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The ν_1 and ν_3 Bands of $H_2{}^{17}O$ and $H_2{}^{18}O$: Line Positions and Strengths

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High-resolution spectra of $H_2{}^{17}O$ and $H_2{}^{18}O$ were recorded with a Fourier-transform spectrometer covering transitions in the (100)–(000) and (001)–(000) bands. The measured line positions were used to determine high accuracy values of rotational energy levels in the (100) and (001) vibrational states for the two isotopic species. Measurements of the line strengths were fitted to a model in which 19 transition moment parameters were determined for *B*-type bands and 8 parameters for the *A*-type bands for each molecule. The fitting technique did not consider interactions between the (020), (100), and (001) vibrational states. The experimental results provide a more accurate representation of the line positions and strengths than those presently available for these bands.

I. INTRODUCTION

This is the last of three papers involving high resolution measurements and analysis of the three interacting vibrational states (020), (100), and (001) of H_2O. The first paper (*1*) covered observations of the (020)–(010) and (020)–(000) bands of $H_2{}^{16}O$, $H_2{}^{17}O$, and $H_2{}^{18}O$. The second report (*2*) presented further measurements in the (100)–(010), (001)–(010), (100)–(000), and (001)–(000) bands of $H_2{}^{16}O$. The present study includes high accuracy data for line positions and strengths of vibration–rotation transitions in the (100)–(000) and (001)–(000) bands of $H_2{}^{17}O$ and $H_2{}^{18}O$.

Several papers (*3–13*) have been published which include measurements and/or calculations of line positions and strengths in the ν_1 and ν_3 bands for one or both of the isotopic species noted above. The extensive listing of computed values given by Flaud *et al.* (*12*) covering $H_2{}^{16}O$, $H_2{}^{17}O$, and $H_2{}^{18}O$ transitions between 0 and 4350 cm^{-1} was based upon measurements made prior to 1981. The values given in that compilation for the (020)–(000), (100)–(000), and (001)–(000) bands of $H_2{}^{17}O$ and $H_2{}^{18}O$ were taken from reports by Camy-Peyret *et al.* (*9*) ($H_2{}^{17}O$) and Flaud *et al.* (*10*) ($H_2{}^{18}O$) which, further, were derived from an analysis of unreported measurements, obtained, for the most part, with a grating spectrometer with a spectral resolution of 0.03–0.05 cm^{-1}. These same values (*9, 10*) of computed line positions and strengths were incorporated in the 1986 edition of the HITRAN database (*13*) and they are also included in the 1993 compilation (*14*). The results obtained in the present study provide a more accurate representation of line positions and strengths for the bands and isotopic species noted above than those given in Refs. (*12, 13*).

The present study (as well as the previous ones (*1, 2*)) does not include a perturbation treatment of the data. Instead, the experimental linestrengths for each band of each molecule were analyzed using a one-band fit and the computed results represent unperturbed values.

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II. EXPERIMENTAL DETAILS

The experimental details are the same as those discussed in Ref. (*1*) related to the $2\nu_2$ bands of $H_2{}^{17}O$ and $H_2{}^{18}O$. The experimental conditions and extent of the measurements used in the present study are given in Table I. The table lists the spectral range, unapodized spectral resolution, absorption path lengths, total sample pressures and percent abundances of each isotopic species (including $H_2{}^{16}O$) for each run. The lower portion of the table lists the wavenumber range and number of lines measured for each band and molecule. The first two runs given at the top of the table were observations of normal samples of water vapor contained in a 6-m base length multiple transversal absorption cell, whereas the remainder of the runs were obtained with oxygen-enriched H_2O samples contained in a 2.39-m-long absorption cell. The $H_2{}^{17}O$ and $H_2{}^{18}O$ samples were purchased from Merck and Company, Inc.; the stated isotopic purities were 98.1% $H_2{}^{18}O$ for one sample and 60.4% $H_2{}^{17}O$ for the other. Due to slight contamination from various H_2O samples used prior to a given run of o-enriched H_2O, the values of the isotopic abundances were not always the same as the stated values shown for several of the runs listed in the table. The method used to determine the correct relative amounts in the samples was described in Ref. (*15*). Also in that article is a description of the method used to transfer the evaporated gas from the glass tubes (containing the $H_2{}^{17}O$ and $H_2{}^{18}O$ liquid samples) to the absorption cell.

The spectra were obtained with a Fourier transform spectrometer (FTS) located at the McMath solar telescope facility at the Kitt Peak National Observatory. All data were obtained with the sample temperatures near or at room temperature (296 K), with sample temperatures inferred from readings of one or more thermistor probes in thermal contact with the absorption cell walls. Total sample pressures were measured with a Baratron gauge. The IR source was a 1000-W iodine lamp enclosed in a quartz envelope and the radiation traveled through a short open space and the absorption cell before entering the vacuum tank which enclosed the FTS. The IR detector was

TABLE I

Experimental Conditions and Extent of Measurements

spectral range (cm^{-1})	unapodized resolution (cm^{-1})	path length (m)	sample pressure (Torr)	percent abundance of isotopic species $H_2{}^{16}O$	$H_2{}^{17}O$	$H_2{}^{18}O$
2622-4457	0.011	193.	3.98	99.6	0.04	0.2
2622-4506	0.011	433.	4.01	99.6	0.04	0.2
2954-4124	0.011	2.39	0.30	25	0.47	73.5
2922-4235	0.011	2.39	1.08	17	0.52	81.3
2890-4254	0.011	2.39	5.30	6	0.58	92.2
2881-4298	0.011	2.39	13.8	4	0.60	94.0
2967-4131	0.011	2.39	0.52	15	52.6	31.7
2948-4196	0.011	2.39	1.07	15	54.1	30.5
2887-4292	0.011	2.39	5.06	14	56.8	28.1
2881-4298	0.011	2.39	13.8	14	57.7	26.6

Extent of measurements

molecule	band	range(cm^{-1})	number of lines
$H_2{}^{17}O$	(100)-(000)	3201.644 - 4126.271	382
$H_2{}^{17}O$	(001)-(000)	3163.400 - 4298.238	535
$H_2{}^{18}O$	(100)-(000)	3001.891 - 4193.427	469
$H_2{}^{18}O$	(001)-(000)	3160.676 - 4340.151	598

TABLE II

Rotational Energy Levels (cm^{-1}) of the (001) and (100) Vibrational States of $H_2{}^{17}O$
(Estimated Uncertainties Given in $cm^{-1} \times 10^5$)

J	K_a	K_c	(001)		(100)		J	K_a	K_c	(001)		(100)	
0	0	0	3748.31807	10	3653.14226	10	8	6	3	5108.92006	10	5029.00786	33
1	0	1	3771.86095	15	3676.52400	3	8	6	2	5108.96920	45	5029.02781	40
1	1	1	4783.90239	5	3689.17431	18	8	7	2	5274.61150	150	5200.60222	50
1	1	0	3789.20217	10	3694.39500	10	8	7	1	5274.61150	150	5200.60222	50
2	0	2	3817.51409	2	3721.94883	7	8	8	1	5458.29876	30	5391.53415	60
2	1	2	3825.71633	4	3730.71710	4	8	8	0	5458.29876	30	5391.53415	60
2	1	1	3841.58152	7	3746.35251	10	9	0	9	4651.82743	10	4553.74226	40
2	2	1	3877.43858	3	3784.01921	8	9	1	9	4651.84839	20	4553.78478	10
2	2	0	3878.83895	6	3785.31937	6	9	1	8	4807.16175	6	4709.79165	10
3	0	3	3882.99302	5	3787.24098	7	9	2	8	4807.87035	5	4710.85178	40
3	1	3	3887.62564	6	3792.25525	7	9	2	7	4930.17007	4	4831.84526	35
3	1	2	3919.00154	3	3823.23808	10	9	3	7	4939.07021	12	4843.89790	170
3	2	2	3948.31771	4	3854.14435	10	9	3	6	5012.97965	25	4912.72631	9
3	2	1	3954.65561	4	3860.13522	4	9	4	6	5056.67115	9	4963.94255	250
3	3	1	4020.95113	5	3929.61786	6	9	4	5	5077.72631	15	4987.72949	9
3	3	0	4021.19496	12	3929.74821	4	9	5	5	5181.71327	7	5098.94381	8
4	0	4	3966.59425	4	3870.67749	4	9	5	4	5184.93775	6	5098.86644	35
4	1	4	3969.27935	7	3873.13462	8	9	6	4	5326.18185	25	5245.62708	100
4	1	3	4019.82271	10	3923.54217	4	9	6	3	5326.39935	25	5245.71304	10
4	2	3	4041.64371	7	3946.48766	11	9	7	3	5492.07087	25	5417.36993	300
4	2	2	4057.86437	7	3961.82973	6	9	7	2	5492.07725	350	5417.37311	300
4	3	2	4116.33342	10	4025.20685	12	9	8	2	5676.53565	40		
4	3	1	4117.78566	6	4026.21155	20	9	8	1	5676.53565	40		
4	4	1	4214.56639	5	4127.72113	10	10	0	10	4842.72623	7	4743.95860	40
4	4	0	4214.60216	5	4127.59249	12	10	1	10	4842.73229	15	4743.98208	6
5	0	5	4067.86422	6	3971.71433	4	10	1	9	5016.94317	15	4919.10424	300
5	1	5	4068.62867	2	3972.80625	6	10	2	9	5017.44734	25	4919.62375	40
5	1	4	4141.69572	6	4045.07179	6	10	2	8	5160.82672	10	5062.59418	50
5	2	4	4157.26672	6	4060.15374	10	10	3	8	5165.50781	12	5069.29435	300
5	2	3	4187.67204	8	4091.26670	3	10	3	7	5263.93195	10		
5	3	3	4235.64213	5	4144.59505	5	10	4	7	5294.06197	12		
5	3	2	4240.12675	3	4147.98674	6	10	4	6	5345.28925	10	5239.90626	180
5	4	2	4335.03628	3	4249.82533	6	10	5	6	5422.67925	25	5326.23380	15
5	4	1	4335.33740	5	4248.77093	7	10	5	5	5430.72622	25	5342.67699	40
5	5	1	4457.02193	40	4373.40091	40	10	6	5	5567.32600	300	5486.07889	40
5	5	0	4457.02615	8	4373.40171	10	10	6	4	5568.08645	30	5486.38054	300
6	0	6	4186.92222	7	4090.43266	10	10	7	4			5657.65633	300
6	1	6	4187.25228	3	4090.89232	4	10	7	3	5733.23417	40		
6	1	5	4282.22240	5	4185.57028	10	11	0	11	5051.52579	40	4952.01778	40
6	2	5	4288.33256	7	4194.19610	10	11	1	11	5051.52796	20	4952.04885	40
6	2	4	4342.27665	7	4244.82865	10	11	1	10	5244.37621	15		
6	3	4	4378.52498	4	4287.11428	5	11	2	10	5244.50863	10		
6	3	3	4399.26524	4	4302.16382	7	11	2	9	5407.94126	25		
6	4	3	4479.84184	7	4387.17206	8	11	3	9	5410.27657	15		
6	4	2	4481.21259	6	4394.56753	15	11	3	8	5533.33257	40		
6	5	2	4601.83847	7	4518.07989	7	11	4	8	5552.33028	50		
6	5	1	4601.88843	10	4518.08801	30	11	4	7	5621.60364	15	5517.96607	300
6	6	1	4746.49200	80	4667.51172	15	11	5	7	5686.56764	30		
6	6	0	4746.49250	60	4667.51140	30	11	5	6	5703.46118	40	5612.89671	40
7	0	7	4323.90776	3	4226.97829	6	11	6	6	5832.12123	40		
7	1	7	4324.04026	8	4227.16496	12	11	6	5	5834.32472	50		
7	1	6	4440.03444	5	4343.17974	10	12	0	12	5278.16485	40	5178.40101	300
7	2	6	4443.34298	3	4347.74861	25	12	1	12	5278.16565	80	5177.05495	300
7	2	5	4519.27514	10	4421.15734	10	12	1	11	5489.47765	40		
7	3	5	4544.28458	7	4451.85665	25	12	2	11	5489.53304	40		
7	3	4	4577.70564	10	4479.52923	9	12	2	10	5671.82977	40		
7	4	4	4668.74984	7	4556.90685	15	12	3	9	5819.20303	40		
7	4	3	4653.13608	4	4565.81927	8	12	4	9	5830.26057	300		
7	5	3	4770.96047	5	4687.03830	20	12	4	8	5923.03321	200		
7	5	2	4771.23437	6	4687.07805	10	12	5	8	5972.54452	300		
7	6	2	4915.66732	8	4836.28431	40	12	5	7	6002.73086	50		
7	6	1	4915.67534	20	4836.28742	20	13	0	13	5522.58392	20		
7	7	1	5080.94915	15	5007.49515	20	13	1	13	5522.58392	20		
7	7	0	5080.94915	15	5007.49515	20	13	1	12	5752.21200	500		
8	0	8	4478.87693	5	4381.45920	12	13	2	12	5752.23843	40		
8	1	8	4478.92941	25	4381.49044	10	13	2	11	5952.75250	200		
8	1	7	4614.93175	7	4517.89563	18	13	3	11	5953.27833	50		
8	2	7	4616.50215	10	4520.12709	40	13	3	10	6120.76700	300		
8	2	6	4715.97970	4	4617.60571	40	13	4	10	6126.80902	50		
8	3	6	4731.63155	7	4637.79153	25	14	0	14	5784.82645	40		
8	3	5	4783.25092	15	4683.94527	10	14	1	14	5784.77631	40		
8	4	5	4841.26495	10	4749.24034	12	14	1	13	6032.58269	30		
8	4	4	4852.05825	6	4763.10323	15	14	2	12	6250.85811	300		
8	5	4	4964.32685	30	4880.43947	20	15	0	15	6064.38540	50		
8	5	3	4965.38853	6	4880.55231	15	15	1	15	6064.38540	50		

TABLE III

Rotational Energy Levels (cm^{-1}) of the (001) and (100) Vibrational States of $H_2{}^{18}O$
(Estimated Uncertainties Given in $cm^{-1} \times 10^5$)

J	K_a	K_c	(001)		(100)		J	K_a	K_c	(001)		(100)	
0	0	0	3741.56678	10	3649.68540	10	9	1	9	4643.32979	33	4548.48215	15
1	0	1	3765.09081	6	3673.05009	3	9	1	8	4798.43334	5	4704.30162	25
1	1	1	3776.98503	10	3685.53272	10	9	2	8	4799.11091	6	4705.29615	30
1	1	0	3782.30160	7	3690.77404	10	9	2	7	4921.61288	5	4826.63156	80
2	0	2	3810.68419	8	3718.41745	10	9	3	7	4930.22535	7	4838.09525	40
2	1	2	3818.74415	4	3727.02111	4	9	3	6	5004.71998	20	4907.84471	9
2	1	1	3834.65926	6	3742.71920	3	9	4	6	5047.41461	6	4957.34602	45
2	2	1	3870.07803	5	3779.88620	3	9	4	5	5069.45685	30	4981.58277	10
2	2	0	3871.49988	5	3781.20940	25	9	5	5	5171.29735	10	5090.66888	10
3	0	3	3876.04052	9	3783.58525	10	9	5	4	5174.69051	15	5091.06685	20
3	1	3	3880.56321	22	3788.46519	5	9	6	4	5314.25326	10	5236.12756	40
3	1	2	3912.02834	8	3819.56442	7	9	6	3	5314.48513	7	5236.23179	15
3	2	2	3940.91843	6	3849.96105	13	9	7	3	5478.42080	10	5406.04200	300
3	2	1	3947.32976	6	3856.04393	3	9	7	2	5478.42970	30	5406.04826	40
3	3	1	4012.86538	15	3924.67194	7	9	8	2	5661.01620	30		
3	3	0	4013.11596	9	3924.79604	6	9	8	1	5661.01620	30		
4	0	4	3959.46345	7	3866.83471	4	10	0	10	4833.83222	15	4738.26494	10
4	1	4	3962.36785	4	3869.20412	6	10	1	10	4833.83755	30	4738.28690	35
4	1	3	4012.74105	9	3919.77188	7	10	1	9	5007.78481	9	4913.16279	30
4	2	3	4034.20915	10	3942.21751	9	10	2	9	5008.10855	9	4913.64628	40
4	2	2	4050.54138	8	3957.48006	7	10	2	8	5151.72777	15	5056.79122	10
4	3	2	4108.42559	15	4020.22721	4	10	3	8	5156.21738	6	5063.10640	60
4	3	1	4109.97179	6	4021.20102	8	10	3	7	5255.30659	7	5157.97810	50
4	4	1	4205.47841	10	4121.38933	7	10	4	7	5284.56948	7	5193.48290	60
4	4	0	4205.51568	15	4121.31215	20	10	4	6	5336.47107	25	5234.08295	50
5	0	5	4060.51832	8	3967.64363	8	10	5	6	5412.20825	25	5318.47283	15
5	1	5	4061.28012	3	3968.68738	15	10	5	5	5420.65414	3	5335.00275	60
5	1	4	4134.41396	5	4041.10791	6	10	6	5	5555.36961	10	5476.45376	30
5	2	4	4150.24588	5	4055.74723	5	10	6	4	5556.17899	15		
5	2	3	4180.31114	5	4087.16631	7	10	7	4	5719.49331	15	5646.20088	300
5	3	3	4227.83839	5	4139.56169	10	10	7	3	5719.53621	15		
5	3	2	4232.81215	25	4142.46868	12	10	8	3	5902.68520	20		
5	4	2	4325.95661	5	4242.98535	15	10	8	2	5902.68542	20		
5	4	1	4326.27067	5	4242.28762	11	11	0	11	5042.22019	40	4945.89326	10
5	5	1	4446.67449	12	4365.88772	15	11	1	11	5042.22252	15	4945.92012	40
5	5	0	4446.67968	10	4365.88897	15	11	1	10	5234.75974	6	5139.54865	25
6	0	6	4179.33103	4	4086.10335	8	11	2	10	5234.88475	11	5139.83861	40
6	1	6	4179.65094	4	4086.53874	10	11	2	9	5398.28271	10	5303.23145	40
6	1	5	4274.64406	6	4181.20421	25	11	3	9	5400.50663	8		
6	2	5	4280.84742	4	4189.59377	11	11	3	8	5524.15909	20	5426.86487	300
6	2	4	4334.80255	8	4240.67336	9	11	4	8	5542.47664	4		
6	3	4	4370.68155	7	4281.98749	9	11	4	7	5612.52199	40	5512.20890	300
6	3	3	4391.65303	7	4297.00422	9	11	5	7	5675.98316	10	5585.07229	40
6	4	3	4470.76908	6	4380.87731	5	11	5	6	5693.65517	40	5605.48287	40
6	4	2	4472.19937	5	4387.91083	7	11	6	6	5820.12753	35	5740.54381	40
6	5	2	4591.47669	10	4510.45231	10	11	6	5	5822.47291	40	5741.58776	50
6	5	1	4591.52928	20	4510.46651	10	11	7	5	5984.06926	80		
6	6	1	4734.64852	40	4658.34718	25	11	7	4	5984.24135	150		
6	6	0	4734.64955	40	4658.34772	25	12	0	12	5268.41380	80	5171.61187	40
7	0	7	4316.04093	10	4222.35902	8	12	1	12	5268.43030	80	5169.77109	40
7	1	7	4316.16787	8	4222.53453	20	12	1	11	5479.37313	20		
7	1	6	4432.09857	6	4338.51981	10	12	2	11	5479.42422	55	5384.10390	50
7	2	6	4435.32663	5	4342.88788	5	12	2	10	5661.60382	15		
7	2	5	4511.57291	5	4416.80386	10	12	3	10	5662.67037	50		
7	3	5	4536.21815	22	4446.57895	25	12	3	9	5809.35561	15		
7	3	4	4569.75867	3	4476.72438	25	12	4	9	5819.93673	50		
7	4	4	4639.66837	5	4550.18235	25	12	4	8	5913.69227	15		
7	4	3	4664.24533	7	4558.86959	20	12	5	8	5961.76223	40		
7	5	3	4760.58544	11	4679.27672	35	12	5	7	5993.24163	15		
7	5	2	4760.87461	5	4679.35281	20	12	6	7	6108.12702	100	6028.51890	50
7	6	2	4903.79514	20	4827.01377	15	12	6	6	6113.93560	40		
7	6	1	4903.80311	30	4827.01721	10	12	7	5	6272.51536	200		
7	7	1	5067.39246	40	4996.41290	100	13	0	13	5512.35310	50	5414.05971	80
7	7	0	5067.39246	40	4996.41290	100	13	1	13	5512.35340	40	5414.05971	80
8	0	8	4470.70141	16	4376.49563	20	13	1	12	5741.59870	80		
8	1	8	4470.75185	30	4376.54335	4	13	2	12	5741.61135	40		
8	1	7	4606.60984	7	4512.83595	15	13	2	11	5941.94388	20		
8	2	7	4608.12213	20	4514.94633	15	13	3	11	5942.43866	40		
8	2	6	4707.90798	7	4612.89440	10	13	3	10	6110.19355	80		
8	3	6	4723.20405	15	4632.29088	15	13	4	10	6115.93416	40		
8	3	5	4775.18847	4	4679.18888	15	13	4	9	6235.07799	300		
8	4	5	4832.13416	8	4742.69215	15	13	5	9	6268.56517	40		
8	4	4	4843.39937	10	4756.42115	10	14	0	14	5774.07242	15		
8	5	4	4953.93685	10	4872.49703	8	14	1	14	5774.02957	10		
8	5	3	4955.05648	9	4872.75363	15	14	1	13	6021.40190	40		
8	6	3	5097.01901	10	5019.62548	10	14	2	13	6021.37622	40		
8	6	2	5097.07101	30	5019.64845	20	14	2	12	6239.44273	20		
8	7	2	5261.00390	50	5189.40106	40	15	0	15	6053.09666	110		
8	7	1	5261.01026	40	5189.40236	120	15	1	15	6053.09666	110		
8	8	1	5442.82656	15	5378.26560	60	15	2	14	6317.92450	50		
8	8	0	5442.82656	15	5378.26560	60	16	0	16	6349.80428	40		
9	0	9	4643.31014	55	4548.44168	8	16	1	16	6349.80428	40		

TABLE IV

Dipole Moment Expansion Coefficients Derived from Least-Squares Fits of $H_2{}^{17}O$ and $H_2{}^{18}O$ Measured Lines Strengths in the (100)-(000) and (001)-(000) Bands (Values in Debyes—Results Derived without Fermi and/or Coriolis Interactions Included in the Analyses)

	(100)-(000) band					
	$H_2{}^{17}O$			$H_2{}^{18}O$		
j	this work 3200-3600 cm^{-1}	this work 3601-4130 cm^{-1}	Camy-Peyret et al.[a]	this work 3117-3500 cm^{-1}	this work 3501-4153 cm^{-1}	Flaud et al.[b]
1	1.505(59)E-02	1.597(79)E-02	1.464(22)E-02	1.376(28)E-02	1.571(70)E-02	1.427(17)E-02
2	2.97(161)E-05	-3.65(233)E-05	2.72(145)E-07	-3.18(27)E-05	2.37(56)E-05	1.51(69)E-07
3	-2.38(180)E-04	-8.3(368)E-05		3.45(116)E-04	-1.18(248)E-04	9.51(678)E-06
4	-1.28(65)E-03	-1.36(24)E-03	-1.295(39)E-03	-1.68(14)E-03	-9.85(146)E-04	-1.295(24)E-03
5	6.29(102)E-04	4.28(39)E-04	5.54(27)E-04	9.19(42)E-04	4.63(26)E-04	5.63(19)E-04
6	-6.50(960)E-05	-9.71(136)E-05	-6.83(307)E-07	7.47(108)E-05	-7.10(211)E-05	-2.15(132)E-07
7	-2.8(562)E-06	2.72(402)E-05	-4.38(281)E-07	1.02(10)E-04	-4.98(69)E-05	-3.39(90)E-07
8	-2.69(108)E-05	-1.32(307)E-05		2.13(34)E-05	-5.57(195)E-05	
9	5.47(908)E-05	-8.02(159)E-05		-5.57(52)E-05	-5.10(93)E-05	
10	-1.15(132)E-04	9.38(950)E-05		7.72(44)E-05	-3.28(76)E-05	
11	-2.33(441)E-05	3.09(55)E-05		2.70(20)E-05	2.50(43)E-05	
12	-8.85(561)E-08	5.0(151)E-08		1.27(191)E-08	1.79(66)E-07	
13	4.14(535)E-06	1.14(182)E-06		-4.13(80)E-07	-1.30(16)E-06	
14	4.15(933)E-05	3.6(998)E-06		-2.07(607)E-06	8.64(139)E-05	
15	4.9(122)E-06	1.98(227)E-05		4.2(265)E-07	-1.69(78)E-05	
16	4.16(345)E-06	-3.36(181)E-06		-5.90(52)E-07	5.45(60)E-07	
17	-5.62(551)E-05	-1.49(434)E-05		4.75(181)E-05	-9.07(437)E-05	
18	7.1(410)E-06	4.0(239)E-06		3.77(95)E-05	-3.23(186)E-05	
19	-5.22(623)E-05	3.40(787)E-05		9.19(63)E-05	-1.26(28)E-04	
N	75	75		109	78	
σ%	6.2	10.6		7.1	9.5	

	(001)-(000) band			
	$H_2{}^{17}O$		$H_2{}^{18}O$	
j	this work	Camy-Peyret et al.[a]	this work	Flaud et al.[b]
1	7.133(15)E-02	6.786(85)E-02	7.304(8)E-02	6.850(70)E-02
2	1.193(90)E-05	2.01(74)E-05	6.95(39)E-06	8.23(450)E-06
3	-7.72(21)E-05	-8.59(240)E-05	-1.016(11)E-04	-6.62(180)E-05
4	-1.446(6)E-03	-1.410(89)E-03	-1.425(3)E-03	-1.407(60)E-03
5	-1.936(85)E-05		-2.06(36)E-06	
6	6.006(25)E-04	4.50(35)E-04	5.143(12)E-04	4.57(22)E-04
7	-5.148(64)E-05	-1.04(61)E-05	-1.780(25)E-05	-9.67(400)E-06
8	6.81(41)E-06	1.38(47)E-05	9.69(21)E-06	1.55(36)E-05
N	251		360	
σ%	8.5		7.1	

a. Taken from Camy-Peyret et al., ref. 10. Values given above differ from those given in ref. 10 for the (100)-(010) band in which the Fermi interaction between the (020) and (100) states was removed.

b. Taken from Flaud et al., ref. 11. Values given above differ from those given in ref. 11 for the (100)-(000) band in which the Fermi interaction between the (020) and (100) states was removed.

c. N represent the number of line strengths used in the least-squares fit

d. σ% is the standard deviation resulting from the least-squares fit in percent.
$\sigma\% = \{\Sigma[(S_{obs}-S_{cal})/S_{obs}]^2/N\}^{1/2}\times 100$
min and max ν are given in cm^{-1} and pertain to the minimum and maximum frequency range of transitions used the least-squares fits.
values given within parenthesis are estimated uncertainties in the last digit(s).

an InSb element cooled by liquid N_2. Each spectral run consisted of eight coadded interferograms obtained over a time span of approximately 50 min. The composite interferograms were transformed into spectra at the Kitt Peak facility.

III. SPECTRAL ANALYSIS AND ENERGY LEVELS

The line centers were measured with two computer programs. One, labeled LINEFINDER, determines line center positions and relative absorption peaks, and the other uses the technique of nonlinear least-squares (NLLS) in which absorption line positions,

TABLE V

Line Positions (cm^{-1}) and Strengths (cm^{-2}/atm at 296 K) Observed in the (100)–(000) Band of $H_2{}^{17}O$

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)%[a]	R
3223.198	104	7	0	7	8	3	6	9.40E-04	2	-10.6	1.07
3223.6912	-51	7	1	6	8	4	5	1.06E-03	2	1.32E-03	1.17
*3229.1873	-6	7	7	0	8	8	1	1.31E-03	10	1.71E-02	1.21
3230.539	329	9	5	4	10	6	5	4.04E-04	10	8.07E-04	
3238.858	-64	8	2	7	9	3	6	1.10E-03	3	-2.7	1.13
3245.669	0	7	1	7	8	2	6	4.18E-04	10	3.64E-04	
*3254.09063	-55	7	6	1	8	7	2	2.70E-03	5	5.27E-03	1.17
3255.859	23	8	5	3	9	6	4	4.66E-04	10	5.93E-04	
3260.928	-75	6	1	5	7	4	4	3.88E-04	10	6.42E-04	
3275.821	-91	6	0	6	7	3	5	8.40E-04	5	3.1	
3276.5553	-5	8	4	5	9	5	4	3.02E-03	3	0.6	1.13
3280.2355	-18	8	3	6	9	4	5	2.34E-03	6	-16.4	1.06
*3281.0922	-47	6	6	1	7	7	0	6.30E-03	4	-0.1	1.14
3281.8575	13	7	5	3	8	6	2	1.12E-03	3	-9.2	1.15
3281.9306	66	7	5	2	8	6	3	3.50E-03	4	-9.2	1.16
3292.878	31	8	4	4	9	5	5	4.91E-04	10	1.00E-03	
3299.0917	23	7	2	6	8	3	5	1.40E-03	10	6.9	1.23
3305.616	30	7	4	4	8	5	3	2.88E-03	2	2.34E-03	1.17
3308.2615	3	6	5	2	7	6	1	8.62E-03	4	-4.4	1.17
3308.277	238	6	5	1	7	6	2	2.87E-03	4	-4.5	1.15
3315.3212	62	7	4	3	8	5	4	2.48E-03	3	6.99E-03	1.10
3322.9188	29	7	3	5	8	4	4	2.50E-03	10	2.78E-03	1.03
3324.6423	17	5	0	5	6	3	4	3.76E-03	3	4.45E-03	1.07
3331.9169	14	6	4	3	7	5	2	1.72E-02	2	1.49E-02	1.06
3335.0379	-6	9	3	6	10	4	7	1.18E-03	10	1.49E-03	1.06
3339.51378	36	6	4	2	7	5	3	2.81E-03	4	4.97E-03	1.18
3346.4557	-8	8	3	5	9	4	6	1.05E-03	10	1.28E-03	1.06
3353.3312	-3	6	2	5	7	3	4	1.20E-02	2	-2.8	1.08
3358.81841	0	6	3	4	7	4	3	2.07E-02	4	-0.8	1.07
3360.0411	-10	7	3	4	8	4	5	7.50E-03	5	9.37E-03	1.07
3364.69339	25	5	4	1	6	5	2	1.98E-02	2	3.07E-02	1.10
3365.71130	-13	5	4	2	6	5	1	3.77E-03	5	1.02E-02	1.04
3368.4978	-1	4	0	4	5	3	3	1.80E-03	5	-6.0	1.17
3370.8460	55	5	1	5	6	2	4	2.88E-03	6	2.5	1.06
3374.456	0	12	1	12	13	0	13	1.00E-03	10	4.5	1.13
3375.801	0	12	0	12	13	1	13	3.30E-04	10	3.5	
3377.5215	-79	6	3	3	7	4	4	3.70E-03	5	7.09E-03	0.96
3388.8045	31	9	2	7	10	3	8	2.43E-03	4	-6.4	1.04
3389.78320	-4	5	3	3	6	4	2	1.52E-02	4	3.4	1.09
3389.97204	16	4	4	0	5	5	1	1.50E-02	2	2.14E-02	1.12
3390.09718	20	4	4	1	5	5	0	4.50E-02	4	6.42E-02	1.18
3394.28164	0	5	3	2	6	4	3	5.40E-02	3	4.39E-02	1.14
3397.3218	-20	10	1	9	11	2	10	8.00E-04	10	8.27E-04	1.04
3397.6801	0	11	0	11	12	1	12	3.14E-03	2	6.4	1.15
3397.7142	0	11	1	11	12	0	12	1.03E-03	7	4.7	1.13
3398.1062	0	10	2	9	11	1	10	2.40E-03	3	-4.0	1.06
3400.16682	-13	5	2	4	6	3	3	1.09E-02	3	-2.3	1.07
3404.0434	0	8	2	6	9	3	7	2.10E-03	5	3.3	1.11
3406.4350	-5	3	0	3	4	3	2	4.04E-03	5	4.87E-03	1.08
3408.533	241	9	3	7	10	2	8	6.08E-04	10	7.57E-04	
3417.37600	-1	7	2	5	8	3	6	1.42E-02	5	8.5	1.14
3417.80940	-5	4	3	2	5	4	1	8.43E-02	3	2.7	1.10
3418.99312	0	9	1	8	10	2	9	6.72E-03	2	3.6	1.15
3419.05231	5	4	3	1	5	4	2	2.95E-02	2	7.9	1.10
3419.8303	0	10	0	10	11	1	11	2.63E-03	3	-1.1	1.11
3419.8605	-1	10	1	10	11	0	11	8.32E-03	5	4.2	1.17
3420.6236	0	9	2	8	10	1	9	2.27E-03	5	4.4	1.21
3427.34146	28	4	1	4	5	2	3	2.25E-02	2	2.9	1.08
3429.779	41	10	5	6	11	4	7	1.20E-03	10	3.70E-04	0.94
3430.2178	-10	6	2	4	7	3	5	8.42E-03	3	-2.9	1.02
3437.8293	72	8	3	6	9	2	7	3.47E-03	3	4.49E-03	1.15
3439.31318	-9	4	2	3	5	3	2	7.61E-02	4	2.4	1.11
3439.8751	-21	8	1	7	9	2	8	5.00E-03	2	2.3	1.14
3441.7011	0	9	0	9	10	1	10	1.86E-02	2	-2.5	1.12
3441.7598	1	9	1	9	10	0	10	6.30E-03	8	-1.0	1.13
3443.3262	10	8	2	7	9	1	8	1.41E-02	3	-3.1	1.14
3444.19469	-1	5	2	3	6	3	4	4.65E-02	3	-4.4	1.08
3444.3810	-2	3	3	1	4	4	0	4.43E-02	2	-6.0	1.12
3444.53918	0	3	3	0	4	4	1	1.33E-01	2	-5.8	1.11
3459.52766	-17	7	1	6	8	2	7	2.92E-02	3	0.8	1.09
3459.65003	-2	4	2	2	5	3	3	3.35E-02	2	2.83E-02	1.08
3463.31883	13	8	0	8	9	1	9	1.26E-02	2	-6.6	1.09
3464.5405	56	5	0	5	5	3	2	1.50E-03	10	2.00E-03	1.23
3466.6498	22	7	2	6	8	1	7	8.70E-03	6	9.26E-03	1.10
3471.96836	0	3	2	2	4	3	1	4.42E-02	2	-0.5	1.09
3475.7640	-46	9	1	9	9	2	8	1.10E-03	8	6.60E-04	1.28
3476.943	173	9	0	9	9	1	8	2.59E-03	10	2.01E-03	1.00
3477.17685	9	3	1	3	4	2	2	1.80E-02	2	4.4	1.11
3477.55388	-4	6	1	5	7	2	6	1.45E-02	4	1.68E-02	1.11
3479.32928	-1	3	2	1	4	3	2	1.42E-01	2	3.5	1.09
3484.48750	6	7	0	7	8	1	8	7.27E-02	4	-4.4	1.10
3484.76650	11	7	1	7	8	0	8	2.47E-02	2	-2.7	1.12
3491.31017	4	6	2	5	7	1	6	4.19E-02	4	-6.1	1.10
3491.606	0	10	3	8	10	4	7	5.68E-04	10	4.71E-04	
3493.46235	-6	5	1	4	6	2	5	8.32E-02	3	5.8	1.08
3497.2887	-77	9	2	8	9	3	7	7.77E-04	10	2.94E-04	1.03
3497.8375	-103	8	1	8	8	2	7	6.90E-03	10	5.51E-03	1.13
3500.25145	0	2	2	1	3	3	0	1.90E-01	3	-5.8	1.08
3500.3600	-17	8	0	8	8	1	7	2.17E-03	4	1.89E-03	1.03
3501.75765	-6	2	2	0	3	3	1	6.51E-02	2	-3.1	1.10
3501.8530	26	7	4	4	7	5	3	1.75E-03	4	8.61E-07	1.43
3503.0948	53	6	4	3	6	5	2	6.40E-03	4	4.00E-03	1.06
3503.473	-22	3	0	3	3	3	0	1.10E-03	10	1.74E-03	1.22
3505.27072	0	6	0	6	7	1	7	3.90E-02	4	-8.0	1.04
3505.7372	19	6	3	4	7	2	5	3.80E-03	3	9.06E-03	1.07
3505.95145	2	6	1	6	7	0	7	1.25E-01	3	-1.4	1.13
3506.408	-41	9	3	7	9	4	6	7.65E-04	10	6.99E-05	
3508.2697	-1	7	4	4	8	3	5	2.35E-03	4	7.21E-04	1.00
3508.41413	-2	4	1	3	5	2	4	3.93E-02	2	6.5	1.08
3509.8293	60	9	1	8	9	2	7	2.50E-03	10	1.52E-03	1.03
3510.4529	-73	6	4	2	6	5	1	7.00E-04	10	1.33E-03	0.93
3510.5641	13	7	4	3	7	5	2	1.66E-03	10	3.35E-06	1.03
3511.1467	-8	5	4	1	5	5	0	2.86E-03	5	1.53E-02	1.18
3516.3662	64	8	2	7	8	3	6	5.73E-03	3	3.73E-03	1.01
3518.1567	-21	5	2	4	6	1	5	1.88E-02	2	-2.7	1.14
3518.3033	-20	8	3	6	8	4	5	3.80E-03	4	2.43E-05	1.03
3519.1486	0	7	1	7	7	2	6	4.49E-03	4	2.1	1.02
3519.28130	-2	2	1	2	3	2	1	1.03E-01	4	0.0	1.07
3521.1784	31	9	5	4	10	4	7	2.50E-03	6	1.43E-03	1.28
3522.8837	8	8	5	4	9	4	5	8.18E-03	3	2.67E-03	1.11
3523.79926	10	3	1	2	4	2	3	1.52E-01	2	6.2	1.09
3525.46940	3	5	0	5	6	1	6	1.72E-01	4	-8.2	1.02
3527.08696	-7	5	1	5	6	0	6	6.25E-02	2	1.1	1.14
3527.2150	-12	7	3	5	7	4	4	2.85E-03	4	5.40E-04	1.10
3533.1377	-16	7	2	6	7	3	5	4.60E-03	2	3.68E-03	1.09
3533.40918	0	6	3	4	6	4	3	1.42E-02	2	8.35E-03	1.04
3536.3997	3	8	1	7	8	2	6	2.17E-03	4	1.2	1.00
3537.4358	4	5	3	3	5	4	2	7.05E-03	2	-3.7	1.12
3539.28292	-2	6	1	6	6	2	5	2.76E-02	2	1.4	1.07
3539.99813	31	4	3	2	4	4	1	1.93E-02	3	3.23E-02	1.09

* asterisk denotes a doubled absorption with the quantum assignment given for the stronger transition. The strength given represents the sum of the strengths of the two comparable transitions.

o-c are observed minus computed line positions in $cm^{-1} \times 10^5$. Computed values derived from energy levels given in table 2 and ground state levels given in ref. 14.

Xs are estimated uncertainties in the measured line strengths given in percent

a. (o-c)% is the percent difference between the observed and computed line strength or the value of the computed strength if the difference between the observed and computed values is ≈±12% or larger in magnitude.

R is the ratio of the observed line strength derived in this study to the computed value given in ref. 13

strengths, linewidths, and continuum parameters are fitted simultaneously in an interactive mode. The latter technique was used to determine experimental values of linestrengths and the majority of line center values. These computer algorithms have been used in several of my previous studies (*1, 2, 15–17*). The measured line positions obtained by both techniques were calibrated and corrected to $H_2{}^{16}O$, $H_2{}^{17}O$, and $H_2{}^{18}O$ wavenumbers and these standards were used in the previous studies (*1, 2*).

The rotational energy levels in the (100) and (001) vibrational states of both isotopic species were derived by the addition to each measured transition wave-

TABLE V—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R
3540.58929	-5	5	3	2	5	4	1	2.67E-02	3	2.15E-02	1.12
3540.87162	93	2	1	1	3	2	2	6.10E-02	3	7.2	1.12
3540.9744	-31	4	3	1	4	4	0	6.97E-03	3	1.07E-02	1.09
3543.0624	-42	8	5	3	9	4	6	1.96E-03	10	1.12E-03	1.22
3544.6883	-12	9	4	5	10	3	8	1.90E-03	10	2.87E-04	1.17
3546.30727	8	6	4	3	7	3	4	9.23E-02	2	3.18E-03	1.09
3547.12381	-9	6	2	5	6	3	4	2.65E-02	2	4.9	1.09
3547.3520	-1	6	3	3	6	4	2	2.05E-03	10	2.74E-03	0.96
3547.60823	-3	4	2	3	5	1	4	5.43E-02	2	-7.5	1.11
3548.4365	67	6	0	6	6	1	5	1.00E-02	10	0.5	1.10
3548.47367	4	4	1	4	5	0	5	2.15E-01	2	-8.4	1.03
3549.5408	-12	8	4	4	9	3	7	2.70E-03	6	2.38E-04	1.14
3550.5765	-31	9	2	7	9	3	6	2.30E-03	5	4.75E-04	1.03
3551.23347	11	7	3	4	7	4	3	6.20E-03	3	1.86E-03	1.02
3555.007	-13	8	3	5	8	4	4	1.23E-03	10	4.55E-05	1.09
3556.323	13	8	6	3	9	5	4	1.40E-03	5	1.11E-02	1.23
3557.6784	17	5	1	5	5	2	4	1.57E-02	3	-2.6	1.06
3557.97415	9	5	2	4	5	3	3	1.41E-02	2	-7.7	1.08
3558.1000	-16	7	5	3	8	4	4	4.18E-03	3	1.51E-03	1.24
3560.24973	0	1	1	0	2	2	1	1.95E-01	4	3.3	1.10
3561.80247	0	7	1	6	7	2	5	1.67E-02	2	2.00E-02	1.01
3562.03802	8	7	4	3	8	3	6	2.78E-02	2	1.59E-03	1.17
3562.9370	25	3	0	3	4	1	4	2.60E-01	10	-3.8	1.04
3570.5835	81	3	2	2	3	3	1	1.50E-02	10	2.01E-02	1.04
3570.63452	8	3	1	3	4	0	4	7.98E-02	2	-2.2	1.09
3572.83489	-4	5	0	5	5	1	4	5.50E-02	3	-4.6	1.06
3573.69561	-9	4	1	4	4	2	3	7.30E-02	4	0.0	1.10
3576.36750	4	3	2	1	3	3	0	5.00E-02	2	6.00E-02	1.10
3579.0138	0	3	2	2	4	1	3	1.32E-02	10	-10.0	1.14
3579.65380	6	4	2	2	4	3	1	2.26E-02	4	2.19E-02	1.07
3580.0460	-42	2	0	2	3	1	3	8.60E-02	4	-0.8	1.05
3580.2926	13	7	2	5	7	3	4	1.50E-02	10	1.29E-02	0.95
3583.6095	2	6	1	5	6	2	4	1.20E-02	5	1.65E-02	1.09
3584.09232	1	5	2	3	5	3	2	4.48E-02	3	5.03E-02	1.07
3584.84186	0	6	2	4	6	3	3	1.02E-02	3	3.1	1.02
3585.788	-73	7	6	1	8	5	4	2.13E-03	10	2.04E-02	1.34
3586.77336	-7	3	1	3	3	2	2	2.90E-02	2	-3.3	1.06
3589.7840	-2	6	5	2	7	4	3	1.43E-02	2	1.02E-02	1.23
3589.83850	-4	5	4	2	6	3	3	1.11E-01	4	1.35E-03	1.15
3593.4468	32	6	5	1	7	4	4	4.80E-03	4	3.57E-03	1.29
3594.14740	-6	6	3	3	7	2	6	4.28E-02	3	2.37E-04	1.16
3594.17951	3	2	1	2	3	0	3	1.95E-01	2	-0.5	1.10
3595.8771	-22	7	3	4	8	2	7	1.26E-02	3	1.81E-04	1.12
3596.37734	-2	5	3	2	6	2	5	2.46E-01	2	1.99E-03	1.11
3596.57180	-3	2	1	2	2	2	1	7.50E-02	4	-3.7	1.06
3597.29665	-1	1	0	1	2	1	2	2.23E-01	2	2.8	1.09
3599.27842	7	5	1	4	5	2	3	7.90E-02	4	9.72E-02	1.02
3601.69875	2	5	4	1	6	3	4	1.72E-01	2	1.42E-02	1.16
3608.46370	2	4	1	3	4	2	2	4.42E-02	2	5.3	1.08
3610.9090	-12	2	2	1	3	1	2	1.73E-02	10	2.15E-02	1.09
3610.92150	17	2	1	1	2	2	0	3.80E-02	5	6.7	1.14
3611.80235	5	3	1	2	3	2	1	1.48E-01	3	0.6	1.06
3614.1306	-29	3	0	3	3	1	2	1.60E-01	5	-5.6	1.07
3616.21115	0	0	0	0	1	1	1	5.48E-02	3	-1.4	1.14
3618.5891	0	5	5	1	6	4	2	3.44E-03	3	-1.3	1.22
3619.16945	-19	1	1	1	2	0	2	3.40E-02	3	5.4	1.12
3619.6965	-11	5	5	0	6	4	3	1.08E-02	3	2.1	1.29
3620.54675	1	4	4	1	5	3	2	1.74E-01	4	7.61E-03	1.14
3626.97827	-2	2	0	2	2	1	1	7.20E-02	2	-6.8	1.09
3634.33707	1	1	0	1	1	1	0	2.00E-01	2	-6.7	1.11
3635.94947	-3	4	2	2	5	1	5	6.85E-02	2	8.39E-04	1.15
3645.0217	-4	5	2	3	6	1	6	3.76E-02	2	1.65E-03	1.20
3659.666	-71	6	2	4	7	1	7	1.76E-03	10	5.53E-04	1.16
3662.7200	10	4	2	3	3	3	0	2.15E-03	10	2.53E-04	1.25
3670.6213	-19	1	1	0	1	0	1	1.86E-01	2	-1.9	1.12
3676.3487	86	2	1	1	2	0	2	6.70E-02	3	1.0	1.13
3678.268	-7	4	2	2	3	3	1	1.04E-03	5	1.78E-04	1.13
3678.6660	-49	7	2	5	8	1	8	1.39E-03	4	2.03E-03	1.19
3685.01780	8	2	0	2	1	1	1	2.26E-02	3	2.61E-02	1.10
3687.02516	3	3	2	1	3	1	2	9.89E-02	2	1.38E-01	1.09
3689.09265	-16	3	1	2	2	2	1	1.24E-02	2	1.10E-02	1.11
3689.17440	9	1	1	1	0	0	0	4.07E-02	2	-7.2	1.11
3690.34887	4	2	2	0	2	1	1	2.65E-02	3	3.24E-02	1.14
3692.38730	0	5	2	3	5	1	4	1.00E-01	5	7.33E-02	1.08
3698.15188	-8	7	3	4	7	2	5	2.36E-02	2	1.54E-02	1.02
3698.8764	57	5	3	3	6	0	6	1.08E-03	10	6.04E-04	1.40
3700.20319	17	6	3	3	6	2	4	3.20E-02	4	1.10E-02	1.10
3700.5462	34	4	3	2	5	0	5	2.97E-03	4	1.00E-03	1.31
3701.9209	-46	4	1	3	4	0	4	2.75E-02	2	2.48E-02	1.13
3702.19338	8	5	3	2	5	2	3	2.02E-02	2	5.18E-02	1.22
3702.4479	-141	8	3	5	8	2	6	2.85E-03	10	1.77E-03	1.14
3702.8320	18	6	2	4	6	1	5	1.27E-02	2	1.14E-02	1.03
3704.7920	13	2	2	1	2	1	2	5.18E-02	2	6.25E-02	1.10
3706.4611	6	9	4	5	9	3	6	2.72E-03	7	1.59E-03	1.07
3706.94348	-11	2	1	2	1	0	1	1.38E-01	3	1.56E-01	1.09
3708.01369	5	3	0	3	2	1	2	1.06E-01	3	1.21E-01	1.13
3710.4605	-27	5	2	3	4	3	2	2.05E-03	5	6.21E-04	1.27
3712.7633	-6	9	3	6	9	2	7	2.15E-03	7	1.41E-03	0.98
3714.4469	81	8	4	4	8	3	5	2.90E-03	10	1.75E-03	1.13
3716.4415	0	11	5	6	11	4	7	2.88E-04	10	6.88E-05	
3718.0607	35	4	1	3	3	2	2	6.05E-03	5	5.20E-03	1.10
3718.27137	0	7	2	5	7	1	6	1.38E-02	3	1.8	1.00
3720.4110	20	5	1	4	5	0	5	3.87E-02	2	8.6	1.06
3722.18365	22	4	2	3	4	1	4	4.70E-02	6	5.31E-02	1.14
3722.2505	-8	3	1	3	2	0	2	4.85E-02	4	-4.7	1.19
3724.1362	16	3	3	1	3	2	2	1.55E-03	10	1.53E-02	1.03
3724.9538	-60	7	4	3	7	3	4	2.65E-02	7	1.26E-02	1.18
3725.76782	-11	4	3	2	4	2	3	1.61E-02	2	5.56E-02	1.17
3728.77508	0	4	0	4	3	1	3	3.45E-02	2	3.87E-02	1.15
3728.8425	77	4	4	1	5	1	4	1.44E-03	10	5.17E-04	1.25
3729.4672	17	5	3	3	5	2	4	6.20E-03	4	1.52E-02	1.14
3734.5809	16	6	4	2	6	3	3	3.48E-02	2	7.75E-03	1.16
3736.5970	0	4	1	4	3	0	3	1.21E-01	4	-3.3	1.21
3739.8515	44	6	1	5	6	0	6	4.75E-03	3	5.35E-03	1.04
3740.09993	7	6	4	3	6	3	4	4.44E-02	2	2.49E-02	1.16
3741.59668	-6	5	4	1	5	3	2	2.34E-01	2	3.21E-02	1.12
3741.8321	-17	2	2	1	1	1	0	1.15E-01	3	2.9	1.14
3745.41640	-10	4	4	0	4	3	1	1.06E-01	2	9.62E-03	1.16
3745.4582	-81	8	4	5	8	3	6	5.71E-04	10	7.03E-03	
3745.6328	-7	5	1	4	4	2	3	1.77E-02	4	1.32E-02	1.17
3746.91520	0	4	4	1	4	3	2	3.94E-01	2	2.91E-02	1.18
3747.41013	3	5	0	5	4	1	4	7.75E-02	2	-7.8	1.18
3747.64570	5	5	4	2	5	3	3	1.42E-01	2	1.10E-02	1.15
3747.95107	-7	6	2	5	6	1	6	1.46E-02	2	1.70E-02	1.07
3748.38829	3	2	2	0	1	1	1	3.60E-02	3	3.08E-02	1.17
3751.18549	5	5	1	5	4	0	4	2.60E-02	3	2.84E-02	1.14
3751.6143	13	8	5	3	8	4	4	2.75E-03	5	1.66E-03	1.18
3754.1397	8	8	3	6	8	2	7	2.90E-03	2	7.33E-03	1.01
3758.23885	0	7	1	6	7	0	7	7.12E-03	4	2.4	1.00
3758.78218	0	7	5	2	7	4	3	1.85E-02	2	1.04E-02	1.19

number of the (100)–(000) and (001)–(000) bands the appropriate lower state level given in Ref. (*15*) for $H_2{}^{17}O$ and $H_2{}^{18}O$. These results were weighted and then averaged for each level. Table II lists values of the rotational energy levels obtained by this method for the (100) and (001) states of $H_2{}^{17}O$, and Table III is a comparable listing for $H_2{}^{18}O$. Included in the tables are estimates of the uncertainties in the values.

IV. LINESTRENGTHS

The strength, S, of a H_2O transition at the location ν may be expressed to good approximation by

$$S = C\left(\frac{\nu}{Q}\right)\left(\frac{g}{T}\right)\left[1 - \exp\left(\frac{-\nu}{kT}\right)\right]\exp\left(\frac{-E(\mathrm{L})}{kT}\right)|R(\mathrm{L},\mathrm{U})|^2 \qquad (1)$$

TABLE V—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xa	(o-c)X[a]	R
3759.1740	19	3	2	2	2	1	1	3.03E-02	3	2.73E-02	1.14
3760.9511	-34	8	5	4	8	4	5	1.15E-02	3	5.49E-03	1.18
3761.4543	-2	9	5	5	9	4	6	1.90E-03	6	7.43E-04	1.08
3762.3956	-117	7	5	3	7	4	4	7.00E-03	10	3.47E-03	1.19
3762.5868	13	7	2	6	7	1	7	2.14E-03	7	2.58E-03	1.01
3763.2762	0	6	5	1	6	4	2	1.08E-02	2	5.50E-03	1.21
3764.37479	0	6	5	2	6	4	3	3.33E-02	2	1.67E-02	1.20
3764.5521	-33	6	0	6	5	1	5	1.52E-02	2	-6.9	1.18
3766.00437	6	5	5	0	5	4	1	3.60E-02	3	1.71E-02	1.20
3773.0280	-5	9	6	3	9	5	4	1.25E-03	10	-6.2	1.11
3773.37769	12	4	2	3	3	1	2	6.14E-02	2	5.24E-02	1.13
3775.4010	-54	9	6	4	9	5	5	5.44E-04	10	4.57E-07	
3775.4970	-6	8	1	7	8	0	8	1.00E-03	10	4.6	1.08
3777.6357	-54	8	2	7	8	1	8	2.64E-03	5	3.20E-03	1.02
3777.7369	24	8	6	2	8	5	3	1.19E-03	4	6.7	1.35
3778.5088	-37	8	6	3	8	5	4	3.21E-03	10	-2.0	1.19
3780.73330	-3	7	0	7	6	1	6	2.24E-02	2	-7.3	1.19
3780.90786	-2	3	2	1	2	1	2	9.70E-02	2	4.61E-02	1.18
3781.0322	8	7	6	1	7	5	2	6.50E-03	5	0.8	1.32
3781.2302	0	7	6	2	7	5	3	2.22E-03	10	3.0	1.35
3781.44560	-14	7	1	7	6	0	6	7.75E-03	2	-2.1	1.21
3783.3975	0	6	6	0	6	5	1	2.46E-03	5	2.78E-03	1.21
3783.4360	7	6	6	1	6	5	2	7.95E-03	3	-4.9	1.30
3785.0228	-39	5	2	4	4	1	3	1.22E-02	2	9.47E-03	1.14
3791.5706	24	7	1	6	6	2	5	6.60E-03	5	4.85E-03	1.25
3791.6893	-35	9	1	8	9	0	9	9.50E-04	10	1.12E-03	0.97
3793.2100	-59	3	3	0	3	0	3	1.15E-03	3	9.96E-04	0.93
3794.18668	0	3	3	1	2	2	0	4.43E-02	2	3.16E-02	1.23
3795.31683	13	6	2	5	5	1	4	1.90E-02	2	1.30E-02	1.17
3795.60295	1	3	3	0	2	2	1	1.72E-01	4	9.42E-02	1.19
3796.2970	-26	8	0	8	7	1	7	3.25E-03	2	-6.5	1.28
3796.54955	0	8	1	8	7	0	7	1.01E-02	3	-1.4	1.30
*3797.6768	7	7	7	0	7	6	1	2.40E-03	10	4.64E-03	1.58
3805.7515	-28	7	2	6	6	1	5	2.68E-03	5	1.77E-03	1.15
3809.8795	23	8	1	7	7	2	6	8.10E-04	10	-0.9	1.17
3811.3862	-1	9	1	9	8	0	8	1.27E-03	6	-6.5	1.48
3813.7710	-7	4	3	2	3	2	1	9.63E-02	3	5.72E-02	1.23
3819.9271	-22	4	2	2	3	1	3	1.92E-01	6	6.03E-03	1.30
3823.3257	-5	5	3	2	5	0	5	3.85E-02	4	3.13E-03	1.13
3825.8801	2	10	1	10	9	0	9	1.23E-03	10	1.58E-03	
3841.3207	-14	6	3	4	5	2	3	1.92E-02	5	1.43E-02	1.19
3843.95330	-7	4	4	1	3	3	0	7.68E-02	2	6.74E-02	1.08
3844.03083	0	4	4	0	3	3	1	1.66E-02	3	2.25E-02	1.02
3849.8924	87	5	4	1	5	1	4	1.78E-02	3	1.95E-03	1.35
3852.5707	0	6	4	2	6	1	5	4.87E-03	2	1.17E-03	1.24
3856.4142	-6	8	3	6	7	2	5	2.10E-03	3	3.01E-03	1.41
3856.4449	30	6	3	3	6	0	6	5.93E-03	2	9.87E-04	1.18
3862.9336	30	7	4	3	7	1	6	4.90E-03	5	3.99E-03	1.18
3866.9625	3	5	2	3	4	1	4	2.97E-02	3	6.58E-03	1.18
3867.64935	1	5	4	2	4	3	1	1.35E-01	3	1.46E-02	1.11
3867.96495	-5	5	4	1	4	3	2	1.72E-01	2	4.44E-02	1.14
3879.99755	-12	6	4	3	5	3	2	3.39E-01	3	2.68E-02	1.24
3887.03580	0	6	3	3	5	2	4	6.37E-02	3	4.75E-03	1.12
3888.6686	-63	4	3	2	3	0	3	5.00E-03	4	2.16E-03	1.11
3892.38775	-10	6	4	2	5	3	3	4.94E-02	2	9.53E-03	1.15
3894.5875	-84	7	3	4	7	0	7	1.60E-03	5	2.54E-03	1.23
3896.9199	-16	7	4	4	6	3	3	1.82E-02	4	5.05E-03	1.17
3903.4174	50	4	4	1	4	1	4	1.40E-03	10	2.41E-04	1.13
3905.702	122	7	5	2	7	2	5	7.80E-04	10	1.33E-03	
3908.3756	13	8	4	5	7	3	4	8.57E-03	2	7.98E-03	1.15
3910.6823	-19	6	5	2	5	4	1	1.24E-02	2	2.48E-02	1.02
3910.9284	-32	6	5	1	5	4	2	4.43E-03	5	8.30E-03	1.15
3918.74701	-6	7	4	3	6	3	4	5.20E-02	3	1.80E-02	1.13
3922.9743	6	5	3	3	4	0	4	1.32E-03	2	1.08E-03	0.98
3927.9196	-25	7	3	4	6	2	5	1.98E-02	3	7.50E-03	1.11
*3929.8885	93	6	6	1	5	5	0	1.15E-03	6	7.01E-03	0.74
3932.2265	-1	7	5	3	6	4	2	6.15E-03	5	6.77E-03	1.01
3933.3730	5	7	5	2	6	4	3	1.59E-02	2	2.03E-02	1.05
3948.4926	12	8	4	4	7	3	5	7.00E-03	5	3.75E-03	1.23
3952.1437	10	8	5	4	7	4	3	2.07E-02	3	1.48E-02	1.07
3952.2096	-3	7	6	1	6	5	2	2.90E-03	7	7.77E-03	0.84
3954.6117	66	4	4	1	3	1	2	1.01E-02	3	2.92E-04	1.23
3955.9108	2	8	5	3	7	4	4	4.25E-03	3	5.21E-03	1.07
3962.4533	1	6	3	4	5	0	5	3.26E-03	2	-9.5	1.07
3966.473	249	6	5	2	6	2	5	2.66E-04	10	7.13E-04	
3968.6778	-15	10	5	6	9	4	5	8.00E-03	6	5.17E-03	1.07
*3968.730	24	7	7	0	6	6	1	6.60E-04	10	3.85E-05	0.69
3970.0057	3	9	5	5	8	4	4	6.83E-03	4	3.16E-03	1.07
3973.7528	24	8	6	3	7	5	2	3.28E-03	10	9.47E-03	0.94
3973.9737	0	8	6	2	7	5	3	1.20E-03	10	3.17E-03	1.05
3974.6953	52	5	4	2	4	1	3	1.17E-02	2	4.14E-04	1.15
3974.9129	52	7	2	5	6	1	6	2.15E-03	2	2.1	1.09
3975.9290	9	8	3	5	7	2	6	1.65E-03	4	1.0	1.18
3979.3781	-31	9	5	4	8	4	5	6.62E-03	4	1.09E-02	1.04
3983.9482	4	9	4	5	8	3	6	5.64E-03	2	6.97E-03	1.13
3988.29265	-1	6	4	3	5	1	4	4.23E-02	3	3.03E-03	1.17
*3990.7838	0	8	7	2	7	6	1	1.35E-03	3	0.2	0.86
3995.2144	5	9	6	3	8	5	4	2.47E-03	5	9.01E-03	1.06
4005.1875	0	10	5	5	9	4	6	8.40E-04	10	2.24E-03	1.04
4006.1376	17	7	3	5	6	0	6	7.40E-04	10	1.22E-03	1.04
4012.189	0	9	7	3	8	6	2	2.30E-04	10	9.79E-04	
4012.225	0	9	7	2	8	6	3	6.84E-04	10	2.94E-04	
4013.3939	0	10	6	5	9	5	4	1.55E-03	10	6.55E-03	1.14
4014.9101	8	7	4	4	6	1	5	3.68E-03	3	1.70E-03	1.04
4016.155	0	10	6	4	9	5	5	5.39E-04	10	2.25E-03	
4024.4672	50	5	4	1	4	1	4	4.27E-03	3	5.30E-04	1.18
4026.345	105	10	4	6	9	3	7	5.00E-04	10	1.44E-03	
4029.0745	10	9	3	6	8	2	7	1.60E-03	5	3.95E-03	1.14
4032.447	323	8	2	6	7	1	7	4.01E-04	10	7.66E-04	
4032.814	0	10	7	4	9	6	3	5.42E-04	10	3.58E-03	
4035.202	-636	11	5	6	10	4	7	7.50E-04	10	3.65E-03	1.11
4046.3543	-7	8	4	5	7	1	6	3.98E-03	3	6.37E-03	1.08
4052.8510	36	8	3	6	7	0	7	1.45E-03	4	3.79E-03	1.07
4068.6880	70	6	4	2	5	1	5	6.80E-04	10	3.53E-04	0.97
4072.286	-45	6	5	2	5	2	3	4.89E-04	10	3.6	
4074.925	0	11	4	7	10	3	8	4.19E-04	10	2.67E-03	
4089.355	59	9	2	7	8	1	8	7.33E-04	10	2.81E-03	1.05
4099.061	-120	8	5	4	7	2	5	6.49E-04	10	2.61E-03	
4126.2710	15	10	5	6	9	2	7	2.44E-03	5	4.02E-03	1.04

where

$$C = 8\pi^3/3hc$$

$$Q = Q_V \times Q_R$$

and

$$E(L) = E_V(L) + E_R(L),$$

where Q is the partition function which can be expressed as the product of the vibrational, Q_V, and rotational, Q_R, partition functions, g is the degeneracy due to the nuclear spin of the lower state level, k is the Boltzmann constant, T is the temperature, $E(L)$ is the lower state energy equal to the sum of the lower state vibrational energy, $E_V(L)$, and rotational energy, $E_R(L)$, and $R(L, U)$ is the vibration–rotation dipole moment matrix element connecting the lower state, L, with the upper state, U. When T = 296 K, Q_R = 175.5 and 176.1 for $H_2{}^{17}O$ and $H_2{}^{18}O$, respectively, and Q_V = 1.0004 for both species and for temperatures within 30°K of 300 K, $Q(T) = Q(296\text{ K})[296/T]^{3/2}$.

Without considering near resonance effects, the vibration–rotation dipole moment element, $R(L, U)$, given in Eq. (1), can be expressed as

TABLE VI

Line Positions (cm^{-1}) and Strengths (cm^{-2}/atm at 296 K) Observed in the (100)–(000) Band of $H_2{}^{18}O$

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%a	(o-c)%[a]	R
3117.0906	-70	9	2	7	10	5	6	8.27E-05	10	-8.4	
*3177.8608	55	8	8	1	9	9	0	1.90E-04	8	5.37E-05	1.04
3186.9072	57	10	5	6	11	6	5	1.93E-04	10	14.4	1.07
3198.2985	76	9	6	3	10	7	4	2.42E-04	4	3.06E-04	1.09
*3200.0495	46	8	7	2	9	8	1	4.33E-04	3	2.5	0.99
3202.6257	-30	10	4	7	11	5	6	1.95E-04	4	-1.5	0.93
3220.6527	-46	7	0	7	8	3	6	9.66E-04	3	-13.9	1.09
3221.8837	12	7	1	6	8	4	5	1.03E-03	3	6.8	1.08
3225.2451	7	8	6	3	9	7	2	7.13E-04	3	8.67E-04	1.04
3225.2746	90	8	6	2	9	7	3	2.38E-04	10	2.87E-04	1.04
*3227.61247	112	7	7	0	8	8	1	1.28E-03	6	8.71E-04	1.09
3228.6120	3	9	5	4	10	6	5	4.07E-04	4	5.66E-04	1.08
3235.14880	14	8	2	7	9	3	6	1.01E-03	2	1.5	1.06
3241.1457	-41	9	4	6	10	5	5	2.70E-04	3	7.7	0.99
3242.3120	-15	7	1	7	8	2	6	4.20E-04	4	-4.6	1.15
*3252.3386	-35	7	6	1	8	7	2	2.63E-03	4	-7.9	1.06
3253.4410	-9	8	5	4	9	6	3	1.16E-03	3	1.66E-03	1.15
3253.8570	-29	8	5	3	9	6	4	4.10E-04	10	5.56E-04	1.06
3259.3076	-71	6	1	5	7	4	4	4.80E-04	7	3.4	1.09
3272.0423	-21	9	4	5	10	5	6	6.44E-04	3	8.42E-04	1.08
3273.3410	-59	6	0	6	7	3	5	7.10E-04	3	-4.8	1.09
3274.0800	6	8	4	5	9	5	4	2.74E-03	4	2.42E-03	1.06
3277.0920	39	8	3	6	9	4	5	2.35E-03	7	13.6	1.07
*3279.3612	45	6	6	1	7	7	0	6.25E-03	3	4.3	1.06
3279.8135	14	7	5	3	8	6	2	1.15E-03	7	1.45E-03	1.12
3279.9248	5	7	5	2	8	6	3	3.45E-03	3	4.35E-03	1.08
3290.0750	10	5	1	4	6	4	3	1.37E-03	4	1.5	1.05
3295.55925	2	7	2	6	8	3	6	1.20E-03	3	9.9	1.07
3302.9760	-19	7	4	4	8	5	3	2.00E-03	2	2.24E-03	1.05
3306.0861	22	6	1	6	7	2	5	3.20E-03	3	-0.8	1.07
3306.27735	0	6	5	2	7	6	1	8.26E-03	3	1.00E-02	1.06
3306.2970	0	6	5	1	7	6	2	2.60E-03	5	3.33E-03	1.00
3312.50081	-13	7	4	3	8	5	4	4.18E-03	3	6.81E-03	1.06
3315.2268	-86	4	1	3	5	4	2	2.50E-04	5	-7.1	1.00
3320.1396	-19	7	3	5	8	4	4	2.55E-03	4	11.8	1.06
3322.2612	20	5	0	5	6	3	4	3.75E-03	3	-2.4	1.07
3322.4913	0	10	3	7	11	4	8	1.24E-04	10	1.74E-04	0.97
3329.67405	0	6	4	3	7	5	2	1.32E-02	3	1.62E-02	1.06
*3332.69480	-3	5	5	0	6	6	1	2.41E-02	2	-10.7	1.07
3333.3952	6	9	3	6	10	4	7	1.21E-03	2	-13.0	1.07
3344.7095	-3	8	3	5	9	4	6	1.07E-03	6	-9.4	1.07
*3349.3868	0	13	0	13	14	1	14	5.20E-04	10	4.08E-04	1.26
3350.04430	7	6	2	5	7	3	5	1.17E-02	2	12.3	1.07
3350.3382	0	12	2	11	13	1	12	2.64E-04	10	2.90E-04	1.04
3356.2877	4	6	3	4	7	4	3	2.12E-02	3	12.1	1.10
3358.0880	-15	7	3	4	8	4	5	7.60E-03	4	8.75E-03	1.06
3362.21137	11	5	4	1	6	5	2	2.15E-02	3	3.45E-02	1.06
3362.87095	23	5	4	2	6	5	1	4.96E-03	2	1.15E-02	1.05
3366.23840	-4	4	0	4	5	3	3	1.68E-03	3	-0.7	1.08
3367.44940	-12	5	1	5	6	2	4	2.85E-03	3	6.2	1.08
3368.5047	-8	10	2	8	11	3	9	3.10E-04	7	4.45E-04	1.08
70.8056	0	12	1	12	13	0	13	7.42E-04	2	9.93E-04	1.06
3372.209*	-20	11	1	10	12	2	11	9.40E-04	4	2.6	1.12
3372.6135	0	11	2	10	12	1	11	3.04E-04	3	-0.4	1.10
3372.6455	0	12	0	12	13	1	13	3.50E-04	5	5.5	1.17
3375.1085	18	6	3	3	7	4	4	4.70E-03	3	6.87E-03	1.07
3378.6675	54	10	3	8	11	2	9	7.98E-04	3	1.37E-03	1.12
3386.3435	0	9	2	7	10	3	8	2.60E-03	3	3.27E-03	1.10
3387.37427	10	5	3	3	6	4	2	1.51E-02	2	4.5	1.08
3387.63260	-16	4	4	0	5	5	1	1.61E-02	3	2.14E-02	1.11
3387.70630	7	4	4	1	5	5	0	4.55E-02	2	6.43E-02	1.08
3391.4357	3	5	3	2	6	4	3	5.05E-02	2	4.44E-02	1.09
3394.3748	0	10	1	9	11	2	10	9.05E-04	4	3.6	1.16
3394.68830	0	11	0	11	12	1	12	3.10E-03	3	5.7	1.13
3394.7180	0	11	1	11	12	0	12	1.06E-03	5	8.3	1.16
3395.1037	0	10	2	9	11	1	10	2.60E-03	3	-0.7	1.13
3397.13710	-3	5	2	4	6	3	3	1.10E-02	2	10.8	1.10
3401.7086	-4	8	2	6	9	3	7	2.15E-03	5	2.39E-03	1.12
3404.29380	17	3	0	3	4	3	2	4.11E-03	2	-3.2	1.08
3405.0670	74	9	3	7	10	2	8	6.22E-04	10	1.14E-03	1.11
3412.8200	2	7	1	6	7	4	3	2.70E-04	5	1.7	0.91
3415.0[illegible]10	10	7	2	5	8	3	6	1.39E-02	2	-3.5	1.11
3415.4343	3	4	[illegible]	2	5	4	1	8.37E-02	2	-1.5	1.09
3416.0344	13	9	1	8	10	2	9	6.65E-03	3	-1.2	1.13
3416.6569	10	4	3	1	5	4	2	2.94E-02	3	3.2	1.08
3416.80447	5	10	0	10	11	1	11	2.64E-03	3	1.5	1.11
3416.8328	24	10	1	10	11	0	11	8.00E-03	3	2.5	1.13
3417.5616	30	9	2	8	10	1	9	2.10E-03	4	-6.7	1.11
3424.04570	16	4	1	4	5	2	3	2.22E-02	2	9.3	1.10
3424.2770	4	10	5	6	11	4	7	1.36E-03	4	3.25E-04	1.01
3434.09145	23	8	3	6	9	2	7	3.50E-03	3	7.35E-03	1.11
3436.48868	1	4	2	3	5	3	2	7.30E-02	4	3.1	1.07
3436.92655	12	8	1	7	9	2	8	4.98E-03	2	-2.9	1.13
3438.6395	-7	9	0	9	10	1	10	1.85E-02	2	-1.1	1.11
3438.6952	13	9	1	9	10	0	10	6.25E-03	3	0.1	1.13
3440.1832	-5	8	2	7	9	1	8	1.42E-02	3	-8.2	1.14
3441.78372	4	5	2	3	6	3	4	4.79E-02	2	-4.4	1.11
3441.99933	1	3	3	1	4	4	0	4.39E-02	2	-9.6	1.11
3442.15248	1	3	3	0	4	4	1	1.33E-01	2	-8.7	1.10
3444.969	178	8	6	3	8	7	2	1.41E-04	10	7.79E-05	
*3448.0297	-108	7	6	1	7	7	0	2.63E-04	5	3.72E-05	1.15
3450.0200	45	10	1	10	10	2	9	9.33E-04	3	3.8	0.97
3450.5296	-49	10	0	10	10	1	9	2.95E-04	8	-1.7	0.92
3455.1094	19	11	1	10	11	2	9	2.43E-04	10	1.94E-04	0.93
3456.017	-95	10	5	6	10	6	5	1.64E-04	10	-6.4	0.96
3456.60566	0	7	1	6	8	2	7	2.97E-02	3	-3.9	1.12
3456.88380	1	4	2	2	5	3	3	3.42E-02	2	2.93E-02	1.09
3460.2020	-3	8	0	8	9	1	9	1.30E-02	2	-3.3	1.12
3460.28555	-1	8	1	8	9	0	9	3.98E-02	2	-1.3	1.14
3461.91460	-19	5	0	5	5	3	2	1.30E-03	5	-6.3	1.08
3463.39300	-1	7	2	6	8	1	7	9.22E-03	6	1.03E-02	1.16
3466.3566	3	7	3	5	8	2	6	1.60E-03	3	4.52E-03	1.12
3469.25840	-13	3	2	2	4	3	1	4.41E-02	2	-2.8	1.11
3472.0106	-31	9	5	4	9	6	3	1.33E-04	10	3.84E-04	0.96
3472.5725	-13	9	1	9	9	2	8	8.05E-04	4	-0.3	0.97
3473.0695	53	8	5	4	8	6	3	2.75E-04	5	6.70E-04	1.03
3473.2900	-27	8	5	3	8	6	2	1.39E-04	10	2.25E-04	
3473.67860	0	9	0	9	9	1	8	2.56E-03	3	5.4	1.03
3474.00568	-5	3	1	3	4	2	2	1.75E-02	2	7.1	1.11
3474.60650	12	6	1	5	7	2	6	1.77E-02	2	-1.9	1.11
3475.1073	9	7	5	3	7	6	2	2.21E-04	2	3.12E-04	1.04
3475.17768	-17	7	5	2	7	6	1	6.40E-04	2	9.39E-04	0.96
3476.75233	2	3	2	1	4	3	2	1.41E-01	2	-2.5	1.09
3477.2590	83	6	5	2	6	6	1	9.20E-04	2	5.1	1.03
3477.274	205	6	5	1	6	6	0	3.07E-04	2	5.2	1.02
3479.0153	-1	9	5	5	10	4	6	1.82E-03	3	3.11E-04	1.11
3481.36027	-1	7	0	7	8	1	8	7.47E-02	3	-3.6	1.14
3481.62225	7	7	1	7	8	0	8	2.45E-02	3	-5.2	1.12
3485.5970	14	10	6	5	11	5	6	2.67E-04	5	2.31E-04	1.03
3486.1315	-69	4	0	4	4	3	1	5.60E-04	4	6.79E-04	1.03
3487.8996	16	6	2	5	7	1	6	4.35E-02	4	5.33E-02	1.14
3488.65627	-56	10	3	8	10	4	7	5.10E-04	10	3.61E-04	0.98
3490.65700	-6	5	1	4	6	2	5	8.60E-02	2	3.5	1.13
3494.1101	-29	9	2	8	9	3	7	7.80E-04	4	6.68E-04	1.06
3494.62920	0	8	1	8	8	2	7	6.03E-03	2	1.4	1.02
3494.8691	0	11	2	9	11	3	8	1.70E-04	10	1.03E-04	0.93
3496.3235	0	8	4	5	8	5	4	1.39E-03	3	1.94E-03	0.99
3497.0008	4	8	0	8	8	1	7	2.01E-03	4	1.2	1.00
3497.57910	-1	2	2	1	3	3	0	1.93E-01	3	-10.8	1.12
3499.11505	23	2	2	0	3	3	1	6.60E-02	4	-9.3	1.13
3499.1918	25	7	4	4	7	5	3	5.30E-04	10	1.27E-03	0.86
3499.5165	55	10	5	5	11	4	8	1.77E-04	10	1.38E-04	1.04
3501.5348	17	6	3	4	7	2	5	4.35E-03	3	2.05E-02	1.19
3502.11675	-7	6	0	6	7	1	7	4.18E-02	2	-2.1	1.14
3502.76103	9	6	1	6	7	0	7	1.24E-01	2	-2.5	1.14
3503.6158	-10	9	3	7	9	4	6	4.10E-04	10	5.71E-04	0.84
3505.60366	-3	4	1	3	5	2	4	3.97E-02	2	-8.8	1.11
3506.1022	24	9	1	8	9	2	7	2.26E-03	2	-8.7	0.97
3507.6665	17	7	4	3	7	5	2	1.55E-03	3	5.81E-03	0.95
3507.7966	40	6	4	2	6	5	1	7.53E-04	2	3.54E-03	0.97
3508.60445	-7	5	4	1	5	5	0	2.80E-03	4	1.35E-02	1.01
3509.2155	51	8	4	4	8	5	3	2.70E-04	10	8.79E-04	0.80
3509.3060	4	5	4	2	5	5	1	5.44E-04	3	4.53E-03	0.97
3512.97063	7	9	4	5	9	5	4	4.53E-04	4	1.04E-03	0.90
3513.24033	-14	8	2	7	8	3	6	5.30E-03	4	-0.1	0.96
3514.56710	4	5	2	4	6	1	5	1.86E-02	3	2.73E-02	1.13
3515.65455	-10	8	3	6	8	4	5	3.40E-03	3	-12.1	0.94
3515.93681	11	7	1	7	7	2	6	4.20E-03	3	-2.4	0.99

* asterisk denotes a doubled absorption with the quantum assignment given for the stronger transition. The strength given represents the sum of the strengths of the two comparable transitions.
o-c are observed minus computed line positions in $cm^{-1} \times 10^{3}$. Computed values derived from energy levels given in table 2 and ground state levels given in ref. 14.
%a are estimated uncertainties in the measured line strengths given in percent
a. (o-c)% is the percent difference between the observed and computed line strength or the value of the computed strength if the difference between the observed and computed values is ≈±12% or larger in magnitude.
R is the ratio of the observed line strength derived in this study to the computed value given in ref. 13

$$R(\mathrm{L}, \mathrm{U}) = \sum_j u(j)\mathrm{x}(j)$$

$$x(j) = \langle V'', J'', K_a'', K_c'' | A(j) | V', J', K_a', K_c' \rangle, \qquad (2)$$

TABLE VI—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)X[a]	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)X[a]	R
3516.22184	1	2	1	2	3	2	1	1.04E-01	2	-7.0	1.11	3615.60512	-16	1	1	1	2	0	2	3.35E-02	2	-4.6	1.14
3516.6177	42	9	5	4	10	4	7	1.95E-03	3	4.9	1.11	3620.71587	-1	4	4	0	5	3	3	3.53E-02	6	2.53E-03	1.17
3517.2980	24	8	5	4	9	4	5	7.27E-03	2	2.81E-03	1.09	3623.6289	10	2	0	2	2	1	1	6.94E-02	3	0.2	1.11
3520.6649	21	7	0	7	7	1	6	1.31E-02	2	-5.1	1.01	3626.1760	14	3	3	0	4	2	3	1.70E-02	5	1.05E-02	1.16
3520.94429	5	3	1	2	4	2	3	1.57E-01	4	0.4	1.15	3631.02665	-1	1	0	1	1	1	0	1.93E-01	5	-2.7	1.13
3522.29740	0	5	0	5	6	1	6	1.88E-01	3	1.1	1.14	3632.2644	8	4	2	2	5	1	5	1.90E-01	4	2.04E-03	1.20
3523.84115	0	5	1	5	6	0	6	5.97E-02	3	-2.4	1.11	3639.6409	-44	2	2	0	3	1	3	3.80E-04	5	3.71E-03	1.06
3524.6829	-15	7	3	5	7	4	4	2.54E-03	3	-4.2	1.00	3641.3800	-16	6	1	6	5	2	3	2.30E-04	10	1.07E-04	1.31
3526.69153	0	9	6	3	10	5	6	6.51E-04	3	1.03E-03	1.16	3641.81995	-13	5	2	3	6	1	6	2.89E-02	2	3.03E-03	1.22
3530.1259	-22	7	2	6	7	3	5	4.06E-03	2	9.5	0.99	3653.6822	13	3	1	3	2	2	0	1.32E-03	2	1.91E-03	1.03
3530.9546	12	6	3	4	6	4	3	1.39E-02	2	-6.9	1.03	3654.2281	18	5	1	5	4	2	2	2.60E-04	5	3.36E-04	1.02
3532.6135	-7	8	1	7	8	2	6	1.97E-03	3	-4.2	0.94	3658.40514	30	4	1	4	3	2	1	2.64E-03	3	3.71E-03	1.11
3535.0175	3	5	3	3	5	4	2	6.40E-03	4	7.90E-03	1.02	3659.8255	39	5	3	2	4	4	1	9.32E-04	6	7.74E-04	1.13
3536.08780	-9	6	1	6	6	2	5	2.52E-02	2	3.3	1.02	3659.9097	-72	4	2	3	3	3	0	2.04E-03	3	2.56E-03	1.25
3537.58365	1	4	3	2	4	4	1	1.91E-02	3	2.65E-02	1.09	3667.01914	0	1	1	0	1	0	1	1.80E-01	3	-5.8	1.14
3537.67585	11	5	3	2	5	4	1	2.52E-02	2	10.6	1.05	3667.9294	33	8	4	5	9	1	8	4.85E-04	3	1.96E-03	1.34
3537.96330	1	2	1	1	3	2	2	5.90E-02	2	-0.8	1.11	3672.79177	1	2	1	1	2	0	2	6.42E-02	2	-1.5	1.14
3538.27428	0	8	5	3	9	4	6	1.67E-03	3	1.08E-03	1.14	3675.3854	-8	4	2	2	3	3	1	1.10E-03	3	9.31E-04	1.07
3538.5285	10	4	3	1	4	4	0	6.90E-03	3	8.74E-03	1.06	3681.66875	-5	2	0	2	1	1	1	2.20E-02	2	-8.6	1.13
3541.32775	-2	6	4	3	7	3	4	1.04E-01	3	8.93E-03	1.11	3683.1610	-2	3	2	1	3	1	2	9.40E-02	2	1.22E-01	1.12
3541.61900	3	4	0	4	5	1	5	8.23E-02	2	3.2	1.14	3683.22772	-3	3	1	2	3	0	3	1.37E-01	2	1.9	1.13
3543.85692	-7	4	2	3	5	1	4	5.50E-02	2	7.97E-02	1.13	3685.53272	0	1	1	1	0	0	0	4.00E-02	3	-6.1	1.15
3544.21108	-6	6	2	5	6	3	4	2.56E-02	2	2.10E-02	1.08	3686.08862	0	3	1	2	2	2	1	1.22E-02	3	1.46E-02	1.15
3544.92335	17	6	0	6	6	1	5	8.72E-03	3	-4.0	1.00	3686.4206	-15	2	2	0	2	1	1	2.52E-02	5	3.19E-02	1.15
3545.15733	-4	4	1	4	5	0	5	2.30E-01	5	-0.4	1.13	3688.8058	1	5	2	3	5	1	4	1.00E-01	3	5.58E-02	1.18
3545.7960	-51	10	4	6	11	3	9	1.50E-04	10	2.78E-04		3694.27147	-5	7	3	4	7	2	5	2.26E-02	2	9.85E-03	1.06
3546.8345	61	9	2	7	9	3	6	2.06E-03	3	11.2	0.96	3695.76645	9	6	3	3	6	2	4	2.70E-02	3	6.54E-03	1.12
3549.0251	55	7	3	4	7	4	3	5.80E-03	4	6.66E-03	0.95	3697.31010	0	5	3	2	5	2	3	5.96E-02	2	3.24E-02	1.18
3550.74968	8	1	1	1	2	2	0	5.41E-02	2	-3.2	1.11	3698.2101	41	6	3	4	7	0	7	1.46E-03	10	1.89E-03	1.08
3551.01323	-4	8	6	3	9	5	4	1.29E-03	4	1.56E-03	1.17	3698.53787	0	4	1	3	4	0	4	2.58E-02	2	5.0	1.13
3552.7502	48	8	3	5	8	4	4	1.00E-03	3	3.5	0.89	3698.9665	0	8	3	5	8	2	6	2.30E-03	4	1.43E-03	0.99
3552.8370	-56	7	5	3	8	4	4	3.60E-03	7	1.50E-03	1.18	3699.4932	1	6	2	4	6	1	5	1.28E-02	3	8.55E-03	1.11
3553.6292	-88	8	6	2	9	5	4	4.05E-04	5	5.34E-04	1.13	3699.7145	-8	10	4	6	10	3	7	1.69E-04	10	9.7	0.76
3554.5192	1	5	1	5	5	2	4	1.48E-02	3	6.4	1.04	3700.89757	2	2	2	1	2	1	2	5.15E-02	2	6.52E-02	1.16
3555.15095	-1	5	2	4	5	3	3	1.30E-02	2	1.17E-02	1.03	3703.26600	-21	2	1	2	1	0	1	1.42E-01	2	-1.4	1.19
3557.16383	10	7	4	3	8	3	6	3.31E-02	2	6.36E-03	1.15	3704.59660	0	3	0	3	2	1	2	9.91E-02	2	-7.5	1.13
3557.29828	4	1	1	0	2	2	1	1.95E-01	4	0.3	1.13	3707.8745	-19	5	2	3	4	3	2	1.54E-03	2	2.88E-03	1.00
3558.06695	0	7	1	6	7	2	5	1.53E-02	3	3.3	0.97	3708.3930	1	3	2	2	3	1	3	1.93E-02	3	2.21E-02	1.15
3559.7567	1	3	0	3	4	1	4	2.88E-01	4	7.5	1.17	3709.0925	0	8	4	4	8	3	5	3.55E-03	3	7.72E-04	1.23
3562.7166	2	7	5	2	8	4	5	9.20E-03	2	4.90E-03	1.15	3709.6451	5	9	3	6	9	2	7	1.97E-03	5	9.0	0.95
3562.92604	15	4	2	3	4	3	2	5.40E-02	2	4.92E-02	1.11	3715.0161	13	4	1	3	3	2	2	5.42E-03	3	7.39E-03	1.06
3565.56575	0	8	2	6	8	3	5	1.95E-03	3	12.1	0.93	3715.10949	-4	7	2	5	7	1	6	1.34E-02	2	1.07E-02	1.03
3567.23117	-1	3	1	3	4	0	4	8.20E-02	3	0.7	1.15	3716.0330	-9	8	3	6	9	0	9	3.90E-04	8	1.29E-03	1.42
3567.86660	13	3	2	2	3	3	1	1.65E-02	7	3.3	1.18	3717.06120	4	5	1	4	5	0	5	3.88E-02	2	6.4	1.13
3569.28317	6	5	0	5	5	1	4	5.18E-02	2	2.7	1.06	3718.38890	-5	4	2	3	4	1	4	4.38E-02	2	-6.1	1.12
3570.3450	-12	8	7	2	9	6	3	2.90E-04	5	0.1	1.31	3718.53780	5	3	1	3	2	0	2	4.33E-02	2	-4.8	1.14
3570.58391	-3	4	1	4	4	2	3	7.04E-02	2	10.7	1.10	3719.31985	-20	7	4	3	7	3	4	3.25E-02	2	4.91E-03	1.13
3573.73685	1	3	2	1	3	3	0	4.91E-02	3	-1.6	1.10	3721.6070	-3	4	3	2	4	2	3	1.36E-02	10	3.81E-02	1.12
3577.2544	8	7	2	5	7	3	4	1.56E-02	5	1.26E-02	1.03	3725.26665	0	4	0	4	3	1	3	3.16E-02	2	-3.7	1.14
3579.8075	-11	7	6	2	8	5	3	6.50E-04	5	-2.2	1.26	3725.3935	0	5	3	3	5	2	4	5.60E-03	3	8.17E-03	1.10
3580.64855	-1	7	6	1	8	5	4	1.94E-03	3	-3.6	1.26	3729.30068	-5	6	4	2	6	3	3	3.12E-02	2	3.39E-03	1.13
3581.43750	3	5	2	3	5	3	2	4.34E-02	4	5.3	1.06	3731.53661	-3	6	3	4	6	2	5	1.25E-02	2	-7.7	1.09
3582.06325	-1	6	2	4	6	3	3	9.70E-03	3	8.45E-03	1.00	3732.86740	-5	4	1	4	3	0	3	1.07E-01	3	-1.7	1.16
3583.70928	0	3	1	3	3	2	2	3.15E-02	8	2.70E-02	1.21	3733.3994	-13	8	2	6	8	1	7	1.56E-03	3	0.2	1.06
3584.37525	0	5	4	2	6	3	3	8.55E-02	3	3.38E-03	1.14	3735.86750	-8	9	5	4	9	4	5	2.56E-03	2	1.30E-03	1.13
3584.75247	-1	6	5	2	7	4	3	1.29E-02	3	5.68E-03	1.21	3736.35793	-5	6	1	5	6	0	6	5.63E-03	2	-1.3	1.07
3590.40633	-6	6	3	3	7	2	6	2.95E-02	2	2.29E-03	1.16	3736.5585	-28	5	4	1	5	3	2	2.04E-01	5	1.89E-02	1.21
3590.68442	-2	2	1	2	3	0	3	1.97E-01	3	-1.6	1.14	3737.8627	-7	2	2	1	1	1	0	1.13E-01	4	-1.8	1.18
3592.8100	-23	7	3	4	8	2	7	1.08E-02	2	3.55E-03	1.17	3739.9811	-2	7	3	5	7	2	6	2.20E-03	8	-5.9	1.06
3593.54533	2	2	1	2	2	2	1	7.44E-02	3	0.1	1.10	3740.60958	-5	4	4	0	4	3	1	8.00E-02	3	8.23E-03	1.15
3594.06145	1	1	0	1	2	1	2	2.23E-01	2	2.0	1.13	3740.9863	1	8	4	5	8	3	6	4.35E-04	3	3.26E-03	0.96
3595.94935	2	5	1	4	5	2	3	7.75E-02	2	6.80E-02	1.04	3742.09766	-5	4	4	1	4	3	2	2.95E-01	2	2.51E-02	1.18
3596.90500	1	5	4	1	6	3	4	1.33E-01	3	1.08E-02	1.16	3742.38905	-3	5	4	2	5	3	3	1.21E-01	3	6.63E-03	1.21
3603.2794	4	8	3	5	9	2	8	6.50E-04	3	1.6	1.18	3742.48740	-33	5	1	4	4	2	3	1.57E-02	2	2.15E-02	1.13
3605.3125	8	4	1	3	4	2	2	4.11E-02	2	3.73E-02	1.05	3743.81515	8	5	0	5	4	1	4	6.85E-02	2	1.0	1.15
3607.03275	-8	4	3	1	5	2	4	2.54E-02	4	4.92E-03	1.25	3744.24750	-4	6	2	5	6	1	6	1.40E-02	2	-0.2	1.09
3607.14388	-4	6	6	1	7	5	2	1.67E-03	4	2.9	1.28	3747.4538	43	5	1	5	4	0	4	2.30E-02	3	-4.0	1.11
3607.3572	-22	6	6	0	7	5	3	5.50E-04	4	1.7	1.27	3750.3763	-43	8	3	6	8	2	7	3.00E-03	2	3.77E-03	1.09
3607.93607	-1	2	1	1	2	2	0	3.55E-02	2	2.0	1.11	3753.1957	86	10	4	7	10	3	8	2.79E-04	10	1.17E-03	1.34
3608.76522	8	3	1	2	3	2	1	1.48E-01	5	8.6	1.10	3753.65303	5	7	5	2	7	4	3	1.66E-02	2	5.85E-03	1.14
3610.70229	-5	3	0	3	3	1	2	1.57E-01	4	4.6	1.11	3754.74185	-16	7	1	6	7	0	7	7.36E-03	2	-7.4	1.10
3612.93675	0	0	0	0	1	1	1	5.10E-02	2	-3.8	1.10	3755.1724	0	3	2	2	2	1	1	2.88E-02	3	2.8	1.15
3613.7004	20	5	5	1	6	4	2	3.06E-03	3	1.48E-03	1.18	3755.86088	8	8	5	4	8	4	5	1.03E-02	2	3.29E-03	1.15
3614.85586	-10	5	5	0	6	4	3	9.10E-03	2	4.49E-03	1.18	3756.1899	37	9	5	5	9	4	6	1.76E-03	3	6.08E-04	1.09

where $u(j)$ are the dipole moment coefficients, $A(j)$ are the transformed transition moment operators, and prime and double prime denote upper and lower states, respectively. $x(1)$ is the matrix element of the direction cosines in which $A(1) = \Phi_\alpha$ with $\alpha = z$ for A-type transitions and $\alpha = x$ for B-type transitions. The asymmetric top wave functions, $AS(V, J, K_a, K_c)$, are expressed as an expansion of the symmetry-adapted wave functions, $s(J, K, \gamma)$, as

$$AS(V, J, K_a, K_c) = \Psi_v C(J, K_a, K_c | J, K, \gamma) s(J, K, \gamma), \tag{3}$$

where the C's are coefficients of the wave functions, thus expressing the lower and upper state wave functions in terms of symmetry-adapted rotational wave functions.

TABLE VI—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%a	(o-c)%[a]	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%a	(o-c)%[a]	R
3757.38043	-39	7	5	3	7	4	4	6.24E-03	2	2.08E-03	1.14	3898.9003	35	7	5	2	7	2	5	6.90E-04	5	1.44E-03	1.30
3758.27905	6	6	5	1	6	4	2	9.77E-03	2	3.73E-03	1.18	3903.14248	-13	8	4	5	7	3	4	7.50E-03	6	1.62E-03	1.13
3758.9016	25	7	2	6	7	1	7	2.02E-03	2	2.32E-03	1.02	3905.6591	-27	6	5	2	5	4	1	1.04E-02	2	1.39E-02	0.98
3759.4189	-40	6	5	2	6	4	3	3.16E-02	2	1.14E-02	1.22	3905.9221	-19	6	5	1	5	4	2	3.24E-03	3	4.65E-03	0.97
3760.8871	-51	6	0	6	5	1	5	1.28E-02	2	1.6	1.11	3906.8195	-19	9	4	5	9	1	8	3.50E-04	4	8.79E-04	1.37
3761.09617	14	5	5	0	5	4	1	3.41E-02	3	1.57E-02	1.21	3909.2287	5	6	5	1	6	2	4	1.88E-04	8	4.02E-04	
3761.34350	0	5	5	1	5	4	2	1.12E-02	2	5.26E-03	1.19	3910.0174	3	9	4	6	8	3	5	3.30E-04	4	4.15E-04	1.01
3762.4918	-19	6	1	6	5	0	5	4.10E-02	2	4.3	1.16	3913.48696	0	7	4	3	6	3	4	6.04E-02	3	3.67E-03	1.14
3767.0360	-2	6	1	5	5	2	4	3.40E-03	6	5.47E-03	1.11	3915.4576	-2	6	2	4	5	1	5	1.28E-03	5	9.05E-04	1.08
3767.6193	-28	9	6	3	9	5	4	1.24E-03	2	2.03E-03	1.14	3920.731	61	5	5	0	5	2	3	1.84E-04	10	6.24E-04	1.36
3769.33458	-2	4	2	3	3	1	2	5.80E-02	2	0.3	1.14	3924.2733	-23	7	3	4	6	2	5	1.58E-02	2	2.80E-03	1.12
3771.4219	67	7	2	5	6	3	4	5.96E-04	10	1.19E-03	1.08	*3924.6652	112	6	6	1	5	5	0	1.11E-03	3	2.31E-02	0.64
3771.9234	-20	8	1	7	8	0	8	8.40E-04	10	1.28E-03	0.96	3927.0892	0	7	5	3	6	4	2	5.79E-03	4	1.78E-03	1.08
3772.4426	31	8	6	2	8	5	3	1.10E-03	10	-7.2	1.28	3928.3197	-10	7	5	2	6	4	3	1.45E-02	2	5.49E-03	1.07
3773.25688	5	8	6	3	8	5	4	3.16E-03	2	3.60E-03	1.20	3943.65936	-3	8	4	4	7	3	5	6.19E-03	2	6.84E-04	1.10
3773.9475	-9	8	2	7	8	1	8	2.60E-03	6	3.56E-03	1.07	3946.79713	-7	8	5	4	7	4	3	1.92E-02	4	2.92E-03	1.14
3774.8391	5	10	3	8	10	2	9	3.55E-04	10	1.41E-03	1.09	3946.8992	6	7	6	2	6	5	1	1.00E-03	10	2.11E-03	0.96
3775.8140	5	7	6	1	7	5	2	6.06E-03	3	4.0	1.25	3948.5066	18	4	4	1	3	1	2	6.60E-03	8	6.34E-04	1.18
3776.0235	3	7	6	2	7	5	3	2.05E-03	2	5.1	1.27	3950.8572	-53	8	5	3	7	4	4	3.80E-03	3	1.07E-03	1.09
3777.01279	0	7	0	7	6	1	6	1.85E-02	5	3.6	1.12	3957.94083	9	6	3	4	5	0	5	2.91E-03	3	1.38E-03	1.03
3777.05526	-2	3	2	1	2	1	2	1.00E-01	3	5.00E-02	1.17	*3963.2188	4	7	7	0	6	6	1	8.20E-04	4	3.78E-04	0.71
3777.68810	-20	7	1	7	6	0	6	6.30E-03	4	3.2	1.13	3963.2737	14	10	5	6	9	4	5	8.80E-03	3	1.73E-03	1.13
3778.2333	21	6	6	0	6	5	1	2.54E-03	3	1.0	1.26	3964.2297	-2	9	5	5	8	4	4	6.47E-03	3	7.29E-04	1.14
3778.2711	28	6	6	1	6	5	2	7.60E-03	3	0.7	1.26	3968.1822	6	5	4	2	4	1	3	8.40E-03	4	4.02E-04	1.13
3780.9441	8	5	2	4	4	1	3	1.08E-02	2	1.25E-02	1.10	3968.4220	-22	8	6	3	7	5	2	3.13E-03	2	-6.7	0.98
3788.0438	-3	9	1	8	9	0	9	9.45E-04	10	2.06E-03	1.02	3968.65800	-15	8	6	2	7	5	3	1.12E-03	4	-0.2	1.07
3788.0692	24	7	1	6	6	2	5	5.18E-03	2	1.12E-02	1.11	3971.45762	-1	7	2	5	6	1	6	1.93E-03	3	1.28E-03	1.08
3788.4595	13	3	3	0	3	0	3	1.93E-03	4	1.50E-03	1.07	3972.5910	-5	8	3	5	7	2	6	1.43E-03	4	5.97E-04	1.19
3789.88881	-1	3	3	1	2	2	0	4.45E-02	3	2.87E-02	1.21	3973.420	128	11	5	7	10	4	6	1.99E-04	10	4.15E-04	1.19
3789.938	-100	8	7	1	8	6	2	4.00E-04	10	5.55E-04	1.44	3974.4312	58	9	5	4	8	4	5	6.05E-03	5	2.67E-03	1.09
3789.9730	0	8	7	2	8	6	3	1.10E-03	10	1.67E-03	1.31	3979.7447	61	4	4	0	3	1	3	6.87E-04	10	1.42E-04	1.15
3791.23336	11	6	2	5	5	1	4	1.65E-02	2	2.31E-02	1.12	3979.8770	9	9	4	5	8	3	6	4.73E-03	3	2.12E-03	1.08
3791.32021	-3	3	3	0	2	2	1	1.90E-01	2	8.61E-02	1.22	3982.51683	4	6	4	3	5	1	4	4.08E-02	3	1.40E-03	1.14
*3792.2400	206	7	7	0	7	6	1	1.88E-03	2	2.15E-03	1.20	*3985.2273	130	8	7	2	7	6	1	1.28E-03	4	4.06E-04	0.91
3792.76555	0	8	1	8	7	0	7	7.60E-03	3	-0.7	1.19	3988.9214	0	9	6	4	8	5	3	7.80E-04	4	8.66E-04	1.05
3799.9673	29	4	3	1	4	0	4	3.50E-03	7	8.02E-04	1.17	3989.8633	16	9	6	3	8	5	4	2.22E-03	3	2.65E-03	1.04
*3803.5874	6	8	8	1	8	7	2	3.30E-04	8	4.07E-06	1.29	3990.5827	-18	8	5	4	8	2	7	1.23E-04	10	1.37E-03	
3809.42793	0	4	3	2	3	2	1	9.40E-02	3	4.18E-02	1.18	*3999.2786	-57	8	8	1	7	7	0	3.17E-04	6	1.18E-02	0.65
3813.2519	-10	8	2	7	7	1	6	2.35E-03	3	8.90E-03	1.12	4000.5236	20	10	5	5	9	4	6	8.00E-04	10	0.3	1.15
3815.91200	0	4	2	2	3	1	3	3.60E-01	5	6.80E-01	1.12	4001.7330	28	7	3	5	6	0	6	7.16E-04	2	3.36E-04	1.10
3816.44518	7	4	3	1	3	2	2	1.15E-01	5	1.38E-02	1.26	4006.5808	216	9	7	3	8	6	2	2.40E-04	8	2.17E-04	0.92
3818.42190	-3	5	3	2	5	0	5	6.55E-02	3	1.67E-03	1.14	4006.6202	0	9	7	2	8	6	3	7.88E-04	3	6.50E-04	1.01
3821.9713	-4	10	0	10	9	1	9	1.84E-04	5	4.95E-04	1.16	4007.8414	-15	10	6	5	9	5	4	1.44E-03	2	2.24E-03	1.17
3822.0288	-31	10	1	10	9	0	9	5.42E-04	10	1.49E-03	1.13	4009.00233	15	7	4	4	6	1	5	2.63E-03	2	4.82E-04	1.11
3822.3872	-27	9	1	8	8	2	7	5.53E-04	2	5.98E-03	1.12	4018.4593	23	5	4	1	4	1	4	3.08E-03	4	6.51E-04	1.19
3825.10213	-10	5	3	3	4	2	2	1.56E-02	2	6.14E-03	1.19	4022.8977	51	10	4	6	9	3	7	4.10E-04	10	6.62E-04	1.13
3825.8011	-18	9	2	8	8	1	7	2.09E-04	10	2.13E-03	1.14	4024.3439	0	11	6	6	10	5	5	2.16E-04	8	5.76E-04	1.06
3836.82885	-6	6	3	4	5	2	3	1.78E-02	2	7.95E-03	1.16	4025.9305	-6	9	3	6	8	2	7	1.40E-03	3	1.71E-03	1.13
3839.08223	-1	4	4	1	3	3	0	4.42E-02	3	5.91E-02	1.05	4028.9084	53	8	2	6	7	1	7	3.90E-04	8	3.30E-04	1.08
3839.2177	13	4	4	0	3	3	1	1.02E-02	2	1.98E-02	1.06	4031.0333	0	11	5	6	10	4	7	6.83E-04	2	1.92E-03	1.18
3843.84838	-12	5	3	2	4	2	3	1.20E-00	5	1.71E-02	1.27	4032.0475	0	11	6	5	10	5	6	4.93E-04	7	1.91E-03	1.12
3843.9271	0	5	4	1	5	1	4	1.32E-02	4	1.85E-03	1.26	4037.6620	0	12	6	7	11	5	6	3.20E-04	6	1.09E-03	1.11
3845.34140	31	7	3	5	6	2	4	1.82E-03	3	1.25E-03	1.10	4048.51317	9	8	3	6	7	0	7	1.36E-03	3	1.01E-03	1.10
3846.50936	42	4	4	0	4	1	3	1.77E-03	8	2.92E-04	1.22	4062.6955	41	6	4	2	5	1	5	6.54E-04	3	2.06E-04	1.21
3846.7303	-36	6	4	2	6	1	5	4.10E-03	8	6.79E-04	1.17	4065.2945	77	6	5	2	5	2	3	3.60E-04	8	1.11E-03	1.33
3862.28275	-8	5	4	2	4	3	1	1.02E-01	2	7.29E-03	1.14	4077.8517	55	9	4	6	8	1	7	4.66E-04	4	6.89E-04	1.08
3862.99595	-5	5	4	1	4	3	2	1.22E-01	2	2.23E-02	1.13	4092.0445	33	8	5	4	7	2	5	5.65E-04	10	1.31E-03	1.28
3863.3378	5	5	2	3	4	1	4	2.15E-02	3	7.37E-03	1.26	4097.1826	-30	9	3	7	8	0	8	2.65E-04	5	4.32E-04	1.11
3875.1485	3	6	4	3	5	3	2	3.36E-01	2	7.54E-03	1.17	4110.4465	0	9	5	5	8	2	6	2.50E-04	6	5.25E-04	1.09
3876.9265	22	8	4	4	8	1	7	5.65E-04	5	3.94E-04	1.23	4113.5236	24	7	4	3	6	1	6	5.94E-04	8	5.33E-04	1.21
3882.8364	37	6	3	3	5	2	4	4.40E-02	3	2.16E-03	1.20	4120.27312	-5	10	5	6	9	2	7	2.33E-03	4	1.89E-03	1.04
3883.8905	-4	4	3	2	3	0	3	4.86E-03	3	2.08E-03	1.10	4128.9028	84	7	5	2	6	2	5	2.10E-04	10	1.34E-03	1.42
3887.31462	6	6	4	2	5	3	3	4.00E-02	2	2.73E-03	1.13	4140.4977	8	10	2	8	9	1	9	1.29E-04	10	5.47E-04	
3891.5717	-55	7	4	4	6	3	3	1.37E-02	3	9.82E-04	1.21	4146.8488	19	10	3	8	9	0	9	4.25E-04	8	1.75E-03	1.16
3892.5315	25	8	5	3	8	2	6	2.21E-04	10	4.73E-04	1.36	4152.0433	0	11	5	7	10	2	8	1.85E-04	8	6.64E-04	1.33

In terms of the F-factor formalism, Eq. (1) becomes

$$S = (\nu/\nu_0)S_v x(1)^2 g[1 - \exp(-\nu/kT)]\exp(-E_R(L)/kT)F/Q_R,$$

where

$$S_v = 8\pi^3|u(1)|^2\nu_0\exp(-E_V(L)/kT/(3hckTQ_V), \tag{4}$$

where F is the F-factor, ν_0 is the band center frequency, and S_v is the vibrational band strength. The coefficients of the F-factor, $a(j)$, are related to the coefficients, $u(j)$, of the dipole moment matrix elements, $x(j)$, by the following. Expressing F by

$$F = f^2$$

$$f = 1 + \sum_{j>1} a(j)y(j),$$

TABLE VII

Line Positions (cm^{-1}) and Strengths (cm^{-2}/atm at 296 K) Observed in the (001)–(000) Band of $H_2{}^{17}O$

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R
3225.220	-66	9	3	7	10	5	6	3.71E-04	10	2.96E-04	
3227.216	8	8	4	4	9	6	3	7.80E-04	10	3.64E-04	1.03
3243.6020	27	7	4	4	8	6	3	1.57E-03	7	7.60E-04	1.27
3247.953	-215	7	4	3	8	6	2	5.69E-04	10	2.51E-04	
3261.405	-101	8	3	6	9	5	5	4.77E-04	10	2.68E-04	
3270.060	155	6	4	3	7	6	2	6.80E-04	8	4.05E-04	
3271.3944	23	6	4	2	7	6	1	2.10E-03	8	1.21E-03	1.08
3278.9155	152	8	0	8	9	2	7	7.20E-04	4	8.51E-04	1.05
3293.7862	31	7	3	5	8	5	4	4.17E-03	2	1.81E-03	1.11
3296.2718	91	5	4	2	6	6	1	2.06E-03	3	1.29E-03	1.07
3296.570	-145	5	4	1	6	6	0	6.86E-04	10	4.29E-04	
3310.562	-393	8	3	5	9	5	4	3.41E-04	10	9.65E-04	
3320.2585	-43	7	1	7	8	3	6	2.06E-03	6	-6.4	1.10
3323.4706	-27	6	3	4	7	5	3	3.16E-03	5	1.10E-03	1.09
3323.8546	-35	7	2	6	8	4	5	3.55E-03	5	2.89E-03	1.06
3333.6635	20	8	1	7	9	3	6	1.47E-03	6	1.69E-03	1.05
3342.412	20	7	0	7	8	2	6	6.94E-04	10	8.05E-04	
3344.011	106	6	3	3	7	5	2	5.60E-04	8	3.36E-03	
3351.5641	-24	5	3	3	6	5	2	1.68E-02	2	4.67E-03	1.17
3356.01280	-5	5	3	2	6	5	1	8.00E-03	4	1.55E-03	1.11
3358.423	-85	8	2	6	9	4	5	2.10E-03	6	-9.4	1.15
3363.6912	17	6	2	5	7	4	4	4.55E-03	6	2.06E-03	1.12
3372.6415	-3	6	1	6	7	3	5	1.70E-03	5	-3.1	1.06
3378.71278	-3	4	3	2	5	5	1	5.50E-03	8	5.50E-03	1.12
3380.1616	9	4	3	1	5	5	0	1.88E-02	2	4.30E-03	1.11
3390.3370	0	7	2	5	8	4	4	1.34E-03	3	1.91E-03	0.94
3391.3778	50	7	1	6	8	3	5	1.70E-03	5	1.96E-03	1.05
3392.451	0	12	4	8	13	4	9	3.24E-04	10	6.1	
3405.54503	8	6	0	6	7	2	5	6.37E-03	4	-5.6	1.13
3408.662	0	12	3	9	13	3	10	4.92E-04	10	-2.2	
3413.9815	72	6	2	4	7	4	3	8.00E-03	5	1.03E-02	1.13
3416.4603	18	11	5	7	12	5	8	8.70E-04	4	9.2	
3418.7063	0	11	4	7	12	4	8	6.40E-04	6	4.45E-04	
3420.138	221	10	7	3	11	7	4	4.44E-04	10	3.86E-04	
3421.55647	0	5	1	5	6	3	4	1.35E-02	2	1.10E-02	1.08
*3429.4910	90	13	2	12	14	2	13	1.14E-03	5	9.6	1.14
3429.6170	-66	12	2	10	13	2	11	1.16E-03	7	8.5	1.14
3430.6666	6	10	6	4	11	6	5	1.10E-03	10	-2.0	1.19
3431.784	-371	14	1	14	15	1	15	2.68E-04	10	9.6	
3431.8150	84	11	4	8	12	4	9	1.60E-03	10	-10.9	1.07
3431.838	-18	14	0	14	15	0	15	8.48E-04	10	7.34E-04	1.20
3432.8597	-53	5	2	3	6	4	2	3.30E-03	5	4.76E-03	1.17
3434.485	58	4	2	3	5	4	2	6.80E-04	10	4.59E-03	
3436.0622	-16	10	5	5	11	5	6	2.55E-03	3	-6.4	1.14
3441.35748	-5	6	1	5	7	3	4	1.58E-02	2	1.78E-02	1.07
3446.431	-102	9	7	3	10	7	4	1.03E-03	5	-2.5	1.21
3448.8343	26	10	4	6	11	4	7	3.85E-03	6	5.13E-03	1.08
3450.4670	3	4	2	2	5	4	1	8.15E-03	3	1.56E-02	1.10
*3451.6808	-66	12	1	11	13	1	12	4.20E-03	6	3.77E-03	1.16
3451.7060	24	11	2	9	12	2	10	1.21E-03	4	-6.8	0.98
3451.9185	26	11	3	9	12	3	10	3.67E-03	4	-3.3	1.03
3453.2650	8	10	3	7	11	3	8	8.12E-03	2	4.9	1.09
*3453.74027	0	13	1	13	14	1	14	3.70E-03	7	4.0	1.08
3455.0243	-10	10	4	7	11	4	8	1.73E-03	3	1.98E-03	1.05
3457.5408	27	9	6	3	10	6	4	1.05E-03	2	-3.6	1.17
3457.8515	38	9	6	4	10	6	5	2.95E-03	4	3.27E-03	1.10
*3459.3423	-11	8	8	0	9	8	1	7.00E-04	10	6.01E-04	
3463.1081	-58	3	2	2	4	4	1	3.03E-03	3	1.13E-02	1.13
3463.8254	3	9	4	5	10	4	6	3.62E-03	4	5.62E-03	1.05
3464.75358	1	9	5	4	10	5	5	2.83E-03	3	1.8	1.23
3465.9035	8	5	0	5	6	2	4	5.94E-03	2	6.25E-03	1.13
3467.8637	-2	9	5	5	10	5	6	7.60E-03	5	-9.2	1.10
3469.4186	-17	3	2	1	4	4	0	1.70E-03	10	3.88E-03	1.19
*3472.62230	97	8	7	1	9	7	2	2.95E-03	4	-4.1	1.19
3473.4438	0	10	2	8	11	2	9	1.35E-02	2	3.9	1.10
3474.0226	-18	10	3	8	11	3	9	4.20E-03	6	1.8	1.11
*3475.5661	20	12	0	12	13	0	13	1.25E-02	4	5.9	1.11
3476.8231	12	9	3	6	10	3	7	8.86E-03	3	1.6	1.07
3478.98290	10	9	4	6	10	4	7	1.62E-02	2	1.82E-02	1.09
3480.342	160	8	3	6	8	5	3	5.25E-04	5	4.77E-04	
3481.70870	-23	5	1	4	6	3	3	1.22E-02	2	-8.2	1.11
3483.1755	11	7	1	7	7	3	4	1.20E-03	10	1.56E-03	1.09
3484.1275	63	8	6	2	9	6	3	7.50E-03	10	-6.2	1.14
3484.2264	-12	8	6	3	9	6	4	2.52E-03	4	-5.4	1.15
3487.5643	29	8	2	7	8	4	4	5.44E-04	10	-9.8	
3489.0300	72	7	3	5	7	5	2	3.13E-03	5	2.40E-03	1.05
3492.7038	26	8	5	3	9	5	4	2.10E-02	5	-3.6	1.16
3494.1016	29	8	5	4	9	5	5	7.20E-03	5	-0.9	1.19
3494.4110	-8	6	3	4	6	5	1	1.60E-03	10	9.54E-04	1.12
3494.50245	5	8	4	4	9	4	5	3.95E-02	2	4.76E-02	1.09
3494.80271	-5	9	2	7	10	2	8	1.36E-02	2	2.7	1.09
3495.42567	5	10	1	9	11	1	10	2.90E-02	2	2.9	1.09
3495.6651	0	10	2	9	11	2	10	6.31E-03	4	9.36E-03	1.11
3496.02916	2	9	3	7	10	3	8	3.56E-02	3	-2.3	1.11
*3497.19011	-17	11	1	11	12	1	12	3.70E-02	4	3.8	1.09
3498.01780	-18	5	3	3	5	5	0	3.85E-03	3	1.97E-03	1.10
3501.98243	-4	8	3	5	9	3	6	8.03E-02	3	3.1	1.10
3502.5055	-66	5	3	2	5	5	1	2.07E-03	4	6.61E-04	1.31
3503.7760	54	8	4	5	9	4	6	1.47E-02	3	-9.7	1.11
3506.81955	-16	3	1	3	4	3	2	1.65E-02	2	2.48E-02	1.15
3510.4944	-1	7	6	1	8	6	2	5.00E-03	6	-3.8	1.16
3510.51914	-7	7	6	2	8	6	3	1.47E-02	3	-5.7	1.14
3512.6484	8	4	1	3	5	3	2	5.56E-02	5	-5.1	1.17
3515.0470	-11	7	2	6	7	4	3	4.90E-03	4	5.2	1.14
3516.01675	0	8	2	6	9	2	7	1.15E-01	3	3.3	1.10
3516.93365	8	9	1	8	10	1	9	2.68E-02	3	4.3	1.11
3517.07185	3	9	2	8	10	2	9	7.95E-02	3	3.9	1.11
3518.06935	11	8	3	6	9	3	7	2.95E-02	2	-7.8	1.11
*3518.60459	-7	10	0	10	11	0	11	1.02E-01	3	4.2	1.10
3519.9433	8	7	5	2	8	5	3	1.46E-02	2	-8.1	1.09
3520.46183	5	7	5	3	8	5	4	4.54E-02	3	-4.8	1.14
3520.80085	4	4	0	4	5	2	3	4.88E-02	3	-1.9	1.16
3524.19793	-1	7	4	3	8	4	4	3.32E-02	2	3.74E-02	1.09
3527.2661	61	6	1	6	6	3	3	1.56E-03	3	-7.7	1.15
3529.26180	-1	7	4	4	8	4	5	1.00E-01	4	1.13E-01	1.07
3529.743	-55	11	0	11	11	2	10	6.44E-04	10	3.3	
3530.0106	19	11	1	11	11	1	10	1.83E-03	2	-2.2	1.28
3532.7520	-23	8	3	5	8	5	4	1.03E-03	5	1.96E-03	1.15
*3536.67495	87	6	6	0	7	6	1	2.63E-02	4	-3.9	1.15
3536.82557	2	3	1	2	4	3	1	1.62E-02	2	1.83E-02	1.14
3537.77953	35	7	2	5	8	2	6	9.65E-02	3	2.6	1.09
3538.13068	-8	8	1	7	9	1	8	1.95E-01	4	1.7	1.09
3538.48183	0	8	2	7	9	2	8	6.42E-02	3	2.1	1.11
*3539.8062	-103	9	1	9	10	1	10	2.60E-01	4	6.5	1.13
3540.50320	-5	7	3	5	8	3	6	1.90E-01	3	2.24E-01	1.12
3542.1547	3	2	1	2	3	3	1	5.10E-03	3	6.60E-03	1.17
3546.6331	-3	6	5	1	7	5	2	8.00E-02	3	-3.8	1.13
3546.78433	-3	6	5	2	7	5	3	2.65E-02	2	-4.4	1.13
3551.9280	30	10	0	10	10	2	9	5.01E-03	10	-6.8	1.21
3552.5043	-70	10	1	10	10	1	9	1.62E-03	4	-9.2	1.17
3552.91676	4	6	4	2	7	4	3	2.05E-01	3	-7.2	1.11
3555.20037	6	6	4	3	7	4	4	6.95E-02	2	-5.7	1.12
*3557.8138	4	2	1	1	3	3	0	2.65E-02	3	3.05E-02	1.17
3558.40037	0	6	3	3	7	3	4	3.31E-01	4	4.36E-01	1.06

* asterisk denotes a doubled absorption with the quantum assignment given for the stronger transition. The strength given represents the sum of the strengths of the two comparable transitions.

o-c are observed minus computed line positions in $cm^{-1} \times 10^5$. Computed values derived from energy levels given in table 2 and ground state levels given in ref. 14.

%s are estimated uncertainties in the measured line strengths given in percent

a. (o-c)% is the percent difference between the observed and computed line strength or the value of the computed strength if the difference between the observed and computed values is ≈±12% or larger in magnitude.

R is the ratio of the observed line strength derived in this study to the computed value given in ref. 13

the $a(j)$'s and $u(j)$'s are related by

$$a(j) = u(j)/u(1) \quad j > 1$$

$$y(j) = x(j)/x(1) \quad j > 1. \tag{5}$$

The matrix elements involved in $R(L, U)$ and used in this study are presented in tables in my recent papers (*1, 2*). The matrix elements involved in the *B*-type transitions

TABLE VII—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)χ^a	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)χ^a	R
3558.93537	-4	7	1	6	8	1	7	1.45E-01	2	0.6	1.08	3667.15533	0	4	0	4	4	2	3	2.98E-01	3	-6.8	1.10
3559.69107	0	7	2	6	8	2	7	4.06E-01	2	-2.9	1.08	3667.40323	6	2	2	0	3	2	1	2.33E-00	2	3.2	1.15
3560.7750	7	8	0	8	9	0	9	4.53E-01	5	9.4	1.17	3668.47145	2	2	1	1	3	1	2	4.54E-00	3	4.8	1.16
3560.7895	59	8	1	8	9	1	9	1.51E-01	5	9.5	1.17	3669.76927	0	5	1	5	5	1	4	2.47E-01	2	2.76E-01	1.15
3560.89932	-6	6	2	4	7	2	5	6.57E-01	3	3.3	1.11	3671.95675	-1	2	2	1	3	2	2	7.56E-01	2	-0.1	1.12
3561.45429	1	5	1	5	5	3	2	1.42E-02	3	1.21E-02	1.16	3677.51116	-6	3	0	3	3	2	2	1.00E-01	3	-2.8	1.14
3563.91431	8	6	3	4	7	3	5	1.17E-01	5	1.52E-01	1.09	*3677.57792	-10	9	8	2	9	8	1	3.07E-03	10	2.70E-03	1.21
3572.6549	-44	4	2	2	4	4	1	4.17E-03	3	7.65E-03	1.05	*3679.99097	0	8	8	0	8	8	1	9.60E-03	4	6.1	1.17
3572.91225	0	5	5	0	6	5	1	3.15E-02	3	-3.6	1.13	3680.1610	-3	10	4	7	10	4	6	9.70E-04	10	8.0	1.25
3573.8076	49	9	0	9	9	2	8	4.10E-03	5	4.66E-03	1.11	3680.97645	-2	2	0	2	3	0	3	5.76E-00	3	5.3	1.16
3573.9030	90	10	1	9	10	3	8	3.70E-03	4	-7.1	1.15	3682.9748	39	8	3	6	8	3	5	9.15E-03	2	1.06E-02	1.13
3580.13998	2	5	3	2	6	3	3	1.55E-01	2	2.59E-01	1.12	3683.36880	-2	2	0	2	2	2	1	1.55E-01	2	-0.5	1.16
3580.31621	1	6	2	5	7	2	6	2.37E-01	2	2.76E-01	1.09	3683.81390	-2	2	1	2	3	1	3	1.66E-00	2	3.1	1.14
3580.52545	-14	5	4	1	6	4	2	1.10E-01	3	-4.4	1.12	3686.37168	-8	6	2	5	6	2	4	4.40E-02	3	6.40E-02	1.14
3581.33120	2	5	4	2	6	4	3	3.30E-01	3	-4.4	1.12	3687.8232	46	5	1	5	4	3	2	3.00E-03	10	3.89E-03	1.07
3581.50920	1	7	0	7	8	0	8	3.03E-01	3	7.5	1.15	3690.0807	0	9	7	3	9	7	2	4.88E-03	3	4.20E-03	1.20
3581.54949	8	7	1	7	8	1	8	8.90E-01	2	5.4	1.14	3690.095	269	9	7	2	9	7	3	1.63E-03	3	1.40E-03	1.20
3582.081	97	10	2	9	10	2	8	8.45E-04	10	1.35E-03		*3692.4142	-106	8	7	1	8	7	2	2.12E-02	4	1.88E-02	1.21
3585.71122	-2	5	2	3	6	2	4	4.10E-01	2	-0.7	1.08	3694.14871	-9	4	1	4	4	1	3	2.03E-01	3	1.69E-01	1.13
3592.6803	-28	9	2	7	9	4	6	1.63E-03	5	-5.1	1.16	3694.23163	0	1	1	0	2	1	1	1.17E-00	3	1.6	1.14
3593.5992	-24	9	1	8	9	3	7	3.46E-03	3	-5.6	1.16	*3694.53016	-1	7	7	1	7	7	0	5.75E-02	4	1.9	1.13
3594.6340	39	7	2	5	7	4	4	4.17E-03	2	5.03E-03	1.11	3699.1153	0	9	4	6	9	4	5	1.08E-02	2	-2.1	1.14
3595.22505	3	8	0	8	8	2	7	2.86E-02	2	3.33E-02	1.07	3699.7558	8	10	6	4	10	6	5	2.45E-03	5	1.97E-03	1.24
3596.4919	23	8	2	6	8	4	5	8.70E-03	3	1.01E-02	1.09	3701.3400	48	9	6	4	9	6	3	7.75E-03	3	3.8	1.06
3597.83050	12	8	1	8	8	1	7	9.69E-03	2	1.11E-02	1.08	3703.41972	1	7	3	5	7	3	4	8.11E-02	3	1.02E-01	1.13
3599.69898	9	5	1	4	6	1	5	5.50E-01	3	0.9	1.09	3703.73926	13	8	6	3	8	6	2	8.95E-03	2	6.8	1.12
3601.98126	-7	6	0	6	7	0	7	1.60E-00	3	2.9	1.11	3703.82060	-49	8	6	2	8	6	3	2.75E-02	2	9.4	1.15
3602.09033	-1	6	1	6	7	1	7	5.25E-01	3	1.6	1.10	3704.67505	0	1	1	1	2	1	2	3.71E-00	2	2.6	1.14
3603.85764	-24	3	1	3	3	3	0	9.01E-03	2	1.38E-02	1.11	3705.8490	10	7	6	2	7	6	1	8.32E-02	10	9.7	1.18
3605.65730	-4	5	2	4	6	2	5	1.20E-00	3	1.44E-00	1.09	3705.8622	25	7	6	1	7	6	2	2.78E-02	10	10.0	1.18
3606.07833	2	2	0	2	3	2	1	1.47E-01	3	0.6	1.17	*3707.72703	-8	6	6	0	6	6	1	2.80E-01	3	2.0	1.12
3607.20474	-2	4	4	0	5	4	1	3.67E-01	2	0.4	1.15	3709.02822	-6	9	5	5	9	5	4	1.12E-02	2	4.6	1.10
3607.40711	1	4	4	1	5	4	2	1.20E-01	2	-1.5	1.13	3711.4733	2	5	2	4	5	2	3	5.00E-01	5	6.0	1.09
3607.90745	5	9	2	8	9	2	7	1.05E-02	2	-8.6	1.10	3712.32674	-7	8	4	5	8	4	4	1.38E-02	4	2.1	1.17
3610.61127	0	4	3	1	5	3	2	9.64E-01	3	1.10E-00	1.17	3713.0360	30	8	5	4	8	5	3	1.24E-02	6	1.23E-02	1.07
3611.15050	8	8	1	7	8	3	6	2.44E-02	2	-8.2	1.11	3714.51557	2	3	1	3	3	1	2	1.01E-00	3	6.8	1.15
3612.07096	3	4	2	2	5	2	3	2.04E-00	2	1.1	1.11	3714.7122	-1	9	5	4	9	5	5	3.78E-03	3	7.8	1.13
3614.1538	6	4	3	2	5	3	3	3.32E-01	4	-9.4	1.16	3714.88985	1	8	5	3	8	5	4	3.85E-02	3	3.68E-02	1.11
3615.8914	0	7	0	7	7	2	6	2.22E-02	2	-7.2	1.14	3715.70508	-9	7	5	3	7	5	2	1.20E-01	2	5.9	1.14
3620.94340	9	4	1	3	5	1	4	2.72E-00	2	1.2	1.11	3716.18034	8	7	5	2	7	5	3	3.88E-02	3	3.77E-02	1.11
3621.15423	-6	7	1	7	7	1	6	6.68E-02	2	-8.4	1.12	3716.8771	43	10	5	5	10	5	6	2.60E-03	5	-0.7	1.04
3622.14503	3	5	0	5	6	0	6	8.55E-01	3	0.1	1.09	3717.72466	9	6	5	2	6	5	1	9.70E-02	4	-6.2	1.02
3622.38371	0	5	1	5	6	1	6	2.58E-00	2	1.5	1.12	*3719.4000	222	5	5	1	5	5	0	1.05E-00	5	2.7	1.14
3626.51568	-1	4	2	3	5	2	4	7.40E-01	3	2.6	1.16	3720.45388	-9	7	4	4	7	4	3	1.27E-01	2	-2.9	1.10
3629.354	286	10	3	8	10	3	7	8.10E-04	10	9.21E-04	1.04	3724.54456	0	0	0	0	1	0	1	3.27E-00	2	5.3	1.17
3635.0061	-9	8	2	7	8	2	6	8.62E-03	4	1.01E-02	1.03	3725.03003	0	6	4	3	6	4	2	1.25E-01	2	1.1	1.14
3635.15025	5	6	1	5	6	3	4	8.45E-02	4	-4.1	1.16	3726.56540	18	4	2	3	4	2	2	3.99E-01	5	5.0	1.11
3635.3126	-24	6	0	6	6	2	5	1.30E-01	3	-6.3	1.14	3727.50755	6	6	4	2	6	4	3	3.66E-01	4	-0.6	1.12
3636.43000	23	1	0	1	2	2	0	2.90E-02	3	-1.1	1.15	3727.65886	-2	5	4	2	5	4	1	9.66E-01	4	3.4	1.15
3639.51600	-4	5	1	4	5	3	3	3.23E-02	2	-5.8	1.15	3728.17812	1	5	4	1	5	4	2	3.23E-01	4	3.9	1.16
3639.57711	-1	3	2	1	4	2	2	9.05E-01	2	4.6	1.16	3728.46770	-4	5	3	3	5	3	2	6.53E-01	3	6.53E-01	1.13
3640.14525	5	3	3	1	4	3	2	1.12E-00	3	6.9	1.21	3728.4945	-5	7	4	3	7	4	4	4.19E-02	2	-1.9	1.13
3641.93325	-1	4	0	4	5	0	5	3.85E-00	2	2.3	1.12	3729.32955	0	4	4	1	4	4	0	7.40E-01	5	4.2	1.15
3643.39914	2	4	1	4	5	1	5	1.20E-00	3	-2.3	1.13	3729.39313	0	4	4	0	4	4	1	2.18E-00	3	2.4	1.13
3643.87096	-3	3	1	2	4	1	3	1.28E-00	2	1.3	1.11	3730.74585	6	2	1	2	2	1	1	6.70E-01	4	9.2	1.21
3645.25547	2	6	1	6	6	1	5	4.65E-02	2	-4.7	1.17	3732.57025	3	8	4	4	8	4	5	3.43E-02	2	3.86E-02	1.11
3648.87885	6	3	2	2	4	2	3	2.65E-00	2	0.0	1.12	3733.0347	-10	3	2	1	4	0	4	4.51E-03	3	5.07E-03	1.12
3652.73610	-10	5	0	5	5	2	4	7.33E-02	3	-5.8	1.13	3733.2030	-38	4	2	2	5	0	5	4.14E-03	10	-2.5	1.08
3657.8022	44	9	3	7	9	3	6	8.40E-03	4	9.51E-03	1.08	3734.15780	37	4	3	2	4	3	1	5.80E-01	5	6.54E-01	1.13
3661.3722	-1	3	0	3	4	0	4	1.65E-00	2	1.6	1.11	3736.05490	-5	4	1	3	3	3	0	9.41E-03	3	1.08E-02	1.14
3661.96572	1	7	2	6	7	2	5	6.95E-02	3	-9.9	1.14	3736.88191	-2	3	2	2	3	2	1	2.80E-00	2	8.5	1.17
3663.32163	2	3	1	3	4	1	4	4.95E-00	2	6.8	1.17	3736.97979	6	4	3	1	4	3	2	1.72E-00	2	1.95E-00	1.16

contain 19 terms in which the elements $j = 2$ to 8 are the ones given by Flaud and Camy-Peyret (*18*) and the following 11 terms ($j = 9$ to 19) were empirically derived and found to be necessary in the $H_2{}^{16}O$ analysis (*16*) of the (010)–(000) band. The parameters used in the *A*-type transitions of the (001)–(000) bands contain the same eight elements as those derived by Flaud and Camy-Peyret (*18*).

The measured linestrengths were least-squares fitted using the expressions given in Eqs. (1)–(3) and outlined in Refs. (*1, 2*). The matrix elements of the direction cosines were computed from the vibration–rotation parameters given in literature: (000) states of $H_2{}^{17}O$ and $H_2{}^{18}O$ from Ref. (*15*), and the (100) and (001) states of $H_2{}^{17}O$ and $H_2{}^{18}O$ from Ref. (*9*). It should be noted that the measured line strengths were normalized to 100% of the isotopic sample, and these normalized values were used in the analyses. Values and associated estimated uncertainties of the matrix elements of the expanded dipole moment derived from the fits are given in Table IV. The lower portion of the entry for each band and isotopic species lists the number of lines fitted and the values of the standard deviation in percent, $\sigma\%$, of the linestrength fits. $\sigma\%$ is defined by

TABLE VII—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R
3737.18332	-5	3	3	1	3	3	0	4.52E-00	3	6.5	1.18	3859.7695	51	8	4	5	8	2	6	1.86E-03	5	2.10E-03	1.03
3737.63330	0	3	3	0	3	3	1	1.40E-00	5	-1.0	1.09	3861.37207	2	6	1	6	5	1	5	1.14E-00	3	-0.4	1.13
3737.94707	0	5	3	2	5	3	3	1.53E-01	4	2.68E-01	1.14	3862.2611	-13	6	0	6	5	0	5	3.45E-00	5	0.0	1.13
3740.2368	-2	9	4	5	9	4	6	2.20E-03	10	3.36E-03	1.09	3864.21779	-7	6	5	2	5	5	1	4.39E-02	2	3.4	1.21
3741.1288	2	6	0	6	5	2	3	7.80E-03	3	1.08E-02	1.09	3864.26428	0	6	5	1	5	5	0	1.28E-01	3	0.5	1.17
3741.71545	0	1	1	1	1	1	0	4.29E-00	2	3.1	1.15	3866.56523	6	5	1	4	4	1	3	1.15E-00	3	3.6	1.14
3742.00742	2	2	2	1	2	2	0	1.90E-00	2	1.4	1.12	3867.37264	7	7	4	4	7	2	5	8.40E-03	3	-7.7	1.13
3742.3012	-13	2	2	0	3	0	3	1.64E-02	2	-4.0	1.14	3872.4408	-10	8	1	7	8	1	8	3.21E-02	2	2.83E-02	1.11
3747.5620	16	3	0	3	2	2	0	1.38E-02	4	-1.6	1.17	3872.59353	-2	5	2	3	4	2	2	8.41E-01	4	1.8	1.13
3752.7858	7	5	0	5	4	2	2	7.62E-03	2	9.31E-03	1.10	3872.68242	-13	6	4	3	5	4	2	1.45E-01	3	-3.1	1.12
3755.1587	23	4	0	4	3	2	1	4.79E-02	3	-6.2	1.17	3873.20445	-9	6	2	5	5	2	4	5.70E-01	2	6.36E-01	1.10
3758.42541	-4	4	2	2	4	2	3	1.23E-00	4	1.09E-00	1.18	3873.81518	-1	6	4	2	5	4	1	4.50E-01	3	0.9	1.17
3759.5196	-13	5	1	4	4	3	1	7.37E-03	4	8.48E-03	1.14	3874.10341	-17	8	2	7	8	0	8	1.04E-02	3	9.28E-03	1.15
3762.35410	-8	2	1	1	2	1	2	1.98E-00	2	9.4	1.19	3875.2795	-13	10	3	8	10	1	9	1.20E-03	2	1.01E-03	1.17
3763.09489	0	7	3	4	7	3	5	3.90E-02	2	3.14E-02	1.16	3876.34528	-2	6	3	4	5	3	3	2.95E-01	3	3.43E-01	1.12
3764.4628	-53	7	2	5	6	4	2	1.43E-03	2	1.77E-03	1.21	*3876.9038	187	7	6	2	6	6	1	3.60E-02	3	-2.4	1.18
3767.6008	-10	10	4	6	10	4	7	2.85E-03	4	2.35E-03	1.16	3877.79530	0	7	1	7	6	1	6	2.20E-00	2	-0.2	1.13
3771.86095	0	1	0	1	0	0	0	1.12E-00	3	3.2	1.15	3878.18853	-1	7	0	7	6	0	6	7.15E-01	2	-2.8	1.10
3772.54413	11	5	2	3	5	2	4	1.72E-01	3	1.48E-01	1.17	3879.2933	75	3	3	0	3	1	3	2.70E-03	5	2.82E-03	1.26
3775.0478	-21	6	1	5	5	3	2	2.22E-02	2	2.61E-02	1.15	3883.34302	2	6	1	5	5	1	4	2.23E-00	3	5.4	1.16
3777.09913	0	3	1	2	3	1	3	3.32E-01	3	8.9	1.16	3884.65095	1	3	2	1	2	0	2	7.50E-02	6	7.09E-02	1.14
3779.4693	-29	8	3	5	8	3	6	4.01E-02	3	2.83E-02	1.26	3886.88269	1	7	5	3	6	5	2	1.12E-01	4	-0.2	1.17
3787.6841	27	8	2	6	7	4	3	3.12E-03	3	4.42E-03	1.07	3887.12045	-2	7	5	2	6	5	1	3.70E-02	3	-1.0	1.16
3788.78517	-5	2	1	2	1	1	1	1.40E-00	5	5.2	1.19	3888.7585	-52	11	3	9	11	1	10	1.10E-03	10	9.75E-04	1.08
3790.66726	-1	6	2	4	6	2	5	2.12E-01	2	1.76E-01	1.18	3889.0212	-5	9	1	8	9	1	9	4.11E-03	4	3.86E-03	1.08
3793.74059	1	2	0	2	1	0	1	5.76E-00	3	4.7	1.17	3889.2435	66	5	4	2	5	2	3	7.17E-03	2	8.39E-03	1.19
3795.5184	-8	4	1	3	4	1	4	5.10E-01	3	6.2	1.11	3889.7684	5	9	2	8	9	0	9	1.27E-02	4	1.15E-02	1.12
3799.39465	7	2	1	1	1	1	0	3.93E-00	3	4.1	1.16	3891.73358	-2	7	2	6	6	2	5	1.14E-00	3	-0.7	1.12
3808.39833	3	3	1	3	2	1	2	5.85E-00	3	4.3	1.18	3892.09085	0	6	3	3	5	3	2	7.00E-01	5	9.88E-01	1.12
3811.78007	-2	3	2	2	3	0	3	2.85E-01	2	2.56E-01	1.20	3893.4814	-3	4	3	1	4	1	4	7.41E-03	3	1.03E-02	1.24
3814.1/245	1	3	2	2	2	2	1	2.56E-00	3	-1.7	1.15	3893.76723	-24	8	1	8	7	1	7	4.10E-01	2	-2.8	1.11
3815.81545	-4	5	1	4	5	1	5	9.70E-02	2	8.47E-02	1.18	3893.93598	-6	8	0	8	7	0	7	1.25E-00	3	-1.2	1.12
3819.22643	0	3	2	1	2	2	0	8.35E-01	2	-2.1	1.12	3895.04478	4	7	4	4	6	4	3	2.95E-01	3	-1.3	1.18
3820.02279	-11	4	2	3	4	0	4	9.68E-02	2	6.9	1.16	3896.48315	-6	6	2	4	5	2	3	1.65E-00	2	4.0	1.13
3820.891	12	10	3	7	10	3	8	3.00E-03	10	2.25E-03	1.13	3897.21238	0	7	3	5	6	3	4	5.48E-01	2	6.22E-01	1.10
3824.03101	1	3	1	2	2	1	1	1.71E-00	3	3.8	1.16	3898.03765	4	7	1	6	6	1	5	3.95E-01	3	-1.6	1.08
3827.37698	4	4	1	4	3	1	3	1.76E-00	3	-6.6	1.15	3898.3243	3	7	4	3	6	4	2	9.69E-02	2	-1.2	1.17
3830.05664	1	4	0	4	3	0	3	6.12E-00	3	4.1	1.17	3899.1064	-27	8	6	3	7	6	2	7.06E-03	2	-2.7	1.18
3832.32782	3	8	2	6	8	2	7	3.16E-02	2	2.60E-02	1.15	3899.1504	-38	8	6	2	7	6	1	2.16E-02	2	-0.8	1.21
3832.6059	17	5	2	4	5	0	5	1.85E-01	2	-7.7	1.18	3905.4231	75	10	2	9	10	0	10	1.05E-03	5	1.45E-03	1.15
3832.77194	18	4	3	2	3	3	1	3.99E-01	2	-4.6	1.11	3908.48592	13	8	2	7	7	2	6	2.05E-01	3	1.0	1.12
3834.01784	-6	4	3	1	3	3	0	1.22E-00	2	-2.2	1.16	3909.2723	-44	8	5	4	7	5	3	2.22E-02	3	-0.1	1.18
3835.97741	-3	6	1	5	6	1	6	1.50E-01	3	1.31E-01	1.17	3909.35754	0	9	1	9	8	1	8	6.35E-01	4	-2.7	1.11
3836.16185	-4	4	2	3	3	2	2	1.03E-00	2	-3.3	1.17	3909.42886	0	9	0	9	8	0	8	2.19E-01	3	0.6	1.15
3836.52811	-4	6	3	4	6	1	5	1.87E-02	2	2.18E-02	1.14	*3909.8744	-23	9	7	3	8	7	2	4.10E-03	10	-7.3	1.18
3836.76272	-1	5	3	3	5	1	4	6.50E-02	5	7.35E-02	1.18	3910.13321	-2	8	5	3	7	5	2	6.31E-02	3	-5.0	1.12
3841.20283	-4	4	3	2	4	1	3	1.70E-02	2	-7.6	1.16	3912.0457	-8	8	1	7	7	1	6	6.22E-01	2	0.0	1.10
3841.39882	21	7	3	5	7	1	6	3.75E-02	2	4.15E-02	1.10	3915.1635	26	4	4	0	4	2	3	2.64E-03	4	3.58E-03	1.24
3842.6134	6	6	2	5	6	0	6	3.77E-02	4	-4.8	1.14	3916.62347	5	8	4	5	7	4	4	5.19E-02	2	-2.1	1.16
3844.3245	6	5	1	5	4	1	4	5.00E-00	3	5.7	1.20	3917.0206	-20	8	3	6	7	3	5	1.00E-01	5	-6.0	1.10
3846.24339	-2	5	0	5	4	0	4	1.69E-00	3	5.7	1.19	3917.3141	-24	7	2	5	6	2	4	2.90E-01	10	2.7	1.10
3846.42868	9	4	2	2	3	2	1	3.20E-00	3	4.7	1.18	3917.7180	-85	7	3	4	6	3	3	1.85E-01	4	-3.0	1.14
3846.71275	13	4	1	3	3	1	2	4.81E-00	2	6.6	1.18	3920.2097	32	5	4	1	5	2	4	1.27E-03	10	1.76E-03	1.26
3847.8411	6	3	3	1	3	1	2	2.39E-02	3	3.1	1.20	3920.3869	-16	11	2	10	11	0	11	1.89E-03	3	1.49E-03	1.29
3849.82722	-3	5	4	2	4	4	1	4.63E-01	3	1.4	1.15	3921.03359	-15	9	6	4	8	6	3	1.18E-02	3	1.15E-02	1.24
3850.10054	-2	5	4	1	4	4	0	1.56E-01	2	2.7	1.16	3921.21835	-7	9	6	3	8	6	2	4.10E-03	3	6.7	1.30
3850.53245	-7	8	3	6	8	1	7	7.21E-03	5	5.4	1.09	3921.32668	-7	4	2	2	3	0	3	2.00E-01	2	1.86E-01	1.16
3854.83625	5	5	3	3	4	3	2	1.25E-00	3	-9.1	1.16	3923.76234	-4	8	4	4	7	4	3	1.44E-01	3	-6.1	1.17
3854.8720	-50	7	1	6	7	1	7	2.50E-02	10	2.11E-02	1.20	3924.21842	-2	9	2	8	8	2	7	2.92E-01	3	1.2	1.12
3855.0654	-4	2	2	0	1	0	1	1.14E-01	3	1.07E-01	1.14	3924.5916	-19	10	1	10	9	1	9	1.00E-01	3	-1.4	1.12
3857.95078	2	5	3	2	4	3	1	3.06E-01	3	4.49E-01	1.07	3926.62428	5	10	0	10	9	0	9	2.96E-01	3	-2.7	1.11
3858.40210	1	7	2	6	7	0	7	6.60E-02	3	6.09E-02	1.14	3926.06268	-6	9	1	8	8	1	7	9.77E-02	3	0.7	1.11

$$\sigma\% = 100\{\Sigma[S_{obs} - S_{cal}]/S_{obs}]^2/N\}^{1/2}, \quad (6)$$

where N is the number of lines included in the fit. Measured linestrengths of transitions strongly affected by resonance effects were not included in the analyses. Included in Table IV are values of matrix elements derived in other studies: the (100)–(000) and (001)–(000) bands of $H_2{}^{17}O$ by Camy-Peyret *et al.* (*10*) and the (100)–(000) and (001)–(000) bands of $H_2{}^{18}O$ by Flaud *et al.* (*11*). Those studies (*10, 11*) took into account the interactions between the three vibrational states (020), (100), and (001) and comparing those results with the present values involves uncoupling the Fermi-type interaction between the (020) and (100) states. The method used in the first two papers (*1, 2*) and used here was to apply the expressions

$$C_{32} = h_{32}/(E_3 - E_2)$$

$$C_{23} = h_{32}/(E_2 - E_3)$$

$$C_{22} = C_{33} = 1\sqrt{1 - C_{23}^2}$$

TABLE VII—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)X[a]	R
3926.2243	-12	3	3	0	2	1	1	1.36E-02	3	3.9	1.15
3929.6032	-1	6	4	2	6	2	5	2.45E-03	4	4.18E-03	1.12
3931.21464	6	9	5	5	8	5	4	3.10E-02	2	-1.8	1.17
3931.2440	0	10	7	3	9	7	2	1.35E-03	7	1.56E-03	1.10
3933.6463	-30	9	5	4	8	5	3	1.00E-02	2	-3.9	1.14
3934.60240	-3	8	2	6	7	2	5	4.02E-01	3	3.0	1.10
3935.28875	-13	9	3	7	8	3	6	1.43E-01	3	0.0	1.12
3937.18297	-15	9	4	6	8	4	5	6.85E-02	3	-3.9	1.14
3939.4268	-22	10	2	9	9	2	8	2.59E-02	2	4.10E-02	1.07
3939.4868	0	11	1	11	10	1	10	1.25E-01	3	-2.7	1.12
3939.5008	0	11	0	11	10	0	10	4.18E-02	3	-2.4	1.12
3940.14202	-16	10	1	9	9	1	8	1.26E-01	3	2.0	1.13
3941.72380	1	3	3	1	2	1	2	2.54E-02	2	3.6	1.19
3942.38600	-5	8	3	5	7	3	4	2.67E-01	3	-2.5	1.06
3943.2437	-42	10	6	4	9	6	3	4.97E-03	2	2.4	1.24
3944.67539	-18	4	3	1	3	1	2	8.30E-02	4	-4.7	1.12
3948.67415	4	9	2	7	8	2	6	5.65E-02	2	5.6	1.12
3948.7878	-37	9	4	5	8	4	4	1.70E-02	2	2.21E-02	1.15
3951.94558	8	10	3	8	9	3	7	1.92E-02	3	1.7	1.12
3953.0208	52	6	3	3	6	1	6	1.22E-03	4	2.20E-03	1.15
3953.71015	5	11	2	10	10	2	9	4.70E-02	2	-0.9	1.10
*3954.0416	-168	12	0	12	11	0	11	6.55E-02	4	-0.3	1.14
3954.14803	0	11	1	10	10	1	9	1.65E-02	4	4.2	1.15
3954.8170	77	6	5	1	6	3	4	6.60E-04	10	1.34E-03	
3956.5726	12	10	4	7	9	4	6	8.80E-03	3	-4.4	1.11
3960.86377	0	10	2	8	9	2	7	6.33E-02	3	5.1	1.11
3963.7905	0	11	6	6	10	6	5	1.60E-03	4	-7.0	1.13
3964.3224	-11	9	3	6	8	3	5	4.05E-02	3	9.8	1.14
3964.99620	0	5	3	2	4	1	3	3.08E-02	3	3.78E-02	1.17
3965.4659	0	11	6	5	10	6	4	4.96E-04	6	5.69E-04	
3966.05115	-8	5	2	3	4	0	4	3.54E-02	3	6.3	1.16
3967.23550	0	11	3	9	10	3	8	2.05E-02	4	1.8	1.10
3967.7508	0	12	2	11	11	2	10	5.60E-03	4	5.53E-03	1.12
3967.9602	10	12	1	11	11	1	10	1.67E-02	2	0.6	1.11
*3968.2468	56	13	1	13	12	1	12	2.21E-02	3	-3.5	1.11
3972.5737	-25	11	2	9	10	2	8	7.50E-03	5	6.93E-03	1.15
3972.7178	-29	11	5	7	10	5	6	4.00E-03	5	-6.5	1.10
3974.6417	-23	11	4	8	10	4	7	9.20E-03	3	-2.0	1.10
3981.4034	0	13	2	12	12	2	11	5.65E-03	4	7.0	1.18
3982.1763	0	14	1	14	13	1	13	1.70E-03	5	-7.1	1.08
3982.2275	0	14	0	14	13	0	13	5.26E-03	4	-3.5	1.12
3982.66343	-7	10	3	7	9	3	6	4.15E-02	3	7.9	1.10
3983.2770	0	11	5	6	10	5	5	1.17E-03	10	1.35E-03	1.05
3984.4469	5	12	2	10	11	2	9	6.70E-03	7	6.57E-03	1.08
3987.73340	0	10	4	6	9	4	5	1.83E-02	2	2.45E-02	1.10
3991.223	0	12	4	9	11	4	8	9.20E-04	5	-2.8	1.06
3991.791	0	12	5	8	11	5	7	3.55E-04	10	4.25E-04	
3994.7863	0	14	1	13	13	1	12	1.59E-03	5	4.0	1.14
3994.9200	0	13	3	11	12	3	10	1.92E-03	4	1.9	1.08
*3995.5423	55	15	1	15	14	1	14	2.00E-03	5	-5.0	1.09
3996.517	0	13	2	11	12	2	10	7.56E-04	15	6.33E-04	

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)X[a]	R
3997.1759	0	11	3	8	10	3	7	4.10E-03	4	4.3	1.05
4000.3859	6	6	3	3	5	1	4	6.40E-02	3	9.22E-02	1.17
4003.1669	52	4	4	0	3	2	1	1.47E-02	4	-8.8	1.13
4006.2929	0	13	4	10	12	4	9	7.50E-04	10	-2.5	1.03
4007.7027	0	11	4	7	10	4	6	2.60E-03	10	1.7	1.07
4008.0670	0	12	5	7	11	5	6	9.60E-04	10	1.16E-03	1.10
4008.5360	0	12	3	9	11	3	8	3.75E-03	3	3.27E-03	1.14
4009.0869	33	4	4	1	3	2	2	4.54E-03	4	5.12E-03	1.12
4011.3379	0	5	3	3	4	1	4	2.95E-02	3	3.40E-02	1.10
4017.61577	11	6	2	4	5	0	5	4.65E-02	3	6.4	1.16
4020.2592	29	5	4	1	4	2	2	8.90E-03	4	-0.5	1.15
4026.5780	0	12	4	8	11	4	7	2.14E-03	3	3.3	1.00
4035.41910	-5	6	4	2	5	2	3	3.16E-02	3	3.8	1.12
4035.59740	4	5	4	2	4	2	3	2.15E-02	2	-6.4	1.14
4035.7085	-31	7	3	4	6	1	5	1.44E-02	3	1.62E-02	1.12
4051.1753	2	7	4	3	6	2	4	9.44E-03	4	5.4	1.08
4052.6446	-15	6	3	4	5	1	5	7.00E-03	4	7.87E-03	1.10
4064.7140	18	6	4	3	5	2	4	7.12E-03	2	-1.7	1.15
4070.6809	-8	8	4	4	7	2	5	2.00E-02	3	11.4	1.09
4073.55587	-5	7	2	5	6	0	6	6.25E-03	2	2.4	1.13
4074.8503	14	5	5	0	4	3	1	1.80E-03	10	2.27E-03	1.18
4076.21603	3	5	5	1	4	3	2	5.17E-03	2	6.80E-03	1.14
4080.36526	31	8	3	5	7	1	6	1.84E-02	3	-2.9	1.12
4094.7142	16	6	5	1	5	3	2	7.91E-03	2	9.18E-03	1.15
4096.2303	-5	9	4	5	8	2	6	3.05E-03	5	2.89E-03	1.06
4097.1404	-6	7	4	4	6	2	5	1.49E-02	2	-2.8	1.10
4098.0396	-2	7	3	5	6	1	6	1.34E-02	3	-1.4	1.16
4099.6590	21	6	5	2	5	3	3	2.40E-03	7	3.03E-03	1.08
4111.2474	-18	7	5	2	6	3	3	2.57E-03	8	-5.7	1.13
4123.8884	13	7	5	3	6	3	4	6.71E-03	3	7.92E-03	1.07
4124.5238	14	8	5	3	7	3	4	5.55E-03	2	-4.6	1.03
4131.0392	39	8	2	6	7	0	7	7.75E-03	3	-0.7	1.12
4131.8798	-82	9	3	6	8	1	7	2.00E-03	10	-6.8	1.05
4133.2492	61	8	4	5	7	2	6	2.98E-03	3	3.2	1.14
4136.2809	29	9	5	4	8	3	5	1.23E-03	2	5.4	1.04
4139.0939	-120	6	6	0	5	4	1	1.30E-03	8	2.50E-03	0.96
4145.3257	-60	10	4	6	9	2	7	1.30E-03	6	3.09E-03	1.07
4146.4698	19	8	3	6	7	1	7	2.20E-03	3	-4.4	1.09
4149.4577	-7	10	5	5	9	3	6	1.97E-03	4	1.77E-03	1.01
4149.716	-10	8	5	4	7	3	5	1.62E-03	4	-8.2	1.08
4161.961	-122	7	6	2	6	4	3	1.77E-03	5	2.92E-03	0.98
4173.0193	6	9	4	6	8	2	7	4.14E-03	3	0.7	1.09
4177.9325	56	9	5	5	8	3	6	2.55E-03	10	2.86E-03	0.99
4180.6733	-3	8	6	2	7	4	3	1.54E-03	6	2.24E-03	0.97
4184.276	-253	8	6	3	7	4	4	5.81E-04	10	7.50E-04	
4187.1303	-66	10	3	7	9	1	8	1.90E-03	3	2.11E-03	1.02
4187.7715	0	9	2	7	8	0	8	1.04E-03	4	-6.3	1.09
4196.5795	14	9	3	7	8	1	8	3.12E-03	3	-2.0	1.13
4206.695	118	9	6	4	8	4	5	9.70E-04	5	1.35E-03	0.93
4216.043	135	10	4	7	9	2	8	5.40E-04	5	-5.2	
4242.7248	8	10	2	8	9	0	9	1.25E-03	10	-10.0	1.09

$$\mu_2^{\circ}(j) = C_{22}\mu_2(j) + C_{23}\mu_3(j)$$

$$\mu_3^{\circ}(j) = C_{33}\mu_3(j) + C_{32}\mu_2(j), \qquad (7)$$

where h_{32} is the first order coupling constants between the (100) state (labeled 3) and (020) state (labeled 2). E_3 and E_2 are the observed rotationless energy levels for the (100) and (020) vibrational states and $\mu_n(j)$ are the matrix elements obtained in the other studies (*10, 11*). $\mu_n^{\circ}(j)$ are the uncoupled constants representing the other studies and the computed values are included in Table IV. The computed values of $\mu^n o(j)$ were derived from Eq. (7) using the coupling constants, h_{32}, given in Ref. (*9*) for $H_2{}^{17}O$ and $H_2{}^{18}O$ and the matrix elements, $\mu_n(j)$, given in Refs. (*10, 11*). These computed values represent a first approximation to the uncoupled constants. Higher order terms, h'_{32} etc., and more involved expressions than those given in Eq. (7) are involved in obtaining a higher order approximation of $\mu_n^{\circ}(j)$; however, the first order results given in Table IV are good approximations.

V. RESULTS

Table V lists lines of the transitions observed in the (100)–(000) bands of $H_2{}^{17}O$. Entries for the table include the observed line position, the observed minus the computed line position (o-c), rotational quantum assignments, the observed strength, the

TABLE VIII

Line Positions (cm^{-1}) and Strengths (cm^{-2}/atm at 296 K) Observed in the (001)–(000) Band of $H_2{}^{18}O$

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R
3160.6757	-33	8	5	3	9	7	2	1.95E-04	8	9.40E-05	1.04
3185.9079	72	7	5	3	8	7	2	3.20E-04	8	1.68E-04	0.98
3186.1965	34	7	5	2	8	7	1	1.20E-04	10	5.61E-05	
3203.0418	7	9	1	9	10	3	8	2.37E-04	10	5.1	1.09
3206.4359	-74	9	4	5	10	6	4	1.38E-04	10	3.85E-05	1.05
3212.4891	-116	6	5	2	7	7	1	1.25E-04	10	6.66E-05	0.99
3212.5430	15	6	5	1	7	7	0	3.88E-04	4	2.00E-04	1.03
3213.2382	38	8	4	5	9	6	4	2.20E-04	8	9.31E-05	1.09
3220.6854	31	9	3	7	10	5	6	4.10E-04	8	2.39E-04	1.16
3223.4406	-20	6	1	5	7	5	2	2.06E-04	10	1.46E-04	1.07
3224.3430	-43	8	4	4	9	6	3	7.88E-04	3	2.78E-04	1.06
3224.6604	-94	9	2	8	10	4	7	3.30E-04	5	6.6	1.01
3240.24030	-1	7	4	4	8	6	3	1.28E-03	4	5.61E-04	1.04
3244.7822	23	7	4	3	8	6	2	4.45E-04	3	1.86E-04	1.02
3253.6316	40	6	0	6	7	4	3	3.22E-04	4	2.51E-04	1.08
3257.1855	-18	8	3	6	9	5	5	4.30E-04	5	2.16E-04	1.07
3259.5662	11	8	1	8	9	3	7	2.47E-04	4	9.6	1.13
3264.0655	53	9	1	8	10	3	7	1.26E-04	10	-4.8	1.02
3266.5995	-7	6	4	3	7	6	2	7.10E-04	3	2.94E-04	1.13
3268.0240	-41	6	4	2	7	6	1	2.05E-03	3	8.81E-04	1.06
3273.64236	-42	8	2	7	9	4	6	4.20E-04	7	3.12E-04	1.19
3289.8496	10	7	3	5	8	5	4	3.77E-03	2	1.46E-03	1.07
3292.76246	-1	5	4	2	6	6	1	2.08E-03	2	9.14E-04	1.08
3293.07625	14	5	4	1	6	6	0	7.10E-04	3	3.05E-04	1.11
3306.5763	4	8	3	5	9	5	4	4.20E-04	3	8.31E-04	1.14
3309.9600	69	9	2	7	10	4	6	2.21E-04	10	5.2	1.20
3314.4620	-1	7	1	7	8	3	6	2.00E-03	4	7.7	1.09
3318.6902	-20	7	2	6	8	4	5	3.45E-03	3	2.44E-03	1.07
3319.6911	-15	6	3	4	7	5	3	2.80E-03	3	8.83E-04	1.06
3326.8121	-7	8	1	7	9	3	6	1.48E-03	4	-2.1	1.08
3335.81866	11	7	0	7	8	2	6	6.68E-04	3	-4.5	1.02
3340.4494	-37	6	3	3	7	5	2	9.50E-04	3	2.75E-03	1.02
3347.76200	-3	5	3	3	6	5	2	1.38E-02	2	3.69E-03	1.08
3352.69780	28	5	3	2	6	5	1	7.50E-03	7	1.24E-03	1.19
3354.6698	-71	4	0	4	5	4	1	6.95E-04	3	5.04E-04	1.03
3358.9514	-12	6	2	5	7	4	4	3.80E-03	3	1.76E-03	1.07
3366.8890	-18	6	1	6	7	3	5	1.72E-03	3	1.52E-03	1.09
3371.2314	10	12	5	7	13	5	8	1.43E-04	10	1.80E-04	1.11
3374.74580	-40	4	3	2	5	5	1	4.54E-03	3	1.12E-03	1.08
3376.2890	31	4	3	1	5	5	0	1.56E-02	3	3.35E-03	1.10
3384.7701	18	7	1	6	8	3	5	1.74E-03	3	-4.0	1.08
3385.1333	-45	7	2	5	8	4	4	1.70E-03	3	-3.0	1.16
3385.791	0	12	5	8	13	5	9	5.83E-05	10	6.63E-05	
3386.0034	0	12	4	8	13	4	9	2.90E-04	7	-4.5	1.01
3397.349	0	11	6	5	12	6	6	8.81E-05	10	1.07E-04	
3398.8781	-7	6	0	6	7	2	5	6.05E-03	2	-0.9	1.09
3399.2126	-27	5	2	4	6	4	3	1.80E-03	3	9.13E-03	1.01
3399.2420	-33	11	6	6	12	6	7	3.50E-04	5	9.0	1.29
3400.6453	13	11	5	6	12	5	7	2.00E-04	6	2.50E-04	1.01
3401.1606	0	14	2	13	15	2	14	7.05E-05	10	8.3	1.20
3401.1990	0	14	1	13	15	1	14	2.07E-04	7	5.8	1.18
3402.5856	-12	12	3	9	13	3	10	5.20E-04	6	3.7	1.12
3403.1527	0	12	4	9	13	4	10	1.45E-04	8	-3.5	1.12
*3403.493	115	15	1	15	16	1	16	2.60E-04	10	6.5	1.23
3409.1028	8	6	2	4	7	4	3	7.90E-03	2	9.37E-03	1.08
3410.5452	41	11	5	7	12	5	8	6.86E-04	3	7.84E-04	1.06
3412.0846	-40	11	4	7	12	4	8	3.99E-04	7	-10.8	1.00
3414.2298	-5	10	7	3	11	7	4	3.70E-04	8	1.1	1.15
3415.8977	21	5	1	5	6	3	4	1.32E-02	2	9.73E-03	1.11
*3423.4746	145	13	2	12	14	2	13	1.12E-03	7	7.7	1.20
3423.5717	-6	12	2	10	13	2	11	1.10E-03	4	2.7	1.13
3423.6405	0	12	3	10	13	3	11	3.60E-04	10	2.3	1.13
3424.596	-54	11	3	8	12	3	9	6.50E-04	10	-5.8	1.02
3424.6125	-29	10	6	4	11	6	5	1.05E-03	8	-3.5	1.12
3425.47182	3	10	6	5	11	6	6	3.50E-04	3	-3.4	1.13
3425.78306	0	14	1	14	15	1	15	2.60E-04	5	6.7	1.22
3425.8260	6	14	0	14	15	0	15	7.40E-04	3	1.2	1.17
3425.90980	2	11	4	8	12	4	9	1.57E-03	3	-8.8	1.07
*3427.6136	63	9	8	2	10	8	3	3.37E-04	2	0.7	1.11
3428.1235	-12	5	2	3	6	4	2	3.10E-03	3	4.25E-03	1.06
3428.2098	-2	6	0	6	6	4	3	4.02E-04	10	3.51E-04	1.10
3428.3583	-37	9	4	6	9	6	3	2.40E-04	4	1.72E-04	0.96
3429.6645	-43	4	2	3	5	4	2	5.05E-04	4	3.91E-03	1.08
3429.79720	-4	10	5	5	11	5	6	2.41E-03	2	-10.4	1.08
3435.09458	6	6	1	5	7	3	4	1.66E-02	2	-0.9	1.13
3435.4930	-41	7	4	4	7	6	1	6.05E-04	3	3.91E-04	1.00
3435.91120	18	10	5	6	11	5	7	8.20E-04	2	-10.5	1.08
3437.5744	-12	6	4	3	6	6	0	1.73E-04	8	9.92E-05	1.11
3439.0051	-13	6	4	2	6	6	1	5.00E-04	6	2.96E-04	1.05
3440.075	-82	7	4	3	7	6	2	1.87E-04	10	1.31E-04	0.88
3440.4672	-25	9	7	2	10	7	3	3.25E-04	7	-2.5	1.09
3440.48675	0	9	7	3	10	7	4	9.75E-04	7	-2.5	1.10
3442.2752	0	10	4	6	11	4	7	3.50E-03	2	5.10E-03	1.02
3443.9115	-14	9	2	8	9	4	5	3.40E-04	4	-5.6	0.99
3443.9708	-51	8	4	4	8	6	3	5.30E-04	6	3.08E-04	1.00
3445.74865	21	4	2	2	5	4	1	8.50E-03	2	1.36E-02	1.10
3445.85287	0	11	3	9	12	3	10	3.85E-03	2	1.0	1.12
*3447.6802	-29	13	1	13	14	1	14	3.63E-03	4	1.8	1.16
3449.08270	2	10	4	7	11	4	8	1.74E-03	3	1.97E-03	1.06
3450.560	-51	9	4	5	9	6	4	1.22E-04	5	6.13E-05	
3451.4652	28	9	6	3	10	6	4	1.00E-03	2	-5.3	1.09
3451.79844	6	9	6	4	10	6	5	3.00E-03	2	-5.2	1.09
*3453.47455	1	8	8	0	9	8	1	5.40E-04	10	-2.0	1.07
3457.8029	-38	9	4	5	10	4	6	3.80E-03	4	5.61E-03	1.07
3458.2745	-36	3	2	2	4	4	1	2.65E-03	3	9.55E-03	1.08
3458.4906	0	9	5	4	10	5	5	2.58E-03	3	-5.8	1.11
3459.2804	-6	5	0	5	6	2	4	5.74E-03	3	-2.0	1.10
3461.6130	-14	9	3	7	9	5	4	5.80E-04	3	4.59E-04	1.05
3461.7574	31	9	5	5	10	5	6	7.55E-03	2	-8.6	1.08
3464.6574	26	3	2	1	4	4	0	1.79E-03	3	3.33E-03	1.23
*3466.6315	169	8	7	1	9	7	2	3.00E-03	3	3.1	1.14
3467.2883	-3	10	2	8	11	2	9	1.31E-02	2	0.0	1.09
3467.533	-163	11	1	10	12	1	11	3.25E-03	3	3.2	1.15
3467.546	-10	11	2	10	12	2	11	9.75E-03	3	3.3	1.15
3467.9309	-6	10	3	8	11	3	9	4.03E-03	3	-3.0	1.09
*3469.4492	89	12	0	12	13	0	13	1.22E-02	2	2.6	1.16
3470.3512	-41	9	3	6	10	3	7	9.45E-03	5	7.3	1.16
3472.96498	-6	9	4	6	10	4	7	1.63E-02	2	1.82E-02	1.10
3475.80390	4	5	1	4	6	3	3	1.26E-02	2	-0.4	1.13
3475.9985	61	8	3	6	8	5	3	4.88E-04	3	3.48E-04	1.01
3476.6185	17	7	1	7	7	3	4	1.11E-03	6	-2.7	1.05
3478.01534	27	8	6	2	9	6	3	7.35E-03	3	-5.1	1.07
3478.1222	-47	8	6	3	9	6	4	2.65E-03	3	-5.1	1.07
3478.5877	0	13	1	13	13	1	12	1.34E-04	6	-9.8	
3481.6825	-47	8	2	7	8	4	4	5.60E-04	10	4.49E-04	1.22
3485.01517	28	7	3	5	7	5	2	3.11E-03	5	1.76E-03	1.07
3486.44436	9	8	5	3	9	5	4	2.00E-02	2	-7.0	1.08
3487.9183	-18	8	5	4	9	5	5	6.50E-03	6	-9.4	1.05
3488.20005	-5	8	4	4	9	4	5	4.05E-02	2	4.74E-02	1.09
3488.58395	6	9	2	7	10	2	8	1.35E-02	3	0.7	1.10
3489.24217	-6	10	1	9	11	1	10	2.95E-02	3	3.3	1.15
3489.3206	4	10	2	9	11	2	10	9.05E-03	2	-4.6	1.08
3489.93733	4	9	3	7	10	3	8	3.60E-02	3	-2.2	1.13
3490.5664	-52	6	3	4	6	5	1	1.42E-03	10	6.96E-04	1.04
*3491.0175	-6	11	1	11	12	1	12	3.58E-02	5	-0.9	1.12
*3492.7142	0	7	7	1	8	7	2	4.40E-03	7	2.9	1.13
3494.1550	-29	5	3	3	5	5	0	3.53E-03	5	1.43E-03	1.08
3495.39080	0	8	3	5	9	3	6	8.00E-02	2	2.0	1.11
3497.65490	9	8	4	5	9	4	6	1.45E-02	2	1.63E-02	1.08
3501.2720	41	3	1	3	4	3	2	1.71E-02	4	2.25E-02	1.17
3503.5796	31	13	2	12	13	2	11	9.42E-05	10	2.1	
3504.34010	35	7	6	1	8	6	2	4.88E-03	5	-3.0	1.08
3504.36708	0	7	6	2	8	6	3	1.46E-02	2	-3.3	1.08
3507.01230	9	4	1	3	5	3	2	5.55E-02	2	-0.5	1.13
3509.6264	-40	7	2	6	7	4	3	4.48E-03	4	3.63E-03	1.06
3509.70827	-5	8	2	6	9	2	7	1.14E-01	3	0.9	1.11
3510.69847	-2	9	1	8	10	1	9	2.63E-02	2	0.6	1.12
3510.84299	-57	9	2	8	10	2	9	7.95E-02	2	2.1	1.14
3512.01833	4	8	3	6	9	3	7	2.95E-02	3	-9.8	1.10
*3512.37786	-2	10	0	10	11	0	11	1.02E-01	3	2.4	1.16
3513.66850	5	7	5	2	8	5	3	1.50E-02	3	-4.4	1.09
3514.21690	11	7	5	3	8	5	4	4.57E-02	2	-2.9	1.11
3514.30480	-7	4	0	4	5	2	3	4.78E-02	2	-0.3	1.13
3517.80624	7	7	4	3	8	4	4	3.41E-02	2	-10.0	1.10
3521.0407	-14	6	1	6	6	3	3	1.30E-03	4	-2.8	0.98
3522.43000	-2	7	3	4	8	3	5	6.60E-02	3	-2.1	1.12
3523.0322	6	7	4	4	8	4	5	1.05E-01	2	-8.6	1.11
3523.4322	0	11	0	11	11	2	10	4.90E-04	5	-11.1	1.07

* asterisk denotes a doubled absorption with the quantum assignment given for the stronger transition. The strength given represents the sum of the strengths of the two comparable transitions.
o-c are observed minus computed line positions in $cm^{-1} \times 10^{2}$. Computed values derived from energy levels given in table 2 and ground state levels given in ref. 14.
%s are estimated uncertainties in the measured line strengths given in percent
a. (o-c)% is the percent difference between the observed and computed line strength or the value of the computed strength if the difference between the observed and computed values is ≈±12% or larger in magnitude.
R is the ratio of the observed line strength derived in this study to the computed value given in ref. 13

estimated uncertainty in the measured strength (*%s*), the observed minus the computed line strength in percent [(o-c)%], the ratio *R* of the observed line strength to that given for $H_2{}^{17}O$ in the tabulation by Flaud *et al.* (*12*) (and in the 1986 edition of the

TABLE VIII—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xa	(o-c)%[a]	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xa	(o-c)%[a]	R
3523.6800	6	11	1	11	11	1	10	1.60E-03	4	-3.3	1.17	3632.87032	2	3	2	1	4	2	2	9.03E-01	2	1.9	1.14
3524.7193	-27	12	1	11	12	3	10	3.00E-04	10	3.47E-04	1.02	3633.44920	-23	4	1	3	4	3	2	7.20E-01	5	-3.7	1.08
3526.7457	-37	12	2	11	12	2	10	1.20E-04	10	1.16E-04		3633.57387	11	3	3	1	4	3	2	1.10E-00	2	3.1	1.16
3528.6599	0	6	2	5	6	4	2	3.75E-03	3	2.24E-03	1.05	3633.8177	1	5	1	4	5	3	3	3.40E-02	6	3.8	1.16
3528.8192	-62	8	3	5	8	5	4	1.19E-03	5	1.58E-03	1.24	3635.4164	-30	4	0	4	5	0	5	3.82E-00	5	-2.1	1.10
*3530.4758	121	6	6	0	7	6	1	2.61E-02	3	-1.5	1.09	3637.15210	-1	4	1	4	5	1	5	1.10E-00	2	1.27E-00	1.13
3531.84672	-4	8	1	7	9	1	8	1.99E-01	2	1.7	1.13	3637.22520	7	3	1	2	4	1	3	1.36E-00	4	4.5	1.17
3532.21265	4	8	2	7	9	2	8	6.36E-02	3	-0.9	1.11	3638.47075	-2	6	1	6	6	1	5	4.60E-02	2	-3.9	1.14
*3533.5265	-118	9	1	9	10	1	10	2.69E-01	3	7.8	1.21	3642.29830	5	3	2	2	4	2	3	2.60E-00	4	-4.6	1.08
3534.51230	1	7	3	5	8	3	6	1.94E-01	2	2.27E-01	1.11	3646.35022	9	5	0	5	5	2	4	7.45E-02	2	-2.0	1.12
3536.6492	-37	2	1	2	3	3	1	4.73E-03	5	6.04E-03	1.04	3648.2787	-7	11	4	8	11	4	7	5.53E-04	4	6.59E-04	1.04
3540.4868	41	6	5	2	7	5	3	2.67E-02	4	-2.5	1.10	3650.42795	27	9	3	7	9	3	6	8.11E-03	2	9.90E-03	1.04
3545.7665	17	10	3	7	10	5	6	4.72E-04	4	-7.0	1.10	3654.80652	1	3	0	3	4	0	4	1.71E-00	4	1.4	1.14
3546.10270	0	10	1	10	10	1	9	1.50E-03	2	-6.8	1.10	3654.87375	-2	7	2	6	7	2	5	7.18E-02	2	-9.1	1.16
3546.49954	0	6	4	2	7	4	3	2.07E-01	2	-6.5	1.09	3656.7349	25	3	1	3	4	1	4	4.70E-00	6	-4.6	1.10
3548.87319	1	6	4	3	7	4	4	7.01E-02	2	-5.2	1.11	3660.7006	0	2	2	0	3	2	1	2.40E-00	5	3.4	1.16
3551.5360	-53	4	2	3	4	4	0	4.95E-04	5	1.79E-03	1.04	3660.84329	2	4	0	4	4	2	3	3.19E-00	3	1.2	1.15
3552.3519	-27	2	1	1	3	3	0	2.76E-02	3	-3.1	1.15	3661.7764	5	2	1	1	3	1	2	4.40E-00	10	-1.6	1.11
3552.60365	-5	7	1	6	8	1	7	1.50E-01	4	1.6	1.13	3662.91958	-2	5	1	5	5	1	4	2.54E-01	4	-8.7	1.14
3553.4125	2	7	2	6	8	2	7	4.30E-01	5	0.5	1.15	3665.32215	3	2	2	1	3	2	2	7.80E-01	5	0.3	1.13
3554.34975	6	6	2	4	7	2	5	6.50E-01	4	0.4	1.10	3667.601	-131	5	2	4	4	4	1	1.74E-04	10	8.23E-04	1.12
3554.445	138	8	0	8	9	0	9	4.22E-01	6	-0.7	1.12	*3669.0828	61	10	8	2	10	8	3	7.44E-04	3	-0.4	0.98
3554.458	-25	8	1	8	9	1	9	1.41E-01	6	-0.7	1.13	3671.2846	-1	3	0	3	3	2	2	1.03E-01	3	1.2	1.13
3555.55130	2	5	1	5	5	3	2	1.29E-02	2	1.01E-02	1.10	*3671.66387	-31	9	8	2	9	8	1	3.07E-03	3	12.8	1.11
3557.91988	9	6	3	4	7	3	5	1.29E-01	4	1.54E-01	1.13	3672.9159	-1	10	4	7	10	4	6	9.40E-04	4	-4.0	1.22
3561.58115	9	3	0	3	4	2	2	3.57E-02	2	1.0	1.13	*3674.0250	-1	8	8	0	8	8	1	9.80E-03	4	10.0	1.08
3562.7965	59	11	2	9	11	4	8	2.21E-04	10	2.3	1.16	3674.3475	-2	2	0	2	3	0	3	5.90E-00	3	3.9	1.17
3566.5650	-5	5	5	0	6	5	1	3.30E-02	3	2.2	1.13	3675.8756	20	8	3	6	8	3	5	9.77E-03	6	1.12E-02	1.18
3566.59813	0	5	5	1	6	5	2	9.70E-02	2	0.1	1.11	3677.1762	11	2	1	2	3	1	3	1.70E-00	5	1.6	1.15
3567.4010	38	9	0	9	9	2	8	4.08E-03	2	-4.7	1.13	3677.2084	1	2	0	2	2	2	1	1.57E-01	3	1.9	1.12
3567.49685	10	10	1	9	10	3	8	3.53E-03	5	-4.8	1.11	3678.7629	0	11	7	5	11	7	4	3.75E-04	7	3.00E-04	1.30
3568.5670	29	9	1	9	9	1	8	1.21E-02	2	-6.2	1.11	3679.60958	2	6	2	5	6	2	4	4.75E-02	4	6.60E-02	1.09
3574.08315	0	5	4	1	6	4	2	1.13E-01	3	-2.2	1.11	3681.53106	0	10	7	4	10	7	3	4.35E-04	2	7.8	1.11
3574.20208	3	5	3	2	6	3	3	1.85E-01	4	2.63E-01	1.14	3681.9886	10	5	1	5	4	3	2	2.97E-03	3	-0.3	1.05
3574.24958	-1	6	2	5	7	2	6	2.55E-01	3	2.83E-01	1.12	3682.474	-68	9	2	8	8	4	5	1.80E-04	10	2.75E-04	0.87
3574.92363	3	5	4	2	6	4	3	3.40E-01	4	-2.0	1.12	3684.0404	5	9	7	3	9	7	2	4.71E-03	5	7.2	1.10
3575.1288	22	7	0	7	8	0	8	3.00E-01	3	3.4	1.16	3684.0552	25	9	7	2	9	7	3	1.57E-03	5	7.2	1.10
3575.1688	-33	7	1	7	8	1	8	9.00E-01	10	3.6	1.17	3684.2936	-2	7	2	6	6	4	3	1.10E-03	10	-5.1	1.10
3575.7666	-32	5	2	3	5	4	2	3.30E-03	4	4.16E-03	1.04	3685.1263	4	11	5	7	11	5	6	6.10E-04	3	6.87E-04	1.04
3577.27775	-45	10	2	8	10	4	7	1.92E-03	4	-1.5	1.12	*3686.3324	40	8	7	1	8	7	2	2.10E-02	4	8.6	1.12
3579.07333	5	5	2	3	6	2	4	4.31E-01	5	2.3	1.13	3687.5130	5	1	1	0	2	1	1	1.14E-00	5	-4.2	1.09
3582.45583	7	5	3	3	6	3	4	6.58E-01	3	8.02E-01	1.09	3687.56465	1	4	1	4	4	1	3	2.13E-01	3	1.72E-01	1.15
3583.76936	-18	6	2	4	6	4	3	1.37E-02	4	1.52E-02	1.10	3689.95862	-8	6	3	3	7	1	6	1.63E-03	2	9.96E-04	1.17
3587.1331	-43	9	2	7	9	4	6	1.64E-03	4	2.1	1.15	3692.21540	6	9	4	6	9	4	5	1.07E-02	2	1.20E-02	1.12
3588.7871	-16	8	0	8	8	2	7	3.20E-02	10	2.7	1.21	3692.3490	-40	10	6	5	10	6	4	7.95E-04	5	9.2	1.18
3589.6768	-21	7	2	5	7	4	4	4.15E-03	4	4.55E-03	1.05	3693.72457	46	10	6	4	10	6	5	2.50E-03	2	2.16E-03	1.24
3591.2571	12	8	1	8	8	1	7	1.12E-02	4	6.8	1.26	3695.16333	-4	1	0	1	2	0	2	1.64E-00	5	-5.6	1.07
3591.2724	65	8	2	6	8	4	5	8.70E-03	8	-6.5	1.05	3695.197	-32	9	6	4	9	6	3	8.01E-03	5	1.3	1.07
3592.1435	-58	11	3	9	11	3	8	7.10E-04	10	-8.5	1.09	3695.58875	-4	9	6	3	9	6	4	2.75E-03	2	3.0	1.10
3593.2338	1	5	1	4	6	1	5	5.90E-01	5	5.3	1.17	3696.0076	-74	10	5	6	10	5	5	9.46E-04	3	-6.4	1.08
3595.55323	0	6	0	6	7	0	7	1.60E-00	5	-0.3	1.13	3696.66859	-2	7	3	5	7	3	4	8.63E-02	2	1.09E-01	1.14
3595.66443	2	6	1	6	7	1	7	5.44E-01	5	2.0	1.15	3697.55565	0	8	6	3	8	6	2	9.30E-03	3	5.4	1.12
3598.25590	-22	3	1	3	3	3	0	9.10E-03	3	1.22E-02	1.09	3697.64288	-7	8	6	2	8	6	3	2.85E-02	5	7.0	1.14
3599.79505	2	5	2	4	6	2	5	1.10E-00	5	1.48E-00	1.16	3697.99642	4	1	1	1	2	1	2	3.70E-00	5	-1.5	1.11
3599.88495	4	2	0	2	3	2	1	1.45E-01	3	0.0	1.12	3699.6204	22	7	6	2	7	6	1	8.33E-02	5	6.3	1.12
3600.7226	-14	4	4	0	5	4	1	3.69E-01	4	0.4	1.12	3699.6343	70	7	6	1	7	6	2	2.78E-02	5	6.4	1.13
3600.9111	-15	9	2	8	9	2	7	1.04E-02	6	-6.5	1.10	*3701.4549	-51	6	6	0	6	6	1	2.88E-01	6	3.1	1.09
3600.93420	1	4	4	1	5	4	2	1.28E-01	3	4.5	1.16	3702.6849	-24	9	5	5	9	5	4	1.14E-02	3	-2.6	1.11
3604.24297	2	4	3	1	5	3	2	9.94E-01	6	1.10E-00	1.12	3705.08733	3	5	2	4	5	2	3	4.90E-01	5	-0.3	1.15
3604.90388	-10	8	1	7	8	3	6	2.45E-02	3	-3.5	1.11	3705.69499	-1	8	4	5	8	4	4	1.33E-02	2	-9.1	1.12
3605.38280	0	4	2	2	5	2	3	2.00E-00	5	-3.0	1.08	3706.73072	3	8	5	4	8	5	3	1.39E-02	2	4.9	1.17
3609.4427	-40	7	0	7	7	2	6	2.20E-02	4	-3.5	1.12	3707.68049	19	3	1	3	3	1	2	1.06E-00	2	6.8	1.16
3614.38051	-2	4	1	3	5	1	4	2.82E-00	4	2.0	1.14	3709.88427	-4	7	5	2	7	5	3	4.02E-02	2	0.8	1.11
3614.47361	7	7	1	7	7	1	6	7.10E-02	4	1.2	1.19	3711.36211	5	6	5	2	6	5	1	1.10E-01	3	2.2	1.11
3615.93390	1	5	1	5	6	1	6	2.55E-00	4	-3.0	1.10	3711.4531	18	6	5	1	6	5	2	3.30E-01	4	2.2	1.11
3619.3367	-11	7	1	6	7	3	5	1.61E-02	3	-7.7	1.05	3711.61136	9	4	3	1	5	1	4	3.33E-03	4	4.74E-03	1.06
3620.04096	0	4	2	3	5	2	4	7.07E-01	4	-3.4	1.10	3712.0715	5	6	3	4	6	3	3	8.90E-02	3	1.08E-01	1.20
3621.8495	29	10	3	8	10	3	7	8.40E-04	4	9.37E-04	1.08	3713.96850	-4	7	4	4	7	4	3	1.33E-01	2	-5.1	1.13
3627.89992	17	8	2	7	8	2	6	9.28E-03	2	-7.8	1.11	3717.81188	0	0	0	0	1	0	1	3.30E-00	5	2.1	1.16
3628.88020	2	6	0	6	6	2	5	1.32E-01	2	-1.6	1.14	3718.58148	-8	6	4	3	6	4	2	1.30E-01	2	-0.6	1.15
3629.2615	7	6	1	5	6	3	4	8.50E-02	6	0.4	1.13	3719.74966	-3	4	2	3	4	2	2	4.21E-01	4	7.1	1.15
3629.9337	-6	3	1	2	3	3	1	9.70E-03	2	1.05E-02	1.05	3721.72650	5	5	4	1	5	4	2	3.22E-01	2	-0.9	1.11
3630.30775	6	1	0	1	2	2	0	2.98E-02	2	2.4	1.12	3722.10950	-5	5	3	3	5	3	2	6.80E-01	7	8.68E-01	1.08
3632.4133	-14	3	3	0	4	3	1	3.57E-01	3	0.4	1.13	3722.34938	-5	7	4	3	7	4	4	4.30E-02	2	-6.6	1.13

HITRAN database (*13*)). If the magnitude of (o-c)% is about 14% or greater, the computed line strength value is given instead of the percent difference. The majority of these entries are of transitions which are moderately to strongly perturbed. The values for the line strengths are normalized to 100% of the isotopic species in units of inverse square centimeters per atmosphere (1 atm = 760 Torr) whereas the values in Refs. (*12, 13*) are given in $cm^{-1}/(mol\ cm^2)$ and reduced by the normal isotopic abundances (3.7×10^{-4} for $H_2{}^{17}O$). Therefore values from Refs. (*12, 13*) were converted to inverse centimeters squared per atmosphere by applying the factor 2.48×10^{19} (at 296 K) and dividing the result by the proper isotopic abundance in natural water to determine the values of R given in Table V. The experimental linestrengths

TABLE VIII—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)X[a]	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	Xs	(o-c)X[a]	R
3722.80560	-19	4	4	1	4	4	0	7.30E-01	8	-0.4	1.09	3851.5486	-23	7	2	6	7	0	7	6.85E-02	3	5.6	1.19
3722.87206	-5	4	4	0	4	4	1	2.11E-00	3	-4.1	1.05	3851.6257	0	5	2	4	4	2	3	1.75E-00	8	2.83E-00	1.14
3723.95551	1	2	1	2	2	1	1	6.66E-01	3	4.7	1.17	3855.28425	-3	6	0	6	5	0	5	3.40E-00	6	-4.1	1.11
3726.09602	27	3	2	1	4	0	4	4.50E-03	3	-7.4	1.08	3855.4625	23	9	3	7	9	1	8	9.30E-03	2	3.1	1.14
3726.76320	6	8	4	4	8	4	5	3.47E-02	3	4.24E-02	1.09	3857.79725	-5	6	5	2	5	5	1	4.26E-02	2	1.0	1.11
3727.72330	23	4	3	2	4	3	1	6.58E-01	5	-3.9	1.19	3857.84600	-18	6	5	1	5	5	0	1.30E-01	2	2.7	1.13
3730.11918	3	3	2	2	3	2	1	2.85E-00	3	5.8	1.17	3858.0352	0	11	4	8	11	2	9	5.30E-04	8	6.3	1.15
3730.5581	-19	3	3	1	3	3	0	3.80E-00	5	4.41E-00	0.96	3859.21560	9	7	4	4	7	2	5	8.70E-03	3	-1.3	1.11
3730.68015	-2	4	3	1	4	3	2	1.80E-00	5	2.04E-00	1.12	3859.61081	6	5	1	4	4	1	3	1.15E-00	3	-1.0	1.13
3731.02138	0	3	3	0	3	3	1	1.44E-00	4	-1.9	1.10	3863.4603	-12	10	2	8	10	2	9	3.70E-03	3	7.2	1.15
3732.2158	-8	5	3	2	5	3	3	2.00E-01	3	2.85E-01	1.23	3865.61117	7	8	1	7	8	1	8	3.27E-02	5	8.0	1.21
3734.1720	-45	6	0	6	5	2	3	8.60E-03	8	-1.7	1.20	3865.85166	-2	5	2	3	4	2	2	8.68E-01	5	0.0	1.15
3734.9615	-10	1	1	1	1	1	0	4.30E-00	8	-0.5	1.13	3866.2247	-16	6	4	3	5	4	2	1.54E-01	4	1.2	1.15
3735.1630	-21	2	2	0	3	0	3	1.62E-02	5	-5.1	1.07	3866.67922	-1	6	2	5	5	2	4	5.88E-01	2	6.59E-01	1.09
3735.2947	-21	2	2	1	2	2	0	1.95E-00	5	-0.0	1.13	3867.20958	-20	8	2	7	8	0	8	1.04E-02	3	5.9	1.18
3738.0240	-8	2	2	0	2	2	1	6.00E-00	5	2.8	1.16	3867.40640	-3	6	4	2	5	4	1	4.45E-01	4	-2.2	1.11
3741.2577	30	3	0	3	2	2	0	1.41E-02	2	4.6	1.16	3868.48255	2	10	3	8	10	1	9	1.35E-03	5	1.08E-03	1.37
3742.57380	-5	3	2	1	3	2	2	9.30E-01	2	4.8	1.16	3869.5313	8	6	4	3	6	2	4	2.94E-03	3	-5.9	1.07
3745.55295	0	1	1	0	1	1	1	1.43E-00	4	-0.8	1.12	*3870.6026	160	7	6	2	6	6	1	3.65E-02	3	2.6	1.12
3746.05880	-6	5	0	5	4	2	2	7.40E-03	4	8.23E-03	1.07	3870.82160	-4	7	1	7	6	1	6	2.15E-00	4	-4.6	1.12
3746.27041	1	6	3	3	6	3	4	2.76E-01	2	3.15E-01	1.15	3871.19462	-8	7	0	7	6	0	6	7.10E-01	4	5.8	1.10
3748.66422	5	4	0	4	3	2	1	4.70E-02	2	-1.3	1.13	3876.28352	-2	6	1	5	5	1	4	2.11E-00	5	-4.6	1.09
3751.92122	2	4	2	2	4	2	3	1.30E-00	2	10.8	1.23	3877.40230	-2	3	2	1	2	0	2	7.70E-02	4	1.8	1.14
3753.71150	6	5	1	4	4	3	1	7.40E-03	3	-2.0	1.09	3880.5089	-18	7	5	3	6	5	2	1.14E-01	3	1.9	1.14
3755.67055	-6	2	1	1	2	1	2	1.85E-00	3	-3.1	1.09	3880.75994	-4	7	5	2	6	5	1	3.66E-02	2	-1.7	1.10
3756.99690	-1	7	3	4	7	3	5	3.86E-02	2	10.3	1.16	3880.7987	67	5	4	2	5	2	3	6.86E-03	5	-7.5	1.06
3759.3853	-9	7	2	5	6	4	2	1.30E-03	10	-7.7	1.04	3881.9639	5	11	3	9	11	1	10	1.18E-03	6	1.03E-03	1.24
3762.0215	0	10	4	6	10	4	7	2.72E-03	2	0.1	1.17	*3882.0236	-23	8	7	1	7	7	0	6.30E-03	2	7.9	1.16
3765.09076	-5	1	0	1	0	0	0	1.14E-00	5	0.7	1.15	3882.1391	-64	9	1	8	9	1	9	4.35E-03	4	7.1	1.19
3766.1429	-5	5	2	3	5	2	4	1.75E-01	4	9.6	1.18	3882.85308	-4	9	2	8	9	0	9	1.23E-02	2	1.9	1.14
3767.0600	-30	8	1	7	7	3	4	3.30E-03	3	3.90E-03	1.07	3884.87580	2	7	2	6	6	2	5	1.13E-00	2	-4.4	1.11
3768.91520	-2	6	1	5	5	3	2	2.30E-02	2	1.2	1.16	3885.92422	3	6	3	3	5	3	2	6.60E-01	5	1.03E-00	1.14
3781.99551	1	2	1	2	1	1	1	1.44E-00	5	4.1	1.20	3886.7649	-42	8	1	8	7	1	7	4.10E-01	3	-4.2	1.13
3782.2081	-5	8	2	6	7	4	3	3.22E-03	4	-6.9	1.06	3886.92368	7	8	0	8	7	0	7	1.21E-00	3	-5.8	1.11
3786.35170	0	6	2	4	6	2	5	2.05E-01	3	6.5	1.14	3888.6354	4	7	4	4	6	4	3	2.89E-01	4	-5.5	1.11
3786.9292	-9	2	0	2	1	0	1	5.70E-00	6	-0.8	1.14	3889.64385	-12	6	2	4	5	2	3	1.61E-00	2	-3.7	1.10
3788.91255	6	4	1	3	4	1	4	5.40E-01	4	4.6	1.16	3890.8353	-22	7	3	5	6	3	4	6.15E-01	4	-4.2	1.19
3792.63584	1	2	1	1	1	1	0	3.90E-00	4	-1.2	1.13	3890.91846	6	7	1	6	6	1	5	4.33E-01	3	3.8	1.19
3793.53422	0	9	3	6	9	3	7	3.46E-03	2	11.2	1.13	3892.05783	2	7	4	3	6	4	2	1.00E-01	4	-0.3	1.17
3795.1736	-12	9	2	7	8	4	4	5.12E-04	8	5.84E-04	1.04	3892.84951	1	8	6	3	7	6	2	7.63E-03	3	8.9	1.21
3800.15056	-3	2	2	1	2	0	2	4.68E-02	2	6.0	1.14	3892.89565	-40	8	6	2	7	6	1	2.16E-02	3	2.7	1.14
3804.58170	-6	3	2	2	3	0	3	2.85E-01	3	5.6	1.15	3901.5246	30	8	2	7	7	2	6	2.14E-01	4	2.8	1.19
3804.97510	2	7	2	5	7	2	6	2.73E-02	2	8.5	1.15	3902.3307	-35	9	1	9	8	1	8	6.50E-01	3	-0.8	1.18
3806.11302	-6	3	0	3	2	0	2	2.10E-00	5	-3.7	1.11	3902.3974	-39	9	0	9	8	0	8	2.17E-01	3	-0.7	1.17
3807.44264	1	3	2	2	2	2	1	2.70E-00	5	-3.9	1.19	3902.94652	-3	8	5	4	7	5	3	2.19E-02	3	-1.2	1.12
3809.19816	-6	5	1	4	5	1	5	9.80E-02	3	7.1	1.18	*3903.7450	246	9	7	3	8	7	2	4.14E-03	3	1.0	1.11
3812.54668	4	3	2	1	2	2	0	8.65E-01	4	-2.7	1.14	3903.8533	8	8	5	3	7	5	2	6.60E-02	3	-0.5	1.14
3812.9756	46	4	2	3	4	0	4	1.04E-01	3	7.8	1.23	3904.9155	-1	8	1	7	7	1	6	6.40E-01	3	-0.2	1.15
3815.01855	2	10	3	7	10	3	8	2.87E-03	3	10.4	1.13	3906.6074	-80	8	5	4	8	3	5	2.47E-04	10	1.3	1.19
3817.23979	10	3	1	2	2	1	1	1.76E-00	2	1.9	1.17	3906.8956	10	4	4	0	4	2	3	2.58E-03	3	-9.0	1.12
3820.79970	-9	4	1	4	3	1	3	1.50E-00	6	1.95E-00	1.09	3907.5959	-51	5	3	2	5	1	5	9.00E-04	3	1.70E-03	1.10
3823.12678	0	6	0	6	3	0	3	5.80E-00	5	-5.0	1.09	3910.23819	-7	8	4	5	7	4	4	5.28E-02	2	-2.5	1.16
3825.99380	-3	8	2	6	8	2	7	3.10E-02	2	8.1	1.15	3910.33512	7	7	2	5	6	2	4	2.95E-01	2	-0.7	1.13
3826.19912	-1	5	2	4	5	0	5	1.61E-01	2	2.13E-01	1.18	3910.4422	-9	8	3	6	7	3	5	1.07E-01	2	-2.4	1.17
3826.33093	-8	4	3	2	3	3	1	4.36E-01	2	1.2	1.15	3911.14860	3	7	3	4	6	3	3	1.85E-01	2	-8.1	1.15
3827.66467	-3	4	3	1	3	3	0	1.28E-00	5	-0.5	1.14	3912.1024	-8	5	4	1	5	2	4	1.24E-03	3	-10.4	1.15
3829.29782	-1	6	1	5	6	1	6	1.52E-01	2	7.6	1.19	3913.29926	4	11	1	10	11	1	11	5.75E-04	3	5.07E-04	1.28
3829.4530	-24	4	2	3	3	2	2	1.02E-00	2	-7.7	1.16	*3913.33340	0	10	8	2	9	8	1	4.80E-04	4	2.3	1.10
3829.4776	-27	5	3	3	5	1	4	7.05E-02	6	-7.7	1.16	3913.4303	-11	11	2	10	11	0	11	1.75E-03	4	1.52E-03	1.30
3829.50138	0	6	3	4	6	1	5	2.04E-02	6	-11.7	1.14	3914.20470	-1	4	2	2	3	0	3	1.98E-01	3	-0.5	1.14
3833.62235	-3	4	3	2	4	1	3	1.82E-02	2	-2.5	1.14	3914.82507	-13	9	6	4	8	6	3	1.15E-02	4	3.0	1.16
3834.52354	-28	7	3	5	7	1	6	4.23E-02	2	-3.8	1.18	3915.02179	2	9	6	3	8	6	2	3.81E-03	3	2.4	1.15
3836.00119	0	6	2	5	6	0	6	4.10E-02	2	-3.0	1.17	3917.5433	-65	10	1	10	9	1	9	1.03E-01	4	2.1	1.22
3837.45156	-1	5	1	5	4	1	4	4.80E-00	5	-1.6	1.14	3917.5746	17	10	0	10	9	0	9	3.00E-01	3	-0.9	1.19
3839.28429	-2	5	0	5	4	0	4	1.67E-00	4	1.1	1.17	3917.6994	-14	8	4	4	7	4	3	1.42E-01	4	-11.3	1.13
3839.7422	10	4	2	2	3	2	1	3.10E-00	6	-3.3	1.12	3918.93849	2	9	1	8	8	1	7	9.90E-02	5	-0.1	1.16
3839.8578	-34	4	1	3	3	1	2	4.80E-00	7	1.3	1.16	3921.74868	-4	6	4	2	6	2	5	2.44E-03	4	3.13E-03	1.07
3839.9825	3	3	3	1	3	1	2	2.44E-02	3	5.7	1.15	3924.92870	0	9	5	5	8	5	4	3.04E-02	3	-4.6	1.12
3843.31300	-4	5	4	2	4	4	1	4.70E-01	3	1.4	1.13	3927.45512	0	8	2	6	7	2	5	4.05E-01	4	-1.2	1.12
3843.59783	-22	5	4	1	4	4	0	1.53E-01	3	-0.8	1.10	3927.4845	15	9	5	4	8	5	3	1.02E-02	4	-2.2	1.14
3845.70330	-6	9	2	7	9	2	8	3.75E-03	3	9.0	1.16	3928.1678	-37	12	1	11	12	1	12	4.50E-04	10	-3.9	1.09
3847.74500	2	2	2	0	1	0	1	1.14E-01	2	0.9	1.10	3928.51946	-3	9	3	7	8	3	6	1.48E-01	3	0.9	1.18
3848.54680	3	5	3	3	4	3	2	1.20E-00	5	1.42E-00	1.03	3930.77833	-5	9	4	6	8	4	5	6.94E-02	3	-4.7	1.15
3849.2150	5	9	4	6	9	2	7	3.48E-03	3	0.6	1.13	3932.1990	-3	10	2	9	9	2	8	4.30E-02	3	3.8	1.23

are presented in the table for a temperature of 296 K whereas the sample temperatures of several of the spectra from which the strengths were determined were slightly different from 296 K. These values were converted to the ones for $T = 296$ K with the use of the relations given in Eq. (1) and the ground state rotational levels given in Ref. (*15*).

The observed positions are given to three, four, or five decimal places in Table V, which indicates the accuracy of these measurements. Obviously, the most accurate estimates are those given with five significant figures past the decimal, and as was reported in Refs. (*1, 2*), the absolute uncertainty for these measurements is $\pm 6 \times 10^{-5}$ cm^{-1}. The computed line positions were derived from the rotational energies given in Table II for the (100) state and the levels given for the (000) states given in

TABLE VIII—*Continued*

observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R	observed position	o-c	upper J	K_a	K_c	lower J	K_a	K_c	observed strength	%s	(o-c)%[a]	R
3932.424	359	11	1	11	10	1	10	1.29E-01	4	2.0	1.23	4003.1268	0	13	5	9	12	5	8	3.30E-04	5	-1.7	1.17
3932.434	89	11	0	11	10	0	10	4.33E-02	4	2.7	1.24	4004.0104	57	5	3	3	4	1	4	3.26E-02	5	-5.3	1.16
3932.8666	1	6	5	2	6	3	3	2.75E-04	10	-8.0	1.21	4010.6310	0	13	3	10	12	3	9	3.27E-04	4	8.3	1.27
3933.02165	-8	10	1	9	9	1	8	1.26E-01	3	0.8	1.18	4010.75582	2	6	2	4	5	0	5	4.55E-02	3	-2.6	1.16
3933.87633	-40	3	3	1	2	1	2	2.55E-02	2	3.2	1.14	4011.8114	19	5	4	1	4	2	2	8.91E-03	3	3.2	1.11
3935.63893	0	8	3	5	7	3	4	2.88E-01	2	-0.1	1.15	4019.4964	0	12	4	8	11	4	7	2.16E-03	5	-0.8	1.09
3936.4733	3	10	6	5	9	6	4	1.63E-03	2	3.6	1.19	4027.04083	4	6	4	2	5	2	3	3.33E-02	4	9.3	1.15
3937.08881	-7	4	3	1	3	1	2	9.15E-02	2	0.4	1.15	4027.3364	-3	5	4	2	4	2	3	2.23E-02	3	3.9	1.14
3937.1229	-15	10	6	4	9	6	3	4.80E-03	6	1.9	1.17	4028.57850	0	7	3	4	6	1	5	1.42E-02	3	1.74E-02	1.15
3937.6475	0	7	4	3	7	2	6	3.45E-04	5	4.85E-04	1.11	4043.00741	-6	7	4	3	6	2	4	1.00E-02	2	8.5	1.12
3940.9453	-35	5	5	1	5	3	2	4.43E-04	3	5.55E-04	1.09	4045.46574	-7	6	3	4	5	1	5	7.44E-03	3	-5.7	1.15
3941.39055	5	9	2	7	8	2	6	5.72E-02	3	2.5	1.16	4056.60095	6	6	4	3	5	2	4	6.88E-03	3	0.3	1.10
3943.01790	21	9	4	5	8	4	4	1.74E-02	2	2.30E-02	1.14	4062.94675	24	8	4	4	7	2	5	2.00E-02	4	3.0	1.11
3945.03160	-2	10	3	8	9	3	7	1.93E-02	2	0.1	1.15	4065.9772	4	5	5	0	4	3	1	1.78E-03	5	0.6	1.11
3946.1897	-18	10	5	6	9	5	5	3.90E-03	3	-6.8	1.10	4066.72665	-3	7	2	5	6	0	6	6.03E-03	3	-5.4	1.13
3946.2791	0	11	7	4	10	7	3	2.00E-04	10	10.0	1.25	4067.3830	13	5	5	1	4	3	2	5.00E-03	4	-5.0	1.05
3946.3069	10	6	3	3	6	1	6	1.16E-03	5	1.58E-03	1.16	4069.181	199	4	4	0	3	0	3	2.04E-04	10	-3.6	1.12
3946.61746	6	11	2	10	10	2	9	4.83E-02	3	1.8	1.19	4073.4941	-4	8	3	5	7	1	6	1.83E-02	3	-9.5	1.17
*3946.9587	-76	12	0	12	11	0	11	6.35E-02	4	-0.6	1.12	4085.80050	6	6	5	1	5	3	2	7.71E-03	2	2.1	1.09
3947.02486	-3	11	1	10	10	1	9	1.66E-02	3	4.7	1.23	4089.2178	28	7	4	4	6	2	5	1.55E-02	3	6.3	1.16
3950.0900	-13	10	4	7	9	4	6	8.88E-03	4	-5.7	1.13	4089.235	53	9	4	5	8	2	6	2.92E-03	4	-4.6	1.04
3952.04196	3	10	5	5	9	5	4	1.17E-02	3	-5.0	1.14	4102.2647	19	7	5	2	6	3	3	2.46E-03	4	3.7	1.07
3953.52820	9	10	2	8	9	2	7	6.28E-02	3	0.9	1.15	4105.0371	44	5	4	1	4	0	4	2.00E-04	10	2.0	1.19
3957.3914	7	9	3	6	8	3	5	4.07E-02	3	4.7	1.17	4115.20270	-11	7	5	3	6	3	4	6.70E-03	3	1.0	1.06
3957.6730	35	11	6	6	10	6	5	1.60E-03	3	-4.4	1.12	4115.50686	-8	8	5	3	7	3	4	5.58E-03	5	4.3	1.04
3958.0089	-4	5	3	2	4	1	3	3.44E-02	2	4.00E-02	1.15	4124.13025	7	8	2	6	7	0	7	7.59E-03	4	-3.0	1.16
3959.07713	0	5	2	3	4	0	4	3.56E-02	3	-0.7	1.17	4125.2246	-51	9	3	6	8	1	7	2.03E-03	3	-6.0	1.13
3959.4527	0	11	6	5	10	6	4	5.35E-04	7	-3.7	1.13	4125.5366	27	8	4	5	7	2	6	2.78E-03	5	1.8	1.10
3960.2183	-7	11	3	9	10	3	8	2.07E-02	2	1.4	1.16	4127.3618	-6	9	5	4	8	3	5	1.23E-03	3	10.4	1.08
3960.6366	37	12	2	11	11	2	10	5.61E-03	5	2.5	1.21	4129.8564	-21	6	6	0	5	4	1	1.40E-03	4	-8.9	0.99
3960.83055	0	12	1	11	11	1	10	1.68E-02	2	2.2	1.20	4130.1043	0	6	6	1	5	4	2	4.83E-04	3	-5.7	1.03
*3961.1492	76	13	1	13	12	1	12	2.15E-02	3	-2.1	1.21	4138.2715	9	10	4	6	9	2	7	1.25E-03	4	3.27E-03	1.18
3961.4846	-62	8	4	4	8	2	7	1.64E-04	10	4.18E-04	0.82	4139.2175	-2	8	3	6	7	1	7	2.14E-03	4	-2.8	1.11
3965.2537	-2	11	2	9	10	2	8	7.29E-03	2	3.0	1.17	4140.85644	-3	10	5	5	9	3	6	2.03E-03	2	1.77E-03	1.09
3966.44281	-9	11	5	7	10	5	6	4.00E-03	3	-6.8	1.11	4141.1749	-19	8	5	4	7	3	5	1.56E-03	4	2.9	1.06
3966.8577	17	4	3	2	3	1	3	1.16E-02	4	-7.8	1.09	4148.1531	48	6	4	2	5	0	5	5.55E-04	7	6.64E-04	0.99
3967.2090	0	12	7	5	11	7	4	1.85E-04	10	9.7	1.23	4151.61522	-37	7	6	1	6	4	2	6.48E-04	6	0.8	1.05
3968.0250	-7	11	4	8	10	4	7	9.36E-03	4	-2.0	1.15	4152.7617	-43	7	6	2	6	4	3	1.82E-03	2	-5.2	0.99
3974.2727	0	13	2	12	12	2	11	5.13E-03	4	-0.5	1.18	4159.2868	0	11	5	6	10	3	7	2.56E-04	4	3.8	0.97
3975.0632	0	14	1	14	13	1	13	1.65E-03	3	-4.0	1.21	4165.5005	4	9	4	6	8	2	7	4.01E-03	3	4.6	1.12
3975.1069	-3	14	0	14	13	0	13	5.39E-03	3	4.5	1.32	4169.5914	-9	9	5	5	8	3	6	2.54E-03	3	1.6	1.03
3975.50890	-2	10	3	7	9	3	6	4.22E-02	3	4.2	1.16	4171.37136	18	8	6	2	7	4	3	1.61E-03	4	1.5	1.03
3977.16444	6	12	2	10	11	2	9	6.78E-03	3	2.3	1.17	4179.4937	70	11	4	7	10	2	8	2.04E-04	10	3.07E-04	1.09
3977.4542	-106	11	5	6	10	5	5	1.24E-03	3	-11.3	1.13	4180.5437	19	10	3	7	9	1	8	2.00E-03	6	-5.3	1.17
3978.2292	0	12	6	7	11	6	6	1.58E-04	10	-7.0	1.10	4180.6998	-73	9	2	7	8	0	8	1.07E-03	5	1.3	1.21
3981.2715	-30	10	4	6	9	4	5	1.80E-02	3	2.56E-02	1.15	4184.8798	52	12	5	7	11	3	8	2.60E-04	4	9.5	1.01
3982.3694	0	12	6	6	11	6	5	4.33E-04	3	5.04E-04	1.02	4188.0455	-47	9	6	3	8	4	4	3.69E-04	7	8.7	1.06
3984.4495	-43	12	4	9	11	4	8	9.60E-03	5	2.6	1.16	4189.22658	-3	9	3	7	8	1	8	3.01E-03	3	2.7	1.18
3985.4650	0	12	5	8	11	5	7	4.20E-04	4	-1.5	1.19	4197.6168	-23	9	6	4	8	4	5	1.00E-03	2	1.1	0.99
3987.5580	0	14	2	13	13	2	12	5.00E-04	5	1.9	1.22	4200.97985	13	10	6	4	9	4	5	5.88E-04	4	9.4	1.04
3987.6362	0	14	1	13	13	1	12	1.44E-03	4	-2.2	1.17	4208.6608	84	10	4	7	9	2	8	5.62E-04	2	8.6	1.16
3987.7851	0	13	3	11	12	3	10	1.87E-03	5	-4.3	1.14	4209.8070	0	8	7	1	7	5	2	3.58E-04	4	4.06E-04	0.88
*3988.4230	-75	15	1	15	14	1	14	2.00E-03	3	2.1	1.30	4210.8193	-4	11	6	5	10	4	6	1.10E-04	10	8.01E-05	
3989.26573	0	13	2	11	12	2	10	6.50E-04	3	3.2	1.19	4220.8902	-6	10	6	5	9	4	6	1.52E-04	10	-11.2	0.86
3989.7923	158	11	3	8	10	3	7	4.26E-03	3	3.5	1.15	4232.052	-15	9	7	3	8	5	4	2.70E-04	7	-9.6	0.87
3993.29248	-3	6	3	3	5	1	4	5.69E-02	3	9.87E-02	1.16	4235.4700	2	10	2	8	9	0	9	1.19E-03	3	-4.4	1.14
3994.7165	10	4	4	0	3	2	1	1.53E-02	2	1.9	1.13	4235.6951	0	11	5	7	10	3	8	4.85E-04	5	4.32E-04	1.11
3999.3693	0	13	4	10	12	4	9	7.50E-04	7	-2.9	1.11	4236.42424	0	11	3	8	10	1	9	2.04E-04	2	-6.4	1.13
3999.7863	0	15	2	14	14	2	13	3.20E-04	10	-10.9	1.12	4239.9237	-8	10	3	8	9	1	9	3.81E-04	5	-4.6	1.11
4000.72250	0	4	4	1	3	2	2	4.66E-03	3	-0.5	1.10	4245.6780	4	11	6	6	10	4	7	2.41E-04	10	11.2	1.04
4000.8688	38	11	4	7	10	4	6	2.52E-03	4	-6.1	1.09	4253.3614	-75	8	5	3	7	1	6	2.03E-04	10	0.1	1.09
4000.9933	4	12	3	9	11	3	8	3.48E-03	3	2.6	1.14	4254.2073	1	11	4	8	10	2	9	5.55E-04	2	-0.6	1.07
4001.41067	0	14	2	12	13	2	11	5.00E-04	7	1.6	1.17	4290.7053	98	11	3	9	10	1	10	4.24E-04	10	-7.0	1.10
*4001.5578	0	16	0	16	15	0	15	4.98E-04	3	-2.1	1.26	4290.8131	7	12	3	9	11	1	10	1.81E-04	10	-8.6	1.08
4002.38469	-4	12	5	7	11	5	6	9.55E-04	3	1.19E-03	1.12	4340.151	152	12	2	10	11	0	11	1.63E-04	10	0.1	1.21

Ref. (*15*). An asterisk next to the line position denotes a doubled absorption for which two transitions were not adequately resolved in the spectra. The quantum assignments given for these features are for the stronger of the two and the values of the observed and computed strengths represent the sum of the strengths of the two comparable transitions.

The computed linestrengths were derived from the dipole moment expansion coefficients given in Table IV and Eqs. (1)–(3). Not all of the linestrength measurements given in Table V were included in the least-squares analyses. Strongly perturbed transitions were not included and, in addition, entries with $\%S = 15\%$ were not included because these transitions resulted in averaged values with uncertainties from as much as 60% to possibly less than 10%. This range of uncertainty for each of these transitions arises from one or more of the following reasons: (a) blending, (b) weakness of transition intensity, and (c) poor agreement between values derived from the various spectra.

Table VI is a listing comparable in content to Table V. This table lists the measurements and computations for the (100)–(000) band of $H_2{}^{18}O$. Tables VII and VIII are the listings for the (001)–(000) bands of $H_2{}^{17}O$ and $H_2{}^{18}O$, respectively. A few of the transitions given in Tables V–VIII do not have entries for R, which means that those transitions were not included in the previous calculations (*12, 13*). This is because Refs. (*12, 13*) used an intensity cutoff criterion which includes the isotopic abundance.

VI. ACKNOWLEDGMENTS

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