E-04	0.1900E-03	0.4577E-03	0.7816E-03	0.1025E-02		
21200.	4716.38	0.5036E-10	0.8131E-07	0.5185E-05	0.4836E-04	0.1921E-03	0.4566E-03	0.7810E-03	0.1025E-02		
21207.	4715.42	0.1219E-08	0.2722E-06	0.8119E-05	0.6599E-04	0.2493E-03	0.5948E-03	0.1020E-02	0.1446E-02		
21800.	4587.16	0.1159E-08	0.2620E-06	0.7935E-05	0.6487E-04	0.2457E-03	0.5873E-03	0.1008E-02	0.1332E-02		
21845.	4577.71	0.1182E-08	0.3138E-06	0.1122E-04	0.9497E-04	0.3621E-03	0.8571E-03	0.1463E-02	0.1922E-02		
22500.	4444.44	0.1113E-08	0.2952E-06	0.1056E-04	0.3958E-04	0.3405E-03	0.8122E-03	0.1389E-02	0.1828E-02		
22545.	4435.57	0.1179E-08	0.4416E-06	0.1763E-04	0.1714E-03	0.6484E-03	0.1533E-02	0.2597E-02	0.3388E-02		
23200.	4310.34	0.1107E-08	0.4070E-06	0.1766E-04	0.1570E-03	0.5932E-03	0.1410E-02	0.2394E-02	0.3129E-02		
23210.	4308.49	0.3396E-08	0.7403E-06	0.2275E-04	0.1838E-03	0.6925E-03	0.1616E-02	0.2745E-02	0.3593E-02		
23700.	4219.41	0.3151E-08	0.6886E-06	0.2121E-04	0.1718E-03	0.6416E-03	0.1516E-02	0.2578E-02	0.3379E-02		
23763.	4208.22	0.3155E-08	0.6988E-06	0.2181E-04	0.1771E-03	0.6613E-03	0.1560E-02	0.2652E-02	0.3475E-02		
31100.	3215.43	0.1261E-08	0.3104E-06	0.1032E-04	0.9183E-04	0.3515E-03	0.8460E-03	0.1461E-02	0.1941E-02		
31165.	3208.73	0.1314E-08	0.3811E-06	0.1498E-04	0.1161E-03	0.4315E-03	0.1016E-02	0.1727E-02	0.2265E-02		
33000.	3030.30	0.1164E-08	0.3502E-06	0.1319E-04	0.1091E-03	0.4054E-03	0.9557E-03	0.1625E-02	0.2134E-02		
33042.	3026.45	0.1718E-08	0.3952E-06	0.1465E-04	0.1111E-03	0.4115E-03	0.9678E-03	0.1644E-02	0.2158E-02		
34000.	2941.18	0.1557E-08	0.3811E-06	0.1321E-04	0.1076E-03	0.3982E-03	0.9366E-03	0.1592E-02	0.2090E-02		
34026.	2938.93	0.2595E-08	0.1439E-05	0.5732E-04	0.4160E-03	0.1371E-02	0.2942E-02	0.4645E-02	0.5752E-02		
36000.	2777.78	0.2414E-08	0.1339E-05	0.5351E-04	0.3889E-03	0.1284E-02	0.2758E-02	0.4363E-02	0.5411E-02		
36069.	2772.46	0.4298E-08	0.1467E-05	0.5468E-04	0.3938E-03	0.1297E-02	0.2785E-02	0.4403E-02	0.5460E-02		
73000.	1363.86	0.2222E-08	0.5312E-06	0.1837E-04	0.1314E-03	0.4346E-03	0.9413E-03	0.1506E-02	0.1894E-02		
73360.	1363.14	0.2662E-08	0.1197E-05	0.5163E-04	0.3950E-03	0.1351E-02	0.2984E-02	0.4832E-02	0.6124E-02		
88000.	1136.36	0.2056E-08	0.9530E-06	0.4153E-04	0.3189E-03	0.1093E-02	0.2418E-02	0.3922E-02	0.4979E-02		

88505.	1129.88	0.2350E-03	0.1016E-01	0.6014E-01	0.1153E-00	0.1457E-00	0.1530E-00	0.1397E-00	0.1126E-00
98000.	1020.41	0.2247E-03	0.9720E-02	0.5750E-01	0.1122E-00	0.1393E-00	0.1461E-00	0.1332E-00	0.1072E-00
98118.	1019.18	0.2111E-02	0.5559E-01	0.2494E-00	0.4017E-00	0.4505E-00	0.4326E-00	0.3678E-00	0.2795E-00
103000.	970.87	0.2043E-02	0.5374E-01	0.2409E-00	0.3877E-00	0.4345E-00	0.4170E-00	0.3544E-00	0.2693E-00
103821.	963.20	0.2136E-02	0.5799E-01	0.2566E-00	0.4373E-00	0.4973E-00	0.4827E-00	0.4138E-00	0.3164E-00
109000.	917.43	0.2028E-02	0.5507E-01	0.2532E-00	0.4154E-00	0.4724E-00	0.4585E-00	0.3931E-00	0.3005E-00
109837.	910.44	0.1026E-01	0.9526E-00	0.8382E-00	0.8374E-00	0.8044E-00	0.7173E-00	0.5857E-00	0.4332E-00
113000.	884.96	0.1104E-01	0.9561E-00	0.8304E-00	0.8210E-00	0.7847E-00	0.6977E-00	0.5687E-00	0.4202E-00
113434.	881.57	0.1105E-01	0.9371E-00	0.8603E-00	0.1018E-01	0.9950E-00	0.8913E-00	0.7271E-00	0.5365E-00
116000.	862.07	0.1101E-01	0.9824E-00	0.9595E-00	0.1004E-01	0.9793E-00	0.8762E-00	0.7143E-00	0.5268E-00
116516.	858.25	0.1100E-01	0.9818E-00	0.9509E-00	0.1005E-01	0.9816E-00	0.8792E-00	0.7176E-00	0.5298E-00
117000.	854.70	0.1098E-01	0.9797E-00	0.9467E-00	0.9993E-00	0.9751E-00	0.8730E-00	0.7123E-00	0.5258E-00
117345.	852.19	0.1288E-01	0.2435E-01	0.3998E-01	0.3921E-01	0.3219E-01	0.2486E-01	0.1803E-01	0.1213E-01
120000.	833.33	0.1278E-01	0.2406E-01	0.4060E-01	0.3977E-01	0.3397E-01	0.2509E-01	0.1815E-01	0.1218E-01
120788.	827.90	0.1305E-01	0.2523E-01	0.4135E-01	0.4057E-01	0.3340E-01	0.2588E-01	0.1884E-01	0.1273E-01
121000.	826.45	0.1305E-01	0.2532E-01	0.4154E-01	0.4073E-01	0.3359E-01	0.2594E-01	0.1887E-01	0.1274E-01
121198.	825.10	0.1305E-01	0.2536E-01	0.4170E-01	0.4099E-01	0.3380E-01	0.2625E-01	0.1915E-01	0.1296E-01
121442.	823.44	0.1306E-01	0.2538E-01	0.4174E-01	0.4102E-01	0.3382E-01	0.2627E-01	0.1916E-01	0.1297E-01
134000.	746.27	0.1187E-01	0.2439E-01	0.4081E-01	0.3977E-01	0.3274E-01	0.2526E-01	0.1831E-01	0.1233E-01
134436.	743.95	0.1187E-01	0.2442E-01	0.4091E-01	0.4009E-01	0.3286E-01	0.2538E-01	0.1842E-01	0.1242E-01
136000.	735.29	0.1168E-01	0.2416E-01	0.4045E-01	0.3962E-01	0.3245E-01	0.2504E-01	0.1817E-01	0.1224E-01
136656.	731.76	0.1852E-01	0.2977E-01	0.4411E-01	0.4225E-01	0.3453E-01	0.2666E-01	0.1937E-01	0.1307E-01
138000.	724.64	0.1853E-01	0.2982E-01	0.4370E-01	0.4181E-01	0.3414E-01	0.2635E-01	0.1914E-01	0.1291E-01
138413.	722.48	0.1953E-01	0.2958E-01	0.4361E-01	0.4171E-01	0.3405E-01	0.2628E-01	0.1909E-01	0.1288E-01
150000.	666.67	0.1798E-01	0.2781E-01	0.40714E-01	0.3815E-01	0.3105E-01	0.2391E-01	0.1734E-01	0.1168E-01
150304.	665.32	0.2144E-01	0.3065E-01	0.4419E-01	0.3948E-01	0.3210E-01	0.2473E-01	0.1795E-01	0.1210E-01
179000.	554.66	0.1011E-01	0.2416E-01	0.3134E-01	0.2905E-01	0.2353E-01	0.1809E-01	0.1312E-01	0.0835E-00
180000.	555.56	0.1795E-01	0.2390E-01	0.3798E-01	0.2870E-01	0.2324E-01	0.1787E-01	0.1296E-01	0.08729E-00
184322.	542.53	0.1726E-01	0.2285E-01	0.2946E-01	0.2726E-01	0.2207E-01	0.1697E-01	0.1230E-01	0.08270E-00
193000.	502.51	0.1474E-01	0.1928E-01	0.2461E-01	0.2271E-01	0.1835E-01	0.1413E-01	0.1024E-01	0.06879E-00
200000.	500.00	0.1458E-01	0.1905E-01	0.2431E-01	0.2243E-01	0.1815E-01	0.1395E-01	0.1011E-01	0.06813E-00

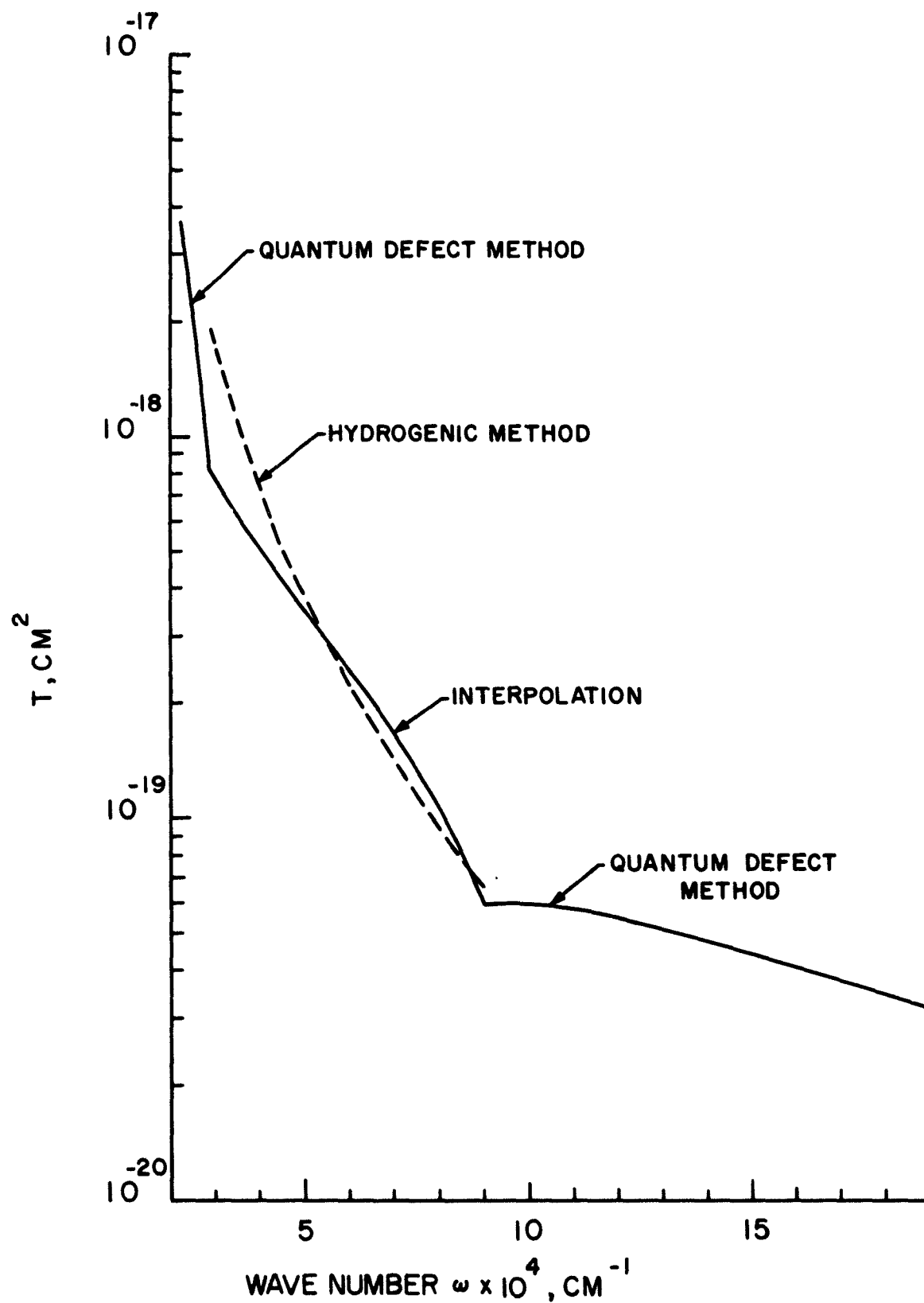


Figure 1. Photoabsorption Cross Section for the 8-1 Transition of N (D wave portion)

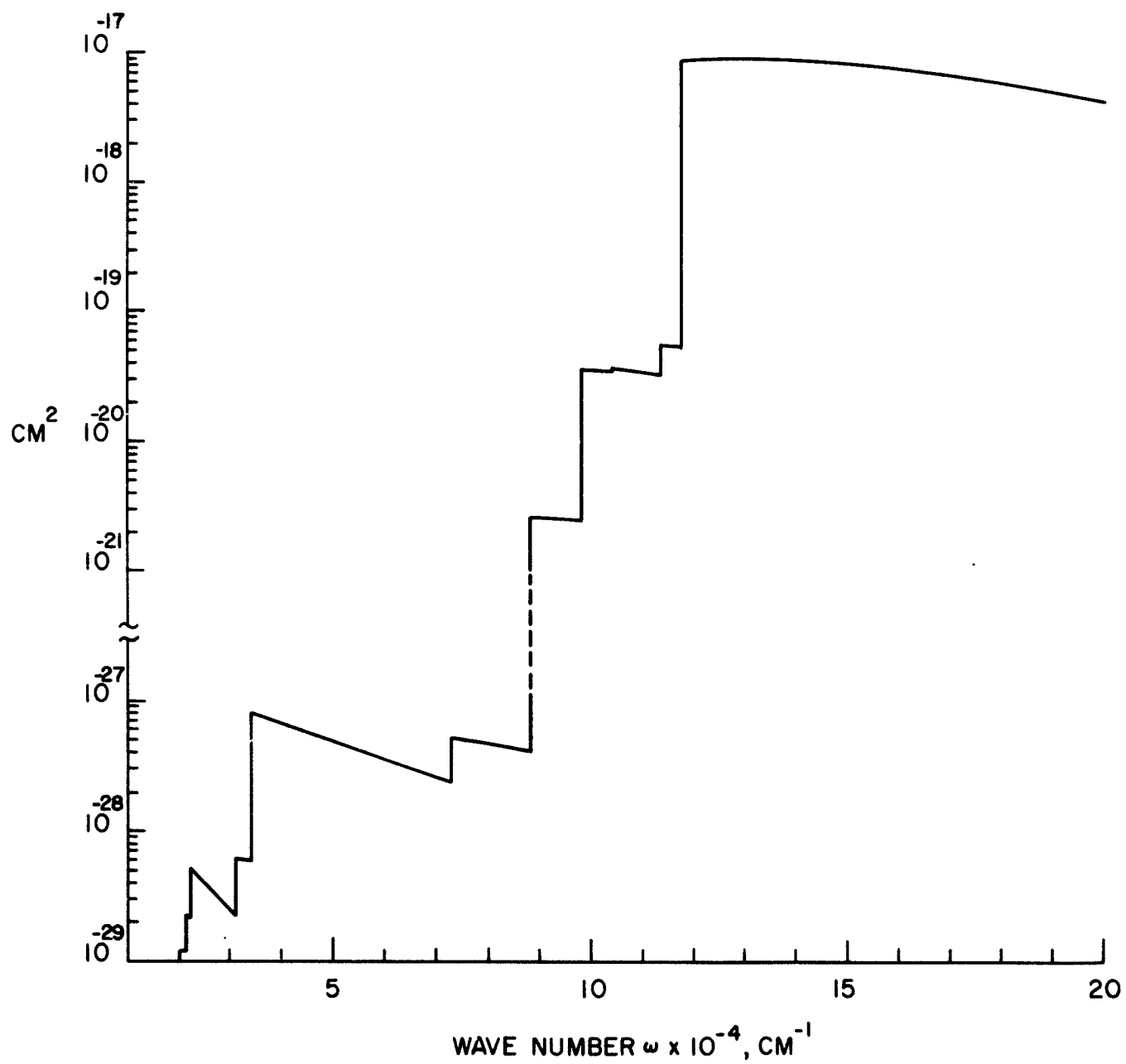


Figure 2. Absorption Coefficient Per Nitrogen Atom - 5000 K

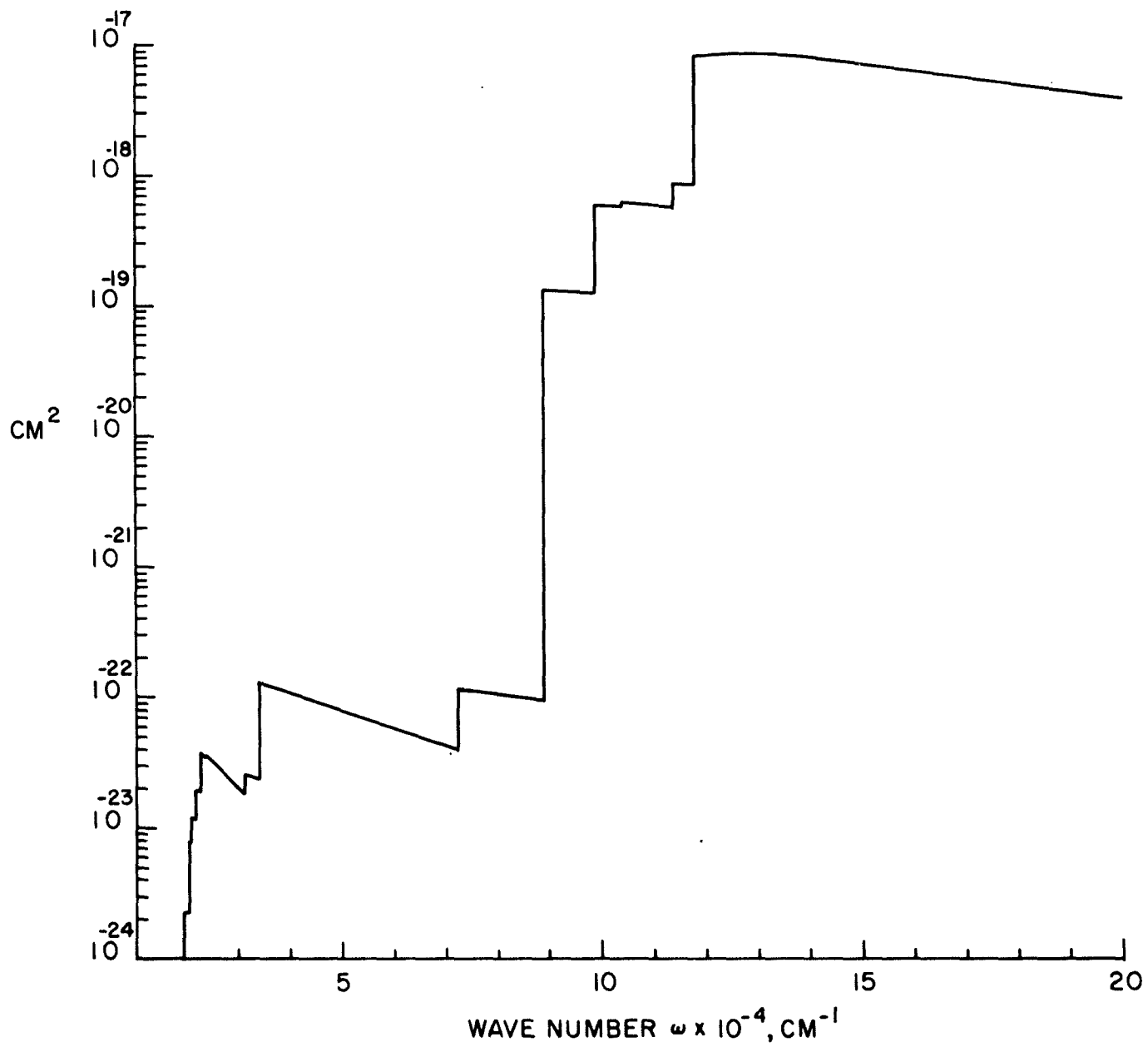


Figure 3. Absorption Coefficient Per Nitrogen Atom - 10,000 K

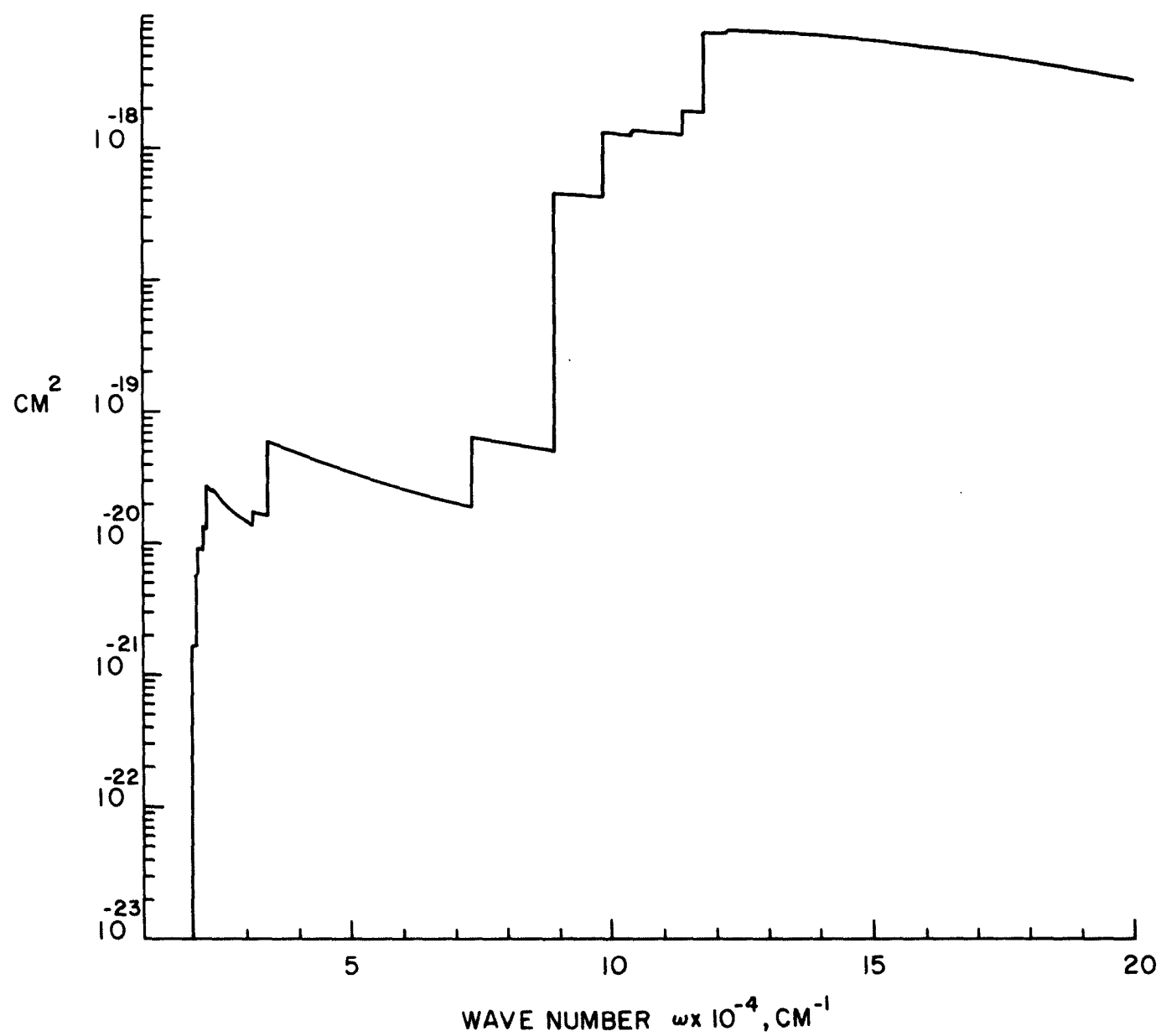


Figure 4. Absorption Coefficient Per Nitrogen Atom - 15,000 K

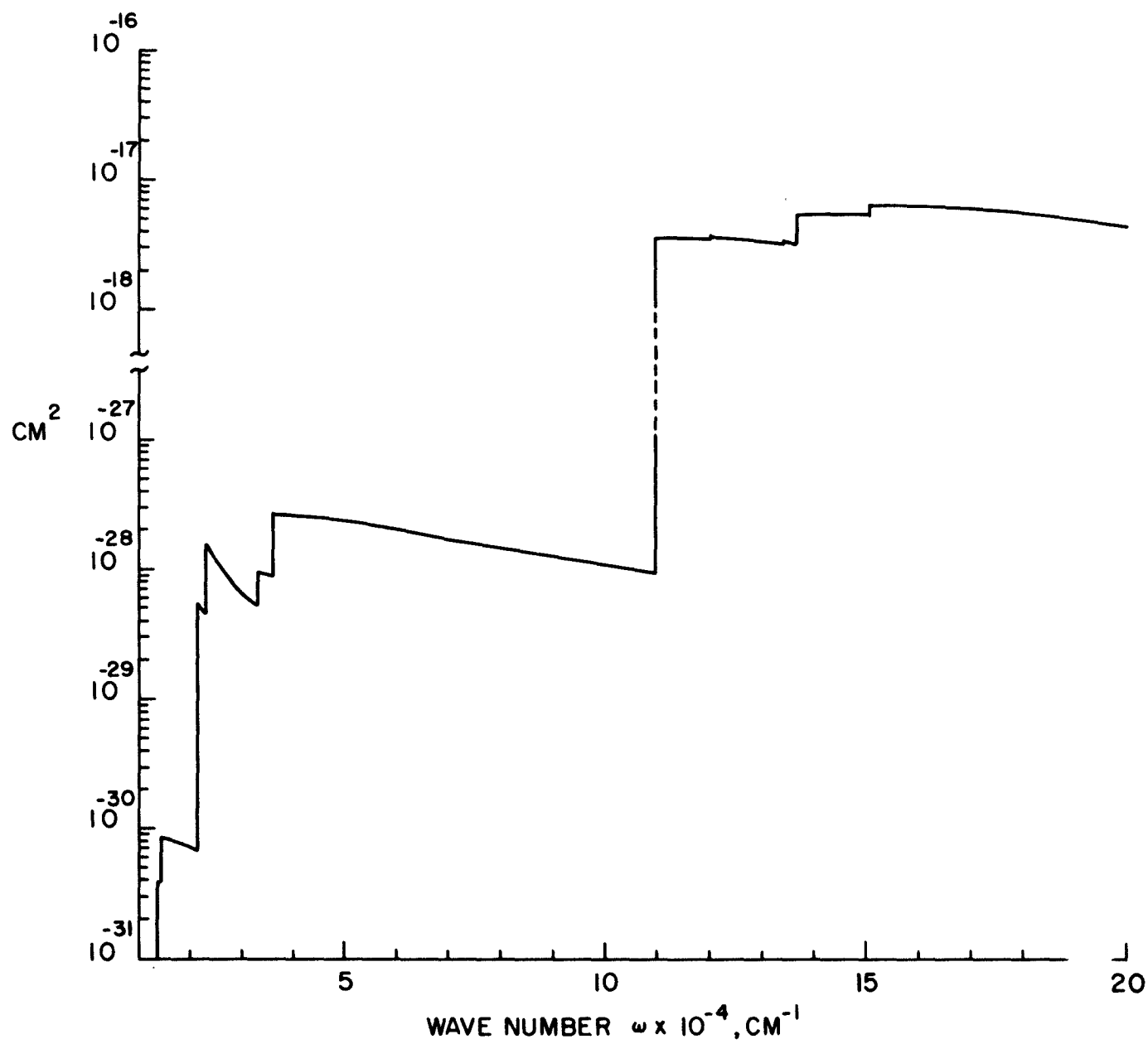


Figure 5. Absorption Coefficient Per Oxygen Atom - 5,000 K

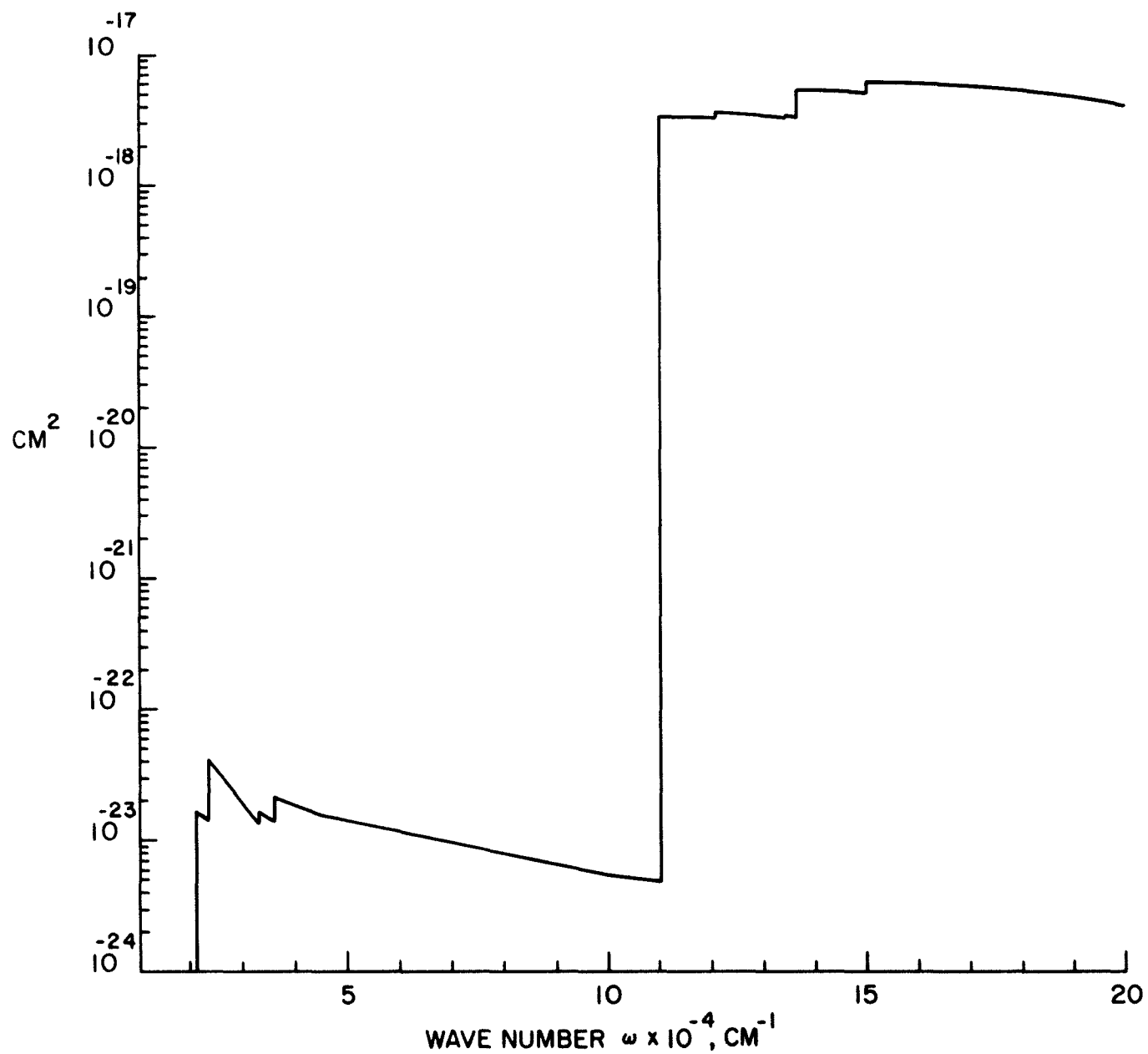


Figure 6. Absorption Coefficient Per Oxygen Atom - 10,000 K

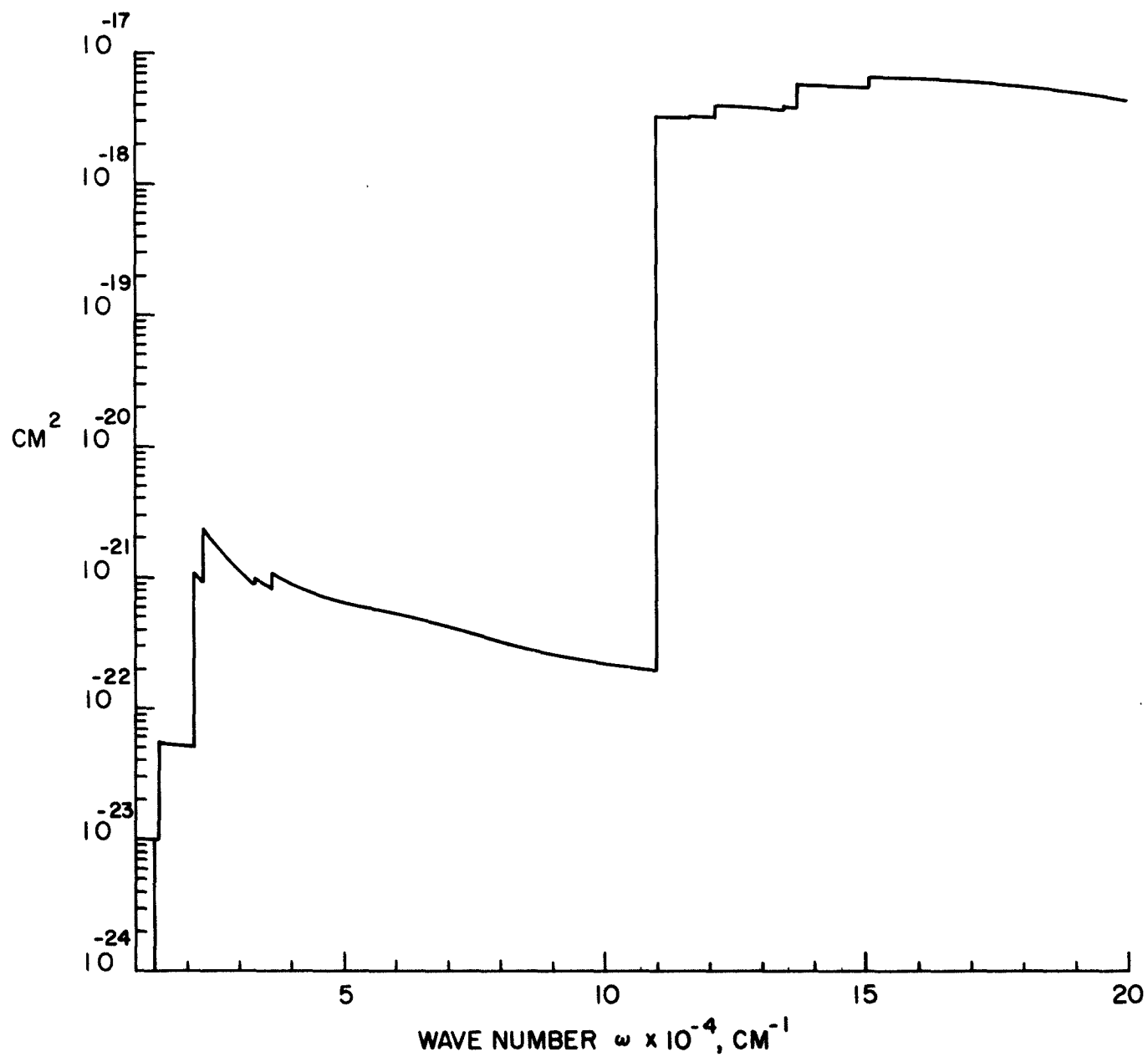


Figure 7. Absorption Coefficient Per Oxygen Atom - 15,000 K

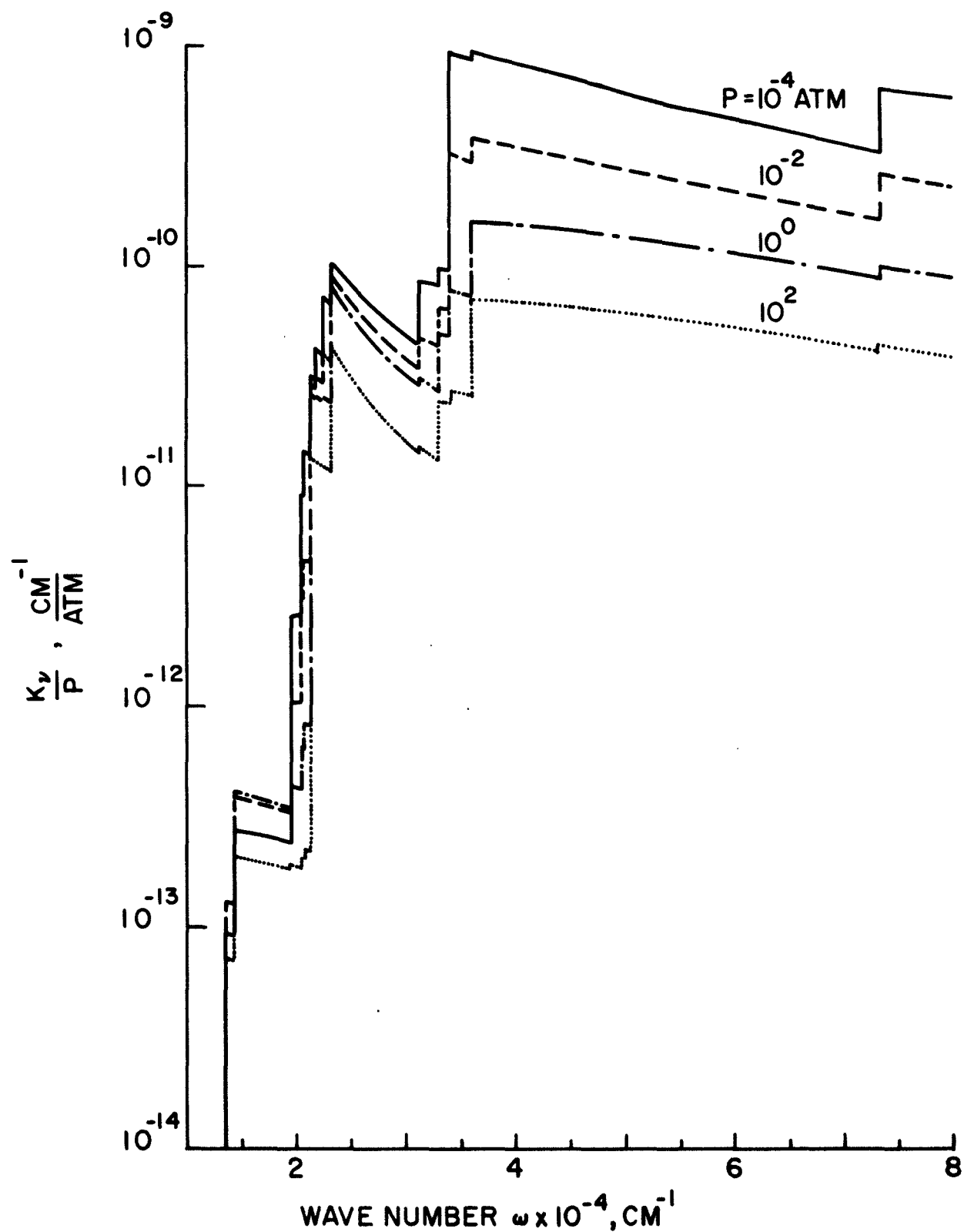


Figure 8. Bound-Free Absorption Coefficient of Equilibrium Air - 5,000 K

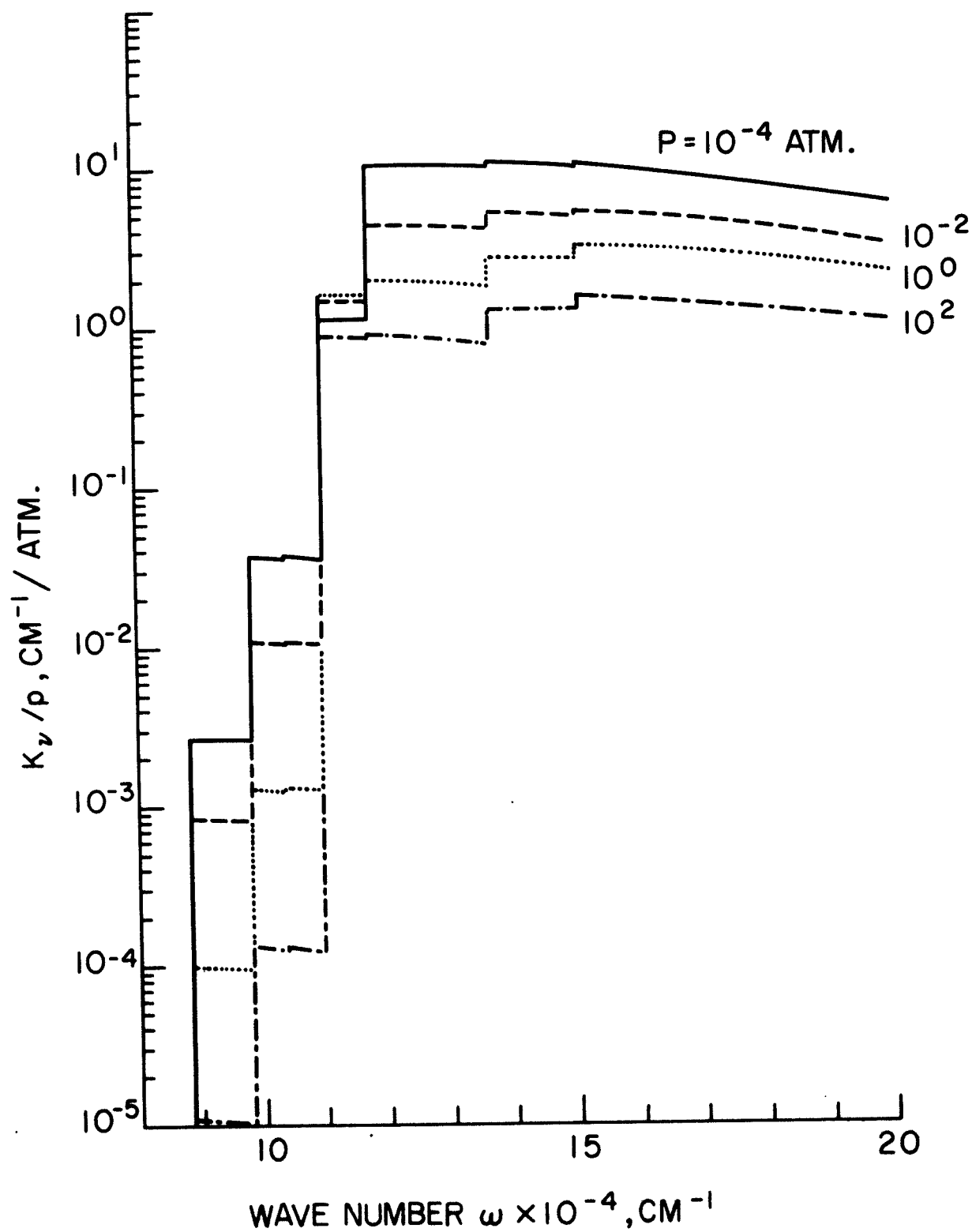


Figure 9. Bound-Free Absorption Coefficient of Equilibrium Air - 5,000 K

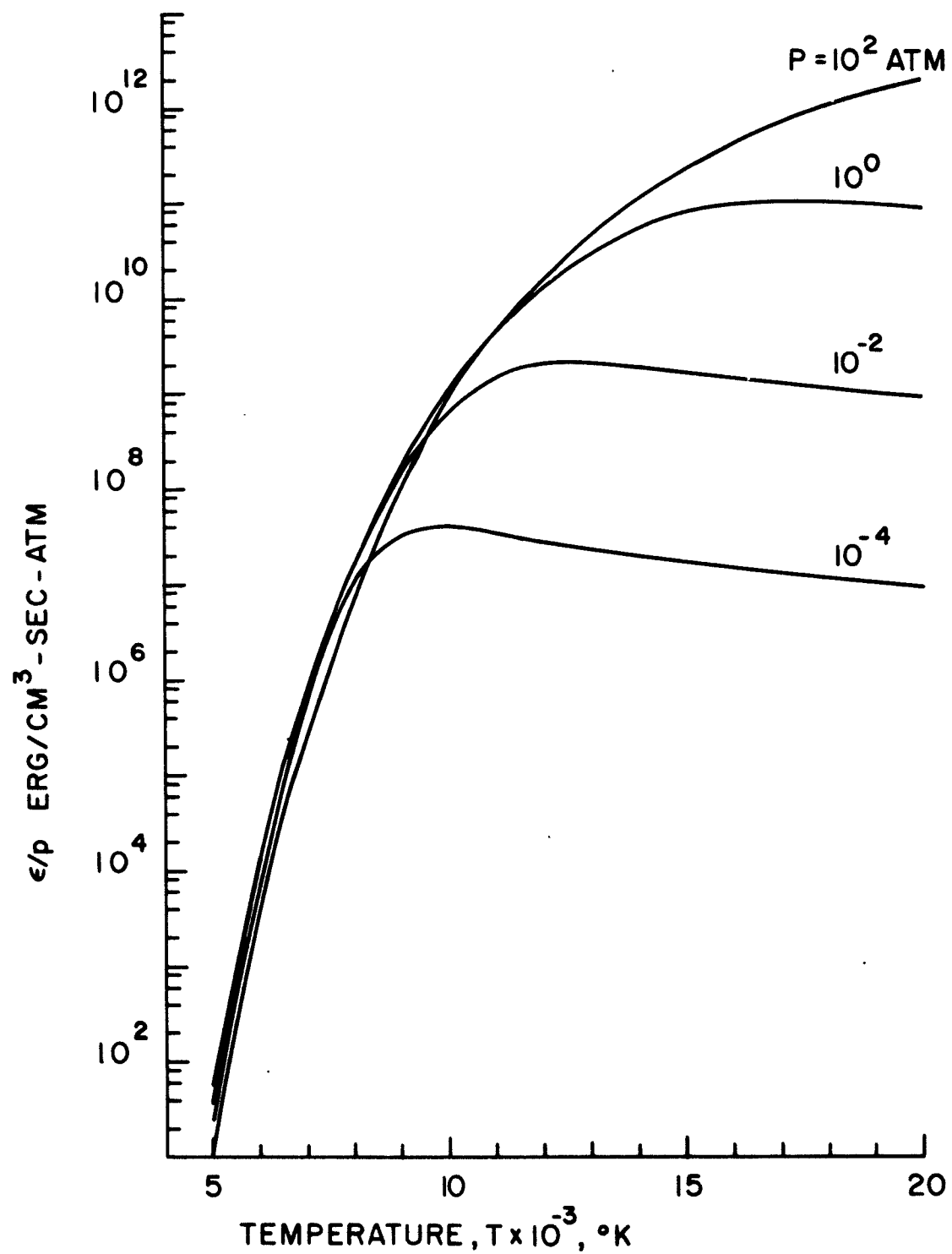


Figure 10. Total Rate of N^+ and O^+ Free-Bound Emission of Equilibrium Air

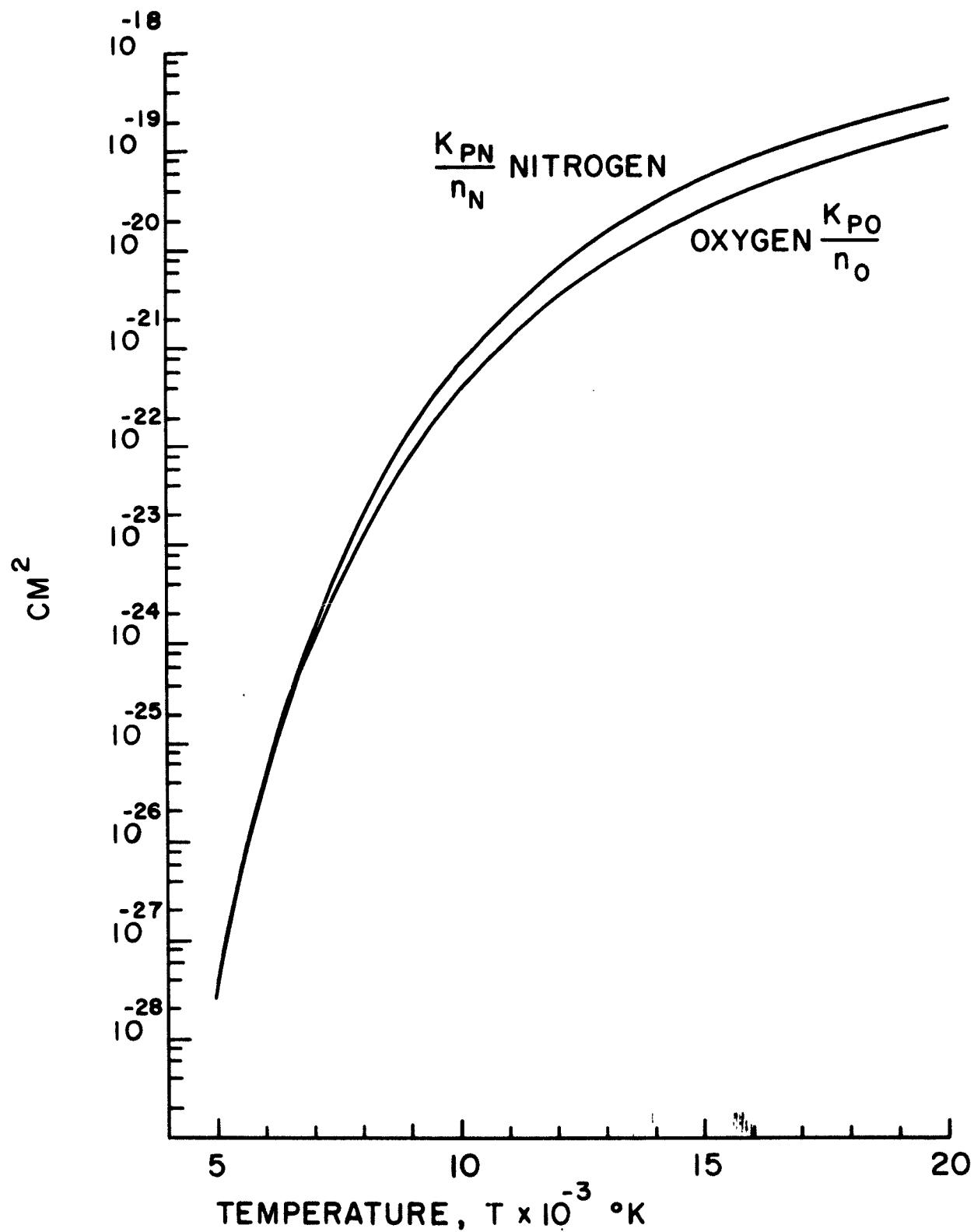


Figure 11. Planck Mean Absorption Coefficient Per Atom of Nitrogen and Oxygen

SPACE SCIENCES LABORATORY
MISSILE AND SPACE DIVISION

GENERAL ELECTRIC

TECHNICAL INFORMATION SERIES

AUTHOR M. P. Sherman J. L. Kulander	SUBJECT CLASSIFICATION Plasma Dynamics	NO. R65SD15
		DATE May, 1965
TITLE FREE-BOUND RADIATION FROM NITROGEN, OXYGEN, AND AIR		G. E. CLASS I
		GOV. CLASS U
REPRODUCIBLE COPY FILED AT MSD LIBRARY. DOCUMENTS LIBRARY UNIT. VALLEY FORGE SPACE TECHNOLOGY CENTER, KING OF PRUSSIA, PA.		NO. PAGES 39
SUMMARY Photoabsorption cross sections for nitrogen and oxygen atoms are computed using the Method of Burgess and Seaton [2]. Results are presented for the radiative recombination of singly ionized nitrogen and oxygen applicable for equilibrium air, for chemical nonequilibrium with internal equilibrium, and internal nonequilibrium.		
KEY WORDS Absorption coefficients, Free-bound radiation		

BY CUTTING OUT THIS RECTANGLE AND FOLDING ON THE CENTER LINE THE ABOVE INFORMATION CAN BE FITTED INTO A STANDARD CARD FILE

AUTHOR Martin P. Sherman John L. Kulander

COUNTERSIGNED S. M. Scala S. M. Scala, Manager
Theoretical Fluid Physics