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Vibration-Rotation Bands of HF and DF

Aerophysics Laboratory
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El Segundo, Calif. 90245

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SPACE AND MISSILE SYSTEMS ORGANIZATION
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Calculations have been made for HF of the rotational lines for both the P- and R-branches in 45 ($v \rightarrow v - \Delta v$) bands with $v = \Delta v$ to $v = 9$, and for DF of the rotational lines for both P- and R-branches in 78 ($v \rightarrow v - \Delta v$) bands with $v = \Delta v$ to $v = 12$. The line positions for the P-branch and R-branch are listed for each Δv sequence for values of J from 0 to 50. The rotational constants for DF were calculated from isotopic relations by means of the Dunham coefficients for HF published by Mann et al. Band centers, vibrational-energy and rotational-energy-term values are presented for both HF and DF.

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PREFACE

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I. INTRODUCTION

Recent theoretical kinetic studies on $v \rightarrow R$ energy-transfer processes in the HF and DF systems required rotation-vibration energy terms and band centers for both HF and DF. Previous spectroscopic tables calculated in this laboratory terminated at J = 30, and an incomplete set of Dunham coefficients[1] was used for DF, which was obtained from the work of Talley, Kaylor, and Nielsen[2] published in 1950. Their work was done on the $v \rightarrow R$ bands of DF when the technique of measurements was in a somewhat uncertain state.[3] A more complete set of Dunham coefficients was calculated by Mann et al.[4] for HF in 1961 from a rotation-vibration analysis carried out on measured hydrogen-fluoride vibration-rotation emission spectrum obtained from a hydrogen-fluoride diffusion flame.

A complete set of Dunham coefficients for HF that were slightly different from those of Mann et al.[4] were calculated by Webb and Rao[5] in 1968 from their measurements of the high J rotational structure of the $1 \rightarrow 0$ and $2 \rightarrow 0$ bands of heated HF. Since the Dunham coefficients provided by Webb and Rao[5] did not agree very well with all of the P- and R-branch line positions of HF provided by Mann et al.,[4] we decided that the Dunham coefficients provided by Mann et al.[4] were better since they are in excellent agreement with all available measurements, including those of Webb and Rao.[5] The Dunham coefficients for DF were calculated from those of HF provided by Mann et al.[4]

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[1] J. L. Dunham, Phys. Rev. 41, 721 (1932).

[2] R. M. Talley, H. M. Kaylor, and A. H. Neilsen, Phys. Rev. 77, 529 (1950).

[3] R. N. Spanbauer and K. Narahari Rao, J. Molecular Spectroscopy, 16, 100 (1965).

[4] D. E. Mann, R. A. Thrush, D. R. Like, Jr., J. J. Ball, and N. Acquista, J. Chem. Phys. 34, 420 (1961).

[5] D. U. Webb and K. Narahari Rao, J. Molecular Spectroscopy, 28, 121 (1968).

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by means of isotope relationships.[1] For HF, the rotational lines were calculated for both the P- and R-branches in 45 ($v \rightarrow v - \Delta v$) bands with $v = \Delta v$ to $v = 9$, and, for DF, the rotational lines were calculated for both the P- and R-branches in 78 ($v \rightarrow v - \Delta v$) bands with $v = \Delta v$ to $v = 12$. Rotational constants, band centers, vibrational energy terms, and rotation-vibration energy terms were calculated for HF and DF.

II. METHOD OF COMPUTATION

The rotational constants B_v, D_v, and H_v and the vibrational energy terms G(v) are expressed as power series in (v + 1/2). In the notation of Dunham,

$$B_v = \sum_{k=0}^{k=4} \rho^{2+k} Y_{k1} \left(v + \frac{1}{2}\right)^k \tag{1}$$

$$D_v = \sum_{k=0}^{k=2} \rho^{4+k} Y_{k2} \left(v + \frac{1}{2}\right)^k \tag{2}$$

$$H_v = \sum_{k=0}^{k=1} \rho^{6+k} Y_{k3} \left(v + \frac{1}{2}\right)^k \tag{3}$$

and

$$G(v) = \sum_{k=1}^{k=5} \rho^{k} Y_{k0} \left(v + \frac{1}{2}\right)^k \tag{4}$$

where Y_{jk} are the Dunham coefficients and $\rho = \mu/\mu^i$ (where μ is the reduced mass of the ordinary diatomic molecule and μ^i is the reduced mass of its isotopic molecule). With ρ = 1 and 0.72494822, and with the use of Dunham coefficients for HF (Table 1), the rotational constants B_v, D_v, and H_v and the vibrational energy terms G(v) tabulated in Tables 2 and 3 for HF and DF, respectively, were calculated. The rotation-vibration energy terms are expressed as a double expansion in J(J + 1) and (v + 1/2)

$$E_{v,J} = \sum_{j=1}^{j=4} \sum_{k=0}^{k=5} Y_{kj} \left(v + \frac{1}{2}\right)^k [J(J+1)]^j \tag{5}$$

The rotation-vibration energy terms were calculated for HF for v = 0 to v = 9 with J = 0 through J = 50, and for DF for v = 0 to v = 12 with J = 0 through J = 50 by means of the Dunham coefficients given in Table 1. The rotation-vibration energy terms of HF and DF are listed in Tables 4 and 5, respectively. The positions of the band centers or the v' to v lines of a diatomic molecule are given by

$$\omega_c(v', v) = G(v') - G(v) \tag{6}$$

The 45 band centers for HF are listed in Table 6, and the 78 band centers for DF are listed in Table 7. The positions of the (v', J') to (v, J) lines of a diatomic molecule are given by

$$\omega_c(v, J, m) = G(v') - G(v) + E(v', J + m) - E(v, J) \tag{7}$$

where m = -1 for the P-branch and +1 for the R-branch. P-branch and R-branch line positions were calculated and are tabulated in Tables 8 and 9 for HF, and in Tables 10 and 11 for DF.

In Tables 12 through 16, the calculated line positions for HF and DF are compared with available experimental data.[4-7] The P-branch and R-branch line position values are in excellent agreement with HF and DF wavelength measurements.

[6] T. F. Deutsch, Appl. Phys. Lett., 10, 234 (1967).

[7] D. J. Spencer, G. C. Denault, and H. H. Takimoto, Atmospheric Gas Absorption DF Laser Wavelengths, TR-0074(4240-10)-7, The Aerospace Corporation (January 1974).

Table 1. Dunham Coefficients[a]

Coefficient	Approximate Identification	HF[b]	DF
Y_{10}	ω_e	4138.73	3000.36
Y_{20}	$-\omega_e x_e$	-90.05	-47.33
Y_{30}	$\omega_e y_e$	0.932	0.355
Y_{40}	$\omega_e z_e$	-1.42×10^{-2}	-0.392×10^{-2}
Y_{50}		-5.9×10^{-4}	-1.181×10^{-4}
Y_{01}	B_e	20.9555	11.0132
Y_{11}	$-\alpha_e$	-0.7958	-0.3032
Y_{21}	γ_e	1.182×10^{-2}	0.326×10^{-2}
Y_{31}		-3.11×10^{-4}	-0.623×10^{-4}
Y_{41}		-5.8×10^{-6}	-0.842×10^{-6}
Y_{02}	$-D_e$	-2.153×10^{-3}	-0.5947×10^{-3}
Y_{12}	β_e	6.23×10^{-5}	1.25×10^{-5}
Y_{22}		-2.06×10^{-6}	-0.299×10^{-6}
Y_{03}	H_e	1.68×10^{-7}	0.244×10^{-7}
Y_{13}		-6.5×10^{-9}	-0.684×10^{-9}
Y_{04}		-1.9×10^{-11}	-0.145×10^{-11}

[a]In units of cm^{-1}.

[b]D. E. Mann, B. A. Thrush, D. R. Lide, Jr., J. J. Ball, and N. Acquista, J. Chem. Phys. 34, 420 (1961).

Table 2. Molecular Constants of the HF Molecule

v	B_v, cm^{-1}	$D_v \times 10^3$, cm^{-1}	$H_v \times 10^7$, cm^{-1}	G(v), cm^{-1}
0	20.561	2.122	1.648	2046.968
1	19.787	2.064	1.583	6008.552
2	19.035	2.010	1.518	9797.963
3	18.301	1.960	1.453	13419.961
4	17.583	1.914	1.388	16878.789
5	16.879	1.873	1.323	20178.101
6	16.186	1.835	1.258	23320.889
7	15.502	1.802	1.193	26309.419
8	14.824	1.772	1.128	29145.153
9	14.148	1.747	1.063	31828.683

Table 3. Molecular Constants of the DF Molecule

v	B_v, cm^{-1}	$D_v \times 10^4$, cm^{-1}	$H_v \times 10^8$, cm^{-1}	G(v), cm^{-1}
0	10.862	5 885	2.405	1488.395
1	10.566	5.766	2.336	4395.242
2	10.274	5.654	2.268	7210.510
3	9.989	5.547	2.199	9936.110
4	9.709	5.446	2.131	12573.827
5	9.433	5.351	2.063	15125.297
6	9.162	5.262	1.994	17592.003
7	8.894	5.179	1.926	19975.252
8	8.629	5.102	1.857	22276.169
9	8.367	5.031	1.789	24495.674
10	8.107	4.967	1.720	26634.475
11	7.849	4.908	1.652	28693.050
12	7.591	4.855	1.584	30671.636

Table 4. Rotation-Vibration Energy of HF Molecule

CALC. E(V,J) , 1/CM

V=	J= 0	1	2	3	4	5	6
0	0.00	41.11	123.29	246.42	410.36	614.91	859.81
1	0.00	39.57	118.65	237.15	394.92	591.77	827.44
2	0.00	38.06	114.14	228.13	379.89	569.24	795.93
3	0.00	36.59	109.73	219.33	365.23	547.26	765.19
4	0.00	35.16	105.43	210.72	350.90	525.77	735.12
5	0.00	33.75	101.21	202.28	336.83	504.69	705.63
6	0.00	32.37	97.05	193.97	323.00	483.94	676.60
7	0.00	31.00	92.95	185.77	309.33	463.45	647.93
8	0.00	29.64	88.88	177.63	295.77	443.13	619.49
9	0.00	28.29	84.83	169.53	282.27	422.88	591.15

V=	J= 7	8	9	10	11	12	13
0	1144.76	1469.42	1833.37	2236.19	2677.38	3156.40	3672.69
1	1101.64	1414.04	1764.25	2151.84	2576.32	3037.18	3533.85
2	1059.67	1360.14	1696.96	2069.70	2477.91	2921.07	3398.64
3	1018.72	1307.55	1631.30	1989.56	2381.88	2807.76	3266.67
4	978.67	1256.11	1567.07	1911.15	2287.92	2696.88	3137.52
5	939.38	1205.64	1504.05	1834.22	2195.71	2588.06	3010.74
6	900.71	1155.96	1442.01	1758.47	2104.92	2480.89	2885.88
7	862.50	1106.87	1380.70	1683.61	2015.18	2374.96	2762.44
8	824.60	1058.18	1319.88	1609.33	1926.13	2269.82	2639.91
9	786.84	1009.66	1259.27	1535.31	1837.37	2165.01	2517.74

V=	J= 14	15	16	17	18	19	20
0	4225.60	4814.49	5438.65	6097.34	6789.79	7515.17	8272.65
1	4065.73	4632.18	5232.51	5866.00	6531.90	7229.40	7957.68
2	3910.03	4454.60	5031.70	5640.61	6280.60	6950.89	7650.68
3	3758.03	4281.23	4835.61	5420.49	6035.15	6678.82	7350.73
4	3609.26	4111.52	4643.64	5204.96	5794.78	6412.34	7056.87
5	3463.22	3944.88	4455.13	4993.28	5558.65	6150.51	6768.09
6	3319.35	3780.72	4269.37	4784.66	5325.89	5892.36	6483.32
7	3177.10	3618.37	4085.64	4578.26	5095.58	5636.87	6201.41
8	3035.87	3457.15	3903.15	4373.24	4866.74	5382.96	5921.18
9	2895.04	3296.36	3721.11	4168.66	4638.35	5129.50	5641.37

V=	J= 21	22	23	24	25	26	27
0	9061.33	9880.32	10728.66	11605.38	12509.49	13439.95	14395.72
1	8715.89	9503.13	10318.49	11161.00	12029.71	12923.59	13841.63
2	8379.12	9135.35	9918.47	10727.54	11561.62	12419.71	13300.80
3	8050.03	8775.89	9527.43	10303.72	11103.83	11926.80	12771.63
4	7727.57	8423.60	9144.09	9888.16	10654.87	11443.27	12252.39
5	7410.61	8077.25	8767.14	9479.41	10213.14	10967.41	11741.24
6	7097.98	7735.53	8395.14	9075.93	9777.00	10497.43	11236.25
7	6788.42	7397.10	8026.61	8676.10	9344.68	10031.42	10735.38
8	6480.62	7060.50	7659.98	8278.22	8914.33	9567.40	10236.47
9	6173.21	6724.23	7293.61	7880.51	8484.03	9103.27	9737.28

Table 4. Rotation-Vibration Energy of HF Molecule (Continued)

CALC. E(V,J) , 1/CM

	J= 28	29	30	31	32	33	34
V= 0	15375.72	16378.83	17403.95	18449.92	19515.56	20599.68	21701.06
1	14782.76	15745.91	16729.97	17733.81	18756.28	19796.21	20852.39
2	14203.87	15127.85	16071.64	17034.16	18014.25	19010.75	20022.48
3	13637.31	14522.79	15426.99	16348.83	17287.18	18240.89	19208.79
4	13081.23	13928.74	14793.88	15675.56	16572.67	17484.07	18408.60
5	12533.65	13343.60	14170.06	15011.95	15868.17	16737.58	17619.01
6	11992.50	12765.14	13553.15	14355.46	15170.96	15998.53	16837.00
7	11455.58	12191.01	12940.64	13703.40	14478.19	15263.89	16059.33
8	10920.59	11618.73	12329.88	13052.96	13786.87	14530.49	15282.64
9	10385.10	11045.72	11718.10	12401.18	13093.85	13794.97	14503.37

	J= 35	36	37	38	39	40	41
V= 0	22818.46	23950.59	25096.18	26253.88	27422.35	28600.19	29785.98
1	21923.59	23008.56	24106.01	25214.63	26333.07	27459.95	28593.86
2	21048.23	22086.74	23136.75	24196.96	25266.01	26342.54	27425.12
3	20189.67	21182.30	22135.41	23197.70	24217.83	25244.43	26276.07
4	19345.04	20292.19	21248.76	22213.47	23184.97	24161.88	25142.78
5	18511.29	19413.17	20323.40	21240.67	22163.64	23090.91	24021.07
6	17685.18	18541.85	19405.73	20275.51	21149.85	22027.34	22906.53
7	16863.32	17674.61	18491.94	19313.99	20139.38	20966.71	21794.52
8	16042.12	16807.69	17578.05	18351.89	19127.81	19904.39	20680.13
9	15217.83	15937.10	16659.87	17384.80	18110.49	18835.47	19558.25

	J= 42	43	44	45	46	47	48
V= 0	30978.24	32175.48	33376.13	34578.59	35781.18	36982.16	38179.74
1	29733.[illegible]	30876.83	32022.83	33169.71	34315.78	35459.30	36598.45
2	28512.29	29602.54	30694.31	31785.97	32875.82	33962.11	35042.99
3	27311.29	28348.56	29386.32	30422.92	31456.66	32485.75	33508.32
4	26126.18	27110.57	28094.35	29075.85	30053.36	31025.06	31989.06
5	24952.61	25883.98	26813.59	27739.74	28660.69	29574.59	30479.52
6	23785.92	24663.95	25538.97	26409.28	27273.10	28128.56	28973.68
7	22621.26	23445.36	24265.15	25078.89	25884.77	26680.86	27465.17
8	21453.49	22222.84	22986.50	23742.68	24489.53	25225.10	25947.32
9	20277.23	20990.76	21697.11	22394.48	23080.96	23754.54	24413.12

	J= 49	50
V= 0	39372.03	40557.05
1	37731.33	38855.93
2	36116.54	37180.73
3	34522.42	35525.99
4	32943.[illegible]7	33885.88
5	31373.45	32254.23
6	29806.39	30624.50
7	28235.57	28989.81
8	26654.02	27342.91
9	25054.46	25676.20

Table 5. Rotation-Vibration Energy of DF Molecule

CALC. E(V,J) , 1/CM

	J= 0	1	2	3	4	5	6
V= 0	0.00	21.72	65.15	130.26	217.01	325.34	455.18
1	0.00	21.13	63.37	126.70	211.08	316.45	442.74
2	0.00	20.55	61.63	123.21	205.27	307.73	430.54
3	0.00	19.98	59.92	119.79	199.56	299.18	418.57
4	0.00	19.42	58.23	116.43	193.96	290.78	406.81
5	0.00	18.86	56.58	113.12	188.45	282.52	395.25
6	0.00	18.32	54.95	109.86	183.02	274.38	383.87
7	0.00	17.79	53.34	106.65	177.67	266.35	372.63
8	0.00	17.26	51.76	103.48	172.38	258.42	361.53
9	0.00	16.73	50.18	100.33	167.14	250.56	350.54
10	0.00	16.21	48.63	97.21	161.95	242.77	339.63
11	0.00	15.70	47.07	94.11	156.78	235.02	328.78
12	0.00	15.18	45.53	91.02	151.63	227.30	317.97

	J= 7	8	9	10	11	12	13
V= 0	606.45	779.05	972.86	1187.77	1423.63	1680.30	1957.60
1	589.86	757.74	946.24	1155.26	1384.65	1634.27	1903.96
2	573.61	736.85	920.15	1123.39	1346.44	1589.16	1851.38
3	557.66	716.35	894.55	1092.13	1308.96	1544.89	1799.79
4	541.99	696.22	869.40	1061.41	1272.13	1501.41	1749.10
5	526.58	676.42	844.67	1031.21	1235.91	1458.64	1699.24
6	511.41	656.92	820.31	1001.45	1200.22	1416.50	1650.12
7	496.44	637.68	796.27	972.09	1165.01	1374.91	1601.65
8	481.64	618.67	772.51	943.07	1130.21	1333.81	1553.73
9	466.99	599.84	748.98	914.33	1095.74	1293.10	1506.27
10	452.45	581.15	725.64	885.81	1061.54	1252.70	1459.16
11	437.99	562.57	702.42	857.44	1027.52	1212.52	1412.31
12	423.58	544.05	679.28	829.17	993.61	1172.46	1365.60

	J= 14	15	16	17	18	19	20
V= 0	2255.36	2573.40	2911.50	3269.46	3647.04	4044.01	4460.12
1	2193.54	2502.82	2831.62	3179.71	3546.87	3932.88	4337.48
2	2132.93	2433.64	2753.30	3091.72	3448.66	3823.91	4217.23
3	2073.47	2365.75	2676.45	3005.37	3352.28	3716.97	4099.19
4	2015.04	2299.05	2600.94	2920.52	3257.57	3611.87	3983.19
5	1957.56	2233.43	2526.65	2837.03	3164.37	3508.45	3869.04
6	1900.94	2168.77	2453.45	2754.77	3072.53	3406.53	3756.53
7	1845.05	2104.96	2381.20	2673.57	2981.88	3305.92	3645.45
8	1789.80	2041.88	2309.77	2593.29	2892.24	3206.42	3535.60
9	1735.08	1979.39	2239.00	2513.75	2803.42	3107.83	3426.74
10	1680.77	1917.36	2168.75	2434.78	2715.24	3009.94	3318.65
11	1626.74	1855.65	2098.87	2356.22	2627.50	2912.53	3211.07
12	1572.87	1794.12	2029.18	2277.87	2540.00	2815.37	3103.77

Table 5. Rotation-Vibration Energy of DF Molecule (Continued)

CALC. E(V,J) , 1/CM

	J= 21	22	23	24	25	26	27
V= 0	4895.11	5348.70	5820.62	6310.57	6818.24	7343.33	7885.52
1	4760.42	5201.44	5660.25	6136.57	6630.11	7140.55	7667.57
2	4628.35	5057.02	5502.98	5965.93	6445.58	6941.63	7453.78
3	4498.71	4915.26	5348.58	5798.38	6264.39	6746.31	7243.83
4	4371.29	4775.92	5196.81	5633.68	6086.27	6554.27	7037.39
5	4245.89	4638.77	5047.42	5471.55	5910.91	6365.19	6834.11
6	4122.29	4503.58	4900.14	5311.71	5738.00	6178.75	6633.65
7	4000.26	4370.10	4754.72	5153.85	5567.23	5994.58	6435.61
8	3879.56	4238.06	4610.85	4997.67	5398.26	5812.34	6239.63
9	3759.94	4107.19	4468.25	4842.85	5230.74	5631.65	6045.28
10	3641.15	3977.22	4326.61	4689.06	5064.32	5452.11	5852.15
11	3522.92	3847.85	4185.60	4535.94	4898.60	5273.32	5659.81
12	3404.98	3718.77	4044.91	4383.15	4733.22	5094.87	5467.81

	J= 28	29	30	31	32	33	34
V= 0	8444.46	9019.83	9611.27	10218.42	10840.92	11478.39	12130.46
1	8210.87	8770.09	9344.89	9934.94	10539.86	11159.28	11792.84
2	7981.70	8525.06	9083.53	9656.77	10244.41	10846.09	11461.45
3	7756.63	8284.40	8826.80	9383.49	9954.13	10538.35	11135.80
4	7535.31	8047.72	8574.29	9114.69	9668.57	10235.58	10815.37
5	7317.36	7814.62	8325.58	8849.90	9387.24	9937.26	10499.61
6	7102.50	7584.70	8080.22	8588.65	9109.65	9642.87	10187.96
7	6890.03	7357.52	7837.77	8330.46	8835.26	9351.84	9879.84
8	6679.82	7132.63	7597.73	8074.81	8563.55	9063.60	9574.62
9	6471.35	6909.57	7359.61	7821.18	8293.93	8777.55	9271.68
10	6264.17	6687.85	7122.90	7569.00	8025.83	8493.06	8970.36
11	6057.80	6466.98	6887.06	7317.72	7758.64	8209.50	8669.95
12	5851.76	6246.44	6651.53	7066.74	7491.73	7926.19	8369.77

	J= 35	36	37	38	39	40	41
V= 0	12796.73	13476.81	14170.29	14876.77	15595.82	16327.03	17069.96
1	12440.15	13100.82	13774.46	14460.66	15159.00	15869.08	16590.47
2	12090.12	12731.70	13385.81	14052.04	14730.00	15419.27	16119.44
3	11746.10	12368.88	13003.75	13650.31	14308.17	14976.93	15656.16
4	11407.56	12011.79	12627.67	13254.82	13892.84	14541.33	15199.88
5	11073.92	11659.82	12256.94	12864.90	13483.29	14111.74	14749.82
6	10744.57	11312.34	11890.89	12479.83	13078.79	13687.37	14305.17
7	10418.91	10968.69	11528.81	12098.90	12678.56	13267.42	13865.06
8	10096.27	10628.18	11169.99	11721.33	12281.81	12851.04	13428.62
9	9775.99	10290.11	10813.68	11346.33	11887.68	12437.34	12994.92
10	9457.36	9953.73	10459.09	10973.08	11495.33	12025.43	12563.01
11	9139.66	9618.27	10105.41	10600.73	11103.84	11614.36	12131.88
12	8822.14	9282.94	9751.81	10228.39	10712.30	11203.14	11700.53

Table 5. Rotation-Vibration Energy of DF Molecule (Continued)

CALC. E(V,J) , 1/CM

	J= 42	43	44	45	46	47	48
V= 0	17824.18	18589.24	19364.70	20150.09	20944.96	21748.84	22561.25
1	17322.73	18065.44	18818.14	19580.39	20351.72	21131.69	21919.80
2	16830.07	17550.74	18281.00	19020.42	19768.54	20524.90	21289.03
3	16345.44	17044.36	17752.48	18469.34	19194.52	19927.54	20667.95
4	15868.07	16545.49	17231.69	17926.25	18628.72	19338.64	20055.55
5	15397.13	16053.25	16717.76	17390.20	18070.16	18757.16	19450.76
6	14931.77	15566.77	16209.73	16860.22	17517.81	18182.04	18852.47
7	14471.09	15085.08	15706.62	16335.28	16970.61	17612.17	18259.50
8	14014.16	14607.23	15207.43	15814.31	16427.44	17046.37	17670.65
9	13560.01	14132.20	14711.08	15296.20	15887.14	16483.44	17084.66
10	13107.65	13658.94	14216.47	14779.81	15348.51	15922.14	16500.22
11	12656.02	13186.36	13722.48	14263.94	14810.31	15361.15	15915.98
12	12204.07	12713.33	13227.91	13747.36	14271.25	14799.13	15330.53

	J= 49	50
V= 0	23381.70	24209.72
1	22715.59	23518.57
2	22060.45	22838.70
3	21415.28	22169.04
4	20778.99	21508.48
5	20150.49	20855.88
6	19528.61	20210.01
7	18912.14	19569.62
8	18299.82	18933.38
9	17690.32	18299.95
10	17082.30	17667.90
11	16474.34	17035.76
12	15864.99	16402.01

Table 6. Band Centers of HF Molecule[a]

v'	v = 0	v = 1	v = 2	v = 3	v = 4	v = 5	v = 6	v = 7	v = 8
1	3961.58								
2	7750.99	3789.41							
3	11372.99	7411.41	3622.00						
4	14831.82	10870.24	7080.83	3458.83					
5	18131.13	14169.55	10380.14	6758.14	3299.31				
6	21273.92	17312.34	13522.93	9900.93	6442.10	3142.79			
7	24262.45	20300.87	16511.46	12889.46	9430.63	6131.32	2988.53		
8	27098.19	23136.60	19347.19	15725.19	12266.36	8967.05	5824.26	2835.73	
9	29781.71	25820.13	22030.72	18408.72	14949.89	11650.58	8507.79	5519.26	2683.53

[a]In units of cm^{-1}.

Table 7. Band Centers of DF Molecule[a]

v'	v = 0	v = 1	v = 2	v = 3	v = 4	v = 5	v = 6	v = 7	v = 8	v = 9	v = 10	v = 11
1	2906.85											
2	5722.71	2815.27										
3	8447.72	5540.87	2725.60									
4	11085.43	8178.58	5363.32	2637.72								
5	13636.90	10730.05	7914.79	5189.19	2551.47							
6	16103.61	13196.76	10381.49	7655.89	5018.18	2466.71						
7	18486.86	15580.01	12764.74	10039.14	7401.43	4349.96	2383.25					
8	20787.77	17880.93	15065.66	12340.06	9702.34	7150.87	4684.17	2300.92				
9	23007.28	20100.43	17285.16	14559.56	11921.85	9370.38	6903.67	4520.42	2219.50			
10	25146.08	22239.23	19423.96	16698.36	14060.65	11509.18	9042.47	6659.22	4358.31	2138.80		
11	27204.66	24297.81	21482.54	18756.94	16119.22	13567.75	11101.05	8717.80	6416.88	4197.38	2058.58	
12	29183.24	26276.39	23461.13	20735.53	18097.81	15546.34	13079.63	10696.38	8395.47	6175.96	4037.17	1978.59

[a]In units of cm^{-1}.

Table 8a. Line Positions for HF, P-Branch, $\Delta v = 1$ Sequence

NU(V,1,-1) , 1/CM , P-BRANCH , DELTA NU = 1

	J= 1	2	3	4	5	6	7
V= 0	3920.47	3877.86	3833.81	3788.37	3741.60	3693.54	3644.26
1	3749.84	3708.82	3666.40	3622.62	3577.54	3531.21	3483.69
2	3583.94	3544.46	3503.60	3461.43	3417.99	3373.34	3327.51
3	3422.23	3384.25	3344.93	3304.32	3262.46	3219.41	3175.23
4	3264.15	3227.63	3189.80	3150.70	3110.37	3068.88	3026.27
5	3109.04	3073.95	3037.56	2999.93	2961.09	2921.10	2880.01
6	2956.16	2922.47	2887.51	2851.30	2813.91	2775.38	2735.75
7	2804.74	2772.43	2738.85	2704.04	2668.05	2630.93	2592.72
8	2653.89	2622.94	2590.72	2557.29	2522.67	2486.92	2450.08

	J= 8	9	10	11	12	13	14
V= 0	3593.81	3542.25	3489.64	3436.04	3381.50	3326.08	3269.83
1	3435.04	3385.30	3334.53	3282.80	3230.15	3176.63	3122.32
2	3280.58	3232.59	3183.59	3133.65	3082.80	3031.12	2978.64
3	3129.95	3083.64	3036.34	2988.10	2938.99	2889.04	2838.31
4	2982.59	2937.88	2892.21	2845.61	2798.14	2749.85	2700.79
5	2837.86	2794.70	2750.58	2705.55	2659.65	2612.94	2565.46
6	2695.07	2653.40	2610.76	2567.22	2522.82	2477.61	2431.62
7	2553.46	2513.21	2472.00	2429.89	2386.91	2343.11	2298.54
8	2412.20	2373.31	2333.46	2292.71	2251.08	2208.63	2165.39

	J= 15	16	17	18	19	20	21
V= 0	3212.83	3155.12	3096.76	3037.80	2978.31	2918.34	2857.93
1	3067.26	3011.50	2955.10	2898.12	2840.61	2782.62	2724.20
2	2925.43	2871.53	2817.00	2761.90	2706.26	2650.15	2593.60
3	2786.86	2734.73	2681.98	2628.64	2574.78	2520.44	2465.66
4	2651.01	2600.55	2549.47	2497.81	2445.62	2392.95	2339.83
5	2517.26	2468.38	2418.88	2368.79	2318.17	2267.06	2215.49
6	2384.91	2337.53	2289.51	2240.90	2191.75	2142.09	2091.96
7	2253.24	2207.25	2160.62	2113.39	2065.60	2017.29	1968.49
8	2121.41	2076.74	2031.40	1985.45	1938.92	1891.85	1844.28

	J= 22	23	24	25	26	27	28
V= 0	2797.16	2736.06	2674.69	2613.10	2551.34	2489.45	2427.49
1	2665.40	2606.28	2546.88	2487.25	2427.44	2367.49	2307.46
2	2536.68	2479.42	2421.88	2364.10	2306.12	2248.00	2189.76
3	2410.50	2355.00	2299.20	2243.15	2186.89	2130.46	2073.91
4	2286.32	2232.46	2178.29	2123.85	2069.19	2014.33	1959.33
5	2163.52	2111.18	2058.52	2005.57	1952.38	1898.97	1845.40
6	2041.52	1990.49	1939.21	1887.63	1835.78	1783.70	1731.41
7	1919.26	1869.62	1819.62	1769.28	1718.65	1667.75	1616.63
8	1796.24	1747.78	1698.92	1649.70	1600.16	1550.32	1500.23

Table 8a. Line Positions for HF, P-Branch, $\Delta v = 1$ Sequence (Continued)

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 1

	J= 29	30	31	32	33	34	35
V= 0	2365.51	2303.54	2241.63	2179.84	2118.19	2056.73	1995.52
1	2247.37	2187.29	2127.25	2067.28	2007.45	1947.77	1888.30
2	2131.46	2073.14	2014.83	1956.58	1898.43	1840.41	1782.56
3	2017.27	1960.58	1903.88	1847.21	1790.61	1734.11	1677.75
4	1904.22	1849.03	1793.81	1738.59	1683.41	1628.29	1573.28
5	1791.68	1737.87	1683.99	1630.08	1576.17	1522.30	1468.50
6	1678.97	1626.39	1573.71	1520.97	1468.20	1415.42	1362.68
7	1565.31	1513.83	1462.22	1410.50	1358.71	1306.89	1255.05
8	1449.90	1399.37	1348.68	1297.84	1246.89	1195.86	1144.78

	J= 36	37	38	39	40	41	42
V= 0	1934.58	1873.96	1813.71	1753.86	1694.46	1635.56	1577.20
1	1829.08	1770.15	1711.54	1653.30	1595.47	1538.09	1481.21
2	1724.93	1667.54	1610.45	1553.69	1497.29	1441.31	1385.78
3	1621.57	1565.60	1509.89	1454.46	1399.37	1344.64	1290.32
4	1518.42	1463.72	1409.25	1355.01	1301.07	1247.45	1194.19
5	1414.80	1361.24	1307.85	1254.66	1201.72	1149.06	1096.71
6	1310.00	1257.42	1204.96	1152.67	1100.57	1048.71	997.12
7	1203.24	1151.48	1099.80	1048.24	996.83	945.61	894.60
8	1093.67	1042.57	991.51	940.52	889.63	838.87	788.29

	J= 43	44	45	46	47	48	49
V= 0	1519.42	1462.28	1405.83	1350.11	1295.20	1241.14	1188.01
1	1424.87	1369.12	1314.01	1259.60	1205.93	1153.07	1101.08
2	1330.74	1276.25	1222.36	1169.10	1116.55	1064.75	1013.78
3	1236.45	1183.08	1130.25	1078.02	1026.44	975.51	925.47
4	1141.35	1088.95	1037.05	985.69	934.94	884.84	835.47
5	1044.73	993.15	942.02	891.38	841.30	791.82	743.02
6	945.84	894.97	844.39	794.22	744.74	695.72	647.31
7	843.86	793.43	743.34	693.65	644.40	595.66	547.49
8	737.91	687.79	637.96	588.48	539.39	490.75	442.63

	J= 50
V= 0	1135.86
1	1050.03
2	963.69
3	876.21
4	786.88
5	694.94
6	599.59
7	499.95
8	395.08

Table 8b. Line Positions of HF, P-Branch, $\Delta v = 2$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 2

	J= 1	2	3	4	5	6	7
V= 0	7709.88	7665.77	7618.71	7568.76	7515.98	7460.42	7402.16
1	7371.84	7329.35	7283.99	7235.82	7184.88	7131.24	7074.95
2	7042.77	7001.85	6958.13	6911.65	6862.48	6810.67	6756.28
3	6721.55	6682.16	6640.02	6595.19	6547.71	6497.64	6445.05
4	6406.94	6369.04	6328.43	6285.18	6239.32	6190.92	6140.03
5	6097.57	6061.11	6021.99	5980.25	5935.95	5889.14	5839.87
6	5791.90	5756.85	5719.17	5678.90	5636.09	5590.79	5543.04
7	5488.27	5454.60	5418.32	5379.46	5338.08	5294.21	5247.92

	J= 8	9	10	11	12	13	14
V= 0	7341.25	7277.76	7211.76	7143.32	7072.50	6999.38	6924.04
1	7016.09	6954.71	6890.87	6824.65	6756.11	6685.32	6612.34
2	6699.36	6639.97	6578.19	6514.07	6447.67	6379.07	6308.32
3	6389.97	6332.48	6272.63	6210.48	6146.09	6079.53	6010.85
4	6086.70	6030.99	5972.95	5912.65	5850.14	5785.47	5718.72
5	5788.18	5734.14	5677.80	5619.22	5558.44	5495.53	5430.55
6	5492.91	5440.44	5385.68	5328.68	5269.50	5208.20	5144.82
7	5199.24	5148.22	5094.92	5039.39	4981.67	4921.83	4859.90

	J= 15	16	17	18	19	20	21
V= 0	6846.53	6766.94	6685.35	6601.81	6516.42	6429.24	6340.34
1	6537.26	6460.12	6381.02	6300.01	6217.16	6132.55	6046.24
2	6235.49	6160.65	6083.86	6005.20	5924.72	5842.49	5758.57
3	5940.13	5867.41	5792.77	5716.27	5637.97	5557.92	5476.20
4	5649.93	5579.18	5506.50	5431.98	5355.65	5277.59	5197.85
5	5363.54	5294.56	5223.67	5150.93	5076.39	5000.10	4922.12
6	5079.42	5012.05	4942.76	4871.61	4798.64	4723.91	4647.47
7	4795.93	4729.99	4662.11	4592.35	4520.74	4447.35	4372.22

	J= 22	23	24	25	26	27	28
V= 0	6249.80	6157.69	6064.08	5969.05	5872.66	5774.98	5676.08
1	5958.31	5868.82	5777.83	5685.42	5591.65	5496.59	5400.29
2	5673.04	5585.96	5497.38	5407.37	5315.99	5223.29	5129.35
3	5392.86	5307.96	5221.56	5132.71	5044.48	4953.92	4862.07
4	5116.48	5033.54	4949.08	4863.16	4775.83	4687.14	4597.13
5	4842.49	4761.28	4678.52	4594.28	4508.59	4421.50	4333.05
6	4569.35	4489.62	4408.32	4325.49	4241.17	4155.41	4068.24
7	4295.38	4216.88	4136.78	4055.09	3971.87	3887.15	3800.97

	J= 29	30	31	32	33	34	35
V= 0	5576.03	5474.89	5372.72	5269.59	5165.56	5060.68	4955.02
1	5302.81	5203.23	5104.59	5003.95	4902.38	4799.91	4696.61
2	5034.21	4937.92	4840.55	4742.14	4642.75	4542.42	4441.19
3	4769.00	4674.75	4579.37	4482.91	4385.42	4286.92	4187.48
4	4505.86	4413.36	4319.69	4224.89	4128.99	4032.03	3934.06
5	4243.29	4152.27	4060.01	3966.55	3871.94	3776.20	3679.36
6	3979.71	3889.85	3798.69	3706.26	3612.61	3517.75	3421.72
7	3712.36	3624.35	3533.97	3442.25	3349.22	3254.90	3159.31

Table 8b. Line Positions of HF, P-Branch, Δv = 2 Sequence (Continued)

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 2

	J= 36	37	38	39	40	41	42
V= 0	4848.63	4741.56	4633.87	4525.60	4416.81	4307.55	4197.87
1	4592.53	4487.70	4382.19	4276.04	4169.29	4061.[illegible]	3954.16
2	4339.13	4236.26	4132.63	4028.28	3923.25	3817.59	3711.31
3	4087.13	3985.90	3883.84	3780.98	3677.35	3572.99	3467.92
4	3835.10	3735.19	3634.36	35[illegible].64	3430.07	3326.66	3222.45
5	3581.47	3482.53	3382.59	3[illegible]1.67	3179.79	3076.97	2973.23
6	3324.54	3226.22	3126.81	3026.31	2924.74	2822.12	2718.47
7	3062.48	2964.4[illegible]	2865.15	2764.68	2663.04	2560.22	2456.25

	J= 43	44	45	46	47	48	49
V= 0	4087.80	3977.40	3866.72	3755.78	3644.65	3533.36	3421.96
1	3845.87	3737.14	3628.02	3518.55	3408.77	3298.70	3188.40
2	3604.47	3497.09	3389.21	3280.86	3172.08	3062.90	2953.35
3	3362.18	3255.80	3148.80	3041.22	2933.08	2824.41	2715.24
4	3117.45	3011.70	2905.22	2798.02	2690.14	2581.60	2472.41
5	2868.60	2763.09	2656.72	2549.52	2441.49	2332.66	2223.04
6	2613.81	2508.14	2401.48	2293.84	2185.24	2075.69	1965.20
7	2351.13	2244.87	2137.49	2028.98	1919.36	1808.64	1696.82

	J= 50
V= 0	3310.49
1	3077.90
2	2843.47
3	2605.60
4	2362.61
5	2112.65
6	[illegible]53.78
7	1583.91

Table 8c. Line Positions of HF, P-Branch, $\Delta v = 3$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 3

	J= 1	2	3	4	5	6	7
V= 0	11331.88	11286.30	11236.31	11181.96	11123.32	11060.45	10993.42
1	10830.67	10786.75	10738.52	10686.04	10629.37	10568.57	10503.71
2	10342.08	10299.75	10253.22	10202.52	10147.73	10088.90	10026.10
3	9864.33	9823.56	9778.65	9729.67	9676.66	9619.69	9558.81
4	9395.47	9356.20	9312.86	9265.50	9214.18	9158.96	9099.89
5	8933.30	8895.49	8853.65	8807.85	8758.13	8704.55	8647.16
6	8475.43	8439.03	8398.65	8354.33	8306.12	8254.07	8198.24

	J= 8	9	10	11	12	13	14
V= 0	10922.30	10847.17	10768.10	10685.17	10598.47	10508.07	10414.06
1	10434.86	10362.09	10285.47	10205.07	10120.98	10033.27	9942.02
2	9959.38	9888.82	9814.48	9736.44	9654.78	9569.55	9480.85
3	9494.09	9425.59	9353.37	9277.52	9198.09	9115.15	9028.78
4	9037.02	8970.43	8900.18	8826.32	8748.93	8668.07	8583.81
5	8586.02	8521.18	8452.72	8380.68	8305.13	8226.13	8143.75
6	8138.68	8075.45	8008.60	7938.18	7864.27	7786.92	7706.18

	J= 15	16	17	18	19	20	21
V= 0	10316.53	10215.57	10111.26	10003.70	9892.97	9779.17	9662.39
1	9847.32	9749.24	9647.88	9543.31	9435.52	9324.89	9211.22
2	9388.75	9293.33	9194.66	9092.82	8987.90	8879.97	8769.11
3	8939.05	8846.03	8749.80	8650.43	8548.00	8442.57	8334.21
4	8496.22	8405.36	8311.30	8214.12	8113.87	8010.63	7904.47
5	8058.04	7969.08	7876.92	7781.64	7683.28	7581.92	7477.62
6	7622.11	7534.78	7444.25	7350.56	7253.79	7153.98	7051.19

	J= 22	23	24	25	26	27	28
V= 0	9542.71	9420.23	9295.04	9167.22	9036.87	8904.07	8768.91
1	9094.68	8975.35	8853.33	8728.69	8601.52	8471.88	8339.87
2	8655.40	8538.91	8419.73	8297.93	8173.58	8046.75	7917.51
3	8223.01	8109.03	7992.35	7873.02	7751.13	7626.72	7499.87
4	7795.45	7683.63	7569.08	7451.87	7332.04	7209.66	7084.78
5	7370.43	7260.41	7147.63	7032.13	6913.97	6793.21	6669.88
6	6945.47	6836.89	6725.48	6611.30	6494.39	6374.81	6252.58

	J= 29	30	31	32	33	34	35
V= 0	8631.47	8491.83	8350.07	8206.26	8060.49	7912.82	7763.33
1	8205.56	8069.01	7930.31	7789.52	7646.70	7501.92	7355.25
2	7785.94	7652.10	7516.04	7377.84	7237.56	7095.23	6950.93
3	7370.64	7239.08	7105.25	6969.21	6831.00	6690.66	6548.26
4	6957.47	6827.76	6695.71	6561.36	6424.75	6285.93	6144.92
5	6544.04	6415.72	6284.98	6151.84	6016.35	5878.53	5738.40
6	6127.75	6000.36	5870.44	5738.02	5603.12	5465.77	5325.98

Table 8c. Line Positions of HF, P-Branch, $\Delta v = 3$ Sequence (Continued)

NU(V,J,-1) 1/CM , P-BRANCH , DELTA NU = 3

	J= 36	37	38	39	40	41	42
V= 0	7612.07	7459.11	7304.52	7148.34	6990.63	6831.44	6670.82
1	7206.73	7056.42	6904.37	6750.63	6595.25	6438.26	6279.69
2	6804.68	6656.56	6506.58	6354.80	6201.24	6045.93	5888.91
3	6403.81	6257.37	6108.96	5958.61	5806.35	5652.20	5496.17
4	6001.76	5856.48	5709.11	5559.65	5408.13	5254.57	5098.96
5	5596.00	5451.34	5304.44	5155.31	5003.95	4850.37	4694.58
6	5183.78	5039.17	4892.15	4742.75	4590.94	4436.74	4280.12

	J= 43	44	45	46	47	48	49
V= 0	6508.80	6345.42	6180.73	6014.74	5847.49	5678.99	5509.28
1	6119.59	5957.98	5794.88	5630.31	5464.30	5296.85	5127.97
2	5730.20	5569.81	5407.76	5244.06	5078.72	4911.74	4743.12
3	5338.29	5178.55	5016.98	4853.55	4688.29	4521.17	4352.19
4	4941.32	4781.64	4619.92	4456.16	4290.33	4122.43	3952.43
5	4536.56	4376.31	4213.81	4049.04	3881.99	3712.63	3540.92
6	4121.07	3959.58	3795.62	3629.17	3460.20	3288.66	3114.53

	J= 50
V= 0	5338.36
1	4957.68
2	4572.86
3	4181.33
4	3780.31
5	3366.84
6	2937.75

Table 8d. Line Positions of HF, P-Branch, $\Delta v = 4$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 4

	J= 1	2	3	4	5	6	7
V= 0	14790.71	14743.69	14690.83	14632.18	14567.81	14497.78	14422.18
1	14129.98	14084.65	14033.61	13976.91	13914.62	13846.80	13773.53
2	13484.87	13441.16	13391.85	13337.01	13276.68	13210.95	13137.86
3	12852.86	12810.72	12763.08	12709.99	12651.52	12587.72	12518.66
4	12231.21	12190.58	12144.52	12093.10	12036.36	11974.37	11907.18
5	11616.83	11577.66	11533.13	11483.28	11428.16	11367.83	11302.36

	J= 8	9	10	11	12	13	14
V= 0	14341.08	14254.55	14162.70	14065.59	13963.33	13856.02	13743.74
1	13694.88	13610.93	13521.76	13427.45	13328.08	13223.76	13114.56
2	13063.49	12981.92	12895.23	12803.48	12706.77	12605.18	12498.78
3	12444.41	12365.03	12280.60	12191.19	12096.88	11997.75	11893.87
4	11834.86	11757.47	11675.09	11587.78	11495.61	11398.67	11297.01
5	11231.79	11156.19	11075.64	10990.18	10899.89	10804.84	10705.10

	J= 15	16	17	18	19	20	21
V= 0	13626.59	13504.69	13378.12	13247.00	13111.43	12971.51	12827.36
1	13000.58	12881.92	12758.67	12630.93	12498.80	12362.37	12221.75
2	12387.68	12271.95	12151.69	12026.99	11897.93	11764.61	11627.12
3	11785.33	11672.22	11554.60	11432.57	11306.21	11175.61	11040.84
4	11190.72	11079.88	10964.55	10844.82	10720.77	10592.46	10459.97
5	10600.74	10491.82	10378.41	10260.59	10138.43	10011.99	9881.34

	J= 22	23	24	25	26	27	28
V= 0	12679.07	12526.76	12370.53	12210.49	12046.74	11879.37	11708.50
1	12077.03	11928.31	11775.68	11619.25	11459.10	11295.34	11128.04
2	11485.55	11339.99	11190.52	11037.24	10880.22	10719.55	10555.31
3	10901.98	10759.13	10612.35	10461.73	10307.33	10149.24	9987.53
4	10323.39	10182.77	10038.19	9889.72	9737.48	9581.37	9421.61
5	9746.55	9607.68	9464.79	9317.94	9167.20	9012.61	8854.22

	J= 29	30	31	32	33	34	35
V= 0	11534.21	11356.61	11175.79	10991.82	10804.81	10614.83	10421.96
1	10957.29	10783.19	10605.80	10425.22	10241.51	10054.74	9864.98
2	10387.58	10216.42	10041.92	9864.14	9683.13	9498.97	9311.70
3	9822.25	9653.48	9481.27	9305.68	9126.76	8944.56	8759.12
4	9258.21	9091.22	8920.68	8746.65	8569.16	8388.26	8203.96
5	8692.08	8526.24	8356.73	8183.60	8006.86	7826.54	7642.66

	J= 36	37	38	39	40	41	42
V= 0	10226.27	10027.83	9826.70	9622.94	9416.60	9207.72	8996.35
1	9672.28	9476.72	9278.32	9077.15	8873.23	8666.61	8457.30
2	9121.37	8928.02	8731.70	8532.43	8330.24	8125.15	7917.17
3	8570.48	8378.66	8183.70	7985.61	7784.41	7580.10	7372.69
4	8016.30	7825.29	7630.95	7433.29	7232.30	7027.98	6820.31
5	7455.24	7264.28	7069.78	6871.75	6670.15	6464.99	6256.22

Table 8d. Line Positions of HF, P-Branch, $\Delta v = 4$ Sequence (Continued)

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 4

	J= 43	44	45	46	47	48	49
V= 0	8782.52	8566.26	8347.58	8126.50	7903.02	7677.14	7448.85
1	8245.32	8030.70	7813.43	7593.51	7370.94	7145.69	6917.75
2	7706.31	7492.56	7275.93	7056.39	6833.92	6608.49	6380.06
3	7162.16	6948.50	6731.68	6511.69	6288.48	6062.00	5832.21
4	6609.28	6394.86	6177.01	5955.68	5730.83	5502.40	5270.32
5	6043.83	5827.75	5607.95	5384.38	5156.95	4925.60	4690.25

	J= 50
V= 0	7218.14
1	6687.07
2	6148.59
3	5599.03
4	5034.50
5	4450.81

Table 8e. Line Positions of HF, P-Branch, $\Delta v = 5$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 5

	J= 1	2	3	4	5	6	7
V= 0	18090.02	18041.60	17985.92	17923.05	17853.06	17776.01	17692.00
1	17272.77	17226.05	17172.24	17111.39	17043.57	16968.84	16887.30
2	16473.40	16428.32	16376.28	16317.33	16251.54	16178.98	16099.71
3	15688.60	15645.10	15594.74	15537.59	15473.70	15403.13	15325.96
4	149[illegible].74	14872.75	14824.00	14768.53	14706.39	14637.65	14562.38

	J= 8	9	10	11	12	13	14
V= 0	17601.10	17503.40	17398.99	17287.97	17170.44	17046.51	16916.28
1	16799.00	16704.04	16602.51	16494.49	16380.08	16259.38	16132.49
2	16013.82	15921.37	15822.45	15717.16	15605.57	15487.77	15363.87
3	15242.24	15152.07	15055.51	14952.65	14843.56	14728.34	14607.07
4	14480.63	14392.48	14298.01	14197.28	14090.38	13977.38	13858.37

	J= 15	16	17	18	19	20	21
V= 0	16779.86	16637.37	16488.92	16334.63	16174.61	16008.99	15837.89
1	15999.51	15860.54	15715.70	15565.10	15408.83	15247.02	15079.76
2	15233.96	[illegible]	14956.49	14809.12	14656.15	14497.65	14333.75
3	14479.84	[illegible]	14207.85	14063.28	13913.11	13757.43	13596.34
4	13733.42	[illegible]	13466.04	13323.78	13175.91	13022.52	12863.70

	J= 22	23	24	25	26	27	28
V= 0	15661.43	15479.72	15292.89	15101.05	14904.32	14702.82	14496.66
1	14907.18	14729.39	14546.48	14358.56	14165.75	13968.14	13765.33
2	14164.52	13990.08	13810.52	13625.94	13436.43	13242.07	13042.97
3	13429.92	13258.26	13081.46	12899.58	12712.72	12520.96	12324.36
4	12699.51	12530.03	12355.35	12175.53	11990.65	11800.77	11605.95

	J= 29	30	31	32	33	34	35
V= 0	14285.95	14070.78	13851.28	13627.53	13399.62	13167.65	12931.69
1	13558.93	13347.51	13131.68	12911.51	12687.08	12458.47	12225.75
2	12839.19	12630.82	12417.94	12200.61	11978.90	11752.87	11522.56
3	12122.99	11916.94	11706.24	11490.97	11271.17	11046.89	10818.16
4	11406.26	11201.73	10992.44	10778.40	10559.67	10336.27	10108.22

	J= 36	37	38	39	40	41	42
V= 0	12691.83	12448.13	12200.65	11949.45	11694.58	11436.07	11173.96
1	11988.97	11748.18	11503.44	11254.78	11002.23	10745.82	10485.55
2	11288.03	11049.32	10806.44	10559.43	10308.30	10053.05	9793.68
3	10585.01	10347.47	10105.55	9859.25	9608.58	9353.51	9094.04
4	9875.54	9638.23	9396.30	9149.73	8898.50	8642.59	8381.95

Table 8e. Line Positions of HF, P-Branch, $\Delta v = 5$ Sequence (Continued)

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 5

	J= 43	44	45	46	47	48	49
V= 0	10908.26	10638.98	10366.13	10089.70	9809.66	9525.98	9238.63
1	10221.43	9953.45	9681.60	9405.84	9126.14	8842.44	8554.69
2	9530.18	9262.51	8990.64	8714.53	8434.11	8149.33	7860.08
3	8830.12	8561.71	8288.76	8011.21	7728.98	7441.97	7150.09
4	8116.55	7846.30	7571.15	7291.02	7005.79	6715.37	6419.65

	J= 50
V= 0	8947.53
1	8262.80
2	7566.29
3	6853.23
4	6118.47

Table 8f. Line Positions of HF, P-Branch, $\Delta v = 6$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 6

	J= 1	2	3	4	5	6	7
V= 0	21232.81	21183.00	21124.55	21057.53	20982.01	20898.06	20805.76
1	20261.30	20213.22	20156.67	20091.71	20018.43	19936.88	19847.15
2	19309.13	19262.70	19207.94	19144.93	19073.72	18994.39	18907.01
3	18372.13	18327.28	18274.22	18213.02	18143.73	18066.41	17981.15
	J= 8	9	10	11	12	13	14
V= 0	20705.21	20596.50	20479.73	20355.01	20222.43	20082.13	19934.20
1	19749.32	19643.49	19529.73	19408.16	19278.87	19141.98	18997.58
2	18811.65	18708.41	18597.37	18478.61	18352.25	18218.37	18077.07
3	17888.02	17787.08	17678.43	17562.15	17438.33	17307.06	17168.43
	J= 15	16	17	18	19	20	21
V= 0	19778.78	19615.99	19445.95	19268.79	19084.64	18893.64	18695.91
1	18845.79	18686.72	18520.50	18347.23	18167.05	17980.06	17786.39
2	17928.46	17772.65	17609.74	17439.83	17263.04	17079.48	16889.25
3	17022.53	16869.47	16709.34	16542.23	16368.25	16187.50	16000.06
	J= 22	23	24	25	26	27	28
V= 0	18491.58	18280.80	18063.68	17840.36	17610.97	17375.63	17134.46
1	17586.15	17379.48	17166.48	16947.27	16721.96	16490.66	16253.49
2	16692.46	16489.22	16279.53	16063.80	15841.82	15613.79	15379.79
3	15806.04	15605.53	15398.62	15185.39	14965.95	14740.35	14508.69
	J= 29	30	31	32	33	34	35
V= 0	16887.58	16635.11	16377.16	16113.82	15845.20	15571.39	15292.46
1	16010.54	15761.91	15507.70	15247.98	14982.85	14712.37	14436.61
2	15139.93	14894.28	14642.91	14385.90	14123.31	13855.20	13581.60
3	14271.04	14027.45	13778.00	13522.72	13261.68	12994.90	12722.42
	J= 36	37	38	39	40	41	42
V= 0	15008.51	14719.59	14425.76	14127.08	13823.58	13515.28	13202.21
1	14155.63	13869.48	13578.18	13281.78	12980.30	12673.73	12362.07
2	13302.57	13018.12	12728.29	12433.07	12132.46	11826.46	11515.03
3	12444.25	12160.41	11870.89	11575.69	11274.78	10968.13	10655.68

Table 8f. Line Positions of HF, P-Branch, $\Delta v = 6$ Sequence (Continued)

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 6

	J= 43	44	45	46	47	48	49
V= 0	12884.36	12561.74	12234.30	11902.03	11564.86	11222.74	10875.57
1	12045.30	11723.39	11396.31	11063.98	10726.33	10383.28	10034.71
2	11198.14	10875.72	10547.72	10214.05	9874.61	9529.30	9177.97
3	10337.38	10013.16	9682.91	9346.55	9003.94	8654.95	8299.42

	J= 50
V= 0	10523.26
1	9680.51
2	8820.48
3	7937.19

Table 8g. Line Positions of HF, P-Branch. Δv = 7 Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 7

	J= 1	2	3	4	5	6	7
V= 0	24221.34	24170.16	24108.98	24037.86	23956.87	23866.09	23765.62
1	23097.04	23047.59	22988.33	22919.31	22840.61	22752.29	22654.44
2	21992.66	21944.87	21887.42	21820.36	21743.75	21657.67	21562.20
	J= 8	9	10	11	12	13	14
V= 0	23655.54	23535.95	23406.96	23268.68	23121.23	22964.73	22799.29
1	22547.16	22430.53	22304.64	22169.62	22025.56	21872.57	21710.78
2	21457.42	21343.42	21220.29	21088.12	20947.02	20797.08	20638.43
	J= 15	16	17	18	19	20	21
V= 0	22625.06	22442.17	22250.74	22050.93	21842.86	21626.68	21402.53
1	21540.29	21361.24	21173.75	20977.94	20773.94	20561.88	20341.89
2	20471.16	20295.38	20111.22	19918.78	19718.19	19509.54	19292.97
	J= 22	23	24	25	26	27	28
V= 0	21170.55	20930.89	20683.68	20429.07	20167.18	19898.15	19622.12
1	20114.09	19878.62	19635.58	19385.12	19127.35	18862.37	18590.32
2	19068.58	18836.48	18596.79	18349.61	18095.04	17833.18	17564.13
	J= 29	30	31	32	33	34	35
V= 0	19339.20	19049.51	18753.17	18450.29	18140.96	17825.28	17503.33
1	18311.28	18025.37	17732.67	17433.28	17127.26	16814.70	16495.65
2	17287.98	17004.80	16714.67	16417.66	16113.82	15803.21	15485.86
	J= 36	37	38	39	40	41	42
V= 0	17175.18	16840.89	16500.51	16154.09	15801.64	15443.19	15078.72
1	16170.17	15838.28	15500.03	15155.42	14804.46	14447.13	14083.42
2	15161.81	14831.06	14493.63	14149.51	13798.67	13441.08	13076.68
	J= 43	44	45	46	47	48	49
V= 0	14708.23	14331.68	13949.01	13560.16	13165.05	12763.57	12355.59
1	13713.26	13336.61	12953.39	12563.50	12166.83	11763.25	11352.59
2	12705.40	12327.17	11941.87	11549.38	11149.57	10742.27	10327.30
	J= 50						
V= 0	11940.97						
1	10934.70						
2	9904.45						

Table 8h. Line Positions of HF, P-Branch, $\Delta v = 8$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 8

	J= 1	2	3	4	5	6	7
V= 0	27057.07	27004.54	26940.64	26865.45	26779.05	26681.50	26572.91
1	25780.57	25729.77	25667.81	25594.74	25510.63	25415.57	25309.64
	J= 8	9	10	11	12	13	14
V= 0	26453.37	26322.99	26181.87	26030.14	25867.91	25695.32	25512.49
1	25192.93	25065.54	24927.56	24779.12	24620.32	24451.29	24272.13
	J= 15	16	17	18	19	20	21
V= 0	25319.57	25116.69	24904.00	24681.63	24449.75	24208.50	23958.03
1	24082.99	23883.98	23675.24	23456.89	23229.09	22991.95	22745.61
	J= 22	23	24	25	26	27	28
V= 0	23698.49	23430.03	23152.79	22866.92	22572.57	22269.86	21958.94
1	22490.21	22225.88	21952.74	21670.93	21380.57	21081.77	20774.66
	J= 29	30	31	32	33	34	35
V= 0	21639.94	21312.97	20978.15	20635.59	20285.38	19927.61	19562.37
1	20459.33	20135.89	19804.43	19465.03	19117.77	18762.71	18399.91
	J= 36	37	38	39	40	41	42
V= 0	19189.71	18809.69	18422.36	18027.72	17625.81	17216.60	16800.07
1	18029.41	17651.22	17265.38	16871.86	16470.67	16061.75	15645.06
	J= 43	44	45	46	47	48	49
V= 0	16376.19	15944.89	15506.09	15059.69	14605.55	14143.54	13673.47
1	15220.53	14788.06	14347.54	13898.83	13441.79	12976.22	12501.92
	J= 50						
V= 0	13195.16						
1	12018.66						

Table 8i. Line Positions of HF, P-Branch, $\Delta v = 9$ Sequence

NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 9

	J= 1	2	3	4	5	6	7
V= 0	29740.60	29686.72	29620.12	29540.88	29449.07	29344.78	29228.11
	J= 8	9	10	11	12	13	14
V= 0	29099.14	28958.00	28804.79	28639.64	28462.68	28274.04	28073.85
	J= 15	16	17	18	19	20	21
V= 0	27862.26	27639.42	27405.48	27160.59	26904.90	26638.57	26361.75
	J= 22	23	24	25	26	27	28
V= 0	26074.61	25777.29	25469.95	25152.73	24825.79	24489.26	24143.28
	J= 29	30	31	32	33	34	35
V= 0	23787.98	23423.49	23049.90	22667.34	22275.88	21875.62	21466.63
	J= 36	37	38	39	40	41	42
V= 0	21048.95	20622.63	20187.70	19744.17	19292.01	18831.21	18361.72
	J= 43	44	45	46	47	48	49
V= 0	17883.46	17396.34	16900.24	16395.02	15880.51	15356.51	14822.80
	J= 50						
V= 0	14279.12						

Table 9a. Line Positions of HF, R-Branch, $\Delta v = 1$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 1

	J= 0	1	2	3	4	5	6
V= 0	4001.15	4039.12	4075.45	4110.08	4142.99	4174.11	4203.42
1	3827.47	3863.98	3898.89	3932.15	3963.73	3993.57	4021.64
2	3658.59	3693.67	3727.19	3759.10	3789.37	3817.95	3844.79
3	3495.99	3527.66	3559.81	3590.40	3619.37	3646.69	3672.31
4	3333.06	3365.36	3396.16	3425.42	3453.11	3479.17	3503.57
5	3175.15	3206.09	3235.55	3263.50	3289.90	3314.70	3337.87
6	3019.53	3049.11	3077.25	3103.88	3128.99	3152.51	3174.43
7	2865.37	2893.62	2920.42	2945.74	2969.53	2991.77	3012.41
8	2711.82	2738.72	2764.18	2788.16	2810.64	2831.56	2850.89

	J= 7	8	9	10	11	12	13
V= 0	4230.87	4256.42	4280.05	4301.71	4321.38	4339.03	4354.63
1	4047.91	4072.32	4094.86	4115.49	4134.17	4150.88	4165.59
2	3869.88	3893.16	3914.60	3934.17	3951.85	3967.59	3981.39
3	3696.21	3718.35	3738.68	3757.19	3773.83	3788.58	3801.42
4	3526.28	3547.25	3566.46	3583.87	3599.45	3613.17	3625.01
5	3359.36	3379.16	3397.21	3413.49	3427.97	3440.61	3451.40
6	3194.59	3213.27	3230.14	3245.25	3258.57	3270.08	3279.75
7	3031.41	3048.74	3064.37	3078.25	3090.37	3100.68	3109.16
8	2868.59	2884.62	2898.96	2911.56	2922.40	2931.45	2938.66

	J= 14	15	16	17	18	19	20
V= 0	4368.17	4379.61	4388.94	4396.14	4401.20	4404.10	4404.83
1	4178.28	4188.92	4197.50	4204.00	4208.40	4210.69	4210.85
2	3993.20	4003.01	4010.80	4016.54	4020.23	4021.84	4021.35
3	3812.31	3821.24	3828.18	3833.11	3836.02	3836.87	3835.67
4	3634.93	3642.92	3648.95	3653.00	3655.04	3655.07	3653.05
5	3460.29	3467.27	3472.32	3475.40	3476.50	3475.60	3472.67
6	3287.55	3293.45	3297.42	3299.45	3299.51	3297.58	3293.63
7	3115.79	3120.52	3123.33	3124.21	3123.12	3120.04	3114.95
8	2944.02	2947.48	2949.04	2948.65	2946.29	2941.94	2935.56

	J= 21	22	23	24	25	26	27
V= 0	4403.38	4399.75	4393.93	4385.91	4375.68	4363.26	4348.62
1	4208.87	4204.75	4198.47	4190.03	4179.41	4166.63	4151.66
2	4018.77	4014.07	4007.25	3998.29	3987.18	3973.93	3958.51
3	3832.40	3827.03	3819.56	3809.98	3798.27	3784.42	3768.42
4	3648.99	3642.85	3634.62	3624.30	3611.86	3597.28	3580.57
5	3467.71	3460.68	3451.58	3440.38	3427.07	3411.63	3394.04
6	3287.65	3279.61	3269.49	3257.28	3242.95	3226.48	3207.85
7	3107.81	3098.62	3087.35	3073.97	3058.45	3040.79	3020.94
8	2927.14	2916.64	2904.05	2889.33	2872.46	2853.42	2832.16

Table 9a. Line Positions of HF, R-Branch, $\Delta v = 1$ Sequence (Continued)

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 1

	J= 28	29	30	31	32	33	34
V= 0	4331.77	4312.72	4291.44	4267.95	4242.24	4214.29	4184.11
1	4134.50	4115.15	4093.60	4069.85	4043.88	4015.68	3985.25
2	3940.91	3921.14	3899.18	3875.02	3848.64	3820.04	3789.19
3	3750.26	3729.92	3707.40	3682.67	3655.72	3626.53	3595.08
4	3561.69	3540.63	3517.38	3491.92	3464.21	3434.25	3402.01
5	3374.28	3352.34	3328.18	3301.79	3273.15	3242.21	3208.96
6	3187.04	3164.03	3138.78	3111.27	3081.46	3049.34	3014.85
7	2998.89	2974.60	2948.05	2919.21	2888.03	2854.48	2818.52
8	2808.66	2782.90	2754.83	2724.42	2691.63	2656.41	2618.72

	J= 35	36	37	38	39	40	41
V= 0	4151.68	4117.00	4080.03	4040.77	3999.19	3955.25	3908.93
1	3952.57	3917.61	3880.36	3840.80	3798.88	3754.58	3707.85
2	3756.07	3720.67	3682.94	3642.87	3600.41	3555.53	3508.17
3	3561.34	3525.29	3486.88	3446.09	3402.88	3357.18	3308.94
4	3367.44	3330.53	3291.22	3249.48	3205.26	3158.50	3109.14
5	3173.35	3135.34	3094.90	3051.97	3006.49	2958.41	2907.65
6	2977.96	2938.62	2896.79	2852.40	2805.40	2755.71	2703.26
7	2780.10	2739.17	2695.68	2649.56	2600.74	2549.15	2494.71
8	2578.51	2535.71	2490.28	2442.13	2391.19	2337.39	2280.62

	J= 42	43	44	45	46	47	48
V= 0	3860.17	3808.93	3755.16	3698.77	3639.71	3577.87	3513.17
1	3658.64	3606.89	3552.54	3495.52	3435.74	3373.10	3307.50
2	3458.27	3405.78	3350.61	3292.69	3231.93	3168.21	3101.43
3	3258.11	3204.61	3148.36	3089.27	3027.23	2962.14	2893.88
4	3057.11	3002.33	2944.71	2884.15	2820.54	2753.77	2683.70
5	2854.13	2797.78	2738.49	2676.15	2610.66	2541.87	2469.65
6	2647.97	2589.73	2528.45	2464.01	2396.29	2325.14	2250.42
7	2437.31	2376.87	2313.27	2246.38	2176.07	2102.19	2024.59
8	2220.80	2157.80	2091.52	2021.81	1948.54	1871.55	1790.67

	J= 49
V= 0	3445.48
1	3238.81
2	3031.45
3	2822.29
4	2610.18
5	2393.84
6	2171.95
7	1943.08
8	1705.71

Table 9b. Line Positions of HF, R-Branch, $\Delta v = 2$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 2

	J= 0	1	2	3	4	5	6
V= 0	7789.06	7824.02	7855.84	7884.47	7909.87	7932.01	7950.86
1	7448.00	7481.58	7512.09	7539.49	7563.75	7584.83	7602.69
2	7115.99	7148.19	7177.41	7203.59	7226.71	7246.71	7263.57
3	6791.89	6823.75	6850.69	6875.65	6897.60	6916.50	6932.33
4	6474.47	6505.99	6530.64	6554.37	6575.15	6592.93	6607.69
5	6162.32	6190.22	6215.88	6238.37	6257.94	6274.56	6288.19
6	5853.90	5880.78	5904.84	5926.06	5944.39	5959.81	5972.26
7	5547.55	5573.09	5595.84	5615.76	5632.82	5646.97	5658.18

	J= 7	8	9	10	11	12	13
V= 0	7966.37	7978.54	7987.32	7992.71	7994.69	7993.23	7988.34
1	7617.31	7628.66	7636.72	7641.45	7642.85	7640.90	7635.59
2	7277.26	7287.75	7295.02	7299.04	7299.80	7297.27	7291.45
3	6945.05	6954.64	6961.06	6964.29	6964.32	6961.12	6954.69
4	6619.39	6628.00	6633.50	6635.87	6635.07	6631.10	6623.93
5	6298.81	6306.38	6310.88	6312.29	6310.57	6305.70	6297.68
6	5981.73	5988.19	5991.59	5991.93	5989.16	5983.28	5974.26
7	5666.42	5671.66	5673.87	5673.02	5669.09	5662.04	5651.86

	J= 14	15	16	17	18	19	20
V= 0	7979.99	7968.20	7952.95	7934.25	7912.10	7886.50	7857.47
1	7626.90	7614.84	7599.39	7580.55	7558.34	7532.74	7503.76
2	7282.32	7269.87	7254.10	7235.00	7212.57	7186.81	7157.72
3	6944.99	6932.04	6915.81	6896.30	6873.50	6847.41	6818.03
4	6613.56	6599.95	6583.11	6563.03	6539.69	6513.08	6483.21
5	6286.47	6272.07	6254.46	6233.62	6209.54	6182.22	6151.65
6	5962.07	5946.70	5928.13	5906.35	5881.34	5853.08	5821.57
7	5638.52	5622.00	5602.29	5579.36	5553.19	5523.76	5491.06

	J= 21	22	23	24	25	26	27
V= 0	7825.02	7789.15	7749.88	7707.23	7661.21	7611.85	7559.14
1	7471.41	7435.70	7396.64	7354.24	7308.51	7259.46	7207.10
2	7125.31	7089.57	7050.51	7008.15	6962.48	6913.51	6861.25
3	6785.35	6749.38	6710.12	6667.57	6621.72	6572.58	6520.15
4	6450.06	6413.64	6373.93	6330.94	6284.66	6235.08	6182.20
5	6117.80	6080.68	6040.28	5996.59	5949.59	5899.29	5845.65
6	5786.78	5748.72	5707.35	5662.67	5614.66	5563.31	5508.60
7	5455.08	5415.78	5373.16	5327.19	5277.85	5225.13	5168.99

	J= 28	29	30	31	32	33	34
V= 0	7503.12	7443.81	7381.20	7315.32	7246.19	7173.80	7098.16
1	7151.44	7092.49	7030.27	6964.78	6896.02	6823.99	6748.69
2	6805.70	6746.86	6684.74	6619.34	6550.65	6478.67	6403.39
3	6464.43	6405.42	6343.10	6277.48	6208.54	6136.26	6060.64
4	6126.02	6066.51	6003.68	5937.50	5867.95	5795.03	5718.69
5	5788.68	5728.35	5664.65	5597.56	5527.04	5453.08	5375.62
6	5450.50	5389.00	5324.07	5255.68	5183.79	5108.38	5029.39
7	5109.41	5046.36	4979.81	4909.71	4836.04	4758.74	4677.76

Table 9b. Line Positions of HF, R-Branch, $\Delta v = 2$ Sequence (Continued)

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 2

	J= 35	36	37	38	39	40	41
V= 0	7019.28	6937.15	6851.77	6763.12	6671.18	6575.92	6477.31
1	6670.12	6588.26	6503.10	6414.61	6322.77	6227.33	6128.84
2	6324.79	6242.84	6157.54	6068.83	5976.69	5881.07	5781.89
3	5981.64	5899.24	5813.40	5724.08	5631.22	5534.78	5434.68
4	5638.90	5555.64	5468.85	5378.48	5284.47	5186.75	5085.25
5	5294.64	5210.09	5121.91	5030.03	4934.40	4834.92	4731.51
6	4946.77	4860.47	4770.43	4676.57	4578.81	4477.06	4371.22
7	4593.04	4504.52	4412.12	4315.76	4215.36	4110.80	4001.97

	J= 42	43	44	45	46	47	48
V= 0	6375.29	6269.82	6160.83	6048.22	5931.93	5811.82	5687.79
1	6026.65	5920.90	5811.50	5698.36	5581.38	5460.43	5335.38
2	5679.11	5572.63	5462.37	5348.22	5230.07	5107.78	4981.20
3	5330.83	5223.16	5111.56	4995.91	4876.08	4751.92	4623.27
4	4979.86	4870.50	4757.04	4639.35	4517.30	4390.71	4259.43
5	4624.07	4512.48	4396.62	4276.34	4151.49	4021.89	3887.36
6	4261.18	4146.81	4027.97	3904.51	3776.26	3643.03	3504.61
7	3888.76	3771.02	3648.60	3521.34	3389.04	3251.52	3108.55

	J= 49
V= 0	5559.69
1	5206.07
2	4850.17
3	4489.95
4	4125.24
5	3747.68
6	3360.79
7	2959.90

Table 9c. Line Positions of HF, R-Branch, $\Delta v = 3$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 3

	J= 0	1	2	3	4	5	6
V= 0	11409.59	11441.61	11469.03	11491.81	11509.89	11523.27	11531.91
1	10905.40	10936.10	10962.31	10983.98	11001.09	11013.59	11021.47
2	10413.89	10443.28	10468.28	10488.84	10504.94	10516.53	10523.59
3	9933.29	9961.39	9985.17	10004.60	10019.64	10030.27	10036.45
4	9461.63	9488.42	9510.97	9529.24	9543.19	9552.79	9558.01
5	8996.69	9022.18	9043.48	9060.54	9073.34	9081.85	9086.03
6	8536.08	8560.25	8580.27	8596.09	8607.68	8615.00	8618.03

	J= 7	8	9	10	11	12	13
V= 0	11535.78	11534.88	11529.18	11518.68	11503.37	11483.26	11458.34
1	11024.70	11023.26	11017.14	11006.32	10990.80	10970.58	10945.65
2	10526.10	10524.04	10517.40	10506.15	10490.29	10469.81	10444.71
3	10038.16	10035.38	10028.10	10016.29	9999.94	9979.05	9953.61
4	9558.83	9555.23	9547.17	9534.66	9517.67	9496.19	9470.22
5	9085.85	9081.30	9072.34	9058.97	9041.16	9018.90	8992.18
6	8616.74	8611.11	8601.10	8586.70	8567.88	8544.64	8516.95

	J= 14	15	16	17	18	19	20
V= 0	11428.62	11394.11	11354.84	11310.80	11262.03	11208.55	11150.38
1	10916.02	10881.70	10842.69	10799.01	10750.68	10697.71	10640.12
2	10415.00	10380.66	10341.72	10298.18	10250.05	10197.34	10140.07
3	9923.62	9889.07	9849.97	9806.33	9758.14	9705.42	9648.18
4	9439.74	9404.75	9365.25	9321.24	9272.73	9219.70	9162.18
5	8960.99	8925.32	8885.16	8840.51	8791.37	8737.72	8679.58
6	8484.80	8448.18	8407.08	8361.49	8311.40	8256.80	8197.69

	J= 21	22	23	24	25	26	27
V= 0	11087.55	11020.10	10948.05	10871.44	10790.31	10704.68	10614.58
1	10577.95	10511.20	10439.91	10364.10	10283.80	10199.04	10109.84
2	10078.26	10011.92	9941.08	9865.74	9785.93	9701.67	9612.98
3	9586.43	9520.17	9449.43	9374.21	9294.52	9210.38	9121.79
4	9100.16	9033.64	8962.64	8887.15	8807.18	8722.74	8633.82
5	8616.94	8549.79	8478.14	8401.98	8321.31	8236.11	8146.40
6	8134.05	8065.87	7993.16	7915.89	7834.06	7747.65	7656.64

	J= 28	29	30	31	32	33	34
V= 0	10520.06	10421.15	10317.87	10210.26	10098.33	9982.10	9861.60
1	10016.22	9918.21	9815.83	9709.10	9598.03	9482.62	9362.89
2	9519.87	9422.36	9320.45	9214.15	9103.47	8988.40	8868.95
3	9028.76	8931.29	8829.39	8723.06	8612.28	8497.04	8377.32
4	8540.41	8442.53	8340.15	8233.26	8121.85	8005.89	7885.35
5	8052.14	7953.33	7849.95	7741.97	7629.37	7512.12	7390.16
6	7561.02	7460.76	7355.82	7246.19	7131.81	7012.64	6888.63

Table 9c. Line Positions of HF, R-Branch, $\Delta v = 3$ Sequence (Continued)

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 3

	J= 35	36	37	38	39	40	41
V= 0	9736.84	9607.81	9474.51	9336.94	9195.07	9048.87	8898.30
1	9238.84	9110.44	8977.70	8840.58	8699.05	8553.06	8402.56
2	8745.08	8616.80	8484.05	8346.82	8205.04	8058.67	7907.62
3	8253.10	8124.35	7991.03	7853.08	7710.43	7563.03	7410.78
4	7760.20	7630.39	7495.86	7356.55	7212.38	7063.27	6909.12
5	7263.45	7131.93	6995.54	6854.20	6707.81	6556.27	6399.48
6	6759.71	6625.82	6486.87	6342.77	6193.42	6038.70	5878.49

	J= 42	43	44	45	46	47	48
V= 0	8743.31	8583.83	8419.78	8251.06	8077.56	7899.15	7715.67
1	8247.49	8087.75	7923.26	7753.89	7579.52	7400.00	7215.15
2	7751.83	7591.18	7425.57	7254.86	7078.91	6897.55	6710.60
3	7253.59	7091.03	6923.89	6751.11	6572.83	6388.86	6199.00
4	6749.80	6585.71	6415.17	6239.54	6058.13	5870.74	5677.13
5	6237.29	6069.57	5896.14	5716.84	5531.46	5339.78	5141.55
6	5712.63	5540.96	5363.31	5179.47	4989.23	4792.36	4588.58

	J= 49
V= 0	7526.95
1	7024.79
2	6517.83
3	6003.01
4	5477.07
5	4936.51
6	4377.61

Table 9d. Line Positions of HF, R-Branch, $\Delta v = 4$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 4

	J= 0	1	2	3	4	5	6
V= 0	14866.98	14896.14	14919.26	14936.30	14947.23	14952.03	14950.68
1	14203.30	14231.19	14253.18	14269.23	14279.32	14283.41	14281.49
2	13555.29	13581.92	13602.76	13617.79	13626.98	13630.29	13627.71
3	12920.46	12945.81	12965.49	12979.46	12987.68	12990.12	12986.77
4	12296.00	12320.09	12338.57	12351.41	12358.59	12360.08	12355.84
5	11678.87	11701.66	11718.90	11730.57	11736.63	11737.04	11731.80

	J= 7	8	9	10	11	12	13
V= 0	14943.17	14929.47	14909.60	14883.55	14851.32	14812.93	14768.40
1	14273.54	14259.55	14239.51	14213.42	14181.29	14143.12	14098.91
2	13619.21	13604.79	13584.44	13558.14	13525.91	13487.74	13443.64
3	12977.61	12962.61	12941.77	12915.08	12882.54	12844.14	12799.89
4	12345.87	12330.14	12308.63	12281.34	12248.26	12209.39	12164.72
5	11720.86	11704.22	11681.85	11653.74	11619.88	11580.26	11534.88

	J= 14	15	16	17	18	19	20
V= 0	14717.74	14660.97	14598.14	14529.26	14454.37	14373.52	14286.75
1	14048.70	13992.49	13930.32	13862.19	13788.16	13708.24	13622.48
2	13393.62	13337.70	13275.89	13208.21	13134.69	13055.36	12970.23
3	12749.80	12693.87	12632.11	12564.54	12491.18	12412.05	12327.15
4	12114.26	12058.00	11995.96	11928.14	11854.55	11775.21	11690.12
5	11483.73	11426.81	11364.12	11295.66	11221.43	11141.45	11055.70

	J= 21	22	23	24	25	26	27
V= 0	14194.09	14095.60	13991.32	13881.31	13765.60	13644.26	13517.33
1	13530.90	13433.55	13330.47	13221.69	13107.26	12987.20	12861.57
2	12879.34	12782.71	12680.39	12572.38	12458.74	12339.47	12214.62
3	12236.52	12140.18	12038.13	11930.42	11817.05	11698.04	11573.40
4	11599.29	11502.75	11400.49	11292.54	11178.89	11059.57	10934.56
5	10964.20	10866.95	10763.95	10655.20	10540.71	10420.45	10294.44

	J= 28	29	30	31	32	33	34
V= 0	13384.85	13246.87	13103.43	12954.58	12800.34	12640.74	12475.80
1	12730.39	12593.71	12451.53	12303.91	12150.84	11992.35	11828.45
2	12084.20	11948.23	11806.74	11659.73	11507.21	11349.18	11185.63
3	11443.16	11307.31	11165.87	11018.82	10866.17	10707.90	10543.99
4	10803.87	10667.50	10525.44	10377.67	10224.18	10064.93	9899.89
5	10162.66	10025.08	9881.70	9732.48	9577.39	9416.38	9249.40

	J= 35	36	37	38	39	40	41
V= 0	12305.55	12129.99	11949.11	11762.90	11571.35	11374.41	11172.03
1	11659.13	11484.39	11304.21	11118.56	10927.39	10730.66	10528.30
2	11016.55	10841.91	10661.68	10475.82	10284.25	10086.92	9883.73
3	10374.40	10199.10	10018.03	9831.14	9638.34	9439.55	9234.65
4	9729.01	9552.23	9369.49	9180.71	8985.79	8784.62	8577.08
5	9076.39	8897.28	8711.98	8520.40	8322.42	8117.92	7906.74

Table 9d. Line Positions of HF, R-Branch, $\Delta v = 4$ Sequence (Continued)

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 4

	J= 42	43	44	45	46	47	48
V= 0	10964.15	10750.69	10531.54	10306.59	10075.71	9838.72	9595.45
1	10320.21	10106.31	9886.46	9660.53	9428.36	9189.77	8944.55
2	9674.58	9459.35	9237.90	9010.07	8775.67	8534.50	8286.32
3	9023.53	8806.04	8582.03	8351.30	8113.66	7868.88	7616.70
4	8363.02	8142.29	7914.70	7680.04	7438.10	7188.62	6931.32
5	7688.73	7463.71	7231.48	6991.80	6744.44	6489.11	6225.52

	J= 49
V= 0	9345.67
1	8692.45
2	8030.89
3	7356.85
4	6665.91
5	5953.33

Table 9e. Line Positions of HF, R-Branch, $\Delta v = 5$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 5

	J= 0	1	2	3	4	5	6
V= 0	18164.88	18191.23	18210.13	18221.55	18225.46	18221.85	18210.70
1	17344.70	17369.82	17387.66	17398.18	17401.36	17397.17	17385.61
2	16542.45	16566.34	16583.09	16592.66	16595.02	16590.15	16578.03
3	15754.83	15777.48	15793.09	15801.64	15803.09	15797.42	15784.61
4	14978.18	14999.56	15013.99	15021.44	15021.88	15015.28	15001.62
	J= 7	8	9	10	11	12	13
V= 0	18192.01	18165.76	18131.97	18090.65	18041.81	17985.47	17921.66
1	17366.65	17340.30	17306.55	17265.42	17216.91	17161.04	17097.84
2	16558.66	16532.02	16498.11	16456.94	16408.50	16352.83	16289.92
3	15764.65	15737.52	15703.23	15661.76	15613.13	15557.34	15494.40
4	14980.88	14953.06	14918.14	14876.11	14826.98	14770.75	14707.41
	J= 14	15	16	17	18	19	20
V= 0	17850.42	17771.77	17685.76	17592.44	17491.85	17384.06	17269.10
1	17027.32	16949.52	16864.48	16772.22	16672.80	16566.26	16452.63
2	16219.80	16142.49	16058.02	15966.43	15867.74	15761.98	15649.20
3	15424.32	15347.12	15262.82	15171.44	15073.01	14967.55	14855.09
4	14636.99	14559.49	14474.91	14383.28	14284.62	14178.93	14066.24
	J= 21	22	23	24	25	26	27
V= 0	17147.05	17017.95	16881.88	16738.90	16589.06	16432.42	16269.06
1	16331.98	16204.35	16069.78	15928.34	15780.06	15625.00	15463.21
2	15529.43	15402.72	15269.09	15128.59	14981.26	14827.13	14666.23
3	14735.66	14609.28	14475.99	14335.81	14188.76	14034.86	13874.14
4	13946.56	13819.91	13686.30	13545.76	13398.29	13243.91	13082.60
	J= 28	29	30	31	32	33	34
V= 0	16099.02	15922.36	15739.13	15549.38	15353.15	15150.47	14941.36
1	15294.72	15119.58	14937.83	14749.49	14554.58	14353.13	14145.13
2	14498.60	14324.25	14143.21	13955.49	13761.10	13560.04	13352.29
3	13706.62	13532.29	13351.16	13163.24	12968.50	12766.94	12558.52
4	12914.39	12739.26	12557.19	12368.18	12172.19	11969.19	11759.13
	J= 35	36	37	38	39	40	41
V= 0	14725.85	14503.94	14275.62	14040.89	13799.70	13552.01	13297.76
1	13930.60	13709.51	13481.84	13247.56	13006.61	12758.92	12504.40
2	13137.84	12916.66	12688.69	12453.88	12212.16	11963.44	11707.60
3	12343.21	12120.95	11891.67	11655.30	11411.75	11160.90	10902.61
4	11541.95	11317.58	11085.93	10846.91	10600.40	10346.26	10084.34

Table 9e. Line Positions of HF, R-Branch, $\Delta v = 5$ Sequence (Continued)

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 5

	J= 42	43	44	45	46	47	48
V= 0	13036.87	12769.24	12494.74	12213.23	11924.55	11628.49	11324.84
1	12242.97	11974.48	11698.79	11415.73	11125.12	10826.71	10520.27
2	11444.52	11174.06	10896.04	10610.26	10316.50	10014.52	9704.03
3	10636.75	10363.12	10081.55	9791.80	9493.63	9186.77	8870.90
4	9814.47	9536.44	9250.03	8955.00	8651.08	8337.95	8015.29

	J= 49
V= 0	11013.33
1	10205.51
2	9384.73
3	8545.68
4	7682.73

Table 9f. Line Positions of HF, R-Branch, $\Delta v = 6$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 6

	J= 0	1	2	3	4	5	6
V= 0	21306.29	21329.86	21344.61	21350.50	21347.50	21335.61	21314.82
1	20331.87	20354.25	20367.99	20373.04	20369.40	20357.03	20335.93
2	19376.83	19398.01	19410.69	19414.83	19410.42	19397.44	19375.87
3	18437.01	18456.95	18468.52	18471.66	18466.37	18452.61	18430.38

	J= 7	8	9	10	11	12	13
V= 0	21285.12	21246.51	21199.01	21142.65	21077.43	21003.40	20920.59
1	20306.10	20267.52	20220.23	20164.22	20099.51	20026.13	19944.12
2	19345.70	19306.93	19259.57	19203.62	19139.10	19066.03	18984.42
3	18399.66	18360.44	18312.73	18256.53	18191.85	18118.70	18037.09

	J= 14	15	16	17	18	19	20
V= 0	20829.04	20728.[illegible]0	20619.93	20502.47	20376.50	20242.07	20099.25
1	19853.50	19754.32	19646.62	19530.44	19405.85	19272.88	19131.60
2	18894.32	18795.74	18688.73	18573.32	18449.56	18317.48	18177.14
3	17947.05	17848.60	17741.77	17626.58	17503.07	17371.27	17231.21

	J= 21	22	23	24	25	26	27
V= 0	19948.12	19788.74	19621.19	19445.54	19261.86	19070.22	18870.70
1	18982.07	18824.35	18658.48	18484.54	18302.58	18112.66	17914.82
2	18028.57	17871.82	17706.95	17533.98	17352.97	17163.96	16966.97
3	17082.92	16926.44	16761.80	16589.03	16408.16	16219.20	16022.19

	J= 28	29	30	31	32	33	34
V= 0	18663.35	18448.24	18225.43	17994.96	17756.89	17511.24	17258.04
1	17709.12	17495.60	17274.30	17045.25	16808.48	16563.99	16311.80
2	16762.05	16549.23	16328.50	16099.91	15863.43	15619.08	15366.83
3	15817.13	15604.04	15382.91	15153.74	14916.51	14671.20	14417.76

	J= 35	36	37	38	39	40	41
V= 0	16997.31	16729.05	16453.25	16169.88	15878.91	15580.26	15273.87
1	16051.89	15784.25	15508.85	15225.62	14934.51	14635.43	14328.27
2	15106.65	14838.50	14562.32	14278.04	13985.57	13684.79	13375.56
3	14156.15	13886.29	13608.11	13321.51	13026.37	12722.54	12409.88

Table 9f. Line Positions of HF, R-Branch, $\Delta v = 6$ Sequence (Continued)

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 6

	J= 42	43	44	45	46	47	48
V= 0	14959.62	14637.41	14307.07	13968.44	13621.30	13265.43	12900.57
1	14012.91	13689.18	13356.93	13015.93	12665.95	12306.74	11937.98
2	13057.74	12731.14	12395.56	12050.76	11696.47	11332.40	10958.22
3	12088.19	11757.27	11416.88	11066.76	10706.61	10336.10	9954.86

	J= 49
V= 0	12526.39
1	11559.35
2	10573.56
3	9562.50

Table 9g. Line Positions of HF, R-Branch, $\Delta v = 7$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 7

	J= 0	1	2	3	4	5	6
V= 0	24293.45	24314.29	24324.93	24325.36	24315.54	24295.47	24265.14
1	23166.24	23185.92	23195.58	23195.22	23184.81	23164.32	23133.77
2	22059.01	22077.49	22086.11	22084.86	22073.71	22052.64	22021.64
	J= 7	8	9	10	11	12	13
V= 0	24224.56	24173.74	24112.69	24041.44	23960.03	23868.49	23766.87
1	23093.13	23042.44	22981.68	22910.90	22830.10	22739.33	22638.63
2	21980.71	21929.85	21869.07	21798.39	21717.82	21627.38	21527.12
	J= 14	15	16	17	18	19	20
V= 0	23655.22	23553.60	23402.06	23260.69	23109.54	22948.69	22778.22
1	22528.02	22407.57	22277.32	22137.34	21987.57	21828.38	21659.54
2	21417.05	21297.23	21167.69	21028.47	20879.62	20721.20	20553.26
	J= 21	22	23	24	25	26	27
V= 0	22598.22	22408.75	22209.90	22001.75	21784.38	21557.88	21322.31
1	21481.21	21293.45	21096.34	20889.93	20674.30	20449.49	20215.56
2	20375.83	20188.98	19992.76	19787.20	19572.37	19348.30	19115.02
	J= 28	29	30	31	32	33	34
V= 0	21077.75	20824.26	20561.90	20290.73	20010.78	19722.10	19424.71
1	19972.58	19720.58	19459.59	19189.66	18910.81	18623.03	18326.33
2	18872.57	18620.98	18360.26	18090.41	17811.45	17523.34	17226.07
	J= 35	36	37	38	39	40	41
V= 0	19118.61	18803.80	18480.26	18147.95	17806.82	17456.78	17097.74
1	18020.70	17706.10	17382.48	17049.79	16707.92	16356.78	15996.23
2	16919.59	16603.85	16278.77	15944.25	15600.18	15246.43	14882.83
	J= 42	43	44	45	46	47	48
V= 0	16729.57	16352.12	15965.21	15568.63	15162.14	14745.46	14318.27
1	15626.12	15246.27	14856.45	14456.43	14045.92	13624.62	13192.17
2	14509.19	14125.29	13730.89	13325.72	12909.45	12481.73	12042.19
	J= 49						
V= 0	13880.23						
1	12748.18						
2	11590.38						

Table 9h. Line Positions of HF, R-Branch, $\Delta v = 8$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 8

	J= 0	1	2	3	4	5	6
V= 0	27127.83	27145.95	27152.53	27147.54	27130.95	27102.75	27062.98
1	25848.42	25865.39	25871.01	25865.25	25848.09	25819.52	25779.54
	J= 7	8	9	10	11	12	13
V= 0	27011.60	26948.65	26874.15	26788.12	26690.62	26581.69	26461.37
1	25728.15	25665.36	25591.19	25505.66	25408.82	25300.69	25181.32
	J= 14	15	16	17	18	19	20
V= 0	26329.74	26186.85	26032.77	25867.58	25691.36	25504.19	25306.16
1	25050.76	24909.06	24756.28	24592.48	24417.73	24232.10	24035.66
	J= 21	22	23	24	25	26	27
V= 0	25097.35	24877.85	24647.75	24407.14	24156.09	23894.71	23623.05
1	23828.47	23610.61	23382.15	23143.16	22893.69	22633.83	22363.61
	J= 28	29	30	31	32	33	34
V= 0	23341.20	23049.23	22747.19	22435.14	22113.11	21781.14	21439.24
1	22083.10	21792.33	21491.35	21180.17	20858.82	20527.29	20185.57
	J= 35	36	37	38	39	40	41
V= 0	21087.42	20725.64	20353.89	19972.11	19580.22	19178.13	18765.70
1	19833.64	19471.45	19098.93	18715.99	18322.54	17918.43	17503.50
	J= 42	43	44	45	46	47	48
V= 0	18342.78	17909.20	17464.73	17009.13	16542.11	16063.34	15572.46
1	17077.57	16640.41	16191.78	15731.39	15258.90	14773.95	14276.14
	J= 49						
V= 0	15069.06						
1	13765.01						

Table 9i. Line Positions of HF, R-Branch, $\Delta v = 9$ Sequence

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 9

	J= 0	1	2	3	4	5	6
V= 0	29810.00	29825.43	29827.96	29817.56	29794.23	29757.96	29708.75
	J= 7	8	9	10	11	12	13
V= 0	29646.61	29571.57	29483.65	29382.89	29269.34	29143.05	29004.07
	J= 14	15	16	17	18	19	20
V= 0	28852.47	28688.33	28511.72	28322.73	28121.43	27907.92	27682.28
	J= 21	22	23	24	25	26	27
V= 0	27444.61	27195.01	26933.56	26660.36	26375.49	26079.05	25771.10
	J= 28	29	30	31	32	33	34
V= 0	25451.72	25120.99	24778.95	24425.65	24061.13	23685.40	23298.48
	J= 35	36	37	38	39	40	41
V= 0	22900.36	22490.99	22070.34	21638.32	21194.84	20739.77	20272.96
	J= 42	43	44	45	46	47	48
V= 0	19794.23	19303.35	18800.06	18284.09	17755.08	17212.67	16656.43
	J= 49						
V= 0	16085.89						

Table 10a. Line Positions of DF, P-Branch, $\Delta v = 1$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 1

	J= 1	2	3	4	5	6	7
V= 0	2885.12	2862.82	2839.96	2816.54	2792.58	2768.11	2743.13
1	2794.14	2772.44	2750.19	2727.40	2704.09	2680.26	2655.94
2	2705.05	2683.95	2662.30	2640.13	2617.43	2594.24	2570.56
3	2617.74	2597.22	2576.16	2554.58	2532.50	2509.92	2486.87
4	2532.05	2512.10	2491.62	2470.63	2449.14	2427.17	2404.73
5	2447.84	2428.45	2408.54	2388.12	2367.21	2345.83	2323.99
6	2364.93	2346.08	2326.73	2306.88	2286.54	2265.74	2244.47
7	2283.13	2264.83	2246.02	2226.72	2206.95	2186.70	2166.01
8	2202.25	2184.48	2166.21	2147.46	2128.23	2108.54	2088.40
9	2122.07	2104.83	2087.09	2068.87	2050.18	2031.04	2011.44
10	2042.36	2025.65	2008.44	1990.74	1972.58	1953.97	1934.91
11	1962.89	1946.69	1930.00	1912.83	1895.19	1877.10	1858.57

	J= 8	9	10	11	12	13	14
V= 0	2717.66	2691.72	2665.32	2638.47	2611.20	2583.52	2555.44
1	2631.14	2605.87	2580.16	2554.01	2527.44	2500.47	2473.11
2	2546.41	2521.81	2496.76	2471.28	2445.40	2419.12	2392.45
3	2463.36	2439.39	2414.99	2390.17	2364.95	2339.34	2313.35
4	2381.83	2358.49	2334.73	2310.55	2285.97	2261.00	2235.67
5	2301.69	2278.96	2255.81	2232.25	2208.29	2183.96	2159.26
6	2222.76	2200.63	2178.07	2155.11	2131.77	2108.04	2083.96
7	2144.87	2123.31	2101.34	2078.97	2056.21	2033.08	2009.59
8	2067.83	2046.83	2025.42	2003.62	1981.44	1958.88	1935.97
9	1991.41	1970.97	1950.11	1928.86	1907.23	1885.24	1862.88
10	1915.42	1895.51	1875.19	1854.48	1833.39	1811.93	1790.12
11	1839.60	1820.22	1800.42	1780.24	1759.67	1738.74	1717.45

	J= 15	16	17	18	19	20	21
V= 0	2526.99	2498.17	2469.01	2439.51	2409.71	2379.60	2349.22
1	2445.38	2417.29	2388.87	2360.12	2331.06	2301.70	2272.07
2	2365.43	2338.05	2310.33	2282.30	2253.97	2225.34	2196.44
3	2287.01	2260.31	2233.29	2205.95	2178.32	2150.39	2122.20
4	2209.98	2183.96	2157.60	2130.94	2103.97	2076.73	2049.21
5	2134.21	2108.83	2083.12	2057.10	2030.79	2004.20	1977.34
6	2059.53	2034.76	2009.68	1984.29	1958.60	1932.64	1906.41
7	1985.76	1961.59	1937.11	1912.32	1887.24	1861.88	1836.25
8	1912.71	1889.12	1865.22	1841.01	1816.51	1791.73	1766.69
9	1840.18	1817.16	1793.81	1770.16	1746.22	1721.99	1697.50
10	1767.96	1745.47	1722.66	1699.55	1676.14	1652.45	1628.50
11	1695.81	1673.84	1651.55	1628.95	1606.06	1582.88	1559.43

Table 10a. Line Positions of DF, P-Branch, $\Delta v = 1$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 1

	J= 22	23	24	25	26	27	28
V= 0	2318.56	2287.66	2256.53	2225.17	2193.62	2161.87	2129.96
1	2242.18	2212.04	2181.67	2151.09	2120.30	2089.33	2058.18
2	2167.28	2137.88	2108.25	2078.41	2048.36	2018.13	1987.73
3	2093.75	2065.06	2036.14	2007.01	1977.67	1948.16	1918.47
4	2021.45	1993.44	1965.20	1936.76	1908.11	1879.28	1850.27
5	1950.23	1922.87	1895.30	1867.51	1839.52	1811.34	1782.99
6	1879.93	1853.21	1826.26	1799.10	1771.74	1744.19	1716.46
7	1810.38	1784.26	1757.91	1731.36	1704.60	1677.65	1650.52
8	1741.39	1715.85	1690.08	1664.10	1637.91	1611.52	1584.96
9	1672.76	1647.77	1622.55	1597.11	1571.47	1545.63	1519.60
10	1604.28	1579.82	1555.12	1530.20	1505.07	1479.74	1454.22
11	1535.72	1511.76	1487.56	1463.13	1438.49	1413.64	1388.59

	J= 29	30	31	32	33	34	35
V= 0	2097.88	2065.67	2033.32	2000.87	1968.31	1935.67	1902.96
1	2026.88	1995.44	1963.87	1932.18	1900.39	1868.52	1836.57
2	1957.17	1926.47	1895.64	1864.69	1833.64	1802.50	1771.28
3	1888.62	1858.63	1828.51	1798.27	1767.93	1737.49	1706.98
4	1821.11	1791.80	1762.36	1732.80	1703.13	1673.37	1643.52
5	1754.48	1725.83	1697.03	1668.12	1639.09	1609.96	1580.75
6	1688.58	1660.54	1632.37	1604.06	1575.65	1547.13	1518.51
7	1623.22	1595.78	1568.19	1540.47	1512.63	1484.68	1456.63
8	1558.23	1531.34	1504.31	1477.14	1449.84	1422.43	1394.92
9	1493.40	1467.04	1440.53	1413.87	1387.09	1360.18	1333.17
10	1428.52	1402.66	1376.63	1350.46	1324.15	1297.72	1271.17
11	1363.37	1337.96	1312.40	1286.68	1260.82	1234.82	1208.70

	J= 36	37	38	39	40	41	42
V= 0	1870.19	1837.38	1804.54	1771.68	1738.82	1705.97	1673.14
1	1804.56	1772.51	1740.42	1708.31	1676.19	1644.07	1611.97
2	1740.00	1708.67	1677.31	1645.91	1614.50	1583.09	1551.69
3	1676.40	1645.76	1615.08	1584.36	1553.63	1522.89	1492.15
4	1613.60	1583.62	1553.59	1523.52	1493.43	1463.33	1433.22
5	1551.46	1522.10	1492.70	1463.24	1433.76	1404.25	1374.74
6	1489.82	1461.05	1432.23	1403.35	1374.44	1345.50	1316.54
7	1428.50	1400.29	1372.01	1343.68	1315.30	1286.89	1258.45
8	1367.31	1339.62	1311.86	1284.03	1256.15	1228.23	1200.27
9	1306.05	1278.85	1251.56	1224.20	1196.78	1169.31	1141.80
10	1244.51	1217.75	1190.91	1163.98	1136.98	1109.93	1082.81
11	1182.46	1156.11	1129.67	1103.14	1076.53	1049.84	1023.09

Table 10a. Line Positions of DF, P-Branch, $\Delta v = 1$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 1

	J= 43	44	45	46	47	48	49
V= 0	1640.34	1607.59	1574.89	1542.27	1509.73	1477.28	1444.94
1	1579.90	1547.87	1515.89	1483.97	1452.12	1420.36	1388.70
2	1520.3[illegible]	1488.96	1457.65	1426.40	1395.22	1364.11	1333.10
3	1461.4[illegible]	1430.73	1400.07	1369.45	1338.89	1308.40	1277.99
4	1403.12	1373.03	1342.98	1312.96	1282.99	1253.08	1223.24
5	1345.22	1315.71	1286.23	1256.77	1227.35	1197.99	1168.68
6	1287.57	1258.61	1229.65	1200.72	1171.81	1142.95	1114.14
7	1229.99	1201.53	1173.06	1144.61	1116.18	1087.79	1059.43
8	1172.28	1144.28	1116.27	1088.27	1060.27	1032.30	1004.35
9	1114.24	1086.67	1059.07	1031.47	1003.87	976.28	948.70
10	1055.66	1028.46	1001.24	974.00	946.75	919.50	892.25
11	996.29	969.44	942.55	915.63	888.69	861.74	834.78

	J= 50
V= 0	1412.72
1	1357.15
2	1302.18
3	1247.67
4	1193.48
5	1139.44
6	1085.38
7	1031.12
8	976.44
9	921.15
10	865.02
11	807.82

Table 10b. Line Positions of DF, P-Branch, $\Delta v = 2$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 2

	J= 1	2	3	4	5	6	7
V= 0	5700.39	5677.51	5653.48	5628.32	5602.04	5574.66	5546.20
1	5519.74	5497.47	5474.08	5449.58	5423.98	5397.31	5369.57
2	5342.77	5321.11	5298.34	5274.48	5249.55	5223.56	5196.52
3	5169.21	5148.14	5125.98	5102.75	5078.46	5053.13	5026.78
4	4998.76	4978.26	4956.70	4934.08	4910.42	4885.74	4860.05
5	4831.09	4811.16	4790.18	4768.16	4745.11	4721.05	4696.00
6	4665.84	4646.47	4626.06	4604.62	4582.17	4558.72	4534.29
7	4502.64	4483.81	4463.95	4443.08	4421.21	4398.35	4374.52
8	4341.05	4322.76	4303.45	4283.14	4261.83	4239.55	4216.29
9	4180.64	4162.89	4144.12	4124.35	4103.59	4081.86	4059.17
10	4020.95	4003.72	3985.48	3966.24	3946.02	3924.83	3902.69

	J= 8	9	10	11	12	13	14
V= 0	5516.67	5486.10	5454.49	5421.87	5388.26	5353.67	5318.13
1	5340.79	5310.98	5280.16	5248.34	5215.55	5181.80	5147.12
2	5168.46	5139.39	5109.33	5078.29	5046.29	5013.35	4979.48
3	4999.42	4971.06	4941.73	4911.44	4880.20	4848.03	4814.96
4	4833.36	4805.70	4777.07	4747.49	4716.99	4685.57	4653.26
5	4669.97	4642.97	4615.02	4586.14	4556.33	4525.63	4494.04
6	4508.88	4482.53	4455.23	4427.01	4397.88	4367.86	4336.96
7	4349.73	4323.99	4297.32	4269.73	4241.25	4211.88	4181.64
8	4192.09	4166.95	4140.88	4113.90	4086.03	4057.28	4027.66
9	4035.53	4010.96	3985.47	3959.08	3931.79	3903.63	3874.60
10	3879.59	3855.57	3830.64	3804.80	3778.07	3750.46	3721.99

	J= 15	16	17	18	19	20	21
V= 0	5281.65	5244.25	5205.96	5166.79	5126.77	5085.91	5044.23
1	5111.51	5075.00	5037.61	4999.36	4960.27	4920.36	4879.64
2	4944.72	4909.06	4872.54	4835.17	4796.97	4757.96	4718.16
3	4781.00	4746.16	4710.47	4673.94	4636.59	4598.45	4559.52
4	4620.06	4586.01	4551.11	4515.38	4478.84	4441.5[illegible]	4403.41
5	4461.58	4428.27	4394.12	4359.15	4323.39	4286.83	4249.51
6	4305.20	4272.60	4239.16	4204.92	4169.88	4134.06	4097.47
7	4150.54	4118.61	4085.85	4052.28	4017.93	3982.79	3946.90
8	3997.20	3965.90	3933.77	3900.85	3867.13	3832.64	3797.39
9	3844.73	3814.02	3782.50	3750.17	3717.05	3683.16	3648.51
10	3692.68	3662.53	3631.56	3599.79	3567.23	3533.88	3499.78

Table 10b. Line Positions of DF, P-Branch, $\Delta v = 2$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 2

	J= 22	23	24	25	26	27	28
V= 0	5001.76	4958.52	4914.52	4869.80	4824.36	4778.23	4731.43
1	4838.14	4795.88	4752.87	4709.15	4664.72	4619.61	4573.83
2	4677.58	4636.26	4594.20	4551.42	4507.95	4463.81	4419.00
3	4519.82	4479.38	4438.22	4396.35	4353.78	4310.55	4266.67
4	4364.55	4324.95	4284.64	4243.62	4201.91	4159.54	4116.51
5	4211.44	4172.64	4133.12	4092.90	4052.00	4010.43	3968.21
6	4060.14	4022.08	3983.31	3943.84	3903.68	3862.86	3821.39
7	3910.26	3872.90	3834.82	3796.04	3756.58	3716.45	3675.68
8	3761.40	3724.68	3687.24	3649.10	3610.28	3570.79	3530.64
9	3613.11	3576.98	3540.13	3502.57	3464.33	3425.42	3385.84
10	3464.92	3429.33	3393.02	3355.99	3318.27	3279.87	3240.80

	J= 29	30	31	32	33	34	35
V= 0	4683.99	4635.91	4587.23	4537.96	4488.13	4437.75	4386.84
1	4527.41	4480.37	4432.73	4384.51	4335.71	4286.38	4236.52
2	4373.56	4327.50	4280.84	4233.60	4185.79	4137.44	4088.56
3	4222.14	4177.01	4131.27	4084.95	4038.07	3990.65	3942.69
4	4072.86	4028.58	3983.71	3938.26	3892.24	3845.68	3798.58
5	3925.36	3881.89	3837.83	3793.18	3747.96	3702.19	3655.88
6	3779.29	3736.57	3693.25	3649.33	3604.85	3559.80	3514.22
7	3634.26	3592.22	3549.58	3506.34	3462.52	3418.13	3373.20
8	3489.85	3448.43	3406.40	3363.76	3320.54	3276.75	3232.39
9	3345.61	3304.75	3263.26	3221.16	3178.47	3135.19	3091.34
10	3201.07	3160.70	3119.69	3078.06	3035.83	2992.99	2949.57

	J= 36	37	38	39	40	41	42
V= 0	4335.43	4283.53	4231.16	4178.34	4125.09	4071.43	4017.37
1	4186.15	4135.29	4083.96	4032.18	3979.96	3927.33	3874.29
2	4039.18	3989.30	3938.95	3888.14	3836.89	3785.21	3733.13
3	3894.22	3845.26	3795.81	3745.91	3695.55	3644.77	3593.56
4	3750.96	3702.84	3654.24	3605.17	3555.64	3505.67	3455.27
5	3609.04	3561.70	3513.87	3465.56	3416.78	3367.55	3317.88
6	3468.10	3421.46	3374.33	3326.70	3278.60	3230.03	3181.02
7	3327.72	3281.72	3235.20	3188.19	3140.68	3092.70	3044.25
8	3187.48	3142.04	3096.07	3049.58	3002.60	2955.12	2907.15
9	3046.93	3001.96	2956.46	2910.43	2863.87	2816.81	2769.25
10	2905.57	2861.01	2815.89	2770.23	2724.03	2677.30	2630.05

Table 10b. Line Positions of DF, P-Branch, $\Delta v = 2$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 2

	J= 43	44	45	46	47	48	49
V= 0	3962.94	3908.15	3853.03	3797.57	3741.81	3685.76	3629.44
1	3820.88	3767.09	3712.96	3658.49	3603.70	3548.61	3493.23
2	3680.65	3627.80	3574.59	3521.03	3467.14	3412.93	3358.41
3	3541.96	3489.97	3437.60	3384.87	3331.80	3278.40	3224.67
4	3404.46	3353.25	3301.65	3249.68	3197.35	3144.67	3091.65
5	3267.79	3217.28	3166.37	3115.08	3063.40	3011.36	2958.96
6	3131.56	3081.67	3031.37	2980.66	2929.56	2878.07	2826.20
7	2995.35	2946.00	2896.22	2846.01	2795.39	2744.36	2692.94
8	2858.72	2809.82	2760.47	2710.68	2660.45	2609.79	2558.71
9	2721.20	2672.66	2623.65	2574.18	2524.25	2473.86	2423.03
10	2582.29	2534.02	2485.26	2436.01	2386.28	2336.07	2285.40

	J= 50
V= 0	3572.85
1	3437.57
2	3303.61
3	3170.64
4	3038.31
5	2906.22
6	2773.97
7	2641.13
8	2507.22
9	2371.77
10	2234.25

Table 10c. Line Positions of DF, P-Branch, $\Delta v = 3$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 3

	J= 1	2	3	4	5	6	7
V= 0	8425.99	8402.54	8377.37	8350.49	8321.93	8291.71	8259.83
1	8157.46	8134.63	8110.12	8083.93	8056.10	8026.63	7995.53
2	7894.24	7872.02	7848.15	7822.64	7795.51	7766.77	7736.43
3	7635.92	7614.30	7591.05	7566.20	7539.74	7511.70	7482.10
4	7382.01	7360.98	7338.34	7314.12	7288.32	7260.96	7232.06
5	7132.01	7111.55	7089.51	7065.90	7040.74	7014.04	6985.82
6	6885.35	6865.45	6843.99	6820.98	6796.44	6770.37	6742.80
7	6641.44	6622.09	6601.20	6578.77	6554.82	6529.36	6502.41
8	6399.63	6380.82	6360.48	6338.62	6315.24	6290.37	6264.02
9	6159.23	6140.96	6121.16	6099.84	6077.03	6052.72	6026.95

	J= 8	9	10	11	12	13	14
V= 0	8226.32	8191.20	8154.49	8116.21	8076.37	8035.01	7992.14
1	7962.84	7928.57	7892.73	7855.35	7816.44	7776.03	7734.13
2	7704.53	7671.06	7636.06	7599.55	7561.53	7522.03	7481.09
3	7450.95	7418.27	7384.07	7348.38	7311.22	7272.60	7232.55
4	7201.64	7169.71	7136.28	7101.38	7065.03	7027.24	6988.03
5	6956.09	6924.87	6892.18	6858.03	6822.45	6785.44	6747.04
6	6713.74	6683.20	6651.21	6617.77	6582.92	6546.65	6509.00
7	6473.99	6444.10	6412.77	6380.02	6345.84	6310.28	6273.33
8	6236.21	6206.94	6176.24	6144.11	6110.59	6075.67	6039.39
9	5999.71	5971.03	5940.92	5909.39	5876.47	5842.16	5806.48

	J= 15	16	17	18	19	20	21
V= 0	7947.78	7901.96	7854.71	7806.04	7755.98	7704.56	7651.80
1	7690.80	7646.02	7599.82	7552.23	7503.28	7452.98	7401.36
2	7438.71	7394.91	7349.72	7303.16	7255.25	7206.01	7155.47
3	7191.08	7148.21	7103.97	7058.38	7011.46	6963.23	6913.71
4	6947.43	6905.45	6862.11	6817.43	6771.44	6724.15	6675.59
5	6707.25	6666.10	6623.60	6579.78	6534.66	6488.25	6440.58
6	6469.98	6429.61	6387.90	6344.88	6300.56	6254.97	6208.12
7	6235.03	6195.38	6154.40	6112.12	6068.55	6023.71	5977.61
8	6001.74	5962.77	5922.46	5880.86	5837.97	5793.81	5748.39
9	5769.45	5731.08	5691.40	5650.41	5608.14	5564.59	5519.79

	J= 22	23	24	25	26	27	28
V= 0	7597.72	7542.35	7485.72	7427.86	7368.77	7308.51	7247.08
1	7348.44	7294.25	7238.82	7182.16	7124.31	7065.28	7005.10
2	7103.66	7050.58	6996.28	6940.76	6884.06	6826.20	6767.20
3	6862.93	6810.90	6757.65	6703.21	6647.59	6590.81	6532.90
4	6625.77	6574.72	6522.46	6469.01	6414.39	6358.62	6301.73
5	6391.66	6341.52	6290.17	6237.64	6183.94	6129.10	6073.14
6	6160.03	6110.72	6060.21	6008.52	5955.67	5901.67	5846.55
7	5930.28	5881.73	5831.98	5781.05	5728.95	5675.72	5621.35
8	5701.75	5653.88	5604.81	5554.56	5503.14	5450.57	5396.87
9	5473.75	5426.49	5378.02	5328.37	5277.54	5225.55	5172.42

Table 10c. Line Positions of DF, P-Branch, $\Delta v = 3$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 3

	J= 29	30	31	32	33	34	35
V= 0	7184.52	7120.85	7056.10	6990.29	6923.45	6855.61	6786.79
1	6943.81	6881.41	6817.94	6753.42	6687.87	6621.32	6553.80
2	6707.08	6645.87	6583.60	6520.28	6455.94	6390.59	6324.28
3	6473.89	6413.79	6352.62	6290.41	6227.19	6162.96	6097.75
4	6243.73	6184.65	6124.51	6063.32	6001.11	5937.90	5873.70
5	6016.07	5957.92	5898.71	5838.45	5777.16	5714.86	5651.58
6	5790.33	5733.02	5674.63	5615.20	5554.74	5493.26	5430.78
7	5565.88	5509.31	5451.67	5392.96	5333.22	5272.45	5210.67
8	5342.05	5286.13	5229.13	5171.06	5111.93	5051.76	4990.56
9	5118.16	5062.79	5006.32	4948.77	4890.14	4830.47	4769.75

	J= 36	37	38	39	40	41	42
V= 0	6717.01	6646.31	6574.70	6502.21	6428.86	6354.68	6279.69
1	6485.32	6415.91	6345.60	6274.40	6202.35	6129.45	6055.73
2	6257.00	6188.80	6119.68	6049.68	5978.81	5907.09	5834.54
3	6031.58	5964.48	5896.47	5827.55	5757.76	5687.11	5615.61
4	5808.54	5742.44	5675.42	5607.48	5538.66	5468.96	5398.42
5	5587.32	5522.12	5455.97	5388.91	5320.94	5252.08	5182.36
6	5367.32	5302.90	5237.52	5171.21	5103.98	5035.85	4966.82
7	5147.89	5084.14	5019.42	4953.74	4887.13	4819.59	4751.14
8	4928.36	4865.16	4800.97	4735.81	4669.69	4602.62	4534.61
9	4707.99	4645.22	4581.45	4516.67	4450.91	4384.18	4316.48

	J= 43	44	45	46	47	48	49
V= 0	6203.92	6127.38	6050.10	5972.09	5893.39	5814.01	5733.96
1	5981.22	5905.93	5829.89	5753.11	5675.62	5597.42	5518.54
2	5761.18	5687.04	5612.12	5536.45	5460.05	5382.92	5305.10
3	5543.30	5470.18	5396.28	5321.60	5246.16	5169.99	5093.08
4	5327.03	5254.82	5181.80	5107.99	5033.40	4958.04	4881.93
5	5111.77	5040.35	4968.09	4895.02	4821.15	4746.48	4671.03
6	4896.92	4826.15	4754.53	4682.06	4608.76	4534.65	4459.72
7	4681.79	4611.54	4540.42	4468.42	4395.57	4321.86	4247.30
8	4465.67	4395.82	4325.05	4253.39	4180.82	4107.38	4033.05
9	4247.83	4178.22	4107.67	4036.19	3963.77	3890.43	3816.18

	J= 50
V= 0	5653.27
1	5439.01
2	5226.58
3	5015.47
4	4805.08
5	4594.81
6	4383.98
7	4171.91
8	3957.84
9	3741.00

Table 10d. Line Positions of DF, P-Branch, $\Delta v = 4$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 4

	J= 1	2	3	4	5	6	7
V= 0	11063.71	11039.69	11013.40	10984.85	10954.05	10921.02	10885.79
1	10708.93	10685.55	10659.93	10632.10	10602.06	10569.83	10535.44
2	10360.95	10338.19	10313.23	10286.09	10256.79	10225.33	10191.75
3	10019.17	9997.01	9972.70	9946.23	9917.64	9886.92	9854.12
4	9682.93	9661.36	9637.67	9611.86	9583.95	9553.95	9521.88
5	9351.51	9330.53	9307.44	9282.26	9255.00	9225.69	9194.33
6	9024.15	9003.73	8981.23	8956.66	8930.04	8901.38	8870.69
7	8700.01	8680.15	8658.22	8634.24	8608.23	8580.19	8550.14
8	8378.21	8358.89	8337.52	8314.11	8288.68	8261.24	8231.80

	J= 8	9	10	11	12	13	14
V= 0	10848.37	10808.79	10767.06	10723.21	10677.26	10629.24	10579.17
1	10498.90	10460.24	10419.47	10376.61	10331.69	10284.73	10235.76
2	10156.06	10118.27	10078.41	10036.50	9992.56	9946.61	9898.68
3	9819.23	9782.28	9743.28	9702.27	9659.26	9614.27	9567.32
4	9487.76	9451.61	9413.44	9373.28	9331.14	9287.05	9241.03
5	9160.94	9125.54	9088.16	9048.80	9007.48	8964.24	8919.08
6	8838.00	8803.32	8766.66	8728.06	8687.51	8645.05	8600.70
7	8518.11	8484.10	8448.13	8410.23	8370.40	8328.67	8285.06
8	8200.39	8167.01	8131.68	8094.43	8055.26	8014.20	7971.26

	J= 15	16	17	18	19	20	21
V= 0	10527.07	10472.98	10416.92	10358.91	10298.99	10237.18	10173.52
1	10184.79	10131.87	10077.00	10020.22	9961.55	9901.03	9838.67
2	9848.79	9796.96	9743.22	9687.60	9630.11	9570.80	9509.67
3	9518.44	9467.65	9414.97	9360.44	9304.06	9245.87	9185.89
4	9193.10	9143.28	9091.59	9038.06	8982.71	8925.57	8866.65
5	8872.03	8823.11	8772.34	8719.75	8665.35	8609.17	8551.22
6	8554.47	8506.38	8456.46	8404.72	8351.19	8295.88	8238.83
7	8239.57	8192.25	8143.09	8092.13	8039.39	7984.87	7928.61
8	7926.46	7879.83	7831.36	7781.10	7729.05	7675.24	7619.68

	J= 22	23	24	25	26	27	28
V= 0	10108.02	10040.73	9971.67	9900.87	9828.37	9754.18	9678.35
1	9774.51	9708.58	9640.90	9571.50	9500.42	9427.67	9353.30
2	9446.76	9382.10	9315.71	9247.62	9177.86	9106.46	9033.44
3	9124.14	9060.67	8995.48	8928.60	8860.07	8789.90	8718.12
4	8805.98	8743.60	8679.51	8613.75	8546.34	8477.30	8406.66
5	8491.55	8430.15	8367.07	8302.32	8235.93	8167.91	8098.30
6	8180.04	8119.55	8057.37	7993.53	7928.04	7860.93	7792.23
7	7870.62	7810.93	7749.55	7686.51	7621.82	7555.50	7487.59
8	7562.39	7503.39	7442.71	7380.35	7316.35	7250.71	7183.45

Table 10d. Line Positions of DF, P-Branch, Δv = 4 Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 4

	J= 29	30	31	32	33	34	35
V= 0	9600.91	9521.88	9441.30	9359.20	9275.61	9190.55	9104.07
1	9277.33	9199.78	9120.69	9040.10	8958.01	8874.47	8789.51
2	8958.83	8882.66	8804.95	8725.74	8645.05	8562.90	8479.33
3	8644.77	8569.86	8493.42	8415.47	8336.05	8255.18	8172.88
4	8334.45	8260.68	8185.39	8108.59	8030.31	7950.57	7869.41
5	8027.11	7954.37	7880.10	7804.32	7727.05	7648.32	7568.14
6	7721.94	7650.10	7576.72	7501.83	7425.44	7347.58	7268.25
7	7418.08	7347.01	7274.40	7200.26	7124.60	7047.46	6968.84
8	7114.60	7044.18	6972.19	6898.66	6823.60	6747.03	6668.97

	J= 36	37	38	39	40	41	42
V= 0	9016.19	8926.93	8836.34	8744.43	8651.24	8556.80	8461.13
1	8703.15	8615.41	8526.34	8435.95	8344.27	8251.33	8157.15
2	8394.37	8308.03	8220.34	8131.32	8041.01	7949.43	7856.59
3	8089.17	8004.08	7917.64	7829.87	7740.78	7650.40	7558.76
4	7786.82	7702.85	7617.52	7530.83	7442.82	7353.50	7262.89
5	7486.55	7403.55	7319.16	7233.41	7146.32	7057.90	6968.16
6	7187.49	7105.31	7021.73	6936.76	6850.43	6762.74	6673.71
7	6888.77	6807.25	6724.32	6639.97	6554.22	6467.09	6378.59
8	6589.42	6508.41	6425.95	6342.05	6256.73	6169.99	6081.84

	J= 43	44	45	46	47	48	49
V= 0	8364.26	8266.22	8167.03	8066.72	7965.31	7862.82	7759.28
1	8061.75	7965.17	7867.43	7768.54	7668.53	7567.42	7465.23
2	7762.53	7667.25	7570.80	7473.18	7374.41	7274.51	7173.51
3	7465.87	7371.75	7276.42	7179.90	7082.21	6983.36	6883.37
4	7171.01	7077.88	6983.52	6887.93	6791.14	6693.16	6594.00
5	6877.13	6784.82	6691.25	6596.42	6500.35	6403.06	6304.54
6	6583.35	6491.69	6398.72	6304.47	6208.94	6112.14	6014.08
7	6288.74	6197.54	6105.00	6011.13	5915.94	5819.44	5721.64
8	5992.30	5901.37	5809.07	5715.39	5620.35	5523.95	5426.19

	J= 50
V= 0	7654.71
1	7361.98
2	7071.41
3	6782.25
4	6493.67
5	6204.82
6	5914.76
7	5622.53
8	5327.07

Table 10e. Line Positions of DF, P-Branch, $\Delta v = 5$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 5

	J= 1	2	3	4	5	6	7
V= 0	13615.18	13590.61	13563.22	13533.01	13500.01	13464.23	13425.70
1	13175.63	13151.71	13125.01	13095.55	13063.34	13028.40	12990.76
2	12744.20	12720.90	12694.87	12666.13	12634.68	12600.56	12563.77
3	12320.08	12297.40	12272.03	12243.97	12213.26	12179.91	12143.93
4	11902.43	11880.35	11855.60	11828.22	11798.21	11765.60	11730.39
5	11490.31	11468.81	11444.68	11417.94	11388.61	11356.70	11322.22
6	11082.73	11061.79	11038.26	11012.14	10983.45	10952.20	10918.42
7	10678.60	10658.22	10635.26	10609.74	10581.66	10551.05	10517.92

	J= 8	9	10	11	12	13	14
V= 0	13384.44	13340.46	13293.80	13244.47	13192.51	13137.94	13080.78
1	12950.43	12907.44	12861.81	12813.56	12762.71	12709.30	12653.34
2	12524.33	12482.28	12437.62	12390.38	12340.60	12288.28	12233.45
3	12105.35	12064.18	12020.44	11974.17	11925.37	11874.08	11820.32
4	11692.61	11652.28	11609.42	11564.04	11516.18	11465.85	11413.07
5	11285.20	11245.66	11203.61	11159.08	11112.08	11062.64	11010.78
6	10882.12	10843.31	10802.02	10758.27	10712.07	10663.45	10612.42
7	10482.29	10444.17	10403.58	10360.54	10315.08	10267.20	10216.93

	J= 15	16	17	18	19	20	21
V= 0	13021.07	12958.83	12894.09	12826.90	12757.27	12685.23	12610.83
1	12594.87	12533.92	12470.50	12404.66	12336.42	12265.81	12192.87
2	12176.15	12116.40	12054.22	11989.65	11922.71	11853.43	11781.85
3	11764.11	11705.48	11644.46	11581.06	11515.33	11447.28	11376.95
4	11357.88	11300.29	11240.33	11178.02	11113.40	11046.48	10977.30
5	10956.52	10899.88	10840.90	10779.58	10715.97	10650.08	10581.93
6	10559.02	10503.25	10445.15	10384.73	10322.02	10257.05	10189.83
7	10164.29	10109.31	10051.99	9992.37	9930.47	9866.30	9799.89

	J= 22	23	24	25	26	27	28
V= 0	12534.09	12455.06	12373.75	12290.21	12204.48	12116.58	12026.55
1	12117.62	12040.10	11960.33	11878.36	11794.22	11707.93	11619.54
2	11707.98	11631.87	11553.53	11473.02	11390.34	11305.55	11218.66
3	11304.36	11229.54	11152.53	11073.34	10992.01	10908.57	10823.05
4	10905.87	10832.23	10756.41	10678.43	10598.32	10516.11	10431.82
5	10511.56	10438.98	10364.23	10287.33	10208.30	10127.17	10043.97
6	10120.39	10048.75	9974.94	9898.99	9820.90	9740.72	9658.46
7	9731.26	9660.44	9587.44	9512.30	9435.02	9355.64	9274.17

	J= 29	30	31	32	33	34	35
V= 0	11934.43	11840.26	11744.06	11645.88	11545.75	11443.71	11339.78
1	11529.07	11436.56	11342.05	11245.56	11147.12	11046.78	10944.57
2	11129.70	11038.72	10945.74	10850.80	10753.91	10655.13	10554.46
3	10735.48	10645.19	10554.30	10460.74	10365.25	10267.86	10168.58
4	10345.48	10257.13	10166.78	10074.46	9980.20	9884.03	9785.97
5	9958.73	9871.45	9782.19	9690.94	9597.75	9502.64	9405.62
6	9574.15	9487.81	9399.46	9309.12	9216.83	9122.59	9026.43
7	9190.63	9105.06	9017.46	8927.86	8836.28	8742.73	8647.25

Table 10e. Line Positions of DF, P-Branch, $\Delta v = 5$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 5

	J= 36	37	38	39	40	41	42
V= 0	11234.01	11126.43	11017.08	10905.98	10793.17	10678.68	10562.55
1	10840.51	10734.64	10626.99	10517.59	10406.47	10293.67	10179.20
2	10451.95	10347.62	10241.51	10133.64	10024.03	9912.72	9799.74
3	10067.45	9964.49	9859.74	9753.21	9644.94	9534.94	9423.23
4	9686.05	9584.28	9480.71	9375.34	9268.20	9159.31	9048.69
5	9306.72	9205.96	9103.37	8998.97	8892.77	8784.79	8675.05
6	8928.37	8828.43	8726.63	8622.99	8517.52	8410.24	8301.16
7	8549.83	8450.51	8349.30	8246.21	8141.26	8034.46	7925.83

	J= 43	44	45	46	47	48	49
V= 0	10444.80	10325.46	10204.57	10082.14	9958.22	9832.81	9705.96
1	10063.10	9945.39	9826.10	9705.26	9582.89	9459.00	9333.64
2	9685.09	9568.82	9450.94	9331.48	9210.46	9087.89	8963.79
3	9309.85	9194.82	9078.14	8959.85	8839.96	8718.48	8595.43
4	8936.37	8822.36	8706.67	8589.33	8470.35	8349.74	8227.51
5	8563.57	8450.36	8335.45	8218.83	8100.53	7980.55	7858.90
6	8190.31	8077.68	7963.30	7847.18	7729.32	7609.73	7488.41
7	7815.37	7703.09	7589.01	7473.14	7355.47	7236.01	7114.78

	J= 50
V= 0	9577.68
1	9206.80
2	8838.19
3	8470.84
4	8103.68
5	7735.60
6	7365.38
7	6991.76

Table 10f. Line Positions of DF, P-Branch, $\Delta v = 6$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 6

	J= 1	2	3	4	5	6	7
V= 0	16081.89	16056.78	16028.30	15996.46	15961.29	15922.80	15881.02
1	15558.88	15534.42	15506.65	15475.58	15441.23	15403.63	15362.78
2	15045.11	15021.29	14994.20	14963.87	14930.31	14893.54	14853.58
3	14539.59	14516.38	14489.96	14460.34	14427.53	14391.56	14352.44
4	14041.23	14018.63	13992.85	13963.90	13931.82	13896.60	13858.28
5	13548.89	13526.87	13501.71	13473.42	13442.02	13407.52	13369.95
6	13061.31	13039.86	13015.30	12987.63	12956.88	12923.07	12886.20

	J= 8	9	10	11	12	13	14
V= 0	15835.97	15787.67	15736.14	15681.42	15623.53	15562.50	15498.36
1	15318.71	15271.45	15221.02	15167.44	15110.75	15050.97	14988.12
2	14810.45	14764.18	14714.78	14662.28	14606.71	14548.09	14486.45
3	14310.20	14264.85	14216.42	14164.93	14110.41	14052.88	13992.37
4	13816.87	13772.40	13724.87	13674.32	13620.77	13564.25	13504.77
5	13329.32	13285.65	13238.97	13189.29	13136.64	13081.03	13022.50
6	12846.29	12803.38	12757.47	12708.58	12656.74	12601.98	12544.30

	J= 15	16	17	18	19	20	21
V= 0	15431.14	15360.88	15287.60	15211.34	15132.13	15050.02	14965.03
1	14922.24	14853.36	14781.50	14706.71	14629.02	14548.45	14465.04
2	14421.82	14354.23	14283.71	14210.28	14133.98	14054.85	13972.91
3	13928.89	13862.50	13793.20	13721.03	13646.02	13568.20	13487.60
4	13442.37	13377.06	13308.88	13237.86	13164.02	13087.39	13008.00
5	12961.06	12896.75	12829.59	12759.60	12686.81	12611.24	12532.93
6	12483.73	12420.31	12354.05	12284.97	12213.10	12138.48	12061.11

	J= 22	23	24	25	26	27	28
V= 0	14877.20	14786.57	14693.18	14597.07	14498.28	14396.84	14292.79
1	14378.84	14289.86	14198.16	14103.76	14006.70	13907.02	13804.76
2	13888.19	13800.74	13710.58	13617.75	13522.29	13424.22	13323.58
3	13404.25	13318.18	13229.43	13138.02	13044.00	12947.38	12848.21
4	12925.88	12841.06	12753.57	12663.44	12570.69	12475.37	12377.49
5	12451.90	12368.18	12281.80	12192.79	12101.16	12006.96	11910.21
6	11981.03	11898.26	11812.84	11724.78	11634.11	11540.85	11445.04

	J= 29	30	31	32	33	34	35
V= 0	14186.18	14077.04	13965.41	13851.34	13734.86	13616.02	13494.84
1	13699.95	13592.63	13482.84	13370.61	13255.99	13139.01	13019.69
2	13220.42	13114.75	13006.62	12896.07	12783.11	12667.80	12550.16
3	12746.52	12642.33	12535.69	12426.61	12315.14	12201.31	12085.14
4	12277.10	12174.21	12068.87	11961.09	11850.90	11738.35	11623.44
5	11810.93	11709.16	11604.92	11498.24	11389.14	11277.65	11163.79
6	11346.70	11245.85	11142.52	11036.73	10928.50	10817.86	10704.83

Table 10f. Line Positions of DF, P-Branch, $\Delta v = 6$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 6

	J= 36	37	38	39	40	41	42
V= 0	13371.38	13245.66	13117.73	12987.62	12855.37	12721.02	12584.60
1	12898.09	12774.24	12648.17	12519.91	12389.49	12256.96	12122.34
2	12430.23	12308.04	12183.61	12056.99	11928.19	11797.26	11664.21
3	11966.67	11845.92	11722.93	11597.72	11470.32	11340.75	11209.04
4	11506.22	11386.70	11264.92	11140.89	11014.64	10886.20	10755.58
5	11047.60	10929.08	10808.27	10685.19	10559.86	10432.29	10302.50
6	10589.43	10471.69	10351.62	10229.23	10104.56	9977.61	9848.39

	J= 43	44	45	46	47	48	49
V= 0	12446.14	12305.68	12163.24	12018.86	11872.58	11724.40	11574.37
1	11985.66	11846.96	11706.25	11563.56	11418.93	11272.38	11123.92
2	11529.08	11391.89	11252.66	11111.43	10968.20	10823.00	10675.86
3	11075.21	10939.29	10801.30	10661.25	10519.16	10375.06	10228.95
4	10622.81	10487.90	10350.87	10211.74	10070.52	9927.23	9781.88
5	10170.52	10036.36	9900.03	9761.54	9620.90	9478.14	9333.24
6	9716.93	9583.24	9447.32	9309.19	9168.84	9026.30	8881.55

	J= 50
V= 0	11422.50
1	10973.58
2	10526.78
3	10080.85
4	9634.47
5	9186.22
6	8734.61

Table 10g. Line Positions of DF, P-Branch, $\Delta v = 7$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 7

	J= 1	2	3	4	5	6	7
V= 0	18465.13	18439.49	18409.94	18376.50	18339.19	18298.03	18253.04
1	17859.80	17834.81	17805.98	17773.32	17736.86	17696.61	17652.59
2	17264.62	17240.27	17212.14	17180.23	17144.58	17105.19	17062.09
3	16678.39	16654.66	16627.20	16596.02	16561.13	16522.57	16480.33
4	16099.81	16076.69	16049.87	16019.38	15985.23	15947.43	15906.01
5	15527.48	15504.94	15478.75	15448.91	15415.45	15378.38	15337.73

	J= 8	9	10	11	12	13	14
V= 0	18204.25	18151.68	18095.35	18035.31	17971.57	17904.17	17833.14
1	17604.83	17553.35	17498.18	17439.34	17376.86	17310.78	17241.12
2	17015.30	16964.85	16910.76	16853.05	16791.75	16726.89	16658.50
3	16434.46	16384.97	16331.88	16275.21	16215.01	16151.28	16084.06
4	15860.99	15812.39	15760.23	15704.54	15645.33	15582.64	15516.49
5	15293.50	15245.72	15194.42	15139.60	15081.31	15019.56	14954.38

	J= 15	16	17	18	19	20	21
V= 0	17758.51	17680.32	17598.60	17513.39	17424.73	17332.65	17237.20
1	17167.91	17091.19	17010.99	16927.34	16840.29	16749.87	16656.11
2	16586.61	16511.24	16432.45	16350.24	16264.67	16175.76	16083.56
3	16013.38	15939.27	15861.75	15780.87	15696.64	15609.11	15518.30
4	15442.91	15373.03	15297.57	15217.87	15134.86	15048.56	14959.00
5	14885.78	14813.81	14738.49	14659.84	14577.89	14492.67	14404.21

	J= 22	23	24	25	26	27	28
V= 0	17138.42	17036.34	16931.01	16822.47	16710.76	16595.92	16478.01
1	16559.05	16458.74	16355.21	16248.49	16138.64	16025.70	15909.69
2	15988.08	15889.38	15787.49	15682.44	15574.27	15463.03	15348.74
3	15424.26	15327.01	15226.59	15123.03	15016.37	14906.64	14793.89
4	14866.23	14770.26	14671.14	14568.90	14463.56	14355.16	14243.73
5	14312.55	14217.70	14119.70	14018.58	13914.37	13807.09	13696.79

	J= 29	30	31	32	33	34	35
V= 0	16357.05	16233.11	16106.21	15976.40	15843.73	15708.24	15569.97
1	15790.66	15668.66	15543.72	15415.88	15285.19	15151.68	15015.40
2	15231.45	15111.20	14988.01	14861.94	14733.01	14601.26	14466.73
3	14678.13	14559.42	14437.78	14313.24	14185.85	14055.63	13922.62
4	14129.31	14011.92	13891.60	13768.38	13642.29	13513.36	13381.62
5	13583.48	13467.20	13347.98	13225.84	13100.81	12972.92	12842.19

	J= 36	37	38	39	40	41	42
V= 0	15428.96	15285.26	15138.90	14989.94	14838.39	14684.32	14527.74
1	14876.37	14734.65	14590.26	14443.25	14293.65	14141.49	13986.82
2	14329.45	14189.47	14046.80	13901.49	13753.57	13603.07	13450.02
3	13786.84	13648.34	13507.14	13363.27	13216.76	13067.64	12915.93
4	13247.10	13109.82	12969.82	12827.11	12681.73	12533.70	12383.04
5	12708.66	12572.34	12433.26	12291.44	12146.90	11999.66	11849.74

Table 10g. Line Positions of DF, P-Branch, $\Delta v = 7$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 7

	J= 43	44	45	46	47	48	49
V= 0	14368.71	14207.24	14043.39	13877.17	13708.62	13537.78	13364.65
1	13829.65	13670.02	13507.97	13343.51	13176.68	13007.50	12835.99
2	13294.44	13136.36	12975.82	12812.83	12647.41	12479.58	12309.37
3	12761.65	12604.83	12445.49	12283.66	12119.34	11952.55	11783.31
4	12229.76	12073.89	11915.45	11754.45	11590.90	11424.82	11256.21
5	11697.15	11541.91	11384.04	11223.55	11060.43	10894.71	10726.38

	J= 50
V= 0	13189.28
1	12662.17
2	12136.79
3	11611.63
4	11085.08
5	10555.45

Table 10h. Line Positions of DF, P-Branch, $\Delta v = 8$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 8

	J= 1	2	3	4	5	6	7
V= 0	20766.65	20739.88	20709.27	20674.24	20634.81	20591.01	20542.85
1	20079.50	20053.79	20023.91	19989.69	19951.13	19908.26	19861.10
2	19403.42	19378.55	19349.38	19315.91	19278.18	19236.20	19189.99
3	18736.96	18712.72	18684.22	18651.49	18614.54	18573.39	18528.06
4	18078.39	18054.76	18026.91	17994.87	17958.66	17918.29	17873.79

	J= 8	9	10	11	12	13	14
V= 0	20490.36	20433.58	20372.51	20307.21	20237.68	20163.98	20086.14
1	19809.68	19754.03	19694.16	19630.11	19561.90	19489.57	19413.16
2	19139.57	19084.97	19026.21	18963.33	18896.34	18825.29	18750.19
3	18478.58	18424.96	18367.24	18305.43	18239.56	18169.67	18095.78
4	17825.17	17772.46	17715.68	17654.85	17590.01	17521.17	17448.37

	J= 15	16	17	18	19	20	21
V= 0	20004.18	19918.15	19828.08	19734.02	19636.00	19534.07	19428.25
1	19332.69	19248.20	19159.73	19067.31	18970.98	18870.78	18766.75
2	18671.09	18588.02	18501.00	18410.08	18315.29	18216.67	18114.26
3	18017.93	17936.14	17850.44	17760.88	17667.48	17570.27	17469.30
4	17371.63	17290.99	17206.47	17118.11	17025.94	16929.99	16830.29

	J= 22	23	24	25	26	27	28
V= 0	19318.63	19205.21	19088.06	18967.20	18842.70	18714.60	18582.94
1	18658.94	18547.38	18432.11	18313.18	18190.63	18064.50	17934.85
2	18008.09	17898.21	17784.64	17667.44	17546.65	17422.29	17294.42
3	17364.60	17256.21	17144.16	17028.49	16909.23	16786.43	16660.12
4	16726.87	16619.78	16509.04	16394.69	16276.76	16155.29	16030.31

	J= 29	30	31	32	33	34	35
V= 0	18447.77	18309.14	18167.09	18021.67	17872.93	17720.92	17565.67
1	17801.70	17665.10	17525.11	17381.75	17235.08	17085.14	16931.96
2	17163.07	17028.28	16890.10	16748.56	16603.71	16455.58	16304.20
3	16530.34	16397.12	16260.51	16120.53	15977.23	15830.64	15680.79
4	15901.86	15769.96	15634.66	15495.98	15353.96	15208.63	15060.02

	J= 36	37	38	39	40	41	42
V= 0	17407.24	17245.67	17081.00	16913.28	16742.55	16568.85	16392.22
1	16775.60	16616.08	16453.46	16287.76	16119.03	15947.31	15772.62
2	16149.63	15991.88	15831.01	15667.05	15500.02	15329.96	15156.90
3	15527.72	15371.46	15212.04	15049.50	14883.85	14715.14	14543.38
4	14908.16	14753.08	14594.80	14433.36	14268.77	14101.07	13930.27

Table 10h. Line Positions of DF, P-Branch, $\Delta v = 8$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 8

	J= 43	44	45	46	47	48	49
V= 0	16212.69	16030.31	15845.11	15657.12	15466.37	15272.89	15076.72
1	15595.01	15414.50	15231.12	15044.91	14855.88	14664.07	14469.50
2	14980.87	14801.90	14620.02	14435.23	14247.58	14057.07	13863.73
3	14368.60	14190.83	14010.07	13826.36	13639.71	13450.14	13257.64
4	13756.39	13579.45	13399.47	13216.46	13030.43	12841.39	12649.35

	J= 50
V= 0	14877.87
1	14272.18
2	13667.57
3	13062.25
4	12454.31

Table 10i. Line Positions of DF, P-Branch, $\Delta v = 9$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 9

	J= 1	2	3	4	5	6	7
V= 0	22985.56	22958.86	22927.20	22890.60	22849.08	22802.66	22751.36
1	22218.10	22192.07	22161.15	22125.37	22084.73	22039.27	21987.00
2	21461.99	21436.61	21406.40	21371.39	21331.59	21287.02	21237.72
3	20715.55	20690.79	20661.27	20626.99	20587.98	20544.26	20495.84

	J= 8	9	10	11	12	13	14
V= 0	22695.22	22634.25	22568.49	22497.97	22422.72	22342.78	22258.18
1	21933.95	21874.14	21809.61	21740.39	21666.50	21587.98	21504.86
2	21183.69	21124.96	21061.57	20993.54	20920.90	20843.68	20761.92
3	20442.76	20385.03	20322.68	20255.74	20184.24	20108.20	20027.66

	J= 15	16	17	18	19	20	21
V= 0	22168.96	22075.16	21976.82	21873.98	21766.69	21654.98	21538.91
1	21417.18	21324.97	21228.28	21127.14	21021.60	20911.69	20797.46
2	20675.64	20584.89	20489.69	20390.09	20286.13	20177.84	20065.26
3	19942.65	19853.20	19759.34	19661.12	19558.56	19451.70	19340.59

	J= 22	23	24	25	26	27	28
V= 0	21418.52	21293.85	21164.96	21031.89	20894.69	20753.41	20608.10
1	20678.05	20556.20	20429.27	20298.19	20163.00	20023.77	19880.52
2	19948.44	19827.41	19702.22	19572.90	19439.51	19302.08	19160.65
3	19225.25	19105.72	18982.06	18854.28	18722.44	18586.56	18446.70

	J= 29	30	31	32	33	34	35
V= 0	20458.80	20305.58	20148.48	19987.54	19822.82	19654.37	19482.23
1	19733.31	19582.19	19427.20	19268.38	19105.79	18939.46	18769.44
2	19015.28	18865.99	18712.84	18555.86	18395.09	18230.59	18062.38
3	18302.89	18155.16	18003.57	17848.13	17688.90	17525.91	17359.19

	J= 36	37	38	39	40	41	42
V= 0	19306.46	19127.10	18944.19	18757.79	18567.93	18374.66	18178.02
1	18595.77	18418.50	18237.67	18053.31	17865.48	17674.20	17479.51
2	17890.50	17715.00	17535.91	17353.27	17167.11	16977.46	16784.36
3	17188.79	17014.72	16837.03	16655.74	16470.89	16282.51	16090.61

Table 10i. Line Positions of DF, P-Branch, $\Delta v = 9$ Sequence (Continued)

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 9

	J= 43	44	45	46	47	48	49
V= 0	17978.05	17774.78	17568.26	17358.51	17145.58	16929.47	16710.23
1	17281.44	17080.04	16875.32	16667.32	16456.06	16241.57	16023.86
2	16587.83	16387.90	16184.60	15977.94	15767.96	15554.66	15338.07
3	15895.23	15696.38	15494.09	15288.37	15079.24	14866.71	14650.78

	J= 50
V= 0	16487.88
1	15802.96
2	15118.19
3	14431.48

Table 10j. Line Positions of DF, P-Branch, $\Delta v = 10$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 10

	J= 1	2	3	4	5	6	7
V= 0	25124.36	25097.14	25064.44	25026.28	24982.68	24933.67	24879.26
1	24276.68	24250.13	24218.18	24180.84	24138.14	24090.09	24036.73
2	23440.58	23414.68	23383.44	23346.88	23305.03	23257.89	23205.49
	J= 8	9	10	11	12	13	14
V= 0	24819.48	24754.37	24683.95	24608.25	24527.32	24441.18	24349.88
1	23978.07	23914.14	23844.97	23770.60	23691.05	23606.37	23516.58
2	23147.86	23085.03	23017.02	22943.85	22865.57	22782.21	22693.79
	J= 15	16	17	18	19	20	21
V= 0	24253.45	24151.93	24045.38	23933.82	23817.31	23695.89	23569.62
1	23421.72	23321.84	23216.97	23107.16	22992.44	22872.86	22748.46
2	22600.36	22501.95	22398.59	22290.33	22177.21	22059.27	21936.54
	J= 22	23	24	25	26	27	28
V= 0	23438.53	23302.68	23162.12	23016.89	22867.06	22712.67	22553.77
1	22619.30	22485.41	22346.84	22203.64	22055.87	21903.55	21746.76
2	21809.08	21676.92	21540.11	21398.69	21252.71	21102.21	20947.23
	J= 29	30	31	32	33	34	35
V= 0	22390.42	22222.67	22050.57	21874.17	21693.52	21508.69	21319.71
1	21585.52	21419.90	21249.93	21075.67	20897.17	20714.47	20527.61
2	20787.83	20624.03	20455.89	20283.46	20106.77	19925.86	19740.78
	J= 36	37	38	39	40	41	42
V= 0	21126.63	20929.52	20728.41	20523.34	20314.38	20101.55	19884.91
1	20336.65	20141.62	19942.57	19739.54	19532.57	19321.70	19106.96
2	19551.57	19358.26	19160.90	18959.52	18754.15	18544.83	18331.59
	J= 43	44	45	46	47	48	49
V= 0	19664.49	19440.32	19212.46	18980.92	18745.75	18506.97	18264.60
1	18888.40	18666.03	18439.90	18210.03	17976.44	17739.15	17498.20
2	18114.45	17893.45	17668.61	17439.95	17207.48	16971.23	16731.21
	J= 50						
V= 0	18018.66						
1	17253.58						
2	16487.42						

Table 10k. Line Positions of DF, P-Branch, $\Delta v = 11$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 11

	J= 1	2	3	4	5	6	7
V= 0	27182.93	27155.20	27121.47	27081.76	27036.09	26984.49	26926.99
1	26255.27	26228.20	26195.22	26156.34	26111.58	26060.96	26004.50
	J= 8	9	10	11	12	13	14
V= 0	26863.60	26794.36	26719.31	26638.46	26551.87	26459.57	26361.60
1	25942.24	25874.20	25800.42	25720.91	25635.73	25544.90	25448.45
	J= 15	16	17	18	19	20	21
V= 0	26258.00	26148.80	26034.07	25913.83	25788.15	25657.06	25520.62
1	25346.44	25238.90	25125.87	25007.39	24883.52	24754.29	24619.74
	J= 22	23	24	25	26	27	28
V= 0	25378.88	25231.88	25079.69	24922.35	24759.92	24592.46	24420.01
1	24479.94	24334.92	24184.74	24029.44	23869.07	23703.69	23533.34
	J= 29	30	31	32	33	34	35
V= 0	24242.63	24060.37	23873.30	23681.46	23484.91	23283.70	23077.88
1	23358.07	23177.94	22992.99	22803.28	22608.84	22409.74	22206.01
	J= 36	37	38	39	40	41	42
V= 0	22867.51	22652.64	22433.30	22209.57	21981.47	21749.05	21512.36
1	21997.71	21784.88	21567.55	21345.78	21119.61	20889.07	20654.19
	J= 43	44	45	46	47	48	49
V= 0	21271.44	21026.32	20777.04	20523.63	20266.13	20004.55	19738.93
1	20415.02	20171.56	19923.92	19672.03	19415.85	19155.73	18891.34
	J= 50						
V= 0	19469.28						
1	18622.81						

Table 101. Line Positions of DF, P-Branch, $\Delta v = 12$ Sequence

DF NU(V,J,-1) , 1/CM , P-BRANCH , DELTA NU = 12

	J= 1	2	3	4	5	6	7
V= 0	29161.52	29133.27	29098.51	29057.25	29009.53	28955.36	28894.76
	J= 8	9	10	11	12	13	14
V= 0	28827.78	28754.43	28674.75	28588.78	28496.55	28398.10	28293.48
	J= 15	16	17	18	19	20	21
V= 0	28182.71	28065.85	27942.97	27814.07	27679.23	27538.49	27391.90
	J= 22	23	24	25	26	27	28
V= 0	27239.52	27081.40	26917.59	26748.14	26573.13	26392.59	26206.59
	J= 29	30	31	32	33	34	35
V= 0	26015.18	25818.41	25616.36	25409.06	25196.58	24978.97	24756.29
	J= 36	37	38	39	40	41	42
V= 0	24528.58	24295.89	24058.29	23815.81	23568.51	23316.42	23059.59
	J= 43	44	45	46	47	48	49
V= 0	22798.07	22531.88	22261.06	21985.64	21705.65	21421.12	21132.07
	J= 50						
V= 0	20838.51						

Table 11a. Line Positions of DF, R-Branch, $\Delta v = 1$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 1

	J= 0	1	2	3	4	5	6
V= 0	2927.98	2945.50	2968.40	2987.66	3006.28	3024.24	3041.53
1	2835.81	2855.77	2875.11	2893.83	2911.92	2929.36	2946.14
2	2745.58	2764.97	2783.76	2801.95	2819.51	2836.44	2852.72
3	2657.13	2675.97	2694.23	2711.89	2728.93	2745.35	2761.14
4	2570.33	2588.63	2606.36	2623.49	2640.03	2655.95	2671.24
5	2485.03	2502.79	2519.99	2536.61	2552.63	2568.06	2582.86
6	2401.04	2418.27	2434.95	2451.06	2466.58	2481.50	2495.82
7	2318.17	2334.89	2351.05	2366.64	2381.66	2396.09	2409.92
8	2236.24	2252.43	2268.08	2283.17	2297.69	2311.62	2324.96
9	2155.01	2170.69	2185.83	2200.41	2214.43	2227.87	2240.71
10	2074.27	2089.44	2104.06	2118.14	2131.65	2144.59	2156.94
11	1993.77	2008.42	2022.54	2036.10	2049.11	2061.54	2073.39

	J= 7	8	9	10	11	12	13
V= 0	3058.13	3074.04	3089.24	3103.73	3117.49	3130.51	3142.78
1	2962.25	2977.68	2992.42	3006.45	3019.78	3032.37	3044.24
2	2868.35	2883.30	2897.58	2911.16	2924.05	2936.23	2947.69
3	2776.28	2790.77	2804.58	2817.72	28[illegible].17	2841.92	2852.97
4	2685.90	2699.92	2713.27	2725.96	27[illegible].98	2749.30	2759.93
5	2597.04	2610.59	2623.48	2635.72	2647.30	2658.19	2668.40
6	2509.52	2522.60	2535.03	2546.82	2557.94	2568.40	2578.18
7	2423.15	2435.74	2447.71	2459.04	2469.72	2479.73	2489.07
8	2337.70	2349.82	2361.32	2372.18	2382.40	2391.96	2400.86
9	2252.96	2264.60	2275.62	2286.01	2295.76	2304.86	2313.30
10	2168.70	2179.85	2190.38	2200.29	2209.56	2218.18	2226.15
11	2084.64	2095.30	2105.34	2114.75	2123.53	2131.67	2139.15

	J= 14	15	16	17	18	19	20
V= 0	3154.31	3165.06	3175.05	3184.26	3192.68	3200.31	3207.15
1	3055.37	3065.75	3075.37	3084.23	3092.31	3099.62	3106.14
2	2958.42	2968.41	2977.66	2986.16	2993.90	3000.88	3007.08
3	2863.30	2872.91	2881.78	2889.92	2897.31	2903.94	2909.82
4	2769.86	2779.07	2787.56	2795.33	2802.35	2808.64	2814.17
5	2677.91	2686.73	2694.83	2702.21	2708.86	2714.78	2719.96
6	2587.28	2595.68	2603.38	2610.36	2616.63	2622.17	2626.98
7	2497.74	2505.72	2513.00	2519.58	2525.45	2530.60	2535.02
8	2409.09	2416.63	2423.48	2429.64	2435.09	2439.83	2443.85
9	2321.07	2328.17	2334.58	2340.30	2345.31	2349.62	2353.21
10	2233.46	2240.09	2246.04	2251.30	2255.86	2259.71	2262.85
11	2145.97	2152.12	2157.59	2162.37	2166.45	2169.83	2172.49

Table 11a. Line Positions of DF, R-Branch, $\Delta v = 1$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 1

	J= 21	22	23	24	25	26	27
V= 0	3213.17	3218.39	3222.80	3226.38	3229.15	3231.09	3232.19
1	3111.87	3116.81	3120.94	3124.28	3126.80	3128.50	3129.40
2	3012.51	3017.15	3021.01	3024.07	3026.33	3027.80	3028.45
3	2914.93	2919.26	2922.82	2925.60	2927.59	2928.79	2929.20
4	2818.95	2822.97	2826.22	2828.70	2830.39	2831.31	2831.44
5	2724.40	2728.08	2731.00	2733.16	2734.54	2735.16	2734.99
6	2631.06	2634.38	2636.96	2638.77	2639.83	2640.12	2639.63
7	2538.71	2541.67	2543.87	2545.33	2546.03	2545.96	2545.13
8	2447.14	2449.69	2451.51	2452.58	2452.89	2452.44	2451.23
9	2356.08	2358.21	2359.61	2360.26	2360.16	2359.31	2357.69
10	2265.27	2266.96	2267.91	2268.12	2267.58	2266.28	2264.22
11	2174.44	2175.65	2176.13	2175.86	2174.85	2173.07	2170.54

	J= 28	29	30	31	32	33	34
V= 0	3232.47	3231.91	3230.52	3228.29	3225.21	3221.30	3216.54
1	3129.47	3128.72	3127.14	3124.74	3121.50	3117.44	3112.54
2	3028.30	3027.34	3025.56	3022.96	3019.55	3015.31	3010.25
3	2928.80	2927.60	2925.60	2922.79	2919.17	2914.73	2909.48
4	2830.78	2829.33	2827.08	2824.02	2820.16	2815.50	2810.02
5	2734.04	2732.31	2729.78	2726.46	2722.33	2717.41	2711.67
6	2638.37	2636.32	2633.49	2629.86	2625.44	2620.22	2614.20
7	2543.52	2541.13	2537.96	2534.00	2529.25	2523.70	2517.35
8	2449.25	2446.49	2442.95	2438.63	2433.51	2427.59	2420.87
9	2355.30	2352.14	2348.19	2343.46	2337.93	2331.61	2324.48
10	2261.39	2257.78	2253.39	2248.21	2242.24	2235.47	2227.88
11	2167.23	2163.14	2158.26	2152.60	2146.13	2138.86	2130.77

	J= 35	36	37	38	39	40	41
V= 0	3210.94	3204.50	3197.21	3189.08	3180.11	3170.29	3159.62
1	3106.81	3100.25	3092.85	3084.61	3075.54	3065.62	3054.87
2	3004.36	2997.65	2990.11	2981.73	2972.53	2962.49	2951.61
3	2903.40	2896.51	2888.79	2880.25	2870.87	2860.67	2849.63
4	2803.73	2796.62	2788.69	2779.94	2770.37	2759.96	2748.73
5	2705.13	2697.77	2689.60	2680.60	2670.78	2660.13	2648.65
6	2607.37	2599.72	2591.26	2581.98	2571.88	2560.94	2549.17
7	2510.19	2502.22	2493.43	2483.82	2473.39	2462.12	2450.01
8	2413.34	2405.00	2395.84	2385.86	2375.04	2363.39	2350.90
9	2316.54	2307.78	2298.20	2287.80	2276.55	2264.46	2251.53
10	2219.48	2210.26	2200.22	2189.33	2177.61	2165.03	2151.59
11	2121.87	2112.13	2101.56	2090.15	2077.89	2064.76	2050.77

Table 11a. Line Positions of DF, R-Branch, $\Delta v = 1$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 1

	J= 42	43	44	45	46	47	48
V= 0	3148.10	3135.74	3122.53	3108.48	3093.57	3077.81	3061.19
1	3043.27	3030.84	3017.55	3003.42	2988.44	2972.61	2955.92
2	2939.89	2927.34	2913.94	2899.70	2884.60	2868.65	2851.85
3	2837.76	2825.05	2811.49	2797.09	2781.84	2765.73	2748.76
4	2736.65	2723.74	2709.98	2695.38	2679.92	2663.60	2646.41
5	2636.34	2623.18	2609.17	2594.31	2578.59	2562.01	2544.56
6	2536.56	2523.11	2508.80	2493.64	2477.61	2460.71	2442.92
7	2437.06	2423.26	2408.60	2393.08	2376.68	2359.40	2341.23
8	2337.55	2323.35	2308.28	2292.34	2275.51	2257.80	2239.17
9	2237.73	2223.07	2207.53	2191.11	2173.80	2155.58	2136.44
10	2137.29	2122.11	2106.04	2089.08	2071.21	2052.42	2032.70
11	2035.89	2020.13	2003.47	1985.90	1967.40	1947.97	1927.59

	J= 49
V= 0	3043.72
1	2938.37
2	2834.18
3	2730.92
4	2628.35
5	2526.22
6	2424.25
7	2322.16
8	2219.64
9	2116.38
10	2012.03
11	1906.25

Table 11b. Line Positions of DF, R-Branch, $\Delta v = 2$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 2

	J= 0	1	2	3	4	5	6
V= 0	5742.66	5762.02	5780.18	5797.12	5812.83	5827.31	5840.54
1	5560.84	5579.65	5597.29	5613.73	5628.97	5642.99	5655.79
2	5382.73	5401.00	5418.12	5434.06	5448.83	5462.40	5474.77
3	5208.05	5225.79	5242.39	5257.85	5272.14	5285.26	5297.20
4	5036.50	5053.71	5069.81	5084.77	5098.59	5111.26	5122.77
5	4867.74	4884.44	4900.03	4914.50	4927.86	4940.07	4951.14
6	4701.42	4717.60	4732.69	4746.68	4759.56	4771.32	4781.94
7	4537.15	4552.82	4567.41	4580.91	4593.31	4604.61	4614.78
8	4374.52	4389.67	4403.76	4416.77	4428.70	4439.52	4449.23
9	4213.07	4227.72	4241.31	4253.82	4265.25	4275.60	4284.83
10	4052.34	4066.48	4079.56	4091.58	4102.51	4112.36	4121.12

	J= 7	8	9	10	11	12	13
V= 0	5852.51	5863.21	5872.64	5880.79	5887.64	5893.20	5897.45
1	5667.36	5677.68	5686.75	5694.57	5701.11	5706.38	5710.37
2	5485.93	5495.87	5504.58	5512.06	5518.28	5523.26	5526.98
3	5307.95	5317.50	5325.84	5332.97	5338.87	5343.53	5346.96
4	5133.11	5142.26	5150.22	5156.98	5162.54	5166.89	5170.01
5	4961.05	4969.80	4977.37	4983.76	4988.96	4992.97	4995.77
6	4791.42	4799.75	4806.93	4812.93	4817.76	4821.40	4823.85
7	4623.82	4631.72	4638.48	4644.08	4648.51	4651.77	4653.86
8	4457.82	4465.28	4471.60	4476.78	4480.80	4483.66	4485.35
9	4292.96	4299.96	4305.84	4310.57	4314.15	4316.58	4317.85
10	4128.76	4135.29	4140.69	4144.96	4148.09	4150.06	4150.87

	J= 14	15	16	17	18	19	20
V= 0	5900.39	5902.02	5902.33	5901.32	5898.99	5895.33	5890.34
1	5713.08	5714.50	5714.62	5713.44	5710.96	5707.18	5702.10
2	5529.43	5530.62	5530.53	5529.17	5526.52	5522.60	5517.38
3	5349.15	5350.09	5349.77	5348.19	5345.36	5341.26	5335.89
4	5171.91	5172.57	5172.00	5170.19	5167.14	5162.83	5157.28
5	4997.35	4997.73	4996.88	4994.80	4991.50	4986.96	4981.18
6	4825.11	4825.16	4824.00	4821.64	4818.05	4813.24	4807.20
7	4654.75	4654.46	4652.97	4650.27	4646.37	4641.25	4634.91
8	4485.86	4485.18	4483.32	4480.26	4476.00	4470.54	4463.86
9	4317.94	4316.86	4314.59	4311.13	4306.48	4300.62	4293.56
10	4150.52	4148.99	4146.28	4142.38	4137.29	4130.99	4123.49

Table 11b. Line Positions of DF, R-Branch, $\Delta v = 2$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 2

	J= 21	22	23	24	25	26	27
V= 0	5884.03	5876.39	5867.42	5857.13	5845.50	5832.56	5818.30
1	5695.71	5688.01	5679.00	5668.69	5657.07	5644.15	5629.93
2	5510.88	5503.10	5494.02	5483.66	5472.01	5459.07	5444.84
3	5329.25	5321.34	5312.16	5301.71	5289.99	5276.99	5262.72
4	5150.47	5142.40	5133.08	5122.50	5110.65	5097.55	5083.19
5	4974.16	4965.90	4956.39	4945.64	4933.63	4920.38	4905.87
6	4799.93	4791.43	4781.70	4770.72	4758.50	4745.05	4730.34
7	4627.35	4618.57	4608.56	4597.31	4584.83	4571.12	4556.16
8	4455.97	4446.85	4436.51	4424.95	4412.15	4398.12	4382.85
9	4285.28	4275.79	4265.07	4253.13	4239.95	4225.54	4209.90
10	4114.78	4104.85	4093.70	4081.32	4067.71	4052.86	4036.77

	J= 28	29	30	31	32	33	34
V= 0	5802.72	5785.82	5767.61	5748.10	5727.29	5705.18	5681.78
1	5614.40	5597.58	5579.47	5560.06	5539.37	5517.39	5494.13
2	5429.33	5412.54	5394.47	5375.12	5354.49	5332.59	5309.42
3	5247.18	5230.36	5212.28	5192.93	5172.32	5150.44	5127.30
4	5067.57	5050.68	5032.54	5013.14	4992.47	4970.56	4947.38
5	4890.11	4873.10	4854.84	4835.[illegible]	4814.55	4792.53	4769.26
6	4714.39	4697.20	4678.76	4659.[illegible]	4638.12	4615.92	4592.48
7	4539.96	4522.52	4503.83	4483.89	4462.71	4440.27	4416.57
8	4366.34	4348.58	4329.58	4309.33	4287.82	4265.06	4241.04
9	4193.01	4174.87	4155.48	4134.84	4112.94	4089.78	4065.35
10	4019.43	4000.84	3981.00	3959.89	3937.51	3913.87	3888.95

	J= 35	36	37	38	39	40	41
V= 0	5657.09	5631.12	5603.87	5575.35	5545.57	5514.52	5482.22
1	5469.60	5443.79	5416.72	5388.39	5358.79	5327.95	5295.85
2	5284.99	5259.29	5232.33	5204.12	5174.65	5143.92	5111.95
3	5102.90	5077.25	5050.33	5022.17	4992.75	4962.08	4930.16
4	4922.96	4897.27	4870.34	4842.15	4812.71	4782.01	4750.07
5	4744.73	4718.95	4691.91	4663.62	4634.08	4603.28	4571.22
6	4567.78	4541.82	4514.61	4486.14	4456.41	4425.42	4393.16
7	4391.62	4365.41	4337.94	4309.20	4279.20	4247.92	4215.37
8	4215.76	4189.21	4161.40	4132.30	4101.93	4070.28	4037.33
9	4039.66	4012.68	3984.43	3954.89	3924.05	3891.92	3858.48
10	3862.74	3835.25	3806.46	3776.37	3744.98	3712.26	3678.22

Table 11b. Line Positions of DF, R-Branch, $\Delta v = 2$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 2

	J= 42	43	44	45	46	47	48
V= 0	5448.67	5413.88	5377.84	5340.56	5302.05	5262.30	5221.32
1	5262.50	5227.91	5192.07	5155.00	5116.69	5077.13	5036.34
2	5078.74	5044.27	5008.56	4971.61	4933.41	4893.97	4853.29
3	4897.00	4862.58	4826.92	4790.00	4751.83	4712.41	4671.73
4	4716.87	4682.41	4646.70	4609.74	4571.50	4532.01	4491.24
5	4537.90	4503.32	4467.48	4430.36	4391.97	4352.29	4311.33
6	4359.63	4324.83	4288.75	4251.38	4212.73	4172.77	4131.51
7	4181.54	4146.41	4110.00	4072.28	4033.26	3992.91	3951.24
8	4003.09	3967.55	3930.69	3892.51	3853.00	3812.16	3769.96
9	3823.73	3787.65	3750.24	3711.49	3671.38	3629.91	3587.06
10	3642.85	3606.13	3568.05	3528.61	3487.78	3445.56	3401.93

	J= 49
V= 0	5179.11
1	4994.31
2	4811.35
3	4629.79
4	4449.19
5	4269.08
6	4088.94
7	3908.23
8	3726.39
9	3542.81
10	3356.87

Table 11c. Line Positions of DF, R-Branch, $\Delta v = 3$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 3

V=	J= 0	1	2	3	4	5	6
0	8467.69	8485.91	8502.35	8517.01	8529.88	8540.94	8550.19
1	8198.00	8215.69	8231.64	8245.84	8258.23	8268.95	8277.84
2	7933.65	7950.82	7966.28	7980.02	7992.04	8002.31	8010.84
3	7674.21	7690.87	7705.84	7719.13	7730.71	7740.58	7748.73
4	7419.21	7435.35	7449.84	7462.67	7473.82	7483.28	7491.05
5	7168.13	7183.76	7197.77	7210.13	7220.84	7229.89	7237.26
6	6920.40	6935.53	6949.05	6960.95	6971.21	6979.83	6986.79
7	6675.43	6690.06	6703.09	6714.52	6724.32	6732.50	6739.04
8	6432.58	6446.70	6459.24	6470.18	6479.52	6487.25	6493.35
9	6191.14	6204.76	6216.80	6227.26	6236.12	6243.37	6249.01

V=	J= 7	8	9	10	11	12	13
0	8557.62	8563.21	8566.98	8568.90	8568.98	8567.20	8563.58
1	8284.94	8290.25	8293.76	8295.45	8295.34	8293.41	8289.67
2	8017.60	8022.61	8025.84	8027.30	8026.98	8024.87	8020.97
3	7755.16	7759.85	7762.79	7763.99	7763.43	7761.12	7757.04
4	7497.12	7501.47	7504.11	7505.02	7504.21	7501.66	7497.38
5	7242.95	7246.96	7249.27	7249.88	7248.78	7245.96	7241.44
6	6992.10	6995.73	6997.69	6997.97	6996.55	6993.44	6988.63
7	6743.94	6747.18	6748.76	6748.67	6746.91	6743.47	6738.34
8	6497.81	6500.64	6501.81	6501.33	6499.19	6495.38	6489.89
9	6253.03	6255.41	6256.15	6255.24	6252.68	6248.46	6242.57

V=	J= 14	15	16	17	18	19	20
0	8558.10	8550.77	8541.58	8530.54	8517.64	8502.90	8486.30
1	8284.10	8276.70	8267.49	8256.45	8243.58	8228.90	8212.40
2	8015.28	8007.80	7998.52	7987.44	7974.57	7959.91	7943.46
3	7751.20	7743.59	7734.21	7723.06	7710.14	7695.45	7678.99
4	7491.35	7483.58	7474.06	7462.79	7449.77	7435.01	7418.49
5	7235.18	7227.21	7217.51	7206.08	7192.91	7178.02	7161.39
6	6982.12	6973.90	6963.97	6952.32	6938.96	6923.88	6907.09
7	6731.53	6723.01	6712.80	6700.89	6687.28	6671.95	6654.92
8	6482.73	6473.87	6463.33	6451.10	6437.17	6421.54	6404.21
9	6235.00	6225.76	6214.83	6202.22	6187.91	6171.90	6154.20

V=	J= 21	22	23	24	25	26	27
0	8467.87	8447.59	8425.48	8401.54	8375.78	8348.21	8318.83
1	8194.08	8173.95	8152.02	8128.28	8102.75	8075.43	8046.32
2	7925.21	7905.18	7883.36	7859.77	7834.40	7807.26	7778.36
3	7660.77	7640.78	7619.02	7595.51	7570.25	7543.23	7514.46
4	7400.23	7380.22	7358.47	7334.98	7309.74	7282.77	7254.07
5	7143.04	7122.95	7101.13	7077.58	7052.31	7025.31	6996.58
6	6888.57	6868.34	6846.38	6822.71	6797.31	6770.20	6741.38
7	6636.18	6615.73	6593.56	6569.69	6544.10	6516.79	6487.78
8	6385.17	6364.42	6341.97	6317.81	6291.94	6264.35	6235.05
9	6134.79	6113.68	6090.86	6066.33	6040.08	6012.12	5982.45

Table 11c. Line Positions of DF, R-Branch, Δv = 3 Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 3

	J= 28	29	30	31	32	33	34
V= 0	8287.65	8254.69	8219.94	8183.43	8145.15	8105.13	8063.36
1	8015.44	7982.79	7948.38	7912.21	7874.31	7834.67	7793.30
2	7747.71	7715.30	7681.15	7645.26	7607.64	7568.30	7527.25
3	7483.96	7451.71	7417.74	7382.04	7344.63	7305.50	7264.66
4	7223.63	7191.48	7157.60	7122.00	7084.70	7045.68	7004.97
5	6966.14	6933.98	6900.11	6864.52	6827.23	6788.23	6747.54
6	6710.84	6678.59	6644.63	6608.95	6571.57	6532.49	6491.70
7	6457.05	6424.61	6390.46	6354.60	6317.02	6277.74	6236.75
8	6204.04	6171.32	6136.87	6100.71	6062.83	6023.24	5981.92
9	5951.05	5917.93	5883.09	5846.52	5808.22	5768.19	5726.42

	J= 35	36	37	38	39	40	41
V= 0	8019.87	7974.66	7927.74	7879.12	7828.82	7776.84	7723.20
1	7750.22	7705.43	7658.95	7610.77	7560.91	7509.38	7456.19
2	7484.49	7440.03	7393.88	7346.04	7296.52	7245.34	7192.48
3	7222.13	7177.90	7131.98	7084.37	7035.09	6984.13	6931.51
4	6962.56	6918.45	6872.65	6825.17	6776.00	6725.16	6672.63
5	6705.14	6661.05	6615.26	6567.78	6518.61	6467.75	6415.21
6	6449.21	6405.01	6359.12	6311.52	6262.22	6211.22	6158.52
7	6194.04	6149.62	6103.49	6055.65	6006.09	5954.81	5901.81
8	5938.88	5894.11	5847.62	5799.39	5749.43	5697.73	5644.28
9	5682.91	5637.67	5590.67	5541.93	5491.42	5439.15	5385.11

	J= 42	43	44	45	46	47	48
V= 0	7667.90	7610.95	7552.36	7492.14	7430.29	7366.82	7301.74
1	7401.34	7344.84	7286.70	7226.91	7165.50	7102.45	7037.78
2	7137.97	7081.81	7023.99	6964.52	6903.41	6840.66	6776.26
3	6877.21	6821.26	6763.64	6704.36	6643.42	6580.82	6516.56
4	6616.44	6562.56	6505.01	6445.78	6384.88	6322.29	6258.02
5	6360.97	6305.04	6247.42	6188.10	6127.09	6064.36	5999.92
6	6104.10	6047.98	5990.14	5930.59	5869.30	5806.29	5741.52
7	5847.08	5790.61	5732.41	5672.46	5610.75	5547.28	5482.02
8	5589.08	5532.12	5473.40	5412.89	5350.59	5286.49	5220.57
9	5329.28	5271.67	5212.25	5151.02	5087.96	5023.05	4956.29

	J= 49
V= 0	7235.05
1	6971.48
2	6710.21
3	6450.63
4	6192.05
5	5933.76
6	5675.01
7	5414.98
8	5152.82
9	4887.65

Table 11d. Line Positions of DF, R-Branch, $\Delta v = 4$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 4

	J= 0	1	2	3	4	5	6
V= 0	11104.85	11121.94	11136.71	11149.13	11159.20	11166.90	11172.24
1	10748.92	10765.51	10779.80	10791.90	10801.49	10808.86	10813.90
2	10399.81	10415.90	10429.73	10441.30	10450.61	10457.63	10462.37
3	10056.93	10072.51	10085.88	10097.02	10105.93	10112.60	10117.01
4	9719.60	9734.68	9747.59	9758.29	9766.80	9773.09	9777.17
5	9387.11	9401.70	9414.13	9424.40	9432.49	9438.40	9442.11
6	9058.68	9072.78	9084.74	9094.55	9102.22	9107.72	9111.06
7	8733.49	8747.09	8758.57	8767.92	8775.15	8780.23	8783.16
8	8410.65	8423.74	8434.73	8443.62	8450.38	8455.02	8457.52

	J= 7	8	9	10	11	12	13
V= 0	11175.20	11175.78	11173.98	11169.79	11163.21	11154.23	11142.87
1	10816.62	10816.99	10815.02	10810.70	10804.04	10795.02	10783.66
2	10464.81	10464.95	10462.79	10458.32	10451.54	10442.45	10431.05
3	10119.17	10119.06	10116.68	10112.03	10105.10	10095.89	10084.41
4	9779.02	9778.63	9776.01	9771.14	9764.02	9754.66	9743.05
5	9443.63	9442.94	9440.03	9434.91	9427.57	9418.01	9406.22
6	9112.21	9111.19	9107.97	9102.56	9094.95	9085.14	9073.12
7	8783.93	8782.54	8778.97	8773.23	8765.30	8755.19	8742.89
8	8457.88	8456.08	8452.13	8446.01	8437.72	8427.26	8414.61

	J= 14	15	16	17	18	19	20
V= 0	11129.12	11112.97	11094.45	11073.54	11050.26	11024.61	10996.60
1	10769.94	10753.88	10735.47	10714.72	10691.64	10666.22	10638.47
2	10417.33	10401.30	10382.96	10362.31	10339.36	10314.11	10286.56
3	10070.64	10054.59	10036.26	10015.66	9992.78	9967.63	9940.21
4	9729.18	9713.06	9694.69	9674.06	9651.19	9626.07	9598.71
5	9392.20	9375.95	9357.47	9336.76	9313.83	9288.67	9261.28
6	9058.89	9042.45	9023.81	9002.95	8979.87	8954.59	8927.10
7	8728.40	8711.70	8692.82	8671.73	8648.44	8622.95	8595.27
8	8399.79	8382.77	8363.57	8342.18	8318.60	8292.82	8264.85

	J= 21	22	23	24	25	26	27
V= 0	10966.24	10933.54	10898.50	10861.13	10821.46	10779.48	10735.22
1	10608.41	10576.04	10541.36	10504.39	10465.14	10423.62	10379.84
2	10256.73	10224.61	10190.22	10153.57	10114.66	10073.50	10030.11
3	9910.53	9878.60	9844.42	9807.99	9769.33	9728.45	9685.34
4	9569.11	9537.27	9503.21	9466.92	9428.42	9387.70	9344.78
5	9231.68	9199.85	9165.81	9129.57	9091.12	9050.46	9007.62
6	8897.40	8865.49	8831.39	8795.08	8756.58	8715.88	8673.00
7	8565.38	8533.30	8499.02	8462.55	8423.88	8383.03	8339.98
8	8234.68	8202.32	8167.76	8131.01	8092.07	8050.93	8007.60

Table 11d. Line Positions of DF, R-Branch, $\Delta v = 4$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 4

	J= 28	29	30	31	32	33	34
V= 0	10688.69	10639.89	10588.85	10535.58	10480.09	10422.41	10362.54
1	10333.81	10285.54	10235.06	10182.36	10127.46	10070.38	10011.13
2	9984.49	9936.65	9886.61	9834.37	9779.95	9723.36	9664.61
3	9640.02	9592.51	9542.80	9490.91	9436.85	9380.63	9322.25
4	9299.66	9252.35	9202.87	9151.20	9097.37	9041.39	8983.25
5	8962.59	8915.37	8865.98	8814.41	8760.69	8704.80	8646.76
6	8627.93	8580.68	8531.25	8479.66	8425.89	8369.96	8311.87
7	8294.76	8247.34	8197.75	8145.98	8092.04	8035.92	7977.62
8	7962.08	7914.37	7864.47	7812.39	7758.11	7701.64	7642.98

	J= 35	36	37	38	39	40	41
V= 0	10300.49	10236.30	10169.96	10101.51	10030.94	9958.28	9883.55
1	9949.72	9886.17	9820.49	9752.69	9682.79	9610.80	9536.72
2	9603.71	9540.68	9475.52	9408.24	9338.86	9267.39	9193.83
3	9261.73	9199.07	9134.29	9067.39	8998.39	8927.28	8854.07
4	8922.97	8860.55	8796.00	8729.33	8660.54	8589.63	8516.62
5	8586.57	8524.24	8459.77	8393.16	8324.43	8253.56	8180.57
6	8251.63	8189.22	8124.67	8057.97	7989.11	7918.11	7844.95
7	7917.16	7854.52	7789.72	7722.74	7653.59	7582.26	7508.76
8	7582.14	7519.10	7453.87	7386.43	7316.8[illegible]	7244.96	7170.91

	J= 42	43	44	45	46	47	48
V= 0	9806.74	9727.88	9646.98	9564.05	9479.[illegible]	9392.[illegible]	9303.18
1	9460.58	9382.37	9302.12	9219.83	91[illegible]	9049.13	8960.75
2	9118.19	9040.48	8960.71	8878.88	87[illegible].00	8709.07	8621.08
3	8778.78	8701.40	8621.94	8540.41	8[illegible]6.79	8371.10	8283.33
4	8441.50	8364.28	8284.96	8203.53	81[illegible].00	8034.36	7946.60
5	8105.45	8028.20	7948.82	7867.31	7783.66	7697.88	7609.93
6	7769.64	7692.18	7612.55	7530.76	744[illegible].80	7360.65	7272.31
7	7433.07	7355.19	7275.12	7192.83	7108.34	7021.61	6932.64
8	7094.64	7016.14	6935.40	6852.42	6767.16	6679.63	6589.80

	J= 49
V= 0	9212.21
1	8870.34
2	8531.05
3	8193.48
4	7856.73
5	7519.83
6	7181.75
7	6841.41
8	6497.66

Table 11e. Line Positions of DF, R-Branch, $\Delta v = 5$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 5

	J= 0	1	2	3	4	5	6
V= 0	13655.77	13671.76	13684.87	13695.09	13702.40	13706.81	13708.30
1	13215.08	13230.58	13243.25	13253.08	13260.06	13264.18	13265.43
2	12782.53	12797.54	12809.77	12819.20	12825.83	12829.64	12830.64
3	12357.31	12371.84	12383.62	12392.65	12398.91	12402.41	12403.13
4	11938.58	11952.62	11963.95	11972.56	11978.45	11981.61	11982.02
5	11525.39	11538.94	11549.81	11558.00	11563.50	11566.29	11566.37
6	11116.74	11129.80	11140.21	11147.96	11153.04	11155.45	11155.17
7	10711.56	10724.13	10734.06	10741.36	10746.01	10748.01	10747.34

	J= 7	8	9	10	11	12	13
V= 0	13706.87	13702.52	13695.24	13685.04	13671.90	13655.84	13636.86
1	13263.82	13259.33	13251.97	13241.72	13228.60	13212.61	13193.74
2	12828.82	12824.16	12816.68	12806.36	12793.21	12777.23	12758.41
3	12401.07	12396.22	12388.58	12378.14	12364.91	12348.89	12330.08
4	11979.69	11974.61	11966.77	11956.18	11942.82	11926.70	11907.83
5	11563.74	11558.39	11550.31	11539.51	11525.97	11509.71	11490.70
6	11152.21	11146.55	11138.18	11127.12	11113.34	11096.86	11077.67
7	10744.00	10737.98	10729.29	10717.90	10703.83	10687.07	10667.61

	J= 14	15	16	17	18	19	20
V= 0	13614.96	13590.15	13562.43	13531.82	13498.31	13461.93	13422.68
1	13171.99	13147.38	13119.91	13089.59	13056.42	13020.41	12981.58
2	12736.77	12712.30	12685.01	12654.91	12621.99	12586.28	12547.78
3	12308.47	12284.07	12256.89	12226.93	12194.20	12158.69	12120.43
4	11886.19	11861.80	11834.65	11804.75	11772.11	11736.72	11698.60
5	11468.97	11444.50	11417.31	11387.39	11354.74	11319.37	11281.29
6	11055.76	11031.14	11003.82	10973.78	10941.04	10905.59	10867.44
7	10645.46	10620.60	10593.06	10562.81	10529.87	10494.24	10455.91

	J= 21	22	23	24	25	26	27
V= 0	13380.57	13335.62	13287.84	13237.24	13183.85	13127.68	13068.74
1	12939.92	12895.47	12848.22	12798.19	12745.40	12689.86	12631.59
2	12506.49	12462.43	12415.62	12366.05	12313.75	12258.72	12200.97
3	12079.41	12035.65	11989.16	11939.94	11888.01	11833.37	11776.05
4	11657.75	11614.18	11567.89	11518.91	11467.23	11412.86	11355.82
5	11240.50	11197.01	11150.82	11101.94	11050.38	10996.14	10939.24
6	10826.60	10783.07	10736.85	10687.94	10636.36	10582.11	10525.20
7	10414.90	10371.20	10324.81	10275.75	10224.02	10169.61	10112.53

	J= 28	29	30	31	32	33	34
V= 0	13007.06	12942.65	12875.53	12805.72	12733.25	12658.12	12580.36
1	12570.59	12506.90	12440.52	12371.47	12299.77	12225.44	12148.49
2	12140.56	12077.45	12011.67	11943.24	11872.17	11798.49	11722.20
3	11716.05	11653.39	11588.07	11520.11	11449.53	11376.33	11300.53
4	11296.11	11233.74	11168.74	11101.09	11030.83	10957.95	10882.47
5	10879.67	10817.46	10752.60	10685.12	10615.00	10542.27	10466.93
6	10465.63	10403.41	10338.55	10271.04	10200.90	10128.14	10052.75
7	10052.80	9990.40	9925.35	9857.65	9787.31	9714.32	9638.69

Table 11e. Line Positions of DF, ℓ Branch, Δv = 5 Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 5

	J= 35	36	37	38	39	40	41
V= 0	12499.99	12417.04	12331.51	12243.43	12152.82	12059.70	11964.08
1	12068.95	11986.82	11902.13	11814.90	11725.13	11632.85	11538.06
2	11643.31	11561.85	11477.83	11391.26	11302.16	11210.53	11116.39
3	11222.14	11141.17	11057.64	10971.55	10882.92	10791.75	10698.06
4	10804.40	10723.74	10640.51	10554.71	10466.35	10375.44	10281.98
5	10388.99	10308.45	10225.32	10139.61	10051.31	9960.45	9867.00
6	9974.74	9894.12	9810.89	9725.06	9636.61	9545.56	9451.90
7	9560.42	9479.51	9395.96	9309.78	9220.96	9129.50	9035.39

	J= 42	43	44	45	46	47	48
V= 0	11865.98	11765.42	11662.41	11556.96	11449.10	11338.82	11226.15
1	11440.79	11341.05	11238.84	11134.18	11027.08	10917.54	10805.57
2	11019.76	10920.63	10819.02	10714.93	10608.37	10499.35	10387.86
3	10601.85	10503.12	10401.89	10298.15	10191.91	10083.17	9971.92
4	10185.98	10087.44	9986.35	9882.74	9776.58	9667.87	9556.62
5	9770.99	9672.40	9571.23	9467.49	9361.16	9252.24	9140.71
6	9355.64	9256.76	9155.26	9051.14	8944.38	8834.98	8722.92
7	8938.63	8839.21	8737.12	8632.36	8524.91	8414.75	8301.87

	J= 49
V= 0	11111.08
1	10691.18
2	10273.90
3	9858.17
4	9442.80
5	9026.58
6	8608.19
7	8186.25

Table 11f. Line Positions of DF, R-Branch, $\Delta v = 6$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 6

	J= 0	1	2	3	4	5	6
V= 0	16121.93	16136.84	16148.32	16156.37	16160.97	16162.13	16159.83
1	15597.80	15612.23	15623.29	15630.98	15635.28	15636.19	15633.71
2	15082.92	15096.87	15107.51	15114.83	15118.81	15119.46	15116.76
3	14576.30	14589.77	14599.98	14606.92	14610.56	14610.92	14607.98
4	14076.86	14089.86	14099.63	14106.17	14109.46	14109.50	14106.28
5	13583.45	13595.96	13605.29	13611.41	13614.32	13614.02	13610.49
6	13094.81	13106.84	13115.71	13121.40	13123.91	13123.23	13119.35

	J= 7	8	9	10	11	12	13
V= 0	16154.08	16144.86	16132.19	16116.06	16096.47	16073.43	16046.94
1	15627.83	15618.54	15605.86	15589.76	15570.27	15547.38	15521.10
2	15110.72	15101.32	15088.58	15072.48	15053.03	15030.23	15004.08
3	14601.74	14592.19	14579.34	14563.18	14543.71	14520.94	14494.86
4	14099.81	14090.06	14077.05	14060.77	14041.22	14018.40	13992.31
5	13603.74	13593.75	13580.53	13564.07	13544.37	13521.43	13495.25
6	13112.28	13101.99	13088.50	13071.79	13051.87	13028.74	13002.39

	J= 14	15	16	17	18	19	20
V= 0	16017.01	15983.66	15946.88	15906.69	15863.10	15816.12	15765.78
1	15491.43	15458.39	15421.97	15382.19	15339.06	15292.59	15242.79
2	14974.60	14941.78	14905.64	14866.18	14823.41	14777.34	14727.99
3	14465.48	14432.81	14396.86	14357.62	14315.11	14269.34	14220.31
4	13962.96	13930.35	13894.49	13855.37	13813.02	13767.43	13718.61
5	13465.84	13433.19	13397.32	13358.22	13315.90	13270.38	13221.64
6	12972.82	12940.04	12904.06	12864.86	12822.47	12776.87	12728.09

	J= 21	22	23	24	25	26	27
V= 0	15712.08	15655.05	15594.70	15531.04	15464.11	15393.92	15320.49
1	15189.69	15133.29	15073.61	15010.67	14944.49	14875.08	14802.46
2	14675.37	14619.48	14560.36	14498.00	14432.42	14363.65	14291.70
3	14168.05	14112.55	14053.84	13991.92	13926.82	13858.53	13787.09
4	13666.58	13611.34	13552.90	13491.28	13426.49	13358.53	13287.43
5	13169.71	13114.58	13056.28	12994.80	12930.16	12862.37	12791.44
6	12676.11	12620.96	12562.64	12501.14	12436.50	12368.69	12297.75

	J= 28	29	30	31	32	33	34
V= 0	15243.84	15164.00	15080.99	14994.84	14905.56	14813.18	14717.72
1	14726.66	14647.69	14565.58	14480.34	14391.99	14300.57	14206.08
2	14216.59	14138.32	14056.94	13972.44	13884.85	13794.19	13700.48
3	13712.50	13634.78	13553.94	13470.00	13382.98	13292.89	13199.75
4	13213.19	13135.83	13055.36	12971.80	12885.15	12795.42	12702.64
5	12717.38	12640.19	12559.90	12476.50	12390.01	12300.45	12207.81
6	12223.67	12146.47	12066.15	11982.71	11896.18	11806.54	11713.81

Table 11f. Line Positions of DF, R-Branch, $\Delta v = 6$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 6

	J= 35	36	37	38	39	40	41
V= 0	14619.22	14517.69	14413.15	14305.63	14195.16	14081.75	13965.42
1	14108.55	14008.00	13904.45	13797.92	13688.43	13575.99	13460.63
2	13603.72	13503.95	13401.18	13295.42	13186.69	13075.01	12960.38
3	13103.57	13004.36	12902.15	12796.93	12688.73	12577.56	12463.42
4	12606.81	12507.95	12406.06	12301.15	12193.24	12082.32	11968.41
5	12112.11	12013.35	11911.54	11806.70	11698.82	11587.90	11473.95
6	11618.00	11519.11	11417.14	11312.10	11203.98	11092.79	10978.53

	J= 42	43	44	45	46	47	48
V= 0	13846.19	13724.09	13599.13	13471.32	13340.69	13207.23	13070.97
1	13342.36	13221.20	13097.15	12970.23	12840.46	12707.83	12572.35
2	12842.82	12722.35	12598.96	12472.67	12343.49	12211.41	12076.45
3	12346.32	12226.28	12103.29	11977.36	11848.49	11716.68	11581.93
4	11851.52	11731.63	11608.76	11482.91	11354.07	11222.23	11087.40
5	11356.98	11236.97	11113.94	10987.86	10858.74	10726.57	10591.33
6	10861.19	10740.78	10617.27	10490.67	10360.96	10228.12	10092.15

	J= 49
V= 0	12931.91
1	12434.03
2	11938.59
3	11444.24
4	10949.55
5	10453.01
6	9953.03

Table 11g. Line Positions of DF, R-Branch, $\Delta v = 7$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 7

	J= 0	1	2	3	4	5	6
V= 0	18504.64	18518.48	18528.36	18534.26	18536.20	18534.15	18528.11
1	17898.18	17911.55	17921.03	17926.60	17928.27	17926.01	17919.83
2	17301.90	17314.80	17323.87	17329.09	17330.46	17327.97	17321.62
3	16715.58	16727.01	16735.66	16740.52	16741.57	16738.82	16732.24
4	16134.92	16146.88	16155.10	16159.57	16160.28	16157.23	16150.40
5	15561.52	15573.00	15580.78	15584.85	15585.19	15581.80	15574.67

	J= 7	8	9	10	11	12	13
V= 0	18518.09	18504.08	18486.08	18464.10	18438.14	18408.21	18374.31
1	17909.73	17895.70	17877.75	17855.88	17830.09	17800.38	17766.77
2	17311.39	17297.30	17279.34	17257.51	17231.82	17202.27	17168.87
3	16721.86	16707.65	16689.62	16667.77	16642.11	16612.63	16579.34
4	16139.80	16125.42	16107.26	16085.33	16059.61	16030.12	15996.86
5	15563.81	15549.20	15530.84	15508.74	15482.89	15453.30	15419.97

	J= 14	15	16	17	18	19	20
V= 0	18336.45	18294.66	18248.93	18199.28	18145.73	18088.30	18027.00
1	17729.26	17687.87	17642.60	17593.46	17540.47	17483.65	17423.01
2	17131.61	17090.52	17045.60	16996.87	16944.33	16887.99	16827.88
3	16542.25	16501.37	16456.69	16408.24	16356.02	16300.04	16240.33
4	15959.83	15919.04	15874.50	15826.21	15774.18	15718.43	15658.95
5	15382.90	15342.09	15297.56	15249.30	15197.33	15141.66	15082.28

	J= 21	22	23	24	25	26	27
V= 0	17961.85	17892.87	17820.09	17743.52	17663.20	17579.14	17491.37
1	17358.57	17290.34	17218.35	17142.62	17063.16	16980.01	16893.18
2	16764.01	16696.39	16625.04	16549.98	16471.23	16388.81	16302.74
3	16176.88	16109.71	16038.85	15964.30	15886.08	15804.21	15718.71
4	15595.78	15528.91	15458.36	15384.14	15306.27	15224.77	15139.64
5	15019.22	14952.48	14882.07	14808.01	14730.30	14648.95	14563.99

	J= 28	29	30	31	32	33	34
V= 0	17399.91	17304.80	17206.05	17103.70	16997.78	16888.30	16775.31
1	16802.69	16708.57	16610.84	16509.54	16404.67	16296.27	16184.36
2	16213.03	16119.71	16022.81	15922.33	15818.31	15710.76	15599.70
3	15629.59	15536.87	15440.57	15340.71	15237.30	15130.37	15019.92
4	15050.90	14958.57	14862.66	14763.18	14660.16	14553.60	14443.52
5	14475.42	14383.25	14287.50	14188.17	14085.29	13978.85	13868.87

	J= 35	36	37	38	39	40	41
V= 0	16658.82	16538.86	16415.47	16288.66	16158.46	16024.89	15887.94
1	16068.96	15950.10	15827.80	15702.08	15572.96	15440.47	15304.62
2	15485.16	15367.15	15245.69	15120.80	14992.50	14860.81	14725.74
3	14905.99	14788.57	14667.70	14543.38	14415.62	14284.44	14149.85
4	14329.93	14212.85	14092.28	13968.24	13840.74	13709.78	13575.37
5	13755.36	13638.33	13517.79	13393.74	13266.18	13135.13	13000.58

Table 11g. Line Positions of DF, R-Branch, $\Delta v = 7$ Sequence (Continued)

DF

NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 7

	J= 42	43	44	45	46	47	48
V= 0	15747.76	15604.24	15457.44	15307.37	15154.06	14997.5[illegible]	14837.75
1	15165.43	15022.92	14877.09	14727.98	14575.57	14419.89	14260.94
2	14587.30	14445.50	14300.36	14151.88	14000.07	13844.93	13686.46
3	14011.86	13870.47	13725.70	13577.53	13425.98	13271.05	13112.72
4	13437.51	13296.21	13151.47	13003.29	12851.65	12696.57	12538.01
5	12862.54	12720.99	12575.95	12427.39	12275.32	12119.71	11960.56

	J= 49
V= 0	14674.77
1	14098.72
2	13524.66
3	12950.99
4	12375.99
5	11797.85

Table 11h. Line Positions of DF, R-Branch, $\Delta v = 8$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 8

	J= 0	1	2	3	4	5	6
V= 0	20805.03	20817.81	20826.10	20829.89	20829.18	20823.96	20814.23
1	20117.16	20129.49	20137.39	20140.87	20139.92	20134.52	20124.68
2	19440.18	19452.04	19459.55	19462.70	19461.47	19455.86	19445.88
3	18772.54	18784.04	18791.14	18793.93	18792.40	18786.55	18776.36
4	18112.99	18123.92	18130.60	18133.01	18131.15	18125.01	18114.58

	J= 7	8	9	10	11	12	13
V= 0	20799.99	20781.24	20757.97	20730.21	20697.95	20661.20	20619.98
1	20110.40	20091.68	20068.52	20040.92	20008.88	19972.43	19931.55
2	19431.51	19412.76	19389.62	19362.11	19330.22	19293.97	19253.35
3	18761.85	18743.01	18719.83	18692.33	18660.50	18624.35	18583.89
4	18099.87	18080.87	18057.58	18030.00	17998.14	17962.00	17921.58

	J= 14	15	16	17	18	19	20
V= 0	20574.28	20524.14	20469.56	20410.56	20347.15	20279.36	20207.21
1	19886.28	19836.61	19782.56	19724.15	19661.39	19594.30	19522.90
2	19208.39	19159.08	19105.44	19047.49	18985.24	18918.70	18847.89
3	18539.12	18490.06	18436.70	18379.08	18317.19	18251.05	18180.67
4	17876.89	17827.94	17774.74	17717.29	17655.61	17589.71	17519.60

	J= 21	22	23	24	25	26	27
V= 0	20130.73	20049.92	19964.83	19875.47	19781.87	19684.07	19582.08
1	19447.21	19367.24	19283.04	19194.60	19101.97	19005.17	18904.21
2	18772.83	18693.55	18610.05	18522.35	18430.49	18334.49	18234.35
3	18106.08	18027.28	17944.31	17857.16	17765.87	17670.44	17570.91
4	17445.29	17366.80	17284.15	17197.35	17106.41	17011.35	16912.19

	J= 28	29	30	31	32	33	34
V= 0	19475.94	19365.68	19251.32	19132.90	19010.46	18884.01	18753.59
1	18799.13	18689.96	18576.71	18459.43	18338.12	18212.83	18083.58
2	18130.12	18021.80	17909.43	17793.03	17672.62	17548.23	17419.87
3	17467.29	17359.60	17247.86	17132.09	17012.31	16888.54	16760.80
4	16808.94	16701.63	16590.26	16474.85	16355.43	16232.00	16104.58

	J= 35	36	37	38	39	40	41
V= 0	18619.23	18480.96	18338.81	18192.81	18042.99	17889.37	17731.97
1	17950.39	17813.29	17672.30	17527.46	17378.77	17226.27	17069.98
2	17287.57	17151.36	17011.24	16867.25	16719.39	16567.70	16412.17
3	16629.11	16493.47	16353.92	16210.47	16063.12	15911.90	15756.81
4	15973.19	15837.84	15698.53	15555.28	15408.11	15257.01	15102.00

Table 11h. Line Positions of DF, R-Branch, $\Delta v = 8$ Sequence (Continued)

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 8

	J= 42	43	44	45	46	47	48
V= 0	17570.83	17405.96	17237.38	17065.12	16889.18	16709.58	16526.34
1	16909.90	16746.07	16578.49	16407.18	16232.15	16053.41	15870.95
2	16252.84	16089.70	15922.77	15752.06	15577.56	15399.29	15217.24
3	15597.86	15435.05	15268.41	15097.91	14923.57	14745.38	14563.33
4	14943.07	14780.23	14613.46	14442.81	14268.23	14089.71	13907.25

	J= 49
V= 0	16339.45
1	15684.79
2	15031.41
3	14377.42
4	13720.82

Table 11[illegible]. Line Positions of DF, R-Branch, $\Delta v = 9$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 9

	J= 0	1	2	3	4	5	6
V= 0	23024.01	23035.74	23042.46	23044.16	23040.83	23032.47	23019.08
1	22255.44	22266.73	22273.08	22274.48	22270.92	22262.41	22248.95
2	21498.24	21509.07	21515.03	21516.11	21512.30	21503.59	21490.00
3	20750.71	20761.08	20766.63	20767.36	20763.26	20754.32	20740.54

	J= 7	8	9	10	11	12	13
V= 0	23000.66	22977.21	22948.74	22915.25	22876.75	22833.25	22784.76
1	22230.52	22207.14	22178.80	22145.51	22107.28	22064.12	22016.04
2	21471.50	21448.12	21419.84	21386.67	21348.62	21305.69	21257.90
3	20721.92	20698.45	20670.15	20637.01	20599.03	20556.23	20508.61

	J= 14	15	16	17	18	19	20
V= 0	22731.30	22672.88	22609.52	22541.24	22468.07	22390.01	22307.10
1	21963.05	21905.16	21842.40	21774.77	21702.30	21625.00	21542.91
2	21205.26	21147.77	21085.45	21018.33	20946.40	20869.70	20788.24
3	20456.18	20398.96	20336.94	20270.16	20198.61	20122.33	20041.31

	J= 21	22	23	24	25	26	27
V= 0	22219.36	22126.83	22029.51	21927.45	21820.68	21709.22	21593.11
1	21456.03	21364.40	21268.04	21166.98	21061.23	20950.84	20835.83
2	20702.04	20611.12	20515.50	20415.22	20310.28	20200.72	20086.56
3	19955.59	19865.18	19770.10	19670.36	19566.00	19457.02	19343.46

	J= 28	29	30	31	32	33	34
V= 0	21472.38	21347.06	21217.19	21082.79	20943.91	20800.57	20652.81
1	20716.22	20592.05	20463.34	20330.13	20192.44	20050.31	19903.75
2	19967.82	19844.54	19716.73	19584.42	19447.64	19306.40	19160.75
3	19225.33	19102.66	18975.46	18843.76	18707.58	18566.94	18421.86

	J= 35	36	37	38	39	40	41
V= 0	20500.66	20344.15	20183.32	20018.19	19848.80	19675.17	19497.33
1	19752.81	19597.50	19437.86	19273.90	19105.66	18933.16	18756.41
2	19010.69	18856.26	18697.46	18534.34	18366.89	18195.15	18019.13
3	18272.36	18118.46	17960.17	17797.51	17630.49	17459.13	17283.43

Table 11i. Line Positions of DF, R-Branch, $\Delta v = 9$ Sequence (Continued,

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 9

	J= 42	43	44	45	46	47	48
V= 0	19315.30	19129.11	18938.78	18744.32	18545.76	18343.10	18136.35
1	18575.44	18390.27	18200.90	18007.36	17809.65	17607.77	17401.73
2	17838.83	17654.28	17465.48	17272.43	17075.15	16873.62	16667.86
3	17103.41	16919.07	16730.41	16537.44	16340.14	16138.52	15932.56

	J= 49
V= 0	17925.52
1	17191.54
2	16457.84
3	15722.26

Table 11j. Line Positions of DF, R-Branch, $\Delta v = 10$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 10

	J= 0	1	2	3	4	5	6
V= 0	25162.29	25172.98	25178.14	25177.76	25171.84	25160.37	25143.35
1	24313.50	24323.75	24328.55	24327.88	24321.75	24310.14	24293.07
2	23476.31	23486.11	23490.52	23489.54	23483.16	23471.37	23454.17

	J= 7	8	9	10	11	12	13
V= 0	25120.78	25092.67	25059.02	25019.84	24975.15	24924.94	24869.25
1	24270.51	24242.49	24209.01	24170.07	24125.68	24075.85	24020.59
2	23431.57	23403.56	23370.15	23331.34	23287.14	23237.57	23182.62

	J= 14	15	16	17	18	19	20
V= 0	24808.07	24741.43	24669.36	24591.87	24508.98	24420.72	24327.11
1	23959.92	23893.85	23822.41	23745.61	23663.46	23576.01	23483.25
2	23122.32	23056.67	22985.69	22909.41	22827.83	22740.98	22648.88

	J= 21	22	23	24	25	26	27
V= 0	24228.19	24123.98	24014.52	23899.83	23779.94	23654.90	23524.73
1	23385.24	23281.98	23173.50	23059.84	22941.02	22817.08	22688.03
2	22551.55	22449.01	22341.30	22228.42	22110.41	21987.30	21859.11

	J= 28	29	30	31	32	33	34
V= 0	23389.47	23249.15	23103.82	22953.50	22798.23	22638.04	22472.98
1	22453.93	22414.79	22270.63	22121.51	21967.45	21808.48	21644.63
2	21725.87	21587.60	21444.53	21296.09	21142.91	20984.81	20821.81

	J= 35	36	37	38	39	40	41
V= 0	22303.08	22128.87	21948.87	21764.64	21575.69	21382.06	21183.77
1	21475.92	21302.40	21124.08	20940.99	20753.16	20560.61	20363.36
2	20653.95	20481.24	20303.71	20121.38	19934.26	19742.38	19545.76

	J= 42	43	44	45	46	47	48
V= 0	20980.84	20773.31	20561.19	20344.50	20123.25	19897.46	19667.13
1	20161.44	19954.85	19743.61	19527.74	19307.23	19082.10	18852.35
2	19344.39	19137.30	18927.48	18711.96	18491.72	18266.77	18037.09

	J= 49
V= 0	19432.27
1	18617.97
2	17802.68

Table 11k. Line Positions of DF, R-Branch, $\Delta v = 11$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 11

	J= 0	1	2	3	4	5	6
V= 0	27220.35	27230.01	27233.62	27231.17	27222.66	27208.09	27187.46
1	26291.57	26300.79	26304.05	26301.32	26292.61	26277.92	26257.24
	J= 7	8	9	10	11	12	13
V= 0	27160.77	27128.03	27089.23	27044.40	26993.54	26936.67	26873.79
1	26230.58	26197.94	26159.32	26114.74	26064.20	26007.72	25945.31
	J= 14	15	16	17	18	19	20
V= 0	26804.94	26730.12	26649.37	26562.70	26470.14	26371.72	26267.46
1	25876.98	25802.75	25722.65	25636.69	25544.89	25447.29	25343.90
	J= 21	22	23	24	25	26	27
V= 0	26157.39	26041.56	25919.98	25792.69	25659.73	25521.13	25376.94
1	25234.75	25119.87	24999.29	24873.04	24741.15	24603.66	24460.58
	J= 28	29	30	31	32	33	34
V= 0	25227.18	25071.89	24911.11	24744.88	24573.24	24396.22	24213.86
1	24311.97	24157.84	23998.24	23833.19	23662.73	23486.88	23305.69
	J= 35	36	37	38	39	40	41
V= 0	24076.20	23833.26	23635.10	23431.73	23223.19	23009.51	22790.72
1	23119.18	22927.38	22730.33	22528.03	22320.53	22107.85	21889.99
	J= 42	43	44	45	46	47	48
V= 0	22566.84	22337.89	22103.90	21864.88	21620.84	21371.79	21117.75
1	21666.99	21438.87	21205.62	20967.26	20723.80	20475.24	20221.58
	J= 49						
V= 0	20858.71						
1	19962.81						

Table 111. Line Positions of DF, R-Branch, $\Delta v = 12$ Sequence

DF NU(V,J,+1) , 1/CM , R-BRANCH , DELTA NU = 12

	J= 0	1	2	3	4	5	6
V= 0	29198.42	29207.05	29209.11	29204.61	29193.53	29175.87	29151.64
	J= 7	8	9	10	11	12	13
V= 0	29120.84	29083.47	29039.55	28989.08	28932.07	28868.54	28798.51
	J= 14	15	16	17	18	19	20
V= 0	28722.00	28639.02	28549.61	28453.78	28351.57	28243.00	28128.10
	J= 21	22	23	24	25	26	27
V= 0	28006.91	27879.45	27745.77	27605.89	27459.86	27307.71	27149.49
	J= 28	29	30	31	32	33	34
V= 0	26985.22	26814.95	26638.71	26456.55	26268.51	26074.62	25874.92
	J= 35	36	37	38	39	40	41
V= 0	25669.46	25458.25	25241.34	25018.77	24790.56	24556.74	24317.35
	J= 42	43	44	45	46	47	48
V= 0	24072.39	23821.91	23565.91	23304.40	23037.41	22764.93	22486.98
	J= 49						
V= 0	22203.54						

Table 12a. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 1$ Sequence[a]

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.
	1 → 0 band (ν_0 - 3961.60 cm^{-1}) obs. (ν_0 3961.58 cm^{-1}) calc.			
5	3741.66	+.06		
6	3693.64	+.10		
7	3644.24	+.02	4230.85	-.02
8	3593.89	+.08	4256.32	-.10
9	3542.21	-.04	4279.91	-.14
10	3489.67	.03	4301.55	-.16
11	3436.08	+.04	4321.28	-.10
12	3381.45	-.05	4339.15	-.12
13	3326.00	-.08	4354.66	+.03
14	3269.85	.02	4368.12	-.05
15	3212.88	.05	4379.67	+.06
16			4389.01	+.07
17			4396.12	-.02
18			4401.21	-.01
19			4404.10	0.00
20			4404.87	-.04
21			4403.45	.07
22			4399.89	.14
23			4394.20	.27
24			4386.37	.46
25			4376.28	.60
26			4363.78	.52
27			4349.57	.95

Table 12a. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 1$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc)
		2 → 1 band (ν_0 = 3789.42 cm^{-1}) obs. (ν_0 = 3789.41 cm^{-1}) calc.		
0			3827.49	.02
1	3749.91	.07	3863 97	-.01
2	3708.88	.06	3898.90	.01
3	3666.42	.02	3932.16	.01
4	3622.58	-.04	3963.70	-.03
5	3577.52	-.02	3993.55	-.02
6	3531.20	-.01	4021.70	.06
7	3483.71	-.02	4047.98	-.07
8	3435.10	-.06	4072.24	-.08
9	3385.23	-.07	4094.85	-.01
10	3334.48	-.05	4115.38	.11
11	3282.76	.04	4134.14	-.03
12	3229.97	-.18	4150.84	-.04
13			4165.50	-.09
14			4178.21	-.07
15			4188.86	-.06
16			4197.50	.00
18			4208.42	.02
19			4210.68	-.01
20			4210.81	-.04
21			4209.05	.18
22			4205.05	.30
23			4198.93	.46
24			4190.41	.38

Table 12a. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 1$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		3→2 band (ν_0 = 3622.02 cm^{-1}) obs. (ν_0 = 3222.00 cm^{-1}) calc.		
0			3658.59	0.00
1	3583.95		3693.64	-.03
2	3544.48		3727.25	.06
3	3503.68		3759.13	.03
4	3461.54			
5	3417.99		3817.94	-.01
6	3373.32		3844.87	.08
7	3327.49		3869.85	-.03
8	3280.63		3893.15	-.01
9	3232.51		3914.61	.01
10			3934.26	.09
11			3951.84	-.01
12			3967.60	.01
13			3981.40	.01
14			3993.23	.03
15			4003.11	.10
16			4010.90	.10
17			4016.63	.11
18			4020.30	.07
21			4019.00	.23
22			4014.47	.40

[a] D.E. Mann et al., J. Chem. Phys. 34, 420 (1961).
[b] Units in cm^{-1}.

Table 12b. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 2$ Sequence[a]

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		2 → 0 band (ν_o = 7750.98 cm^{-1}) obs.		
		(ν_o = 7750.99 cm^{-1}) calc.		
1	7709.78	-.10		
2	7666.00	+.23	7855.83	-.01
3	7618.57	-.14	7884.33	-.14
4	7568.66	-.10	7909.99	+.12
5	7515.94	-.04	7932.01	+.00
6	7460.39	-.03	7950.91	+.05
7	7402.02	-.12	7966.33	-.04
8	7341.34	+.09	7978.39	-.15
9	7277.96	-.20	7987.09	-.23
10	7211.70	-.06	7992.58	-.13
11	7143.14	-.18	7994.55	-.14
12	7072.57	+.07	7992.94	-.29
13	6999.31	-.07	7988.07	-.27
14	6923.91	-.13	7979.86	-.13
15	6846.57	+.04	7968.13	-.07
16	6766.93	+.01	7953.11	+.16
17	6685.36	+.01	7934.37	+.12
18	6601.75	-.06	7912.34	+.24
19	6516.35	-.06	7886.49	-.01
20	6429.23	-.01	7857.68	+.21
21	6340.41	+.07	7825.14	[illegible].12
22	6249.84	+.04	7789.66	+.51
23	6157.64	-.05	7750.66	+.78
24	6063.94	-.14	7707.79	+.56
25	5968.88	-.17	7662.46	+1.25
26	5872.65	-.01	7613.10	+1.25
27	5775.10	+.12		
28	5676.05	-.03		

Table 12b. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 2$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		3→1 band (ν_o = 7411.45 cm^{-1}) obs.		
		(ν_o = 7411.41 cm^{-1}) calc.		
0			7448.01	+.01
1	7372.07	+.23	7481.66	+.08
2	7329.42	+.07	7512.10	-.01
3	7284.00	-.01	7539.56	+.07
4	7235.95	+.13	7563.69	-.06
5	7185.01	+.13	7584.88	-.05
6	7131.19	-.05	7602.94	+.25
7	7074.99	+.04	7617.58	+.27
8	7016.04	-.05	7629.01	+.35
9	6954.62	-.09	7636.95	+.23
10	6890.84	-.03	7641.62	+.17
11	6824.52	-.13	7643.23	+.38
12	6756.26	-.15	7641.06	+.16
13	6685.81	+.49	7635.78	+.19
14	6612.16	-.18	7627.26	+.36
15	6537.41	-.15	7615.13	+.29
16	6460.41	-.29	7599.59	+.20
17	6380.92	-.10	7580.46	-.09
18	6299.89	-.12	7558.27	-.07
19	6216.79	-.37	7532.93	+.19
20	6132.37	-.18	7504.11	+.35
21	6046.16	-.08	7471.88	+.47
22	5958.34	+.03	7436.12	+.42
23	5868.88	+.66	7397.21	+.57
24	5773.03	+.20	7355.32	+1.08
25	5685.59	+.17	7309.61	+1.10

Table 12b. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 2$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		4→2 band (ν_o = 7080.85 cm^{-1}) obs.		
		(ν_o = 7080.83 cm^{-1}) calc.		
0			7115.97	-.02
1	7042.61	-.16	7148.12	-.07
2	7001.90	+.05	7177.35	-.06
3	6958.18	+.05	7203.60	+.01
4	6911.54	-.11	7226.89	+.18
5	6862.73	-.23	7246.99	+.28
6	6810.56	-.11	7263.79	+.22
7	6756.26	-.02	7277.43	+ 17
8	6699.37	+.01	7287.77	+.02
9	6640.08	+.11	7295.08	+.06
10	6578.39	+.20	7299.06	+.02
11	6514.05	-.02	7299.74	-.06
12	6447.87	+.20	7297.33	+.03
13	6379.05	-.02	7291.53	+.08
14	6308.17	-.15	7282.38	+.06
15	6235.41	-.08	7270.17	+.30
16	6160.74	+.09	7254.34	+.24
17	6083.99	+.13	7235.26	+.26
18	6005.34	+.14	7212.84	+.27
19	5924.78	+.06	7187.27	+.46
20	5842.83	+.35	7158.00	+.28
21	5758.72	+.15	7125.95	+.64
22	5673.17	+.13	7090.43	+.86
23			7051.31	+.80
24			7009.41	+1.26

Table 12b. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 2$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		5 → 3 band (ν_o = 6758.22 cm^{-1}) obs.		
		(ν_o = 6758.14 cm^{-1}) calc.		
0			6791.95	+.06
1	6721.59	+.04	6822.61	-.14
2	6682.27	-.11	6850.86	+.17
3	6640.19	+.17	6875.78	+.13
4	6595.14	-.05	6897.65	+.05
5	6547.96	+.25		
6	6497.70	+.06	6932.18	-.15
7	6445.24	+.19	6945.12	+.07
8	6389.97	+.00		
9	6332.51	+.03	6961.22	+.16
10	6272.75	+.12	6964.38	+.11
11	6210.50	+.02	6964.38	+.06
12	6145.96	-.13	6961.22	+.10
13	6079.74	+.21		
14	6011.17	+.32	6945.12	+.13
15	5940.23	+.10	6932.29	+.25
16	5867.55	+.14	6915.99	+.18
17	5792.94	+.17	6896.70	+.40
18	5716.45	+.18	6874.06	+.56
19			6847.98	+.57
20			6818.48	+.45

Table 12b. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 2$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		6→4 band (ν_o = 6442.10 cm^{-1}) obs.		
		(ν_o = 6442.10 cm^{-1}) calc.		
0			6774.59	+.12
1	6406.89	-.05	6503.95	-.04
2	6369.07	+.03	6530.76	+.12
3	6328.33	-.10	6554.60	+.23
4	6285.18	+.00	6575.34	+.19
5	6239.30	-.02	6592.99	+.06
6	6190.92	+.00	6607.63	-.06
7	6139.78	-.25	6619.39	+.00
8	6086.85	-.15	6628.09	+.09
9	6031.23	+.24	6633.68	+.18
10	5972.91	-.04	6635.39	+.22
11	5912.82	+.17	6636.09	+.32
12	5850.44	+.30	6631.32	+.22
13	5785.79	+.32	6624.07	-.14
14	5718.85	+.13	6613.76	+.20
15			6600.33	+.38
16			6583.66	+.55
17			6563.77	+.74
18			6540.51	+.82

[a] D. E. Mann et al., J. Chem. Phys. 34, 420 (1961).

[b] Units in cm^{-1}.

Table 12c. Comparison of Observed and Calculated Line Positions of ^1F, $\Delta v = 3$ Sequence[a]

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		3→0 band (ν_0 = 11372.92 cm^{-1}) obs. (ν_0 = 11372.99 cm^{-1}) calc.		
0			11409.51	-.08
1	11331.81	-.07	11441.59	-.02
2	11286.18	-.12	11468.95	-.08
3	11236.24	-.07	11491.73	-.08
4	11181.94	.02	11509.79	-.10
5	11123.27	-.05	11523.19	-.08
6	11060.44	-.01	11531.82	-.09
7	10993.36	-.06	11535.66	-.12
8	10992.30	.00	11534.82	.06
9	10847.18	-.01	11529.10	-.08
10	10768.09	-.01	11518.63	-.05
11			11503.36	-.01
12	10598.45	-.02	11483.29	.03
13	10508.10	.03	11458.39	-.05
14	10414.07	-.01	11428.66	.04
15	10316.59	.06	11394.16	.05
16	10215.63	.06	11354.95	.11
17	10111.34	.08	11310.95	.15
18	10003.69	-.01	11262.18	.15
19	9892.97	.00	11208.82	.27
			11150.65	.27
			11087.88	.33

Table 12c. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 3$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		4→1 band (ν_0=10870.37 cm^{-1}) obs. (ν_0=10870.24 cm^{-1}) calc.		
0			10905.50	.10
1	10830.82	.15		
2	10786.88	.13	10962.44	.13
3	10738.63	.11	10984.11	.13
4	10686.14	.10	11001.21	.13
5	10629.48	.11	11013.71	.13
6	10568.68	.11	11021.58	.11
7	10503.82	.11	11024.81	.11
8	10434.92	.06	11023.35	.11
9	10362.17	.08	11017.23	.09
10	10285.57	.10	11006.40	.08
11	10205.17	.10	10990.91	.11
12	10121.08	.10	10970.69	.11
13	10033.33	.06	10945.75	.10
14	9942.03	.01	10916.18	.16

Table 12c. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 3$ Sequence[a] (Continued)

J	P(J) [b]	Δ (obs.-calc.)	R(J) [b]	Δ (obs-calc.)
		5→2 band (ν_0 = 10380.29 cm^{-1}) obs. (ν_0 = 10380.14 cm^{-1}) calc.		
0			10414.07	.18
1	10342.17	.09	10443.43	.15
2	10299.94	.19	10468.45	.17
3	10253.41	.19	10488.98	.14
4	10202.68	.16	10505.17	.23
5	10147.91	.18	10516.68	.15
6	10089.07	.17	10523.74	.15
7	10026.20	.10	10526.25	.15
8	9959.45	.07	10524.20	.16
9			10517.55	.15
10			10506.31	.16
11			10490.46	.17
12			10470.02	.21
13			10444.90	.19
14			10415.24	.24
15			10380.98	.32
16			10342.17	.45
17			10298.69	.51
18			10250.65	.60
19			10198.07	.71
20			10140.82	.75

Table 12c. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 3$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		6 → 3 band (calc $\nu_0 = 9900.93$ cm^{-1})		
1			9961.49	.10
2			9985.21	.04
3			10004.62	.02
4			10019.75	.11
5			10030.35	.08
6			10036.57	.12
7			10038.31	.15
8			10035.54	.16
9			10028.28	.18
10			10016.49	.20
11			10000.19	.25
12			9979.33	.28
13			9953.95	.34

[a] D. E. Mann et al., J. Chem. Phys. 34, 420 (1961).
[b] In units cm^{-1}.

Table 12d. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 4$ Sequence[a]

J	P(J) [b]	Δ (obs.-calc.)	R(J) [b]	Δ (obs.-calc.)
		4 → 0 band (ν_0 = 14831.75 cm^{-1}) obs. (ν_0 = 14831.82 cm^{-1}) calc.		
0			14866.92	-.06
1	14790.63	-.08	14896.08	-.06
2	14743.60	-.09	14919.19	-.07
3	14690.77	-.06	14936.22	-.08
4	14632.12	-.06	14947.14	-.09
5	14567.75	-.06	14951.94	-.09
6	14497.72	-.06	14950.62	-.06
7	14422.12	-.06	14943.11	-.06
8	14341.00	-.08	14929.42	-.05
9	14254.50	-.05	14909.57	-.03
10	14162.65	-.05	14883.54	-.01
11	14065.56	-.03	14851.33	.01
12	13963.28	-.05	14812.96	.03
13	13856.00	-.02	14768.41	.01
14	13743.74	.00	14717.73	-.01
15	13626.61	.02	14661.06	.09
16	13504.71	-.02	14598.29	.15
17	13378.16	.04	14529.47	.21
18	13247.08	.08	14454.60	.23
19	13111.48	.05	14373.87	.35
20			14287.25	.50
21			14194.67	.58

Table 12d. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 4$ Sequence[a] (Continued)

J	P(J) [b]	Δ (obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		5 → 1 band (ν_0 = 14169.64 cm^{-1}) obs. (ν_0 = 14169.55 cm^{-1}) calc.		
0			14203.36	.06
1	14130.06	.08	14231.26	.07
2	14084.72	.07	14253.26	.08
3	14033.68	.07	14269.32	.09
4	13977.01	.10	14279.40	.08
5	13914.70	.08	14283.50	.09
6	13846.92	.12	14281.58	.09
7	13773.62	.09	14273.62	.08
8	13694.98	.10	14259.63	.08
9	13611.01	.08	14239.58	.07
10	13521.83	.07	14213.48	.06
11	13427.52	.07	14181.38	.09
12	13328.13	.05	14143.22	.10
13	13223.84	.08	14099.06	.15
14	13114.61	.05	14048.89	.19
15	13000.68	.10		
16	12882.08	.16	13930.63	.31
17	12758.88	.21	13862.61	.42
18	12631.18	.25	13788.69	.53
19	12499.07	.27	13708.88	.64
20	12362.75	.38	13623.26	.78
21	12222.22	.47	13531.86	.96
22	12077.60	.57		
23			13331.91	1.44

Table 12d. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 4$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		6→2 band (ν_0 = 13523.02 cm^{-1}) obs. (ν_0 = 13522.93 cm^{-1}) calc.		
0			13555.38	.09
1	13484.93	.06	13582.02	.10
2	13441.29	.13	13602.88	.12
3	13391.95	.10	13617.94	.15
4	13337.09	.08	13627.12	.14
5	13276.78	.10	13630.41	.12
6	13211.04	.13	13627.84	.13
7	13139.96	.10	13619.36	.15
8	13063.60	.11	13604.94	.15
9	12982.04	.12	13584.61	.17
10	12895.36	.13	13558.34	.20
11	12803.66	.18	13526.14	.23
12	12706.96	.19	13488.02	.28
13	12605.40	.22	13444.00	.36
14	12499.06	.28	13394.00	.38
15	12388.00	.32	13338.14	.44
16	12272.30	.35		
17	12152.09	.40	13208.86	.65
18	12027.45	.46	13135.42	.73
19	11898.47	.54	13056.29	.93
20	11765.24	.63	12971.30	1.03
21			12880.63	1.27

Table 12d. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 4$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		7→3 band (υ_0 = 12889.53 cm^{-1}) obs. (υ_0 = 12889.46 cm^{-1}) calc.		
0			12920.48	.02
1			12945.89	.08
2	12810.81	.09	12965.60	.11
3	12763.20	.12	12979.56	.10
4	12710.11	.12	12987.79	.11
5	12651.64	.12	12990.26	.14
6	12587.85	.13	12986.95	.18
7	12518.84	.18	12977.82	.21
8	12444.61	.20	12962.85	.24
9	12365.22	.19	12942.05	.28
10	12280.85	.25	12915.39	.31
11	12191.48	.29	12882.91	.37
12	12097.21	.33	12844.60	.46
13	11998.15	.40	12800.40	.51
14	11894.32	.45	12750.37	.57
15	11785.81	.49	12694.48	.61
16	11672.69	.45	12632.79	.68
17			12565.32	.78
18			12492.05	.77
19			12413.02	.97

Table 12d. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 4$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		8 → 4 band (ν_0 = 12266.46 cm^{-1}) obs. (ν_0 = 12266.36 cm^{-1}) calc.		
1			12320.17	.08
2	12190.67	.09		
3	12144.63	.11	12351.55	.14
4	12093.24	.14	12358.73	.14
5	12036.52	.16	12360.25	.17
6	11974.56	.18	12356.05	.21
7	11907.37	.19		
8	11835.12	.26	12330.39	.25
9	11757.72	.25	12308.89	.26
10	11675.37	.28	12281.72	.38
11	11588.07	.29	12248.67	.41
12			12209.85	.46
13			12165.18	.46
14			12114.74	.48
15			12058.45	.45
16			11996.37	.41
		9 → 5 band (ν_0 = 11650.72 cm^{-1}) obs. (ν_0 = 11650.58 cm^{-1}) calc.		
3			11731.11	.54
4			11737.53	.90
6			11734.03	2.23
7			11724.06	3.30
8			11708.61	4.39
9			11687.75	5.90

[a] D.E. Mann et al., J. Chem. Phys. 34, 420 (1961).
[b] In units of cm^{-1}.

Table 12e. Comparison of Observed and Calculated Line Position of HF, $\Delta v = 5$ Sequence[a]

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		5 → 0 band (ν_0=18131.10 cm^{-1}) obs. (ν_0=18131.13 cm^{-1}) calc.		
1			18191.17	-.06
2				
3				
4	17923.09	.04	18225.37	-.09
5	17853.10	.04		
6	17776.05	.04		
7	17692.02	.02	18192.02	-.01
8	17601.10	.00	18165.72	-.04
9	17503.37	-.03	18131.90	-.07
10			18090.75	
11				
12	17170.41	-.03		
13	17046.51	.00	17921.89	.23
14	16916.31	-.03		

Table 12e. Comparison of Observed and Calculated Line Position of HF, $\Delta v = 5$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		6 → 1 band (ν_0=17312.42 cm^{-1}) obs. (ν_0=17312.34 cm^{-1}) calc.		
1			17370.01	.19
2	172[illegible].07	-.02	17387.82	.16
3	17172.22	.02	17398.35	.17
4	17111.40	-.01	17401.51	.15
5	17043.64	.07	17397.36	.19
6	16968.88	-.04	17385.77	.16
7	16887.32	-.02	17366.83	.18
8			17340.49	.19
9	16704.21	.17	17306.76	.21
10	16602.62	.11	17265.54	.12
11	16494.64	.15		
12	16380.29	.21	17161.24	.20
13	16259.62	.24	17098.15	.31
14	16132.70	.21	17027.64	.32
15	15999.82	.31	16949.94	.42
16	15860.91	.37	16865.09	.61

Table 12e. Comparison of Observed and Calculated Line Position of HF, $\Delta v = 5$ Sequence[a] (Continued)

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
		7 → 2 Band (ν_0=16511.60 cm^{-1}) obs. (ν_0=16511.46 cm^{-1}) calc.		
2	16428.46	.14	16583.25	.16
3	16376.39	.11	16592.80	.24
4	16317.46	.13	16595.22	.20
5	16251.72	.18	16590.32	.17
6	16179.14	.16	16578.23	.20
7	16099.87	.16	16558.87	.21
8	16014.04	.22	16532.23	.21
9	15921.59	.22	16498.39	.28
10	15822.70	.25	16457.23	.29
11	15717.42	.26	16408.84	.34
12	15605.96	.39	16353.23	.40
13	15488.17	.40	16290.40	.48
14	15364.28	.41	16220.29	.49
15	15234.48	.52	16143.16	.67
16	15098.61	.48	16058.77	.75
17	14957.10	.61	15967.21	.74
18	14809.71	.59	15868.55	.81

Table 12e. Comparison of Observed and Calculated Line Position of HF, $\Delta v = 5$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		8 → 3 band (ν_o = 15725.33 cm^{-1}) obs.		
		(ν_o = 15725.19 cm^{-1}) calc.		
0			15754.93	.10
1	15688.82	.22	15777.58	.10
2	15645.29	.19	15793.21	.12
3	15594.94	.20	15801.80	.16
4	15537.82	.23	15803.27	.18
5	15473.89	.19	15797.62	.20
6	15403.30	.17	15784.85	.24
7	15326.16	.20	15764.90	.25
8	15242.59	.35	15737.84	.32
9	15152.34	.27	15703.54	.31
10	15055.81	.30	15662.16	.40
11	14953.06	.41	15613.61	.48
12			15557.84	.50
13			15494.90	.50
14	14607.48	.41	15424.76	.44
15	14480.28	.44	15347.63	.51
16			15263.33	.51
17			15171.85	.41
18			15073.27	.26
20			14855.06	-.03
21			14735.37	-.29

Table 12e. Comparison of Observed and Calculated Line Position of HF, $\Delta v = 5$ Sequence[a] (Continued)

J	P(J) [b]	Δ(obs.-calc.)	R(J) [b]	Δ(obs.-calc.)
		9 → 4 band (ν_o = 14949.94 cm^{-1} obs.		
		(ν_o = 14949.89 cm^{-1}) calc.		
0			14978.30	.12
1			14999.62	.06
2	14872.74	-.01	15014.13	.14
3	14823.98	-.02	15021.60	.16
4			15021.99	.11
5			15015.36	.08
6	14637.75	-.10	15001.78	.16
7	14562.43	.05	14981.05	.17
8	14480.73	.10		
9			14918.28	.14
10			14876.12	.01
11			14826.94	-.04
14			14636.67	.32
15			14558.94	.55

[a] D. E. Mann et al., J. Chem. Phys. 34, 420 (1961).

[b] In units of cm^{-1}.

Table 13a. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 1$ Sequence, $1 \rightarrow 0$ Band[a]

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
0			4000.99	-.16
1	3920.29	-.18	4038.97	-.16
2	2877.70	-.16	4075.30	-.15
3	3833.65	-.16	4109.95	-.13
4	3788.23	-.14	4142.83	-.16
5	3741.48	-.12	4173.98	-.13
6	3693.41	-.13	4203.30	-.12
7	3644.16	-.10	4230.75	-.12
8	3593.71	-.10	4256.32	-.10
9			4279.96	-.09
10	3489.56	-.08	4301.64	-.07
11	3435.95	-.09	4321.33	-.05
12	3381.42	-.08	4339.00	-.03
13	3326.02	-.06	4354.59	-.04
14	3269.78	-.05	4368.14	-.03
15	3212.78	-.05		

[a]D. U. Webb and K. Narahari Rao, J. Molecular Spectroscopy, 28, 121 (1968).

[b]In units of cm^{-1}.

Table 13b. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 2$ Sequence, $2 \rightarrow 0$ Band[a]

J	P(J)[b]	Δ(obs.-calc.)	R(J)[b]	Δ(obs.-calc.)
0			7788.87	-.19
1	7709.70	-.18	7823.83	-.19
2	7665.60	-.17	7855.65	-.19
3	7618.52	-.19	7884.29	-.18
4			7909.72	-.15
5	7517.81	-.17	7931.85	-.16
6	7460.27	-.15	7950.72	-.14
7	7402.02	-.14	7966.23	-.14
8			7978.25	-.29
9	7277.64	-.12		

[a]D. U. Webb and K. Narahari Rao, J. Molecular Spectroscopy, 28, 121 (1968).

[b]In units of cm^{-1}.

Table 14. Comparison of Observed and Calculated Line Positions of HF, $\Delta v = 1$ Sequence[a]

	1 → 0 band		2 → 1 band		3 → 2 band	
J	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)
2			3708.86	+.04	3544.51	+.05
3			3666.38	-.02	3503.80	+.20
4			3622.71	+.09	3461.54	+.11
5			3577.47	-.07	3418.16	+.17
6	3693.50	-.04	3531.31	+.10	3373.46	+.12
7	3644.16	-.10	3483.63	-.06	3327.73	+.22
8	3593.80	-.01	3435.17	+.13	3280.64	+.06
9	3542.20	-.05	3385.34	+.04		
10	3489.59	-.05	3334.55	+.02		
11	3436.12	+.08	3282.86	+.06		
12	3381.50	+.00	3230.18	+.03		
13	3326.21	+.13	3176.60	+.03		
14	3269.90	+.07	3122.14	-.18		
15	3212.80	-.03	3067.22.	-.04		

[a] T. F. Deutsch, Appl. Phys. Letters 10, 234 (1967).

[b] In units of cm^{-1}.

Table 15. Comparison of Observed and Calculated Line Positions of DF, $\Delta v = 1$ Sequence[a]

	1→0 band		2→1 band		3→2 band		4→3 band	
J	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)
3			2750.05	-.14	2662.17	-.13		
4			2727.38	-.02	2640.04	-.09		
5			2703.98	-.11	2617.41	-.02	2532.50	+.00
6			2680.28	+.02	2594.23	-.01	2509.86	-.06
7			2655.97	+.03	2570.51	-.05	2486.83	-.04
8			2631.09	-.05	2546.37	-.04		
9			2605.87	+.00	2521.81	.00		
10			2580.16	+.00	2496.61	-.15		
11			2553.97	-.04	2471.34	+.06		
12	2611.10	-.10	2527.47	+.03	2445.29	-.11		
13			2500.32	-.15				
14					2392.46	+.01		
15	2527.06	+.07						
16	2498.02	-.15	2417.27					

[a] T. F. Deutsch, Appl. Phys. Letters, 10, 234 (1967).

[b] In units of cm^{-1}.

Table 16. Comparison of Observed and Calculated Line Positions of DF, $\Delta v = 1$ Sequence[a]

	1→0 band		2→1 band		3→2 band	
J	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)	P(J)[b]	Δ(obs.-calc.)
1						
2						
3			2750.05	-.14		
4			2727.40	+.00		
5			2703.95	-.14		
6	2767.94	-0.17	2680.25	-.01	2594.24	+.00
7	2743.03	-0.10	2655.97	+.03	2570.50	-.06
8	2717.54	-.012	2631.09	-.05	2546.34	-.07
9	2691.43	-.029	2605.86	-.01	2521.81	+.00
10	2665.25	-0.07	2580.18	+.02	2496.21	+.00
11	2638.38	-0.09	2553.95	-.06	2471.33	-.05
12	2611.10	-0.10				
13	2583.45	+0.07				
14	2555.45	+0.01				
15						

[a] D. J. Spenser, G. C. Denault, and H. H. Takimoto, Atmospheric Gas Absorption DF Laser Wavelengths, TR 0074(4240-10)-7, The Aerospace Corporation (January 1974).

[b] In units of cm^{-1}.

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