Microwave Spectra of Molecules of Astrophysical Interest

XII. Hydroxyl Radical

Robert A. Beaudet

Department of Chemistry, University of Southern California, Los Angeles, California 90007

and

Robert L. Poynter

Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91103

The available data on the microwave spectrum of the hydroxyl radical are critically reviewed for information applicable to radio astronomy. Molecular properties such as the rotational constants, spin-orbit, spin-spin and hyperfine coupling constants and centrifugal distortion parameters employed in or derived from the analysis are tabulated. All the observed and predicted transitions of ^{16}OH, ^{16}OD, and ^{18}OH below 300 GHz and lower state energy levels less than 4000 cm^{-1} are presented for the ground vibrational state. The laboratory data on ^{17}OH is included, but no predicted transitions are presented due to the limited data available. In addition to the transition frequencies the table contains the calculated line strengths and energies of the levels involved in the transition. An extensive bibliography of laboratory and astronomical studies of the hydroxyl radical is presented as an aid to workers in both fields.

Key words: Hydroxyl radical; interstellar molecules; line strengths; microwave spectra; molecular properties; radio astronomy.

Contents

1. Introduction

This study is one in a series of critical reviews of the available literature on the microwave spectra of molecules of interest in radio astronomy. The tables include a refitting of the spectra of OH and OD to all the available data. Though little data are available on ^{18}OH most of the molecular parameters could be estimated by isotopic scaling of the known parameters in ^{16}OH and ^{16}OD. The few most critical molecular parameters were then fit to the observed transitions. The data available on ^{17}OH are also included, but no attempt has been made to fit molecular parameters since very little experimental data are available; however, the observed transitions have been included. All the observed and predicted transitions of ^{16}OH, ^{16}OD, and ^{18}OH below 300 GHz are listed for the lowest vibrational state. Since OH has been observed in stars, a 4000 cm^{-1} limit was set on the lower energy level.

In order to prevent transcription errors, the tables of spectra have been directly reproduced from the computer printouts. The literature has been searched up to September 1976 for both laboratory and astrophysical data relating to OH. The bibliography is more voluminous than those of prior studies, but it was felt that a complete bibliography was advantageous to all workers in the field.

1.1. Molecular Parameter Tables

The theory of the rotational spectrum of $^2\Pi$ molecules has been described in the literature. Unlike the customary microwave absorption resulting from pure rotational transitions the OH spectra originate from transitions between the lambda doublets. The bulk of the theoretical studies on both NO and OH are pertinent to $^2\Pi$ molecules. The theory as applied to OH was first presented by Dousmanis, Sanders, and Townes [1].[1] While these workers solved the Hamiltonian by perturbation theory, we have numerically diagonalized the 3 × 3 matrices containing the $^2\Pi_{3/2}$, $^2\Pi_{1/2}$, and $^2\Sigma_{1/2}$ states.

Rather than using the method of Meerts and Dymanus [2] or Mizushima [3] to obtain more precise fits, we have depended on the expansion of the number of molecular parameters by including centrifugal distortion constants. We felt that such an approach is physically more meaningful though it is more intuitive.

The hyperfine structure of $^2\Pi$ molecules was first treated by Frosch and Foley [4]. A more general treatment can be obtained by using Freed's method [5]. It was found impossible to fit all hyperfine structures to a set of parameters originating from the magnetic interactions unless a centrifugal distortion effect in the d term and a nuclear spin rotational term were invoked [6]. Second order hyperfine interactions could not account for these deviations. The Hamiltonian which was finally used is:

$$\mathcal{H} = \mathcal{H}_\lambda + \mathcal{H}_{hf}$$

$$\mathcal{H}_\lambda = A\, L_z \cdot S_z + B(\mathbf{J} - \mathbf{L} - \mathbf{S})^2$$

$$\mathcal{H}_{hf} = a\mathbf{I}\cdot\mathbf{L} + (b+c)\, I_z S_z + \tfrac{1}{2} b\,(I_+ S_- + I_- S_+) + \tfrac{1}{2} d'(e^{2i\Phi} I_- S_- + e^{-2i\Phi} I_+ S_+) + C(\mathbf{I}\cdot\mathbf{J}).$$

where the following centrifugal distortion terms are defined,

$$A = A_0 - D_A J(J+1)$$

$$B_{11} = B_{10} - D_{1B} J(J+1)$$

$$B_\Sigma = B_{\Sigma 0} - D_{\Sigma B} J(J+1)$$

$$\langle AL_y\rangle = \langle\Sigma|AL_y|\Pi\rangle = \langle AL_y\rangle_0 - D_\alpha J(J+1) + D_{\alpha\alpha} J^2(J+1)^2$$

$$\langle BL_y\rangle = \langle\Sigma|BL_y|\Sigma\rangle = \langle BL_y\rangle_0 - D_\beta J(J+1) + D_{\beta\beta} J^2(J+1)^2$$

$$d' = d - d_J(J+\tfrac{1}{2})^2.$$

For ^{16}OD, the additional electric quadrupole term, $\mathcal{H}_q = -\mathbf{Q}\cdot\nabla\mathbf{E}$ was added [7].

The parameters were fit by a least squares program which also gave the standard deviations in the parameters and calculated lines [8]. The experimental data were weighted inversely by the square of the reported experimental errors. The molecular parameters resulting in the best fits for ^{16}OH and ^{16}OD are given in table I. The parameters which were held fixed are indicated. The calculated frequencies were found to be insensitive to these parameters. The values employed were obtained by M. Geller [6] from a refit of the optical data [9,10]. These tables contain the standard deviations of the parameters derived from the least square fitting procedure. The estimated error for any confidence level can be calculated by the usual techniques by assuming a student's t distribution [11,12]. However, as many digits as necessary to reproduce the observed frequencies to within experimental uncertainties have been kept, though we realize that these numbers are not significant according to the standard deviations. Also, table I contains the parameters for ^{18}OH which were obtained by isotopic scaling of most of the parameters and fitting the five most sensitivie parameters, A_0, $\langle AL_y\rangle$, $\langle BL_y\rangle$, a, and d to the observed transitions. Such a procedure is necessary since very few transitions have been observed.

1.2. Microwave Spectral Tables

The OH spectra observed in the microwave region originate from transitions between the even and odd components of the lambda doublets in the ground $^2\Pi$ state. The J quantum number is identical for the two levels. The electronic states involved are the ground $^2\Pi_{3/2}$ and $^2\Pi_{1/2}$ and the lowest excited $^2\Sigma_{1/2}$ state. The two Π states are essentially split about 140 cm^{-1} by the spin orbit coupling in a Hund's case (a) approximation. Though the molecules are very light, the $\Omega = 3/2$ and $\Omega = 1/2$ states are significantly mixed by the rotational terms and the actual levels are intermediate between case (a) and case (b). The high J levels approach Hund's pure case (b).

Interaction of the Π state with the excited Σ level through the $\langle\Sigma|AL_y|\Pi\rangle$ or $\langle\Sigma|BL_y|\Pi\rangle$ terms affects the even and odd levels differently to split the lambda degeneracy. Hence the energy levels are best calculated by directly diagonalizing the 3×3 matrix for the even or odd symmetry levels of the $^2\Pi_{1/2}$, $^2\Pi_{3/2}$, and $^2\Sigma_{1/2}$ levels for each J value.

The nuclear spin of hydrogen interacts with the electronic angular momentum through a magnetic interaction. With deuterium, there is also a nuclear quadrupole interaction. The F quantum number is the vector sum of $\mathbf{I} + \mathbf{J}$. The two levels are characterized only as upper or lower to avoid confusion about the meaning of the even and odd levels of the lambda doublet.

Tables II, III, and IV contain both observed and calculated microwave transitions in ^{16}OH, ^{16}OD, and ^{18}OH, respectively. Table V contains only the observed transitions of ^{17}OH. The uncertainties given for the observed frequencies are quoted from the original

sources. Those given for the calculated frequencies were derived from the variance-covariance matrix of the least square fit [8,11].

The energy levels of the upper and lower states involved in each transition are also given. However, note that the lowest level is not zero but has a negative value due to the spin orbit coupling term.

The line strengths given in the tables were obtained by calculating the dipole moment matrix in the diagonal representation which is intermediate between Hund's case (a) and (b). The line strength given is defined in the normal way as

$$S(J',J'') = \frac{(2J''+1)}{|\mu|^2} \sum_{m',m'',G} |(F'J'M'|\mu_{Gz}|F''J''M'')|^2.$$

The relative intensities of the hyperfine elements have been included in the strengths. The treatment of these strengths have been described extensively [13].

Calculated transitions with energy levels above 4000 cm^{-1} or frequencies above 300,000 MHz are not included.

1.3. List of Symbols and Conversion Factors

a. Symbols

A_0	Spin orbit coupling constant (MHz).
B_Σ	Rotational constant of Σ state.
B_Π	Rotational constant of π state.
$D_{\Pi B}$	Centrifugal distortion correction to B_Π.
$D_{\Sigma B}$	Centrifugal distortion correction to B_Σ.
$\langle\Sigma\|BL_y\|\Pi\rangle \equiv \langle BL_y\rangle$	Off diagonal matrix element contributing to the lambda doubling.
$\langle\Sigma\|AL_y\|\Pi\rangle \equiv \langle AL_y\rangle$	Off diagonal matrix element contributing to the lambda doubling.
D_α, $D_{\alpha\alpha}$	Centrifugal distortion corrections to $\langle AL_y\rangle$.
D_β, $D_{\beta\beta}$	Centrifugal distortion corrections to $\langle BL_y\rangle$.
D_A	Quadratic centrifugal distortion correction to A.
E_Σ	Zero point energy difference between Π and Σ electronic states.
a, b, c, d	Electron spin-nuclear spin hyperfine coupling constants.
d_J	Centrifugal distortion correction to the hyperfine coupling constant d.
C_{SR}	Nuclear spin-rotation coupling constant.
F	Total angular momentum quantum number including spin, $F = I + J$.
I	Nuclear spin.
J	Total angular momentum quantum number excluding spin, $J = L + S$.
Ω	Component of the J angular momentum quantum number about the internuclear axis.
eq Q_1, eq Q_2	Nuclear electric quadrupole coupling constants for D cf. ref. 7 for discussion of these terms.
μ	Electric dipole moment.

b. Conversion Factors

$$B(\text{MHz}) = \frac{5.05376 \times 10^5}{I(\text{amu}\cdot\text{Å}^2)}$$

$$\nu(\text{MHz}) = 29979.25\ \lambda^{-1}\ (\text{cm}^{-1})$$

1.4. Acknowledgements

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1.5. Text References

[1] G. C. Dousmanis, T. M. Sanders, and C. H. Townes, Phys. Rev. **100**, 1735 (1955).
[2] W. L. Meerts and A. Dymanus, J. Mol. Spectrosc. **44**, 320 (1972).
[3] M. Mizushima, Phys. Rev. A **5**, 143 (1972).
[4] R. A. Frosch and H. M. Foley, Phys. Rev. **88**, 1337 (1952).
[5] K. F. Freed, J. Chem. Phys. **45**, 4214 (1966).
[6] M. Geller, private communication (1976).
[7] C. C. Lin and M. Mizushima, Phys. Rev. **100**, 1726 (1955).
[8] R. H. Moore and R. K. Zeigler, Los Alamos Technical Report LA–2367, 4 March 1960. The least squares program used in our work was a modified version of the one given in this report.
[9] G. H. Dieke and H. M. Crosswhite, J. Quant. Spectrosc. Radiat. Transfer, **2**, 97 (1962).
[10] M. A. A. Clyne, J. A. Coxon, and A. R. Woon Fat, J. Mol. Spectrosc. **46**, 146 (1973).
[11] W. H. Kirchhoff, J. Mol. Spectrosc. **41**, 333(1972).
[12] R. M. Lees, J. Mol. Spectrosc. **33**, 124 (1970).
[13] E. U. Condon and G. H. Shortley, The Theory of Atomic Spectra, Cambridge University Press, Cambridge, England (1957).

[1] Figures in brackets indicate literature references in section 1.5.

2. Hydroxyl Spectral Tables

TABLE I. Molecular Parameters of ^{16}OH, ^{16}OD, and ^{18}OH.[a]

Part A: Microwave Parameters of ^{16}OH, ^{16}OD, and ^{18}OH.

	^{16}OH		^{16}OD		^{18}OH	
E_Σ	979,826,000[b]		979,747,400[b]		979,826,000[b]	
B_Σ	507,471.7[b]		270,817.0[b]		504,122.4[b]	
B_Π	556,140.9[b]		296,312.0[b]		552,470.4[b]	
A	-4,157,663.076	± 450	-4,165,275.463	± 2300	-4,157,071.476	± 26
$\langle BL_y \rangle$	376,653.4542	± 24	200,437.6893	± 79	374,164.503	± 1.1
$\langle (A+2B)L_y \rangle$	-1,534,291.918	± 97	-1,892,097.323	± 751	-1,539,412.716	± 4.6
$D_{\Pi B}$	58.3519[b]		16.1417[b]		57.584	
$D_{\Sigma B}$	61.4491[b]		17.2636[b]		60.641	
D_α	202.6695	± 0.091	27.0824	± 0.20	200.53	
D_β	80.87536	± 0.021	22.71912	± 0.018	79.4438	
$D_{\alpha\alpha}$	0.01638	± 0.0011	.0053539	± 0.0031	0.0141	
$D_{\beta\beta}$	0.0067654	± 0.0019	.0010828	± 0.000086	0.00630	
D	-291.7691	± 21	112.4132	± 37	-288.51	
a	86.1118	± 0.0033	13.3051	± 0.00050	86.1248	± 0.0020
b	-116.2806	± 0.016	-17.8648	± 0.011	-116.281	
c	130.2212	± 0.019	20.1375	± 0.011	130.22	
d	56.6550	± 0.0036	8.7698	± 0.00046	56.6664	± 0.0075
d_J	0.022815	± 0.00020	0.0020301	± 0.00017	0.02255	
C_{SR}	-0.099647	± 0.00079	-0.0080742	± 0.00022	-0.09929	
eq Q_1			0.28496	± 0.0011		
eq Q_2			-0.11889	± 0.0042		

a. All units are MHz unless otherwise noted. As many digits have been kept as are necessary to reproduce the observed frequencies within the range of the experimental measurements. The unfitted molecular parameters of ^{18}OH were obtained by isotopic scaling of the parameters of ^{16}OH.

b. Obtained from M. Geller who has made a new fit of the optical data.

TABLE I. Molecular Parameters of ^{16}OH, ^{16}OD, and ^{18}OH (continued).

Part B: Other Parameters

	Electronic State	Vibrational State, v	Parameter			Ref.
OH	$^2\Pi_{1/2}$	0	μ = 1.721	± 0.029	D	71H
			μ = 1.732	± 0.02	D	65A
			μ = 1.66758	± 0.00010	D	73G
		1	μ = 1.657	± 0.05	D	71H
			μ = 1.667	± 0.04	D	65A
		2	μ = 1.637	± 0.045	D	71H
	$^2\Pi_{3/2}$	0	μ = 1.66	± 0.01	D	65B
	$^2\Sigma^+$	0	μ = 1.977	± 0.084	D	71H
		1	μ = 2.22	± 0.44	D	71H
OD	$^2\Pi_{1/2}$	0	μ = 1.695	± 0.032	D	71H
			μ = 1.65312	± 0.00014	D	73G
		1	μ = 1.646	± 0.023	D	71H
		2	μ = 1.567	± 0.061	D	71H
	$^2\Sigma^+$	0	μ = 1.72	± 0.10	D	73J
			μ = 2.159	± 0.076	D	71H
		0	eq Q = 0.18	± 0.10	MHz	76H

TABLE II. MICROWAVE SPECTRUM OF ^{16}OH IN THE GROUND VIBRATIONAL STATE. FREQUENCIES ARE IN MHz; ENERGY LEVELS IN cm^{-1}.

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF
.5	0	1	4660.2420(	.0030)	4660.2425(	.0030)	.1667	87.8650	87.7096	68C
.5	1	1	4750.6560(	.0030)	4750.6586(	.0020)	.3333	87.8680	87.7096	68C
.5	1	0	4765.5620(	.0030)	4765.5646(	.0030)	.1667	87.8680	87.7091	68C
1.5	1	2	7749.9090(	.0050)	7749.9126(	.0022)	.0188	149.1817	148.9232	70A
1.5	1	1	7761.7470(	.0050)	7761.7455(	.0022)	.0938	149.1817	148.9228	70A
1.5	2	2	7820.1250(	.0050)	7820.1233(	.0026)	.1689	149.1841	148.9232	70A
1.5	2	1	7831.9620(	.0050)	7831.9562(	.0021)	.0188	149.1841	148.9228	70A
2.5	2	3	8118.0510(	.0050)	8118.0566(	.0021)	.0062	250.5030	250.2322	75E
2.5	2	2	8135.8700(	.0050)	8135.8668(	.0019)	.0869	250.5030	250.2316	75F
2.5	3	3	8189.5870(	.0050)	8189.5846(	.0025)	.1242	250.5054	250.2322	75F
2.5	3	2	8207.4020(	.0050)	8207.3949(	.0021)	.0062	250.5054	250.2316	75F
3.5	3	4	5449.4360(	.0050)	5449.4437(	.0017)	.0030	390.9765	390.7947	75F
3.5	3	3	5473.0450(	.0050)	5473.0391(	.0016)	.0806	390.9765	390.7939	75F
3.5	4	4	5523.4380(	.0050)	5523.4428(	.0018)	.1045	390.9790	390.7947	75F
3.5	4	3	5547.0420(	.0050)	5547.0382(	.0017)	.0030	390.9790	390.7939	75F
4.5	5	4	192.9957(	.0005)	192.9960(	.0011)	.0017	569.8040	569.7976	73G
4.5	4	4	164.7960(	.0005)	164.7960(	.0011)	.0757	569.8031	569.7976	73G
4.5	5	5	117.1495(	.0005)	117.1498(	.0011)	.0930	569.8040	569.8001	73G
4.5	4	5	88.9504(	.0005)	88.9498(	.0011)	.0017	569.8031	569.8001	73G

TABLE II. MICROWAVE SPECTRUM OF ^{16}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
5.5	6	5			8611.8226(	.0041)	.0011	786.5529	786.2656	
5.5	5	5	8580.1370(	.0300)	8580.1381(	.0043)	.0717	786.5518	786.2656	74E
5.5	6	6	8534.8340(	.0300)	8534.8417(	.0041)	.0849	786.5529	786.2682	74E
5.5	5	6			8503.1572(	.0042)	.0011	786.5518	786.2682	
6.5	7	6			19596.1878(	.0118)	.0008	1040.4230	1039.7693	
6.5	6	6	19561.8970(	.0200)	19561.8927(	.0122)	.0680	1040.4219	1039.7693	75B
6.5	7	7	19518.6120(	.0100)	19518.6138(	.0116)	.0786	1040.4230	1039.7719	75B
6.5	6	7			19484.3187(	.0118)	.0008	1040.4219	1039.7719	
7.5	8	7			32957.5144(	.0400)	.0005	1330.8533	1329.7539	
7.5	7	7			32921.2508(	.0404)	.0646	1330.8521	1329.7539	
7.5	8	8			32879.7200(	.0395)	.0732	1330.8533	1329.7565	
7.5	7	8			32843.4564(	.0398)	.0005	1330.8521	1329.7565	
8.5	9	8			48531.5445(	.1282)	.0004	1657.3090	1655.6902	
8.5	8	8			48493.7757(	.1285)	.0614	1657.3078	1655.6902	
8.5	9	9			48453.7778(	.1277)	.0686	1657.3090	1655.6928	
8.5	8	9			48416.0090(	.1280)	.0004	1657.3078	1655.6928	
9.5	10	9			66171.5981(	.3365)	.0003	2019.2591	2017.0518	
9.5	9	9			66132.6578(	.3368)	.0584	2019.2578	2017.0518	
9.5	10	10			66094.0228(	.3360)	.0646	2019.2591	2017.0544	
9.5	9	10			66055.0824(	.3362)	.0003	2019.2578	2017.0544	
10.5	11	10			85741.5315(	.7544)	.0002	2416.1600	2413.3000	

TABLE II. MICROWAVE SPECTRUM OF ^{16}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	LOWER	REF.
10.5	10	10			85701.6614(	.7546)	.0556	2416.1587	2413.3000	
10.5	11	11			85664.2553(	.7538)	.0609	2416.1600	2413.3025	
10.5	10	11			85624.3851(	.7540)	.0002	2416.1587	2413.3025	
11.5	12	11			107110.9289(	1.5088)	.0002	2847.4454	2843.8726	
11.5	11	11			107069.8054(	1.5090)	.0530	2847.4440	2843.8726	
11.5	12	12			107033.5233(	1.5082)	.0576	2847.4454	2843.8751	
11.5	11	12			106992.8998(	1.5084)	.0002	2847.4440	2843.8751	
12.5	13	12			130149.0583(	2.7716)	.0002	3312.5186	3308.1773	
12.5	12	12			130107.8114(	2.7717)	.0506	3312.5172	3308.1773	
12.5	13	13			130072.5709(	2.7709)	.0547	3312.5186	3308.1798	
12.5	12	13			130031.3239(	2.7711)	.0002	3312.5172	3308.1798	
13.5	14	13			154727.6763(	4.7670)	.0001	3810.7479	3805.5868	
13.5	13	13			154685.9021(	4.7672)	.0484	3810.7465	3805.5868	
13.5	14	14			154651.6393(	4.7664)	.0520	3810.7479	3805.5893	
13.5	13	14			154609.8651(	4.7665)	.0001	3810.7465	3805.5893	

TABLE II. MICROWAVE SPECTRUM OF ^{16}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
1.5	1	2	1612.2310(	.0002)	1612.2309(	.0002)	.1440	-37.9806	-38.0344	72F
1.5	1	1	1665.4018(	.0002)	1665.4019(	.0002)	.7198	-37.9806	-38.0362	72F
1.5	2	2	1667.3590(	.0002)	1667.3590(	.0002)	1.2956	-37.9788	-38.0344	72F
1.5	2	1	1720.5300(	.0002)	1720.5299(	.0002)	.1440	-37.9788	-38.0362	72F
2.5	2	3	6016.7460(	.0050)	6016.7471(	.0030)	.0389	45.8655	45.6648	68C
2.5	2	2	6030.7470(	.0050)	6030.7454(	.0009)	.5446	45.8655	45.6643	75F
2.5	3	3	6035.0920(	.0050)	6035.0902(	.0010)	.7780	45.8661	45.6648	75F
2.5	3	2	6049.0840(	.0080)	6049.0886(	.0031)	.0389	45.8661	45.6643	68C
3.5	3	4	13442.0300(	.0250)	13442.1048(	.0053)	.0153	164.2682	163.8198	75C
3.5	3	3	13434.5960(	.0100)	13434.6299(	.0020)	.4121	164.2682	163.8201	75C
3.5	4	4	13441.3650(	.0100)	13441.4095(	.0022)	.5342	164.2682	163.8198	75C
3.5	4	3	13433.9300(	.0250)	13433.9347(	.0054)	.0153	164.2682	163.8201	75C
4.5	4	5	23838.9330(	.0100)	23838.9348(	.0068)	.0073	317.7067	316.9115	75B
4.5	4	4	23817.6150(	.0020)	23817.6136(	.0022)	.3227	317.7067	316.9122	75F
4.5	5	5	23826.6210(	.0030)	23826.6181(	.0026)	.3960	317.7063	316.9115	75F
4.5	5	4	23805.2970(	.0100)	23805.2969(	.0069)	.0073	317.7063	316.9122	75B
5.5	5	6	37014.4200(	.0300)	37014.4143(	.0099)	.0040	506.4629	505.2282	75B
5.5	5	5	36983.4700(	.0300)	36983.4967(	.0060)	.2609	506.4629	505.2293	68B
5.5	6	6	36994.4300(	.0500)	36994.4235(	.0062)	.3091	506.4622	505.2282	68B
5.5	6	5	36963.4800(	.0300)	36963.5059(	.0097)	.0040	506.4622	505.2293	75B
6.5	6	7	52759.8900(	.0300)	52759.9254(	.0149)	.0024	730.6361	728.8762	75B

TABLE II. MICROWAVE SPECTRUM OF ^{16}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF
6.5	6	6	52722.0400(	.0200)	52722.0551(	.0119)	.2167	730.6361	728.8775	75B
6.5	7	7	52734.5600(	.0200)	52734.5968(	.0119)	.2504	730.6352	728.8762	75B
6.5	7	6	52696.7200(	.0300)	52696.7265(	.0146)	.0024	730.6352	728.8775	75A
7.5	7	8			70888.1237(	.0188)	.0015	990.1761	987.8115	
7.5	7	7	70845.0810(	.0200)	70845.0478(	.0161)	.1841	990.1761	987.8129	75B
7.5	8	8	70858.9300(	.0200)	70858.9265(	.0160)	.2088	990.1751	987.8115	75B
7.5	8	7			70815.8507(	.0187)	.0015	990.1751	987.8129	
8.5	8	9			91235.3968(	.0689)	.0010	1284.9139	1281.8706	
8.5	8	8	91188.2600(	.1000)	91188.3190(	.0683)	.1592	1284.9139	1281.8722	76B
8.5	9	9	91203.2200(	.1000)	91203.2955(	.0682)	.1781	1284.9128	1281.8706	76B
8.5	9	8			91156.2177(	.0693)	.0010	1284.9128	1281.8722	
9.5	9	10			113655.2643(	.2285)	.0007	1614.5845	1610.7934	
9.5	9	9			113605.0416(	.2284)	.1398	1614.5845	1610.7951	
9.5	10	10			113620.9136(	.2284)	.1546	1614.5834	1610.7934	
9.5	10	9			113570.6909(	.2290)	.0007	1614.5834	1610.7951	
10.5	10	11			138011.3849(	.5756)	.0005	1978.8423	1974.2387	
10.5	10	10			137958.6451(	.5757)	.1244	1978.8423	1974.2405	
10.5	11	11			137975.2416(	.5757)	.1363	1978.8411	1974.2387	
10.5	11	10			137922.5018(	.5761)	.0005	1978.8411	1974.2405	
11.5	11	12			164172.2623(	1.2294)	.0004	2377.2717	2371.7955	
11.5	11	11			164117.4767(	1.2296)	.1118	2377.2717	2371.7973	

TABLE II. MICROWAVE SPECTRUM OF ^{16}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
11.5	12	12			164134.6529(	1.2297)	.1216	2377.2705	2371.7955	
11.5	12	11			164079.8673(	1.2300)	.0004	2377.2705	2371.7973	
12.5	12	13			192007.7002(	2.3541)	.0003	2809.3942	2802.9895	
12.5	12	12			191951.2304(	2.3544)	.1014	2809.3942	2802.9914	
12.5	13	13			191968.8627(	2.3544)	.1095	2809.3929	2802.9895	
12.5	13	12			191912.3930(	2.3548)	.0003	2809.3929	2802.9914	
13.5	13	14			221386.6022(	4.1660)	.0002	3274.6731	3267.2884	
13.5	13	13			221328.7314(	4.1663)	.0927	3274.6731	3267.2904	
13.5	14	14			221346.7130(	4.1663)	.0996	3274.6718	3267.2884	
13.5	14	13			221288.8422(	4.1667)	.0002	3274.6718	3267.2904	
14.5	14	15			252175.7150(	6.9421)	.0002	3772.5167	3764.1050	
14.5	14	14			252116.6688(	6.9424)	.0853	3772.5167	3764.1069	
14.5	15	15			252134.9067(	6.9425)	.0912	3772.5153	3764.1050	
14.5	15	14			252075.8605(	6.9428)	.0002	3772.5153	3764.1069	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE. FREQUENCIES ARE IN MHz; ENERGY LEVELS IN cm^{-1}.

$^2\Pi_{1/2}$ J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
.5	1.5	.5	3114.5294(	.0010)	3114.5298(	.0005)	.1975	79.2786	79.1747	73F
.5	.5	.5	3093.6057(	.0010)	3093.6054(	.0005)	.0247	79.2779	79.1747	73F
.5	1.5	1.5	3111.1414(	.0010)	3111.1411(	.0005)	.2469	79.2786	79.1748	73F
.5	.5	1.5	3090.2163(	.0010)	3090.2167(	.0005)	.1975	79.2779	79.1748	73F
1.5	1.5	.5	5895.1350(	.0050)	5895.1358(	.0009)	.0207	110.7936	110.5970	75F
1.5	2.5	1.5	5906.7120(	.0050)	5906.7116(	.0010)	.0223	110.7940	110.5970	75F
1.5	.5	.5	5887.7410(	.0050)	5887.7401(	.0008)	.0258	110.7934	110.5970	75F
1.5	1.5	1.5	5894.6800(	.0050)	5894.6784(	.0005)	.0500	110.7936	110.5970	75F
1.5	2.5	2.5	5906.2150(	.0050)	5906.2132(	.0007)	.1171	110.7940	110.5970	75F
1.5	1.5	2.5	5894.1790(	.0050)	5894.1800(	.0010)	.0223	110.7936	110.5970	75F
1.5	.5	1.5	5887.2820(	.0050)	5887.2827(	.0009)	.0207	110.7934	110.5970	75F
2.5	2.5	1.5	8118.7330(	.0050)	8118.7333(	.0016)	.0068	163.1654	162.8946	75F
2.5	3.5	2.5	8128.9610(	.0050)	8128.9626(	.0018)	.0070	163.1658	162.8947	75F
2.5	1.5	1.5	8110.7170(	.0050)	8110.7171(	.0016)	.0358	163.1652	162.8946	75F
2.5	2.5	2.5	8118.0130(	.0050)	8118.0098(	.0010)	.0501	163.1654	162.8947	75F
2.5	3.5	3.5	8128.1810(	.0050)	8128.1818(	.0018)	.0782	163.1658	162.8947	75F
2.5	2.5	3.5	8117.2280(	.0050)	8117.2290(	.0018)	.0070	163.1654	162.8947	75F
2.5	1.5	2.5	8109.9940(	.0050)	8109.9937(	.0016)	.0068	163.1652	162.8947	75F
3.5	3.5	2.5			9587.5829(	.0031)	.0031	236.2398	235.9200	
3.5	4.5	3.5			9597.1728(	.0035)	.0032	236.2401	235.9200	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
3.5	2.5	2.5	9578.9000(	.0800)	9578.9323(	.0034)	.0353	236.2395	235.9200	69F
3.5	3.5	3.5	9586.3200(	.0800)	9586.3128(	.0026)	.0449	236.2398	235.9200	69F
3.5	4.5	4.5	9595.7400(	.0800)	9595.7562(	.0039)	.0608	236.2401	235.9201	69F
3.5	3.5	4.5			9584.8962(	.0035)	.0032	236.2398	235.9201	
3.5	2.5	3.5			9577.6622(	.0031)	.0031	236.2395	235.9200	
4.5	4.5	3.5			10201.4374(	.0086)	.0017	329.8343	329.4940	
4.5	5.5	4.5			10210.5669(	.0088)	.0018	329.8347	329.4941	
4.5	3.5	3.5	10192.2100(	.0800)	10192.2233(	.0089)	.0337	329.8340	329.4940	69F
4.5	4.5	4.5	10199.5600(	.0800)	10199.5647(	.0082)	.0408	329.8343	329.4941	69F
4.5	5.5	5.5	10208.5000(	.0800)	10208.4847(	.0093)	.0514	329.8347	329.4942	69F
4.5	4.5	5.5			10197.4824(	.0088)	.0018	329.8343	329.4942	
4.5	3.5	4.5			10190.3506(	.0086)	.0017	329.8340	329.4941	
5.5	5.5	4.5			9924.3907(	.0237)	.0011	443.7542	443.4232	
5.5	6.5	5.5			9933.1301(	.0236)	.0011	443.7546	443.4232	
5.5	4.5	4.5	9914.7000(	.0800)	9914.7051(	.0241)	.0322	443.7539	443.4232	69F
5.5	5.5	5.5	9921.9500(	.0800)	9921.9419(	.0234)	.0378	443.7542	443.4232	69F
5.5	6.5	6.5	9930.4400(	.0800)	9930.4358(	.0240)	.0455	443.7546	443.4233	69F
5.5	5.5	6.5			9919.2477(	.0236)	.0011	443.7542	443.4233	
5.5	4.5	5.5			9912.2563(	.0237)	.0011	443.7539	443.4232	
6.5	6.5	5.5			8763.0098(	.0566)	.0008	577.8024	577.5101	
6.5	7.5	6.5			8771.3994(	.0563)	.0008	577.8027	577.5101	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
6.5	5.5	5.5			8752.9425(	.0571)	.0309	577.8020	577.5101	
6.5	6.5	6.5			8760.0415(	.0563)	.0355	577.8024	577.5101	
6.5	7.5	7.5			8768.1692(	.0564)	.0415	577.8027	577.5103	
6.5	6.5	7.5			8756.8113(	.0563)	.0008	577.8024	577.5103	
6.5	5.5	6.5			8749.9742(	.0566)	.0008	577.8020	577.5101	
7.5	7.5	6.5			6747.3688(	.1186)	.0005	731.7845	731.5594	
7.5	8.5	7.5			6755.4394(	.1179)	.0005	731.7848	731.5595	
7.5	6.5	6.5			6736.9988(	.1191)	.0298	731.7841	731.5594	
7.5	7.5	7.5			6743.9451(	.1181)	.0336	731.7845	731.5595	
7.5	8.5	8.5			6751.7502(	.1178)	.0385	731.7848	731.5596	
7.5	7.5	8.5			6740.2559(	.1179)	.0005	731.7845	731.5596	
7.5	6.5	7.5			6733.5751(	.1185)	.0005	731.7841	731.5595	
8.5	8.5	7.5			3918.0274(	.2245)	.0004	905.5101	905.3794	
8.5	9.5	8.5			3925.8057(	.2235)	.0004	905.5105	905.3795	
8.5	7.5	7.5			3907.4208(	.2251)	.0289	905.5098	905.3794	
8.5	8.5	8.5			3914.2099(	.2239)	.0321	905.5101	905.3795	
8.5	9.5	9.5			3921.7271(	.2232)	.0362	905.5105	905.3797	
8.5	8.5	9.5			3910.1313(	.2235)	.0004	905.5101	905.3797	
8.5	7.5	8.5			3903.6033(	.2244)	.0004	905.5098	905.3795	
9.5	9.5	8.5			318.4415(	.3937)	.0003	1098.7917	1098.7811	
9.5	10.5	9.5			325.9514(	.3924)	.0003	1098.7921	1098.7812	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F_U	F_L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
9.5	8.5	8.5			307.6522(	.3944)	.0279	1098.7913	1098.7811	
9.5	9.5	9.5			314.2854(	.3930)	.0308	1098.7917	1098.7812	
9.5	10.5	10.5			321.5435(	.3919)	.0342	1098.7921	1098.7814	
9.5	9.5	10.5			309.8775(	.3924)	.0003	1098.7917	1098.7814	
9.5	8.5	9.5			303.4961(	.3937)	.0003	1098.7913	1098.7812	
10.5	9.5	10.5			4008.8221(	.6513)	.0002	1311.5761	1311.4424	
10.5	10.5	11.5			4001.5590(	.6497)	.0002	1311.5763	1311.4428	
10.5	9.5	9.5			4019.7507(	.6522)	.0271	1311.5761	1311.4420	
10.5	10.5	10.5			4013.2692(	.6504)	.0296	1311.5763	1311.4424	
10.5	11.5	11.5			4006.2460(	.6490)	.0325	1311.5764	1311.4428	
10.5	11.5	10.5			4017.9561(	.6497)	.0002	1311.5764	1311.4424	
10.5	10.5	9.5			4024.1978(	.6512)	.0002	1311.5763	1311.4420	
11.5	10.5	11.5			9023.5970(	1.0297)	.0002	1543.5751	1543.2741	
11.5	11.5	12.5			9016.5616(	1.0277)	.0002	1543.5752	1543.2745	
11.5	10.5	10.5			9034.6303(	1.0307)	.0262	1543.5751	1543.2737	
11.5	11.5	11.5			9028.2948(	1.0287)	.0284	1543.5752	1543.2741	
11.5	12.5	12.5			9021.4857(	1.0268)	.0311	1543.5754	1543.2745	
11.5	12.5	11.5			9033.2189(	1.0277)	.0002	1543.5754	1543.2741	
11.5	11.5	10.5			9039.3281(	1.0296)	.0002	1543.5752	1543.2737	
12.5	11.5	12.5			14688.4255(	1.5709)	.0002	1794.5849	1794.0950	
12.5	12.5	13.5			14681.6007(	1.5686)	.0002	1794.5851	1794.0954	

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TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	LOWER	REF.
12.5	11.5	11.5			14699.5358(	1.5722)	.0254	1794.5849	1794.0946	
12.5	12.5	12.5			14693.3401(	1.5697)	.0274	1794.5851	1794.0950	
12.5	13.5	13.5			14686.7277(	1.5675)	.0297	1794.5853	1794.0954	
12.5	13.5	12.5			14698.4671(	1.5686)	.0002	1794.5853	1794.0950	
12.5	12.5	11.5			14704.4505(	1.5709)	.0002	1794.5851	1794.0946	
13.5	12.5	13.5			20968.3108(	2.3294)	.0001	2064.4076	2063.7081	
13.5	13.5	14.5			20961.6817(	2.3266)	.0001	2064.4077	2063.7085	
13.5	12.5	12.5			20979.4761(	2.3308)	.0247	2064.4076	2063.7078	
13.5	13.5	13.5			20973.4142(	2.3280)	.0265	2064.4077	2063.7081	
13.5	14.5	14.5			20966.9834(	2.3253)	.0285	2064.4079	2063.7085	
13.5	14.5	13.5			20978.7159(	2.3266)	.0001	2064.4079	2063.7081	
13.5	13.5	12.5			20984.5795(	2.3294)	.0001	2064.4077	2063.7078	
14.5	13.5	14.5			27830.2666(	3.3741)	.0001	2352.8380	2351.9097	
14.5	14.5	15.5			27823.8201(	3.3710)	.0001	2352.8381	2351.9100	
14.5	13.5	13.5			27841.4692(	3.3757)	.0240	2352.8380	2351.9093	
14.5	14.5	14.5			27835.5353(	3.3726)	.0256	2352.8381	2351.9097	
14.5	15.5	15.5			27829.2735(	3.3694)	.0274	2352.8383	2351.9100	
14.5	15.5	14.5			27840.9887(	3.3710)	.0001	2352.8383	2351.9097	
14.5	14.5	13.5			27846.7380(	3.3741)	.0001	2352.8381	2351.9093	
15.5	14.5	15.5			35242.8373(	4.7922)	.0001	2659.6632	2658.4877	
15.5	15.5	16.5			35236.5622(	4.7886)	.0001	2659.6634	2658.4881	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	LOWER	REF.
15.5	14.5	14.5			35254.0630(	4.7940)	.0232	2659.6632	2658.4873	
15.5	15.5	15.5			35248.2520(	4.7904)	.0247	2659.6634	2658.4877	
15.5	16.5	16.5			35242.1482(	4.7869)	.0264	2659.6636	2658.4881	
15.5	16.5	15.5			35253.8379(	4.7886)	.0001	2659.6636	2658.4877	
15.5	15.5	14.5			35259.4776(	4.7922)	.0001	2659.6634	2658.4873	
16.5	15.5	16.5			43175.6665(	6.6910)	.0001	2984.6615	2983.2213	
16.5	16.5	17.5			43169.5530(	6.6870)	.0001	2984.6617	2983.2217	
16.5	15.5	15.5			43186.9035(	6.6930)	.0226	2984.6615	2983.2209	
16.5	16.5	16.5			43181.2108(	6.6891)	.0239	2984.6617	2983.2213	
16.5	17.5	17.5			43175.2560(	6.6851)	.0254	2984.6618	2983.2217	
16.5	17.5	16.5			43186.9138(	6.6871)	.0001	2984.6618	2983.2213	
16.5	16.5	15.5			43192.4478(	6.6910)	.0001	2984.6617	2983.2209	
17.5	16.5	17.5			51599.1391(	9.2014)	.0001	3327.6010	3325.8798	
17.5	17.5	18.5			51593.1787(	9.1970)	.0001	3327.6012	3325.8802	
17.5	16.5	16.5			51610.3779(	9.2036)	.0219	3327.6010	3325.8795	
17.5	17.5	17.5			51604.7995(	9.1993)	.0231	3327.6012	3325.8798	
17.5	18.5	18.5			51598.9858(	9.1948)	.0245	3327.6014	3325.8802	
17.5	18.5	17.5			51610.6066(	9.1971)	.0001	3327.6014	3325.8798	
17.5	17.5	16.5			51616.0383(	9.2015)	.0001	3327.6012	3325.8795	
18.5	17.5	18.5			60484.1012(	12.4803)	.0001	3688.2398	3686.2223	
18.5	18.5	19.5			60478.2867(	12.4755)	.0001	3688.2400	3686.2227	

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TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	LOWER	REF.
18.5	17.5	17.5			60495.3341(	12.4827)	.0213	3688.2398	3686.2219	
18.5	18.5	18.5			60489.8664(	12.4779)	.0224	3688.2400	3686.2223	
18.5	19.5	19.5			60484.1873(	12.4731)	.0237	3688.2402	3686.2227	
18.5	19.5	18.5			60495.7670(	12.4755)	.0001	3688.2402	3686.2223	
18.5	18.5	17.5			60501.0993(	12.4803)	.0001	3688.2400	3686.2219	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F_U	F_L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	LOWER	REF.
1.5	1.5	.5	317.3290(	.0040)	317.3274(	.0007)	.1751	-51.5596	-51.5702	73F
1.5	2.5	1.5	322.4800(	.0020)	322.4803(	.0005)	.1891	-51.5592	-51.5699	73F
1.5	.5	.5	310.1445(	.0010)	310.1440(	.0003)	.2189	-51.5598	-51.5702	73F
1.5	1.5	1.5	310.2147(	.0010)	310.2151(	.0002)	.4238	-51.5596	-51.5699	73F
1.5	2.5	2.5	310.3627(	.0010)	310.3626(	.0002)	.9929	-51.5592	-51.5695	73F
1.5	1.5	2.5	298.0970(	.0010)	298.0974(	.0005)	.1891	-51.5596	-51.5695	73F
1.5	.5	1.5	303.0320(	.0020)	303.0318(	.0007)	.1751	-51.5598	-51.5699	73F
2.5	2.5	1.5	1194.3390(	.0010)	1194.3396(	.0003)	.0528	-5.1583	-5.1981	73F
2.5	3.5	2.5	1196.0060(	.0030)	1196.0073(	.0005)	.0539	-5.1581	-5.1980	73F
2.5	1.5	1.5	1190.5659(	.0020)	1190.5652(	.0004)	.2771	-5.1584	-5.1981	73F
2.5	2.5	2.5	1190.7741(	.0020)	1190.7739(	.0004)	.3882	-5.1583	-5.1980	73F
2.5	3.5	3.5	1191.1047(	.0020)	1191.1039(	.0004)	.6060	-5.1581	-5.1979	73F
2.5	2.5	3.5	1185.8712(	.0010)	1185.8705(	.0004)	.0539	-5.1583	-5.1979	73F
2.5	1.5	2.5	1186.9986(	.0030)	1186.9995(	.0004)	.0528	-5.1584	-5.1980	73F
3.5	3.5	2.5	2823.5328(	.0020)	2823.5317(	.0006)	.0218	59.9384	59.8442	73F
3.5	4.5	3.5	2824.2276(	.0020)	2824.2268(	.0006)	.0220	59.9385	59.8443	73F
3.5	2.5	2.5	2822.0007(	.0020)	2821.9997(	.0006)	.2452	59.9384	59.8442	73F
3.5	3.5	3.5	2822.3883(	.0020)	2822.3857(	.0005)	.3123	59.9384	59.8443	73F
3.5	4.5	4.5	2822.9250(	.0020)**	2822.9279(	.0007)	.4231	59.9385	59.8443	73F
3.5	3.5	4.5	2821.0857(	.0020)	2821.0868(	.0006)	.0220	59.9384	59.8443	73F
3.5	2.5	3.5	2820.8514(	.0020)	2820.8537(	.0006)	.0218	59.9384	59.8443	73F

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
4.5	4.5	3.5	5303.9340(	.0050)**	5303.9421(	.0011)	.0108	143.8228	143.6459	75F
4.5	5.5	4.5	5304.3590(	.0050)	5304.3544(	.0011)	.0109	143.8228	143.6458	75F
4.5	3.5	3.5	5304.0150(	.0050)	5304.0168(	.0011)	.2085	143.8228	143.6459	75F
4.5	4.5	4.5	5304.6000(	.0050)	5304.6019(	.0010)	.2524	143.8228	143.6458	75F
4.5	5.5	5.5	5305.3720(	.0050)	5305.3697(	.0012)	.3181	143.8228	143.6458	75F
4.5	4.5	5.5	5305.6190(	.0050)	5305.6172(	.0011)	.0109	143.8228	143.6458	75F
4.5	3.5	4.5	5304.6810(	.0050)	5304.6766(	.0011)	.0108	143.8228	143.6458	75F
5.5	5.5	4.5			8670.2946(	.0025)	.0061	246.5735	246.2843	
5.5	6.5	5.5			8670.6848(	.0024)	.0061	246.5735	246.2843	
5.5	4.5	4.5	8671.6000(	.0800)	8671.5760(	.0025)	.1773	246.5736	246.2843	69F
5.5	5.5	5.5	8672.3700(	.0800)	8672.3670(	.0023)	.2079	246.5735	246.2843	69F
5.5	6.5	6.5	8673.3500(	.0800)	8673.3604(	.0025)	.2506	246.5735	246.2842	69F
5.5	5.5	6.5			8675.0427(	.0024)	.0061	246.5735	246.2842	
5.5	4.5	5.5			8673.6484(	.0024)	.0061	246.5736	246.2843	
6.5	6.5	5.5			12914.8891(	.0055)	.0037	368.2459	367.8151	
6.5	7.5	6.5			12915.3686(	.0054)	.0037	368.2458	367.8150	
6.5	5.5	5.5	12917.0800(	.0800)	12917.1019(	.0055)	.1522	368.2460	367.8151	69F
6.5	6.5	6.5	12918.1300(	.0800)	12918.0952(	.0054)	.1745	368.2459	367.8150	69F
6.5	7.5	7.5	12919.3300(	.0800)	12919.3048(	.0055)	.2042	368.2458	367.8149	69F
6.5	6.5	7.5			12922.0314(	.0054)	.0037	368.2459	367.8149	
6.5	5.5	6.5			12920.3081(	.0055)	.0037	368.2460	367.8150	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
7.5	7.5	6.5			18006.5372(	.0104)	.0024	508.8666	508.2659	
7.5	8.5	7.5			18007.1539(	.0104)	.0024	508.8664	508.2658	
7.5	6.5	6.5	18009.4600(	.0800)	18009.4827(	.0105)	.1322	508.8667	508.2659	69F
7.5	7.5	7.5	18010.6300(	.0800)	18010.6680(	.0103)	.1490	508.8666	508.2658	69F
7.5	8.5	8.5	18012.1300(	.0800)	18012.0787(	.0105)	.1706	508.8664	508.2656	69F
7.5	7.5	8.5			18015.5928(	.0104)	.0024	508.8666	508.2656	
7.5	6.5	7.5			18013.6135(	.0104)	.0024	508.8667	508.2658	
8.5	8.5	7.5			23903.5682(	.0153)	.0016	668.4324	667.6351	
8.5	9.5	8.5			23904.3393(	.0153)	.0016	668.4323	667.6349	
8.5	7.5	7.5	23907.0800(	.0800)	23907.0987(	.0155)	.1160	668.4325	667.6351	69F
8.5	8.5	8.5	23908.4400(	.0800)	23908.4620(	.0153)	.1290	668.4324	667.6349	69F
8.5	9.5	9.5	23910.0400(	.0800)	23910.0563(	.0155)	.1454	668.4323	667.6347	69F
8.5	8.5	9.5			23914.1790(	.0153)	.0016	668.4324	667.6347	
8.5	7.5	8.5			23911.9924(	.0154)	.0016	668.4325	667.6349	
9.5	9.5	8.5			30561.4085(	.0162)	.0012	846.9118	845.8924	
9.5	10.5	9.5			30562.3354(	.0162)	.0012	846.9116	845.8922	
9.5	8.5	8.5	30565.4200(	.0800)	30565.4122(	.0164)	.1028	846.9119	845.8924	69F
9.5	9.5	9.5	30566.9500(	.0800)	30566.9378(	.0160)	.1132	846.9118	845.8922	69F
9.5	10.5	10.5	30568.7200(	.0800)	30568.6973(	.0164)	.1259	846.9116	845.8920	69F
9.5	9.5	10.5			30573.2997(	.0162)	.0012	846.9118	845.8920	
9.5	8.5	9.5			30570.9414(	.0162)	.0012	846.9119	845.8922	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
10.5	10.5	9.5			37936.3616(	.0242)	.0008	1044.2464	1042.9810	
10.5	11.5	10.5			37937.4380(	.0242)	.0008	1044.2463	1042.9808	
10.5	9.5	9.5	37940.7300(	.0800)	37940.7528(	.0245)	.0920	1044.2466	1042.9810	69F
10.5	10.5	10.5	37942.4200(	.0800)	37942.4248(	.0241)	.1004	1044.2464	1042.9808	69F
10.5	11.5	11.5	37944.3500(	.0800)	37944.3315(	.0245)	.1105	1044.2463	1042.9806	69F
10.5	10.5	11.5			37949.3183(	.0242)	.0008	1044.2464	1042.9806	
10.5	9.5	10.5			37946.8160(	.0242)	.0008	1044.2466	1042.9808	
11.5	11.5	10.5			45987.1158(	.0823)	.0006	1260.3537	1258.8198	
11.5	12.5	11.5			45988.3315(	.0822)	.0006	1260.3535	1258.8195	
11.5	10.5	10.5			45991.8283(	.0824)	.0829	1260.3539	1258.8198	
11.5	11.5	11.5			45993.6310(	.0822)	.0899	1260.3537	1258.8195	
11.5	12.5	12.5			45995.6679(	.0824)	.0981	1260.3535	1258.8193	
11.5	11.5	12.5			46000.9673(	.0822)	.0006	1260.3537	1258.8193	
11.5	10.5	11.5			45998.3435(	.0822)	.0006	1260.3539	1258.8195	
12.5	12.5	11.5			54675.0497(	.2143)	.0005	1495.1286	1493.3049	
12.5	13.5	12.5			54676.3930(	.2143)	.0005	1495.1285	1493.3046	
12.5	11.5	11.5			54680.0317(	.2144)	.0754	1495.1288	1493.3049	
12.5	12.5	12.5			54681.9504(	.2143)	.0812	1495.1286	1493.3046	
12.5	13.5	13.5			54684.1016(	.2144)	.0880	1495.1285	1493.3044	
12.5	12.5	13.5			54689.6590(	.2143)	.0005	1495.1286	1493.3044	
12.5	11.5	12.5			54686.9324(	.2143)	.0005	1495.1288	1493.3046	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F_U	F_L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
13.5	13.5	12.5			63963.9833(	.4597)	.0004	1748.4458	1746.3122	
13.5	14.5	13.5			63965.4419(	.4596)	.0004	1748.4456	1746.3119	
13.5	12.5	12.5			63969.1939(	.4597)	.0689	1748.4459	1746.3122	
13.5	13.5	13.5			63971.2150(	.4596)	.0739	1748.4458	1746.3119	
13.5	14.5	14.5			63973.4659(	.4597)	.0796	1748.4456	1746.3116	
13.5	13.5	14.5			63979.2390(	.4597)	.0004	1748.4458	1746.3116	
13.5	12.5	13.5			63976.4255(	.4596)	.0004	1748.4459	1746.3119	
14.5	14.5	13.5			73819.7254(	.8743)	.0003	2020.1607	2017.6983	
14.5	15.5	14.5			73821.2870(	.8743)	.0003	2020.1605	2017.6980	
14.5	13.5	13.5			73825.1320(	.8743)	.0634	2020.1608	2017.6983	
14.5	14.5	14.5			73827.2428(	.8742)	.0677	2020.1607	2017.6980	
14.5	15.5	15.5			73829.5804(	.8743)	.0725	2020.1605	2017.6978	
14.5	14.5	15.5			73835.5361(	.8743)	.0003	2020.1607	2017.6978	
14.5	13.5	14.5			73832.6495(	.8742)	.0003	2020.1608	2017.6980	
15.5	15.5	14.5			84209.5930(	1.5311)	.0002	2310.1111	2307.3022	
15.5	16.5	15.5			84211.2462(	1.5312)	.0002	2310.1109	2307.3019	
15.5	14.5	14.5			84215.1698(	1.5311)	.0586	2310.1113	2307.3022	
15.5	15.5	15.5			84217.3586(	1.5311)	.0623	2310.1111	2307.3019	
15.5	16.5	16.5			84219.7708(	1.5312)	.0665	2310.1109	2307.3017	
15.5	15.5	16.5			84225.8833(	1.5312)	.0002	2310.1111	2307.3017	
15.5	14.5	15.5			84222.9354(	1.5311)	.0002	2310.1113	2307.3019	

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TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
16.5	16.5	15.5			95101.9794(	2.5226)	.0002	2618.1182	2614.9459	
16.5	17.5	16.5			95103.7131(	2.5226)	.0002	2618.1180	2614.9457	
16.5	15.5	15.5			95107.7053(	2.5225)	.0545	2618.1184	2614.9459	
16.5	16.5	16.5			95109.9616(	2.5226)	.0577	2618.1182	2614.9457	
16.5	17.5	17.5			95112.4375(	2.5227)	.0613	2618.1180	2614.9454	
16.5	16.5	17.5			95118.6860(	2.5226)	.0002	2618.1182	2614.9454	
16.5	15.5	16.5			95115.6874(	2.5225)	.0002	2618.1184	2614.9457	
17.5	17.5	16.5			106465.9955(	3.9626)	.0002	2943.9868	2940.4355	
17.5	18.5	17.5			106467.7995(	3.9627)	.0002	2943.9866	2940.4352	
17.5	16.5	16.5			106471.8534(	3.9625)	.0509	2943.9870	2940.4355	
17.5	17.5	17.5			106474.1674(	3.9626)	.0537	2943.9868	2940.4352	
17.5	18.5	18.5			106476.6972(	3.9628)	.0569	2943.9866	2940.4349	
17.5	17.5	18.5			106483.0651(	3.9627)	.0002	2943.9868	2940.4349	
17.5	16.5	17.5			106480.0254(	3.9625)	.0002	2943.9870	2940.4352	
18.5	18.5	17.5			118271.1897(	5.9898)	.0001	3287.5065	3283.5614	
18.5	19.5	18.5			118273.0545(	5.9899)	.0001	3287.5063	3283.5611	
18.5	17.5	17.5			118277.1658(	5.9896)	.0476	3287.5067	3283.5614	
18.5	18.5	18.5			118279.5286(	5.9898)	.0502	3287.5065	3283.5611	
18.5	19.5	19.5			118282.1032(	5.9900)	.0529	3287.5063	3283.5608	
18.5	18.5	19.5			118288.5773(	5.9899)	.0001	3287.5065	3283.5608	
18.5	17.5	18.5			118285.5047(	5.9896)	.0001	3287.5067	3283.5611	

TABLE III. MICROWAVE SPECTRUM OF ^{16}OD IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
19.5	19.5	18.5			130487.3375(	8.7697)	.0001	3648.4520	3644.0994	
19.5	20.5	19.5			130489.2542(	8.7698)	.0001	3648.4517	3644.0991	
19.5	18.5	18.5			130493.4203(	8.7695)	.0448	3648.4522	3644.0994	
19.5	19.5	19.5			130495.8237(	8.7697)	.0470	3648.4520	3644.0991	
19.5	20.5	20.5			130498.4349(	8.7700)	.0495	3648.4517	3644.0988	
19.5	19.5	20.5			130505.0044(	8.7698)	.0001	3648.4520	3644.0988	
19.5	18.5	19.5			130501.9065(	8.7695)	.0001	3648.4522	3644.0991	

** These transitions were calculated by using SUM RULES.

TABLE IV. MICROWAVE SPECTRUM OF ^{18}OH IN THE GROUND VIBRATIONAL STATE. FREQUENCIES ARE IN MHz; ENERGY LEVELS IN cm^{-1}.

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
.5	0	1	4644.6500(	.0060)	4644.6400(	.0030)	.1667	87.7322	87.5773	74E
.5	1	1	4735.0730(	.0060)	4735.0724(	.0020)	.3333	87.7352	87.5773	74E
.5	1	0	4749.3710(	.0050)	4749.3792(	.0030)	.1667	87.7352	87.5768	74E
1.5	1	2			7746.6238(	.0022)	.0187	148.6183	148.3599	
1.5	1	1			7758.3472(	.0022)	.0937	148.6183	148.3595	
1.5	2	2			7816.7560(	.0026)	.1687	148.6207	148.3599	
1.5	2	1			7828.4795(	.0021)	.0187	148.6207	148.3595	
2.5	2	3			8167.3315(	.0021)	.0062	249.2375	248.9651	
2.5	2	2			8184.9925(	.0019)	.0868	249.2375	248.9645	
2.5	3	3			8238.7585(	.0025)	.1239	249.2399	248.9651	
2.5	3	2			8256.4195(	.0021)	.0062	249.2399	248.9645	
3.5	3	4			5590.8303(	.0017)	.0030	388.7511	388.5646	
3.5	3	3			5614.2675(	.0016)	.0804	388.7511	388.5638	
3.5	4	4			5664.7321(	.0018)	.1042	388.7535	388.5646	
3.5	4	3			5688.1693(	.0017)	.0030	388.7535	388.5638	
4.5	4	5			75.0279(	.0011)	.0017	566.3647	566.3622	
4.5	4	4			103.3761(	.0011)	.0755	566.3647	566.3613	
4.5	5	5			150.7909(	.0011)	.0927	566.3672	566.3622	
4.5	5	4			178.3392(	.0011)	.0017	566.3672	566.3613	

TABLE IV. MICROWAVE SPECTRUM OF ^{18}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
5.5	6	5			8187.1841(	.1001)	.0011	781.6585	781.3854	
5.5	5	5			8155.6388(	.1001)	.0715	781.6575	781.3854	
5.5	6	6			3110.2698(	.1001)	.0847	781.6585	781.3880	
5.5	5	6			3078.7245(	.1001)	.0011	781.6575	781.3880	
6.5	7	6			18988.2343(	.2003)	.0008	1033.8414	1033.2080	
6.5	6	6			18954.0647(	.2004)	.0678	1033.8403	1033.2080	
6.5	7	7			18910.7114(	.2003)	.0783	1033.8414	1033.2106	
6.5	6	7			18876.5418(	.2003)	.0008	1033.8403	1033.2106	
7.5	8	7			32141.3926(	.2040)	.0005	1322.3551	1321.2830	
7.5	7	7			32105.8417(	.2040)	.0644	1322.3539	1321.2830	
7.5	8	8			32064.2358(	.2039)	.0730	1322.3551	1321.2856	
7.5	7	8			32028.0848(	.2039)	.0005	1322.3539	1321.2856	
8.5	9	8			47486.2833(	.3262)	.0004	1646.6702	1645.0863	
8.5	8	8			47448.6160(	.3264)	.0612	1646.6690	1645.0863	
8.5	9	9			47408.5427(	.3260)	.0685	1646.6702	1645.0889	
8.5	8	9			47370.8754(	.3262)	.0004	1646.6690	1645.0889	
9.5	10	9			64376.4143(	.5227)	.0003	2006.2614	2004.0973	
9.5	9	9			64837.5660(	.5229)	.0582	2006.2601	2004.0973	
9.5	10	10			64798.3553(	.5224)	.0644	2006.2614	2004.0999	

TABLE IV. MICROWAVE SPECTRUM OF ^{18}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{1/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	LOWER	REF.
9.5	9	10			84760.0070(	.5225)	.0003	2006.2601	2004.0998	
10.5	11	10			84178.2581(	.9639)	.0002	2400.5911	2397.7833	
10.5	10	10			84138.4722(	.9641)	.0555	2400.5898	2397.7833	
10.5	11	11			84100.9899(	.9634)	.0608	2400.5911	2397.7858	
10.5	10	11			84061.2040(	.9636)	.0002	2400.5898	2397.7858	
11.5	12	11			105262.9850(	1.6633)	.0002	2829.0997	2825.5885	
11.5	11	11			105222.4394(	1.6635)	.0529	2829.0984	2825.5885	
11.5	12	12			105186.0801(	1.6627)	.0575	2829.0997	2825.5911	
11.5	11	12			105145.5345(	1.6629)	.0002	2829.0984	2825.5911	
12.5	13	12			128003.5183(	2.8847)	.0002	3291.1977	3286.9280	
12.5	12	12			127962.3441(	2.8848)	.0535	3291.1964	3286.9280	
12.5	13	13			127927.0253(	2.8841)	.0546	3291.1977	3286.9305	
12.5	12	13			127885.8512(	2.8843)	.0002	3291.1964	3286.9305	
13.5	14	13			152272.3205(	4.8708)	.0001	3786.2613	3781.1820	
13.5	13	13			152230.5151(	4.8710)	.0483	3786.2599	3781.1820	
13.5	14	14			152196.2722(	4.8702)	.0519	3786.2613	3781.1845	
13.5	13	14			152154.5668(	4.8703)	.0001	3786.2599	3781.1845	

TABLE IV. MICROWAVE SPECTRUM OF ^{18}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$ J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
1.5	1	2	1584.2740(	.0020)	1584.2747(	.0002)	.1440	-38.1505	-38.2034	74E
1.5	1	1	1637.5640(	.0020)	1637.5643(	.0002)	.7200	-38.1505	-38.2052	74E
1.5	2	2	1639.5030(	.0020)	1639.5037(	.0002)	1.2961	-38.1487	-38.2034	74E
1.5	2	1	1692.7950(	.0020)	1692.7933(	.0002)	.1440	-38.1487	-38.2052	74E
2.5	2	3	5920.5050(	.0050)	5920.5015(	.0030)	.0389	45.1785	44.9811	74E
2.5	2	2	5934.6440(	.0060)	5934.6534(	.0009)	.5450	45.1785	44.9806	74E
2.5	3	3	5938.9670(	.0050)	5938.9641(	.0010)	.7786	45.1792	44.9811	74E
2.5	3	2	5953.1160(	.0040)	5953.1160(	.0031)	.0389	45.1792	44.9806	74E
3.5	3	4			13237.3834(	.0053)	.0153	162.8389	162.3973	
3.5	3	3			13230.5685(	.0020)	.4126	162.8389	162.3976	
3.5	4	4			13237.3031(	.0022)	.5348	162.8389	162.3973	
3.5	4	3			13229.9882(	.0054)	.0153	162.8389	162.3976	
4.5	4	5			23492.0382(	.0068)	.0073	315.3035	314.5199	
4.5	4	4			23470.8688(	.0022)	.3231	315.3035	314.5206	
4.5	5	5			23479.3228(	.0026)	.3965	315.3031	314.5199	
4.5	5	4			23458.6532(	.0063)	.0073	315.3031	314.5206	
5.5	5	6			36494.6610(	.1005)	.0040	502.8522	501.6349	
5.5	5	5			36463.8808(	.1002)	.2613	502.8522	501.6359	
5.5	6	6			36474.7563(	.1002)	.3095	502.8515	501.6349	

TABLE IV. MICROWAVE SPECTRUM OF ^{18}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
5.5	6	5			36443.3761(	.1005)	.0040	502.8515	501.6359	
6.5	6	7			52040.3885(	.2006)	.0024	725.5849	723.8491	
6.5	6	6			52002.6403(	.2004)	.2170	725.5849	723.8503	
6.5	7	7			52015.1322(	.2004)	.2508	725.5841	723.8491	
6.5	7	6			51977.3840(	.2005)	.0024	725.5841	723.8503	
7.5	7	8			69944.3100(	.2009)	.0015	983.4542	981.1211	
7.5	7	7			69901.3415(	.2006)	.1843	983.4542	981.1225	
7.5	8	8			69915.1738(	.2006)	.2091	983.4532	981.1211	
7.5	8	7			69872.2054(	.2009)	.0015	983.4532	981.1225	
8.5	8	9			90044.8924(	.3078)	.0010	1276.2948	1273.2913	
8.5	8	8			89997.9089(	.3077)	.1595	1276.2948	1273.2928	
8.5	9	9			90012.8432(	.3077)	.1783	1276.2938	1273.2913	
8.5	9	8			89965.8597(	.3079)	.0010	1276.2938	1273.2928	
9.5	9	10			112197.6519(	.4607)	.0007	1603.8466	1600.1041	
9.5	9	9			112147.5120(	.4606)	.1400	1603.8466	1600.1058	
9.5	10	10			112163.3464(	.4606)	.1549	1603.8455	1600.1041	
9.5	10	9			112113.2065(	.4609)	.0007	1603.8455	1600.1058	
10.5	10	11			136268.2844(	.8315)	.0005	1965.7695	1961.2241	
10.5	10	10			136215.6173(	.8315)	.1245	1965.7695	1961.2259	

TABLE IV. MICROWAVE SPECTRUM OF ^{18}OH IN THE GROUND VIBRATIONAL STATE (CONTINUED).

$^2\Pi_{3/2}$

J	F U	F L	OBSERVED FREQUENCY	EST. UNCERT.	CALCULATED FREQUENCY	EST. UNCERT.	LINE STRENGTH	ENERGY LEVELS UPPER	ENERGY LEVELS LOWER	REF.
10.5	11	11			136232.1813(	.8315)	.1365	1965.7683	1961.2241	
10.5	11	10			136179.5142(	.8318)	.0005	1965.7683	1961.2259	
11.5	11	12			152127.4137(	1.4147)	.0004	2361.6543	2356.2463	
11.5	11	11			162072.6919(	1.4149)	.1119	2361.6543	2356.2481	
11.5	12	12			162089.8409(	1.4150)	.1217	2361.6531	2356.2463	
11.5	12	11			162035.1190(	1.4152)	.0004	2361.6531	2356.2481	
12.5	12	13			139647.0466(	2.5203)	.0003	2791.0293	2784.7034	
12.5	12	12			189590.6327(	2.5206)	.1015	2791.0293	2784.7053	
12.5	13	13			189608.2432(	2.5206)	.1097	2791.0280	2784.7034	
12.5	13	12			189551.8294(	2.5209)	.0003	2791.0280	2784.7053	
13.5	13	14			213698.3537(	4.2843)	.0002	3253.3655	3246.0705	
13.5	13	13			218640.5318(	4.2846)	.0928	3253.3655	3246.0724	
13.5	14	14			218658.4971(	4.2846)	.0997	3253.3641	3246.0705	
13.5	14	13			218600.6752(	4.2850)	.0002	3253.3641	3246.0724	
14.5	14	15			249150.3838(	7.0451)	.0002	3748.0791	3739.7684	
14.5	14	14			249091.3801(	7.0453)	.0854	3748.0791	3739.7704	
14.5	15	15			249109.6073(	7.0454)	.0913	3748.0778	3739.7684	
14.5	15	14			249050.6036(	7.0457)	.0002	3748.0778	3739.7704	

TABLE V. MICROWAVE SPECTRUM OF ^{17}OH IN THE GROUND VIBRATIONAL STATE.[a]

$J = 3/2 \quad {}^2\Pi_{3/2}$

TRANSITION F_U^1	F_U		F_L^1	F_L	FREQUENCY, MHz	THEORETICAL RELATIVE INTENSITY	REF.
3	5/2	→	2	3/2	1302.119	0.047	74E
3	7/2	→	2	5/2	1322.464	0.067	74E
2	3/2	→	1	1/2	1418.202	0.029	74E
2	5/2	→	1	3/2	1455.729	0.052	74E
4	7/2	→	4	7/2	1624.516	0.121	74E
4	9/2	→	4	9/2	1626.161	0.153	74E
3	7/2	→	3	7/2	1656.542	0.043	74E
3	5/2	→	3	5/2	1655.499	0.032	74E
1	3/2	→	1	3/2	1683.540	0.020	74E
1	1/2	→	1	1/2	1684.542	0.008	74E
1	3/2	→	2	5/2	1902.093	0.052	74E
1	3/2	→	2	3/2	1912.439	0.005	74E
1	1/2	→	2	3/2	1940.287	0.029	74E
2	5/2	→	3	7/2	2008.354	0.067	74E
2	3/2	→	3	5/2	2027.323	0.047	74E
3	7/2	→	4	9/2	2102.781	0.052	74E
3	5/2	→	4	7/2	2117.800	0.040	74E

$J = 1/2 \quad {}^2\Pi_{1/2}$

TRANSITION F_U^1	F_U		F_L^1	F_L	FREQUENCY, MHz	THEORETICAL RELATIVE INTENSITY	REF.
3	5/2	→	3	5/2	3980.229	0.106	74E
3	7/2	→	3	7/2	4025.914	0.143	74E
2	5/2	→	3	7/2	5473.032	0.185	74E
2	3/2	→	3	5/2	5523.435	0.130	74E
2	5/2	→	2	5/2	5716.505	0.52	74E
2	3/2	→	2	3/2	5746.333	0.033	74E

[a] The following coupling scheme was employed: $F_1 = J + I_{17_O}$, $F = F_1 + I_{1_H}$

TABLE V. MICROWAVE SPECTRUM OF ^{17}OH IN THE GROUND VIBRATIONAL STATE (CONT.).

$J = 5/2 \quad {}^2\Pi_{3/2}$

TRANSITION F_U^1	F_U		F_L^1	F_L	FREQUENCY, MHz	THEORETICAL RELATIVE INTENSITY	REF.
4	7/2	→	3	5/2	5752.916	0.027	74E
4	9/2	→	3	7/2	5760.223	0.035	74E
3	5/2	→	2	3/2	5851.057	0.025	74E
3	7/2	→	2	5/2	5857.578	0.036	74E
5	9/2	→	5	9/2	5914.960	0.116	74E
5	11/2	→	5	11/2	5918.956	0.140	74E
2	3/2	→	1	1/2	5931.908	0.016	74E
2	5/2	→	1	3/2	5938.801	0.030	74E
4	7/2	→	4	7/2	5971.048	0.061	74E
4	9/2	→	4	9/2	5974.374	0.077	74E
1	3/2	→	0	1/2	6005.626	0.018	74E
3	7/2	→	3	7/2	6013.646	0.036	74E
0	1/2	→	1	3/2	6114.648	0.018	74E
1	3/2	→	2	5/2	6157.620	0.030	74E
2	5/2	→	3	7/2	6200.038	0.036	74E
2	3/2	→	3	5/2	6202.176	0.025	74E

TABLE VI. MICROWAVE SPECTRUM OF ^{16}OH IN ORDER OF FREQUENCY.

ORDERED TRANSITION FREQUENCIES
(OBSERVED TRANSITIONS INDICATED BY ASTERISK)

CALC OR OBS FREQUENCY	EST. UNCERT.	J	F_U	F_L	Ω
88.9504(	.0010)*	9/2	4	5	1/2
117.1495(	.0010)*	9/2	5	5	1/2
164.7960(	.0010)*	9/2	4	4	1/2
192.9957(	.0010)*	9/2	5	4	1/2
1612.2310(	.0002)*	3/2	1	2	3/2
1665.4018(	.0002)*	3/2	1	1	3/2
1667.3590(	.0002)*	3/2	2	2	3/2
1720.5300(	.0002)*	3/2	2	1	3/2
4660.2420(	.0030)*	1/2	0	1	1/2
4750.6560(	.0030)*	1/2	1	1	1/2
4765.5620(	.0030)*	1/2	1	0	1/2
5449.4360(	.0050)*	7/2	3	4	1/2
5473.0450(	.0050)*	7/2	3	3	1/2
5523.4380(	.0050)*	7/2	4	4	1/2
5547.0420(	.0050)*	7/2	4	3	1/2
6016.7460(	.0050)*	5/2	2	3	3/2
6030.7470(	.0050)*	5/2	2	2	3/2
6035.0920(	.0050)*	5/2	3	3	3/2
6049.0840(	.0080)*	5/2	3	2	3/2
7749.9090(	.0050)*	3/2	1	2	1/2
7761.7470(	.0050)*	3/2	1	1	1/2
7820.1250(	.0050)*	3/2	2	2	1/2
7831.9620(	.0050)*	3/2	2	1	1/2
8118.0510(	.0050)*	5/2	2	3	1/2
8135.8700(	.0050)*	5/2	2	2	1/2
8189.5870(	.0050)*	5/2	3	3	1/2
8207.4020(	.0050)*	5/2	3	2	1/2
8503.1572(	.0042)	11/2	5	6	1/2
8534.8340(	.0300)*	11/2	6	6	1/2
8580.1370(	.0300)*	11/2	5	5	1/2
8611.8226(	.0041)	11/2	6	5	1/2
13433.9300(	.0250)*	7/2	4	3	3/2
13434.5960(	.0100)*	7/2	3	3	3/2
13441.3650(	.0100)*	7/2	4	4	3/2
13442.0300(	.0250)*	7/2	3	4	3/2
19484.3187(	.0118)	13/2	6	7	1/2
19518.6120(	.0100)*	13/2	7	7	1/2
19561.8970(	.0200)*	13/2	6	6	1/2
19596.1878(	.0118)	13/2	7	6	1/2
23805.2970(	.0100)*	9/2	5	4	3/2
23817.6150(	.0020)*	9/2	4	4	3/2
23826.6210(	.0030)*	9/2	5	5	3/2
23838.9330(	.0100)*	9/2	4	5	3/2
32843.4564(	.0398)	15/2	7	8	1/2
32879.7200(	.0395)	15/2	8	8	1/2
32921.2508(	.0404)	15/2	7	7	1/2
32957.5144(	.0400)	15/2	8	7	1/2
36963.4800(	.0300)*	11/2	6	5	3/2
36983.4700(	.0300)*	11/2	5	5	3/2
36994.4300(	.0500)*	11/2	6	6	3/2
37014.4200(	.0300)*	11/2	5	6	3/2

BLE VI. MICROWAVE SPECTRUM OF ^{16}OH IN ORDER OF FREQUENCY (CONTINUED).

48416.0090(	.1280)	17/2	8	9	1/2
48453.7778(	.1277)	17/2	9	9	1/2
48493.7757(	.1285)	17/2	8	8	1/2
48531.5445(	.1282)	17/2	9	8	1/2
52696.7200(	.0300)*	13/2	7	6	3/2
52722.0400(	.0200)*	13/2	6	6	3/2
52734.5600(	.0200)*	13/2	7	7	3/2
52759.8900(	.0300)*	13/2	6	7	3/2
66055.0824(	.3362)	19/2	9	10	1/2
66094.0228(	.3360)	19/2	10	10	1/2
66132.6578(	.3368)	19/2	9	9	1/2
66171.5981(	.3365)	19/2	10	9	1/2
70815.8507(	.0187)	15/2	8	7	3/2
70845.0810(	.0200)*	15/2	7	7	3/2
70858.9300(	.0200)*	15/2	8	8	3/2
70868.1237(	.0188)	15/2	7	8	3/2
85624.3851(	.7540)	21/2	10	11	1/2
85664.2553(	.7538)	21/2	11	11	1/2
85701.6614(	.7546)	21/2	10	10	1/2
85741.5315(	.7544)	21/2	11	10	1/2
91156.2177(	.0693)	17/2	9	8	3/2
91188.2600(	.1000)*	17/2	8	8	3/2
91203.2200(	.1000)*	17/2	9	9	3/2
91235.3968(	.0689)	17/2	8	9	3/2
106992.8998(	1.5084)	23/2	11	12	1/2
107033.5233(	1.5082)	23/2	12	12	1/2
107069.8054(	1.5090)	23/2	11	11	1/2
107110.4289(	1.5088)	23/2	12	11	1/2
113570.6909(	.2290)	19/2	10	9	3/2
113605.0416(	.2284)	19/2	9	9	3/2
113620.9136(	.2284)	19/2	10	10	3/2
113655.2643(	.2285)	19/2	9	10	3/2
130031.3239(	2.7711)	25/2	12	13	1/2
130072.5709(	2.7709)	25/2	13	13	1/2
130107.8114(	2.7717)	25/2	12	12	1/2
130149.0583(	2.7716)	25/2	13	12	1/2
137922.5018(	.5761)	21/2	11	10	3/2
137958.6451(	.5757)	21/2	10	10	3/2
137975.2416(	.5757)	21/2	11	11	3/2
138011.3849(	.5756)	21/2	10	11	3/2
154609.8651(	4.7665)	27/2	13	14	1/2
154651.6393(	4.7664)	27/2	14	14	1/2
154685.9021(	4.7672)	27/2	13	13	1/2
154727.6763(	4.7670)	27/2	14	13	1/2
164079.8673(	1.2300)	23/2	12	11	3/2
164117.4767(	1.2296)	23/2	11	11	3/2
164134.6529(	1.2297)	23/2	12	12	3/2
164172.2023(	1.2294)	23/2	11	12	3/2
191912.3930(	2.3548)	25/2	13	12	3/2
191951.2304(	2.3544)	25/2	12	12	3/2
191968.8627(	2.3544)	25/2	13	13	3/2
192007.7002(	2.3541)	25/2	12	13	3/2
221288.8422(	4.1667)	27/2	14	13	3/2
221328.7314(	4.1663)	27/2	13	13	3/2
221346.7130(	4.1663)	27/2	14	14	3/2
221386.6022(	4.1660)	27/2	13	14	3/2
252075.8605(	6.9428)	29/2	15	14	3/2
252116.6686(	6.9424)	29/2	14	14	3/2
252134.9067(	6.9425)	29/2	15	15	3/2
252175.7150(	6.9421)	29/2	14	15	3/2

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY.[a]

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
75.0279(	.0011)	1/2	9/2	4	5			18OH
103.0761(	.0011)	1/2	9/2	4	4			18OH
150.7909(	.0011)	1/2	9/2	5	5			18OH
178.8392(	.0011)	1/2	9/2	5	4			18OH
298.0970(	.0010)	3/2	3/2	3/2	5/2			16OD
303.0320(	.0020)	3/2	3/2	1/2	3/2			16OD
303.4961(	.3937)	1/2	19/2	17/2	19/2			16OD
307.6522(	.3944)	1/2	19/2	17/2	17/2			16OD
309.8775(	.3924)	1/2	19/2	19/2	21/2			16OD
310.1445(	.0010)	3/2	3/2	1/2	1/2			16OD
310.2147(	.0010)	3/2	3/2	3/2	3/2			16OD
310.3627(	.0010)	3/2	3/2	5/2	5/2			16OD
314.2854(	.3930)	1/2	19/2	19/2	19/2			16OD
317.3230(	.0040)	3/2	3/2	3/2	1/2			16OD
318.4415(	.3937)	1/2	19/2	19/2	17/2			16OD
321.5435(	.3919)	1/2	19/2	21/2	21/2			16OD
322.4800(	.0020)	3/2	3/2	5/2	3/2			16OD
325.9514(	.3924)	1/2	19/2	21/2	19/2			16OD
1185.8712(	.0010)	3/2	5/2	5/2	7/2			16OD
1186.9986(	.0030)	3/2	5/2	3/2	5/2			16OD
1190.5659(	.0020)	3/2	5/2	3/2	3/2			16OD
1190.7741(	.0020)	3/2	5/2	5/2	5/2			16OD
1191.1047(	.0020)	3/2	5/2	7/2	7/2			16OD
1194.3390(	.0010)	3/2	5/2	5/2	3/2			16OD
1196.0060(	.0030)	3/2	5/2	7/2	5/2			16OD
1302.1190(	.0050)	3/2	3/2	5/2	3/2	3	2	17OH
1322.4040(	.0050)	3/2	3/2	7/2	5/2	3	2	17OH
1413.2020(	.0050)	3/2	3/2	3/2	1/2	2	1	17OH
1455.7290(	.0050)	3/2	3/2	5/2	3/2	2	1	17OH
1584.2740(	.0020)	3/2	3/2	1	2			18OH
1624.5180(	.0050)	3/2	3/2	7/2	7/2	4	4	17OH
1626.1910(	.0050)	3/2	3/2	9/2	9/2	4	4	17OH
1637.5640(	.0020)	3/2	3/2	1	1			18OH
1638.5030(	.0020)	3/2	3/2	2	2			18OH
1655.4090(	.0050)	3/2	3/2	5/2	5/2	3	3	17OH
1656.5420(	.0050)	3/2	3/2	7/2	7/2	3	3	17OH
1683.5400(	.0050)	3/2	3/2	3/2	3/2	1	1	17OH
1684.5420(	.0050)	3/2	3/2	1/2	1/2	1	1	17OH
1692.7950(	.0020)	3/2	3/2	2	1			18OH
1902.0330(	.0050)	3/2	3/2	3/2	5/2	1	2	17OH
1912.4290(	.0050)	3/2	3/2	3/2	3/2	1	2	17OH
1940.2370(	.0050)	3/2	3/2	1/2	3/2	1	2	17OH
2008.3540(	.0050)	3/2	3/2	5/2	7/2	2	3	17OH
2027.3230(	.0050)	3/2	3/2	3/2	5/2	2	3	17OH
2102.7910(	.0050)	3/2	3/2	7/2	9/2	3	4	17OH
2117.8000(	.0050)	3/2	3/2	5/2	7/2	3	4	17OH
2820.8514(	.0020)	3/2	7/2	5/2	7/2			16OD
2821.0357(	.0020)	3/2	7/2	7/2	9/2			16OD
2822.0007(	.0020)	3/2	7/2	5/2	5/2			16OD
2822.3033(	.0020)	3/2	7/2	7/2	7/2			16OD
2822.9250(	.0020)	3/2	7/2	9/2	9/2			16OD

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
2823.5328(	.0020)	3/2	7/2	7/2	5/2			160D
2824.2276(	.0020)	3/2	7/2	9/2	7/2			160D
3090.2163(	.0010)	1/2	1/2	1/2	3/2			160D
3093.5057(	.0010)	1/2	1/2	1/2	1/2			160D
3111.1414(	.0010)	1/2	1/2	3/2	3/2			160D
3114.5234(	.0010)	1/2	1/2	3/2	1/2			160D
3903.6033(	.2244)	1/2	17/2	15/2	17/2			160D
3907.4208(	.2251)	1/2	17/2	15/2	15/2			160D
3910.1313(	.2235)	1/2	17/2	17/2	19/2			160D
3914.2098(	.2239)	1/2	17/2	17/2	17/2			160D
3918.0274(	.2245)	1/2	17/2	17/2	15/2			160D
3921.7271(	.2232)	1/2	17/2	19/2	19/2			160D
3925.8057(	.2235)	1/2	17/2	19/2	17/2			160D
3980.2290(	.0050)	1/2	1/2	5/2	5/2	3	3	170H
4001.5590(	.6497)	1/2	21/2	21/2	23/2			160D
4006.2460(	.6490)	1/2	21/2	23/2	23/2			160D
4008.8221(	.6513)	1/2	21/2	19/2	21/2			160D
4013.2092(	.6504)	1/2	21/2	21/2	21/2			160D
4017.9561(	.6497)	1/2	21/2	23/2	21/2			160D
4019.7507(	.6522)	1/2	21/2	19/2	19/2			160D
4024.1978(	.6512)	1/2	21/2	21/2	19/2			160D
4025.9140(	.0050)	1/2	1/2	7/2	7/2	3	3	170H
4644.6500(	.0060)	1/2	1/2	0	1			180H
4735.0730(	.0060)	1/2	1/2	1	1			180H
4749.9710(	.0050)	1/2	1/2	1	0			180H
5303.9340(	.0050)	3/2	9/2	9/2	7/2			160D
5304.0150(	.0050)	3/2	9/2	7/2	7/2			160D
5304.3590(	.0050)	3/2	9/2	11/2	9/2			160D
5304.6000(	.0050)	3/2	9/2	9/2	9/2			160D
5304.6810(	.0050)	3/2	9/2	7/2	9/2			160D
5305.3720(	.0050)	3/2	9/2	11/2	11/2			160D
5305.6190(	.0050)	3/2	9/2	9/2	11/2			160D
5473.0320(	.0050)	1/2	1/2	5/2	7/2	2	3	170H
5523.4350(	.0050)	1/2	1/2	3/2	5/2	2	3	170H
5590.8303(	.0017)	1/2	7/2	3	4			180H
5614.2075(	.0016)	1/2	7/2	3	3			180H
5664.7321(	.0018)	1/2	7/2	4	4			180H
5688.1693(	.0017)	1/2	7/2	4	3			180H
5716.5050(	.0050)	1/2	1/2	5/2	5/2	2	2	170H
5748.3330(	.0050)	1/2	1/2	3/2	3/2	2	2	170H
5752.9160(	.0050)	3/2	5/2	7/2	5/2	4	3	170H
5760.2230(	.0050)	3/2	5/2	9/2	7/2	4	3	170H
5851.0570(	.0050)	3/2	5/2	5/2	3/2	3	2	170H
5857.5780(	.0050)	3/2	5/2	7/2	5/2	3	2	170H
5887.2820(	.0050)	1/2	3/2	1/2	3/2			160D
5887.7410(	.0050)	1/2	3/2	1/2	1/2			160D
5894.1790(	.0050)	1/2	3/2	3/2	5/2			160D
5894.6800(	.0050)	1/2	3/2	3/2	3/2			160D
5895.1350(	.0050)	1/2	3/2	3/2	1/2			160D
5906.2150(	.0050)	1/2	3/2	5/2	5/2			160D
5906.7120(	.0050)	1/2	3/2	5/2	3/2			160D

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
5914.9600(	.0050)	3/2	5/2	9/2	9/2	5	5	170H
5918.9560(	.0050)	3/2	5/2	11/2	11/2	5	5	170H
5920.5050(	.0050)	3/2	5/2	2	3			180H
5931.9080(	.0050)	3/2	5/2	3/2	1/2	2	1	170H
5934.6440(	.0060)	3/2	5/2	2	2			180H
5938.8010(	.0050)	3/2	5/2	5/2	3/2	2	1	170H
5938.9670(	.0050)	3/2	5/2	3	3			180H
5953.1160(	.0040)	3/2	5/2	3	2			180H
5971.0480(	.0050)	3/2	5/2	7/2	7/2	4	4	170H
5974.3740(	.0050)	3/2	5/2	9/2	9/2	4	4	170H
6005.6260(	.0050)	3/2	5/2	3/2	1/2	1	0	170H
6013.9460(	.0050)	3/2	5/2	7/2	7/2	3	3	170H
6114.6480(	.0050)	3/2	5/2	1/2	3/2	0	1	170H
6157.6200(	.0050)	3/2	5/2	3/2	5/2	1	2	170H
6200.0380(	.0050)	3/2	5/2	5/2	7/2	2	3	170H
6202.1760(	.0050)	3/2	5/2	3/2	5/2	2	3	170H
6733.5751(	.1185)	1/2	15/2	13/2	15/2			160D
6736.3938(	.1191)	1/2	15/2	13/2	13/2			160D
6740.2559(	.1179)	1/2	15/2	15/2	17/2			160D
6743.3451(	.1191)	1/2	15/2	15/2	15/2			160D
6747.3688(	.1186)	1/2	15/2	15/2	13/2			160D
6751.7502(	.1178)	1/2	15/2	17/2	17/2			160D
6755.4394(	.1179)	1/2	15/2	17/2	15/2			160D
7746.6238(	.0022)	1/2	3/2	1	2			180H
7758.3472(	.0022)	1/2	3/2	1	1			180H
7816.7560(	.0026)	1/2	3/2	2	2			180H
7828.4795(	.0021)	1/2	3/2	2	1			180H
8073.7245(	.1001)	1/2	11/2	5	6			180H
8109.9940(	.0050)	1/2	5/2	3/2	5/2			160D
8110.2693(	.1001)	1/2	11/2	6	6			180H
8110.7170(	.0050)	1/2	5/2	3/2	3/2			160D
8117.2280(	.0050)	1/2	5/2	5/2	7/2			160D
8118.0130(	.0050)	1/2	5/2	5/2	5/2			160D
8118.7330(	.0050)	1/2	5/2	5/2	3/2			160D
8128.1810(	.0050)	1/2	5/2	7/2	7/2			160D
8128.9610(	.0050)	1/2	5/2	7/2	5/2			160D
8155.6388(	.1001)	1/2	11/2	5	5			180H
8167.3315(	.0021)	1/2	5/2	2	3			180H
8184.9925(	.0019)	1/2	5/2	2	2			180H
8187.1341(	.1001)	1/2	11/2	6	5			180H
8238.7585(	.0025)	1/2	5/2	3	3			180H
8256.4195(	.0021)	1/2	5/2	3	2			180H
8670.2946(	.0025)	3/2	11/2	11/2	9/2			160D
8670.6848(	.0024)	3/2	11/2	13/2	11/2			160D
8671.6000(	.0800)	3/2	11/2	9/2	9/2			160D
8672.3700(	.0800)	3/2	11/2	11/2	11/2			160D
8673.3500(	.0800)	3/2	11/2	13/2	13/2			160D
8673.6484(	.0024)	3/2	11/2	9/2	11/2			160D
8675.0427(	.0024)	3/2	11/2	11/2	13/2			160D
8749.9742(	.0566)	1/2	13/2	11/2	13/2			160D
8752.9425(	.0571)	1/2	13/2	11/2	11/2			160D

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
8756.8113(	.0563)	1/2	13/2	13/2	15/2			160D
8760.0415(	.0563)	1/2	13/2	13/2	13/2			160D
8763.0098(	.0566)	1/2	13/2	13/2	11/2			160D
8768.1692(	.0564)	1/2	13/2	15/2	15/2			160D
8771.3994(	.0563)	1/2	13/2	15/2	13/2			160D
9016.5616(	1.0277)	1/2	23/2	23/2	25/2			160D
9021.4957(	1.0268)	1/2	23/2	25/2	25/2			160D
9023.5970(	1.0297)	1/2	23/2	21/2	23/2			160D
9028.2948(	1.0287)	1/2	23/2	23/2	23/2			160D
9033.2189(	1.0277)	1/2	23/2	25/2	23/2			160D
9034.6303(	1.0307)	1/2	23/2	21/2	21/2			160D
9039.3281(	1.0296)	1/2	23/2	23/2	21/2			160D
9577.6622(	.0031)	1/2	7/2	5/2	7/2			160D
9578.9000(	.0800)	1/2	7/2	5/2	5/2			160D
9584.8962(	.0035)	1/2	7/2	7/2	9/2			160D
9586.3200(	.0800)	1/2	7/2	7/2	7/2			160D
9587.5829(	.0031)	1/2	7/2	7/2	5/2			160D
9595.7400(	.0800)	1/2	7/2	9/2	9/2			160D
9597.1728(	.0035)	1/2	7/2	9/2	7/2			160D
9912.2563(	.0237)	1/2	11/2	9/2	11/2			160D
9914.7000(	.0800)	1/2	11/2	9/2	9/2			160D
9919.2477(	.0236)	1/2	11/2	11/2	13/2			160D
9921.9500(	.0800)	1/2	11/2	11/2	11/2			160D
9924.3007(	.0237)	1/2	11/2	11/2	9/2			160D
9930.4400(	.0800)	1/2	11/2	13/2	13/2			160D
9933.1301(	.0236)	1/2	11/2	13/2	11/2			160D
10190.3506(	.0086)	1/2	9/2	7/2	9/2			160D
10192.2100(	.0800)	1/2	9/2	7/2	7/2			160D
10197.4824(	.0088)	1/2	9/2	9/2	11/2			160D
10199.5600(	.0800)	1/2	9/2	9/2	9/2			160D
10201.4374(	.0090)	1/2	9/2	9/2	7/2			160D
10208.5000(	.0800)	1/2	9/2	11/2	11/2			160D
10210.5669(	.0088)	1/2	9/2	11/2	9/2			160D
12914.9091(	.0055)	3/2	13/2	13/2	11/2			160D
12915.3686(	.0054)	3/2	13/2	15/2	13/2			160D
12917.0800(	.0800)	3/2	13/2	11/2	11/2			160D
12918.1300(	.0800)	3/2	13/2	13/2	13/2			160D
12919.3700(	.0800)	3/2	13/2	15/2	15/2			160D
12920.3081(	.0055)	3/2	13/2	11/2	13/2			160D
12922.0314(	.0054)	3/2	13/2	13/2	15/2			160D
13229.9882(	.0054)	3/2	7/2	4	3			180H
13230.5585(	.0020)	3/2	7/2	3	3			180H
13237.3031(	.0022)	3/2	7/2	4	4			180H
13237.8334(	.0053)	3/2	7/2	3	4			180H
14681.6007(	1.5686)	1/2	25/2	25/2	27/2			160D
14686.7277(	1.5675)	1/2	25/2	27/2	27/2			160D
14688.4255(	1.5709)	1/2	25/2	23/2	25/2			160D
14693.3401(	1.5687)	1/2	25/2	25/2	25/2			160D
14698.4671(	1.5686)	1/2	25/2	27/2	25/2			160D
14693.5353(	1.5722)	1/2	25/2	23/2	23/2			160D
14704.4505(	1.5709)	1/2	25/2	25/2	23/2			160D

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
18006.5372(	.0104)	3/2	15/2	15/2	13/2			16OD
18007.1539(	.0104)	3/2	15/2	17/2	15/2			16OD
18009.4600(	.0800)	3/2	15/2	13/2	13/2			16OD
18010.6300(	.0800)	3/2	15/2	15/2	15/2			16OD
18012.1300(	.0800)	3/2	15/2	17/2	17/2			16OD
18013.5135(	.0104)	3/2	15/2	13/2	15/2			16OD
18015.5928(	.0104)	3/2	15/2	15/2	17/2			16OD
18876.5418(	.2003)	1/2	13/2	6	7			18OH
18910.7114(	.2003)	1/2	13/2	7	7			18OH
18954.0047(	.2004)	1/2	13/2	6	6			18OH
18988.2343(	.2003)	1/2	13/2	7	6			18OH
20961.6317(	2.3266)	1/2	27/2	27/2	29/2			16OD
20966.9834(	2.3253)	1/2	27/2	29/2	29/2			16OD
20968.3108(	2.3294)	1/2	27/2	25/2	27/2			16OD
20973.4142(	2.3280)	1/2	27/2	27/2	27/2			16OD
20978.7153(	2.3266)	1/2	27/2	29/2	27/2			16OD
20979.4761(	2.3308)	1/2	27/2	25/2	25/2			16OD
20984.5795(	2.3294)	1/2	27/2	27/2	25/2			16OD
23458.6532(	.0069)	3/2	9/2	5	4			18OH
23470.8886(	.0022)	3/2	9/2	4	4			18OH
23479.8228(	.0026)	3/2	9/2	5	5			18OH
23492.0382(	.0069)	3/2	9/2	4	5			18OH
23903.5682(	.0153)	3/2	17/2	17/2	15/2			16OD
23904.3393(	.0153)	3/2	17/2	19/2	17/2			16OD
23907.0800(	.0800)	3/2	17/2	15/2	15/2			16OD
23908.4400(	.0800)	3/2	17/2	17/2	17/2			16OD
23910.0400(	.0800)	3/2	17/2	19/2	19/2			16OD
23911.9024(	.0154)	3/2	17/2	15/2	17/2			16OD
23914.1790(	.0153)	3/2	17/2	17/2	19/2			16OD
27823.8201(	3.3710)	1/2	29/2	29/2	31/2			16OD
27829.2735(	3.3694)	1/2	29/2	31/2	31/2			16OD
27830.2665(	3.3741)	1/2	29/2	27/2	29/2			16OD
27835.5353(	3.3726)	1/2	29/2	29/2	29/2			16OD
27840.9837(	3.3710)	1/2	29/2	31/2	29/2			16OD
27841.4692(	3.3757)	1/2	29/2	27/2	27/2			16OD
27846.7380(	3.3741)	1/2	29/2	29/2	27/2			16OD
30561.4085(	.0162)	3/2	19/2	19/2	17/2			16OD
30562.3354(	.0162)	3/2	19/2	21/2	19/2			16OD
30565.4200(	.0800)	3/2	19/2	17/2	17/2			16OD
30566.9600(	.0800)	3/2	19/2	19/2	19/2			16OD
30568.7200(	.0800)	3/2	19/2	21/2	21/2			16OD
30570.3414(	.0162)	3/2	19/2	17/2	19/2			16OD
30573.2397(	.0162)	3/2	19/2	19/2	21/2			16OD
32028.0343(	.2039)	1/2	15/2	7	8			18OH
32064.2358(	.2039)	1/2	15/2	8	8			18OH
32105.8417(	.2040)	1/2	15/2	7	7			18OH
32141.9926(	.2040)	1/2	15/2	8	7			18OH
35236.5622(	4.7836)	1/2	31/2	31/2	33/2			16OD
35242.1482(	4.7869)	1/2	31/2	33/2	33/2			16OD
35242.3373(	4.7922)	1/2	31/2	29/2	31/2			16OD
35248.2520(	4.7904)	1/2	31/2	31/2	31/2			16OD

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
35253.8379(	4.7886)	1/2	31/2	33/2	31/2			160D
35254.0630(	4.7940)	1/2	31/2	29/2	29/2			160D
35259.4776(	4.7922)	1/2	31/2	31/2	29/2			160D
36443.9761(	.1005)	3/2	11/2	6	5			180H
36463.8808(	.1002)	3/2	11/2	5	5			180H
36474.7563(	.1002)	3/2	11/2	6	5			180H
36494.6610(	.1005)	3/2	11/2	5	6			180H
37936.3616(	.0242)	3/2	21/2	21/2	19/2			160D
37937.4380(	.0242)	3/2	21/2	23/2	21/2			160D
37940.7300(	.0800)	3/2	21/2	19/2	19/2			160D
37942.4200(	.0800)	3/2	21/2	21/2	21/2			160D
37944.3500(	.0800)	3/2	21/2	23/2	23/2			160D
37946.8160(	.0242)	3/2	21/2	19/2	21/2			160D
37948.3183(	.0242)	3/2	21/2	21/2	23/2			160D
43169.5530(	6.6870)	1/2	33/2	33/2	35/2			160D
43175.2560(	6.6851)	1/2	33/2	35/2	35/2			160D
43175.0665(	6.6910)	1/2	33/2	31/2	33/2			160D
43181.2108(	6.6891)	1/2	33/2	33/2	33/2			160D
43186.9035(	6.6930)	1/2	33/2	31/2	31/2			160D
43186.9138(	6.6871)	1/2	33/2	35/2	33/2			160D
43192.4478(	6.6910)	1/2	33/2	33/2	31/2			160D
45987.1153(	.0823)	3/2	23/2	23/2	21/2			160D
45988.3315(	.0822)	3/2	23/2	25/2	23/2			160D
45991.8283(	.0824)	3/2	23/2	21/2	21/2			160D
45993.6310(	.0822)	3/2	23/2	23/2	23/2			160D
45995.6673(	.0824)	3/2	23/2	25/2	25/2			160D
45998.3435(	.0822)	3/2	23/2	21/2	23/2			160D
46000.9673(	.0822)	3/2	23/2	23/2	25/2			160D
47370.8754(	.3262)	1/2	17/2	8	9			180H
47408.5427(	.3260)	1/2	17/2	9	9			180H
47448.6100(	.3264)	1/2	17/2	8	8			180H
47486.2833(	.3262)	1/2	17/2	9	8			180H
51977.3840(	.2005)	3/2	13/2	7	6			180H
52002.6403(	.2004)	3/2	13/2	6	6			180H
52015.1322(	.2004)	3/2	13/2	7	7			180H
52040.3885(	.2005)	3/2	13/2	6	7			180H
54675.0497(	.2143)	3/2	25/2	25/2	23/2			160D
54676.3930(	.2143)	3/2	25/2	27/2	25/2			160D
54680.0317(	.2144)	3/2	25/2	23/2	23/2			160D
54681.9504(	.2143)	3/2	25/2	25/2	25/2			160D
54684.1016(	.2144)	3/2	25/2	27/2	27/2			160D
54686.9324(	.2143)	3/2	25/2	23/2	25/2			160D
54689.6590(	.2143)	3/2	25/2	25/2	27/2			160D
63963.9333(	.4597)	3/2	27/2	27/2	25/2			160D
63965.4419(	.4598)	3/2	27/2	29/2	27/2			160D
63969.1339(	.4597)	3/2	27/2	25/2	25/2			160D
63971.2150(	.4598)	3/2	27/2	27/2	27/2			160D
63973.4659(	.4597)	3/2	27/2	29/2	29/2			160D
63976.4255(	.4598)	3/2	27/2	25/2	27/2			160D
63979.2390(	.4597)	3/2	27/2	27/2	29/2			160D
64760.0070(	.5225)	1/2	19/2	9	10			180H

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
64798.8553(	.5224)	1/2	19/2	10	10			18OH
64837.5660(	.5229)	1/2	19/2	9	9			18OH
64876.4143(	.5227)	1/2	19/2	10	9			18OH
69872.2054(	.2009)	3/2	15/2	8	7			18OH
69901.3415(	.2008)	3/2	15/2	7	7			18OH
69915.1738(	.2008)	3/2	15/2	8	8			18OH
69944.3100(	.2009)	3/2	15/2	7	8			18OH
73813.7254(	.8743)	3/2	29/2	29/2	27/2			16OD
73821.2870(	.8743)	3/2	29/2	31/2	29/2			16OD
73825.1320(	.8743)	3/2	29/2	27/2	27/2			16OD
73827.2428(	.8742)	3/2	29/2	29/2	29/2			16OD
73829.5804(	.8743)	3/2	29/2	31/2	31/2			16OD
73832.6495(	.8742)	3/2	29/2	27/2	29/2			16OD
73835.5381(	.8743)	3/2	29/2	29/2	31/2			16OD
84061.2040(	.9636)	1/2	21/2	10	11			18OH
84100.9833(	.9634)	1/2	21/2	11	11			18OH
84138.4722(	.9641)	1/2	21/2	10	10			18OH
84178.2581(	.9639)	1/2	21/2	11	10			18OH
84209.5930(	1.5311)	3/2	31/2	31/2	29/2			16OD
84211.2462(	1.5312)	3/2	31/2	33/2	31/2			16OD
84215.1698(	1.5311)	3/2	31/2	29/2	29/2			16OD
84217.3536(	1.5311)	3/2	31/2	31/2	31/2			16OD
84219.7708(	1.5312)	3/2	31/2	33/2	33/2			16OD
84222.9754(	1.5311)	3/2	31/2	29/2	31/2			16OD
84225.8933(	1.5312)	3/2	31/2	31/2	33/2			16OD
89965.8597(	.3079)	3/2	17/2	9	8			18OH
89997.9069(	.3077)	3/2	17/2	8	8			18OH
90012.8432(	.3077)	3/2	17/2	9	9			18OH
90044.8924(	.3078)	3/2	17/2	8	9			18OH
95101.9734(	2.5226)	3/2	33/2	33/2	31/2			16OD
95103.7131(	2.5226)	3/2	33/2	35/2	33/2			16OD
95107.7053(	2.5225)	3/2	33/2	31/2	31/2			16OD
95109.9618(	2.5226)	3/2	33/2	33/2	33/2			16OD
95112.4373(	2.5227)	3/2	33/2	35/2	35/2			16OD
95115.6874(	2.5225)	3/2	33/2	31/2	33/2			16OD
95118.6860(	2.5226)	3/2	33/2	33/2	35/2			16OD
105145.5345(	1.6629)	1/2	23/2	11	12			18OH
105186.0801(	1.6627)	1/2	23/2	12	12			18OH
105222.4394(	1.6635)	1/2	23/2	11	11			18OH
105262.9350(	1.6633)	1/2	23/2	12	11			18OH
106465.9955(	3.9620)	3/2	35/2	35/2	33/2			16OD
106467.7935(	3.9627)	3/2	35/2	37/2	35/2			16OD
106471.8534(	3.9625)	3/2	35/2	33/2	33/2			16OD
106474.1074(	3.9628)	3/2	35/2	35/2	35/2			16OD
106476.8972(	3.9628)	3/2	35/2	37/2	37/2			16OD
106480.0254(	3.9625)	3/2	35/2	33/2	35/2			16OD
106483.0051(	3.9627)	3/2	35/2	35/2	37/2			16OD
112113.2065(	.4609)	3/2	19/2	10	9			18OH
112147.5120(	.4608)	3/2	19/2	9	9			18OH
112183.3484(	.4608)	3/2	19/2	10	10			18OH
112197.6519(	.4607)	3/2	19/2	9	10			18OH

TABLE VII. MICROWAVE SPECTRUM OF ^{16}OD, ^{18}OH AND ^{17}OH TRANSITIONS IN ORDER OF FREQUENCY. (CONTINUED)

CALC OR OBS FREQUENCY	EST. UNCERT.	Ω	J	F_U	F_L	F'_U	F'_L	ISOTOPE
136179.5142(	.8318)	3/2	21/2	11	10			18OH
136215.6173(	.8315)	3/2	21/2	10	10			18OH
136232.1813(	.8315)	3/2	21/2	11	11			18OH
136268.2344(	.8315)	3/2	21/2	10	11			18OH
162035.1190(	1.4152)	3/2	23/2	12	11			18OH
162072.6919(	1.4149)	3/2	23/2	11	11			18OH
162089.8409(	1.4150)	3/2	23/2	12	12			18OH
162127.4137(	1.4147)	3/2	23/2	11	12			18OH
189551.8294(	2.5209)	3/2	25/2	13	12			18OH
189590.6327(	2.5206)	3/2	25/2	12	12			18OH
189608.2432(	2.5206)	3/2	25/2	13	13			18OH
189647.0466(	2.5203)	3/2	25/2	12	13			18OH

2.1. Hydroxyl References

a. Laboratory References

[37A] M. Ishaq, "The λ 2708 and λ 2756 Bands of OD," Proc. Roy. Soc. **159,** 110 (1937).

[52A] R. A. Frosch and H. M. Foley, "Magnetic Hyperfine Structure in Diatomic Molecules," Phys. Rev. **88,** 1337 (1952).

[53A] T. M. Sanders, Jr., A. L. Schawlow, G. C. Dousmanis, and C. H. Townes, "A Microwave Spectrum of the Free OH Radical," Phys. Rev. **89,** 1158 (1953).

[54A] M. Mizushima, "Theory of the Hyperfine Structure of the NO Molecule," Phys. Rev. **94,** 569 (1954).

[55A] G. C. Dousmanis, "Magnetic Hyperfine Effects and Electronic Structure of NO," Phys. Rev. **97,** 967 (1955).

[55B] G. C. Dousmanis, T. M. Sanders, and C. H. Townes, "Microwave Spectrum of Free Radicals OH and OD," Phys. Rev. **100,** 1735 (1955).

[55C] C. C. Lin and M. Mizushima, "Theory of the Hyperfine Structure of the NO Molecule, II. Errata and Some Additional Discussion," Phys. Rev. **100,** 1726 (1955).

[55D] R. P. Madden and W. S. Benedict, "Pure Rotation Lines of OH," J. Chem. Phys. **23,** 408 (1955).

[59A] G. Ehrenstein, C. H. Townes, and M. J. Stevenson, "Ground State Λ-doubling Transitions of OH Radical," Phys. Rev. Lett. **3,** 40 (1959).

[60A] D. Garvin, H. P. Broida, and H. J. Kostkowski, "Chemically Induced Vibrational Excitation: Hydroxyl radical emission in the 1–3 micron region produced by the H + 0_3 atomic flame," J. Chem. Phys. **32,** 880 (1960).

[61A] R. T. Meyer and R. J. Myers, "Dipole Moment of the OH Radical From the Stark Effect of Its Microwave Spectrum," J. Chem. Phys. **34,** 1074 (1961).

[61B] H. E. Radford, "Microwave Zeeman Effect of Free Hydroxyl Radicals," Phys. Rev. **122,** 114 (1961).

[62A] F. P. del Greco and F. Kaufman, "Lifetime and Reactions of OH Radicals in Discharge Flow Systems," Disc. Faraday Soc. **33,** 128 (1962).

[62B] G. H. Dieke and H. M. Crosswhite, "The Ultraviolet Bands of OH," J. Quant. Spectrosc. Radiat. Transfer **2,** 97 (1962).

[62C] H. E. Radford, "Microwave Zeeman Effect of Free Hydroxyl Radicals: $^2\Pi_{\frac{1}{2}}$ Levels," Phys. Rev. **126,** 1035 (1962).

[63A] G. Ehrenstein, "Hyperfine Structure in $O^{17}H$ and OH Dipole Moment," Phys. Rev. **130,** 669 (1963).

[63B] D. M. Golden, F. P. del Greco, and F. Kaufman, "Experimental Oscillator Strength of $OH\,^2\Sigma^+ \rightarrow {}^2\Pi$ by a Chemical Method," J. Chem. Phys. **39,** 3034 (1963).

[63C] K. Kayama, "HFS Constants of OH Ground State," J. Chem Phys. **39,** 1507 (1963).

[64A] R. G. Bennett and F. W. Dalby, "Experimental Determination of the Oscillator Strength of the Violet System of OH," J. Chem Phys. **40,** 1414 (1964).

[64B] H. E. Radford, "18-cm Spectrum of OH," Phys. Rev. Lett. **13,** 534 (1964).

[65A] D. H. Phelps and F. W. Dalby, "Optical Observations of the Stark Effect on OH," Can. J. Phys. **43,** 144 (1965).

[65B] F. X. Powell and D. R. Lide, "Improved Measurement of the Electric Dipole Moment of the Hydroxyl Radical," J. Chem Phys. **42,** 4201 (1965).

[66A] K. F. Freed, "Theory of the Hyperfine Structure of Molecules: Application to $^3\Pi$ States of Diatomic Molecules Intermediate Between Hund's Cases (a) and (b)," J. Chem. Phys. **45,** 4214 (1966).

[66B] B. Turner, "Einstein A Coefficient for the Λ Doublet Transitions of the Ground State of OH," Nature **212,** 184 (1966).

[66C] A. A. Westenberg and W. E. Wilson, "ESR Intensity Relations and Some Gas-Phase Chemical Kinetics of the OD Radical," J. Chem. Phys. **45,** 338 (1966).

[67A] J. Anketell and A. Pery-Thorne, "Oscillator Strengths in the $^2\Sigma^+$–$^2\Pi$ Band System of OH by the Hook Method," Proc. Roy. Soc. Ser. A **301,** 343 (1967).

[67B] A. Carrington and T. A. Miller, "Einstein A Coefficients for the 18 cm Transitions of OH," Nature **214,** 998 (1967).

[67C] D. R. Johnson and C. C. Lin, "Low Field Zeeman Effect of the Microwave Spectrum of the OH Radical," J. Mol. Spectrosc. **23,** 201 (1967).

[67D] D. R. Lide, Jr., "Correction of Some Erroneous Calculations of the Einstein A Coefficient for the 18 cm Transition of OH," Nature **213,** 694 (1967).

[67E] R. L. Poynter and R. A. Beaudet, "Dipole Moment of the OH Free Radical," Abstract, 22nd Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio, September, 1967, p. 76.

[67F] A. Stoebner and R. Delbourgo, "Contribution to the Spectrographic Study of the 0–2 Sequence of the $A\,^2\Sigma^+$–$X\,^2\Pi$ Transition of the OH Radical," J. Chem. Phys. **64,** 1115 (1967).

[68A] K. G. Anlauf, R. G. MacDonald, and J. C. Polanyi, "Infrared Chemiluminescence from H + O_3 at Low Pressure," Chem. Phys. Lett. **1,** 619 (1968).

[68B] R. L. Poynter and R. A. Beaudet, "Predictions of Several OH Doubling Transitions Suitable for Radio Astronomy," Phys. Rev. Lett. **21,** 305 (1968).

[68C] H. E. Radford, "Scanning Microwave Echo Box Spectrometer," Rev. Sci. Instrum. **39,** 1687 (1968).

[69A] C. Carlone and F. W. Dalby, "Spectrum of the Hydroxyl Radical," Can. J. Phys. **47,** 1945 (1969).

[69B] A. Carrington and N. J. D. Lucas, "Electron Resonance of Gaseous Diatomic Hydrides. I. ^{17}O Hyperfine and Quad-

rupole Interactions in OH and OD," Proc. Roy. Soc. Ser. A **314,** 567 (1969).

[69C] K. R. German and R. N. Zare, "Measurement of the Hanle Effect for the OH Radical," Phys. Rev. Second Ser. **186,** 9 (1969).

[69D] K. R. German and R. N. Zare, "Optical Radio-Frequency Double Resonance in Molecules: the OH Radical," Phys. Rev. Lett. **23,** 1207 (1969).

[69E] A. Marshall, R. L. deZafra, and H. Metcalf, "Level-crossing Spectroscopy in Molecules: Application to the OH Free Radical," Phys. Rev. Lett, **22,** 445 (1969).

[69F] R. L. Poynter and R. A. Beaudet, "Microwave Spectrum of the OD Free Radical," Abstract, 24th Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio, September, 1969.

[69G] J. L. Yen, B. Zuckerman, P. Palmer and H. Penfield, "Detection of the $^2\Pi_{3/2}$, J = 5/2 State of OH at 5 Centimeter Wavelength," Astrophys. J. **156,** L27 (1969).

[70A] J. A. Ball, D. F. Dickinson, C. A. Gottlieb, and H. E. Radford, "The 3.8 cm Spectrum of OH: Laboratory Measurements and Low Noise Search in W3 (OH)," Astron. J. **75,** 762 (1970).

[70B] J. A. Ball, B. M. Zuckerman, C. A. Gottlieb and H. E. Radford, "18 cm Transitions in $O^{17}H$ and $O^{18}H$ Laboratory and Astronomical Measurements," Bull. Amer. Astron. Soc. **2,** 293 (1970).

[70C] A. Churg and D. H. Levy, "The Magnetic Resonance Spectrum of Vibrationally Excited OH and a Prediction of the Radio-Astronomy Spectrum," Astrophys. J. **162,** L161 (1970).

[70D] K. M. Evenson, J. S. Wells, and H. E. Radford, "Infrared Resonance of OH with the H_2O Laser: A Galactic Maser Pump?," Phys. Rev. Lett. **25,** 199 (1970).

[71A] J. A. Ball, C. A. Gottlieb, M. L. Meeks, and H. E. Radford, "Search for the $^2\Pi_{\frac{1}{2}}$, J = 5/2 Excited State of OH in W3," Astrophys. J. **163,** L33 (1971).

[71B] P. E. Charters, R. G. MacDonald, and J. C. Polanyi, "Formation of Vibrationally Excited OH By the Reaction H + O_3," Appl. Opt. **10,** 1747 (1971).

[71C] P. N. Clough, A. H. Curran, and B. A. Thrush, "The EPR Spectrum of Vibrationally Excited Hydroxyl Radicals," Proc. Roy. Soc. Ser. A **323,** 541 (1971).

[71D] R. L. deZafra, A. Marshall, and H. Metcalf, "Measurement of Lifetime and g Factor by Level Crossing and Optical Double Resonance in the OH and OD Free Radical," Phys. Rev. A **3,** 1557 (1971).

[71E] K. P. Lee, W. G. Tam, R. Larouche, and G. A. Wooten, "Electron Resonance of Vibrationally Excited OH Radicals." Can. J. Phys. **49,** 2207 (1971)

[71F] E. A. Moore and W. G. Richards, "A Reanalysis of the $A^2\Sigma^+$–$X^2\Pi_i$ System of OH," Phys. Scripta (Sweden) **3,** 223 (1971).

[71G] A. E. Potter, Jr., R. N. Coltharp, and S. D. Worley, "Mean Radiative Lifetime of Vibrationally Excited (v=9) Hydroxyl. Rate of the Reaction Vibrationally Excited Hydroxyl (v=9) with Ozone," J. Chem. Phys. **54,** 992 (1971).

[71H] E. A. Scarl and F. W. Dalby, "High Field Stark Effects on the Near Ultraviolet Spectrum of the Hydroxyl Radical," Can. J. Phys. **49,** 2825 (1971).

[72A] B. G. Elmergreen and W. H. Smith, "Direct Measurement of the Lifetimes and Predissociation Probabilities for Rotational Levels of the OH and OD $A^2\Sigma^+$ States," Astrophys. J. **178,** 557 (1972).

[72B] R. K. Hinkley, J. A. Hall, J. E. H. Walker and W. G. Richards, "Λ Doubling in $^2\Pi$ States of Diatomic Molecules," J. Phys. B **5,** 204 (1972).

[72C] C. Marliere, J. Burie and J. L. Destombes, "Spectrometre Hertzien pour l'étude des Radicaux Libres," C. R. Acad. Sci. Paris, Ser. B **275,** 315 (1972).

[72D] W. L. Meerts and A. Dynamus, "The Hyperfine Λ Doubling Spectrum of $^{14}N\ ^{16}O$ and $^{15}N^{16}O$," J. Mol. Spectrosc. **44,** 320 (1972).

[72E] M. Mizushima, "Molecular Parameters of OH Free Radical," Phys. Rev. A **5,** 143 (1972).

[72F] J. J. terMeulen and A. Dymanus, "Beam Maser Measurements of Ground State Transition Frequencies of OH," Astrophys. J. **172,** L21 (1972).

[73A] J. A. Austin, A. Churg, and D. H. Levy, "The Microwave and Magnetic Resonance Spectra of Vibrationally Excited OH Radicals," Abstract, 28th Symposium on Molecular Structure and Spectroscopy, Columbus, Ohio, June 11–15, 1973.

[73B] M. A. A. Clyne, J. A. Coxon, and A. R. Woon Fat, "The $A\ ^2\Sigma^+$–$X\ ^2\Pi_i$ Electronic Band System of the OD Free Radical. 1. Spectroscopic Data for the O–O Sequence and Rotational Term Values for $A\ ^2\Sigma^+$ and $X\ ^2\Pi_i$", J. Molec. Spectrosc. **46,** 146 (1973).

[73C] K. R. German, T. H. Bergeman, E. M. Weinstock, and R. N. Zare, "Zero-field Level Crossing and Optical Radio-Frequency Double Resonance Studies of the $A\ ^2\Sigma^+$ States of OH and OD", J. Chem. Phys. **58,** 4304 (1973).

[73D] R. K. Hinkley, T. E. H. Walker, and W. G. Richards, "On the EPR Spectrum of Vibrationally Excited Hydroxyl Radicals", Proc. Roy. Soc. Ser. A **331,** 553 (1973).

[73E] V. K. Khersonskii, "Radio Transitions of the $O^{16}D$ Molecule", Astro. Zh. **50,** 646 (1973), Sov. Astro. **17,** 411 (1973).

[73F] W. L. Meerts and A. Dynamus, "Accurate Frequencies Below 5 GHz of the Lower J States of OD", Astrophys. J. **180,** L93 (1973).

[73G] W. L. Meerts and A. Dynamus, "Electric Dipole Moments of OH and OD by Molecular Beam Electric Resonance", Chem. Phys. Lett. **23,** 45 (1973).

[73H] R. A. Sutherland and R. A. Anderson, "Radiative and Predissociative Lifetimes of the $A\ ^2\Sigma^+$ State of OH", J. Chem. Phys. **58,** 1226 (1973).

[73I] I. E. Valtz and V. A. Soglasnova, "Lambda-doubling of the $O^{17}H$ Molecule at Microwave Frequencies", Astrophys. Lett. **13,** 23 (1973).

[73J] E. M. Weinstock and R. N. Zare, "High Field Level Crossing and Stark Studies of the $A\ ^2\Sigma^+$ State of OD", J. Chem. Phys. **58,** 4319 (1973).

[74A] J. H. Brophy, J. A. Silver, and J. L. Kinsey, "Direct Measurement of the Radiative Lifetime of the $A\ ^2\Sigma^+$ (v'=0, K'=1, J'=3/2) State of OH and OD", Chem. Phys. Lett. **28,** 418 (1974).

[74B] M. A. A. Clyne and S. Down, "Kinetic Behavior of OH $X\ ^2\Pi$ and $A\ ^2\Sigma^+$ Using Molecular Resonance Fluorescence Spectrometry", J. Chem. Soc. Faraday Trans. II (GB) **70,** 253 (1974).

[74C] J. L. Destombes, C. Marliere, F. Rohart, and J. Burie, "New Analysis of the Microwave Spectrum of the Hydroxyl Radical", C.R. Acad. Sci. Paris, Ser. B **278,** 275 (1974).

[74D] J. L. Destombes, C. Marliere, and P. Rosseels, "Zeeman Modulation Devices for Microwave Spectroscopy of Unstable Species", J. Phys. E (GB) **7,** 996 (1974).

[74E] C. A. Gottlieb, H. E. Radford and B. P. Smith, unpublished data on ^{16}OH, ^{18}OH, ^{17}OH frequencies.

[74F] P. Hogan and D. D. Davis, "OH Lifetime Measurements of Several K Levels in the v'=1 Manifold of the $A\ ^2\Sigma^+$ Electronic State: Excitation via a Tunable UV Laser", Chem. Phys. Lett. **29,** 555 (1974).

[74G] K. P. Lee and W. G. Tam, "Molecular Constants of Vibrationally Excited Hydroxyl Radical From Electron Paramagnetic Resonance", Chem. Phys. **4,** 434 (1974).

[74H] W. H. Smith, B. G. Elmergreen, and N. H. Brooks, "Interactions Among the Lower Valence States of the OH Radical (origin of experimentally observed predissociations)", J. Chem. Phys. **61,** 2793 (1974).

[74I] D. W. Trainor and C. W. von Rosenberg, Jr., "Flash Photolysis Study of the Gas Phase Recombination of Hydroxyl Radicals", J. Chem. Phys. **61,** 1010 (1974).

[75A] J. A. Coxon and R. E. Hammersley, "Spin Orbit Coupling

and Lambda-Type Doubling in the Ground State of OD, $X\ ^2\Pi$. Comparison of Experimental Constants with Ab Initio Calculations", J. Molec. Spectrosc. **58,** 29 (1975).

[75B] J. L. Destombes, G. Journel, C. Marliere, and F. Rohart, "Microwave Spectrum of the Hydroxyl Radical in $^2\Pi_{3/2}$ and $^2\Pi_{1/2}$ States, for $J \geq 7/2$", C.R. Acad. Sci. Paris, Ser. B **280,** 809 (1975).

[75C] J. L. Destombes and C. Marliere,"Measurement of Hyperfine Splitting in the OH Radical by a Radio-Frequency Microwave Double Resonance Method", Chem. Phys. Lett. **34,** 532 (1975).

[75D] K. R. German, "Direct Measurement of the Radiative Lifetimes of the $A\ ^2\Sigma^+$ ($V'=0$) States of OH and OD", J. Chem. Phys. **62,** 2584 (1975).

[75E] K. R. German, "Radiative and Predissociative Lifetimes of the $V'=0$, 1 and 2 Levels of the $A\ ^2\Sigma^+$ State of OH and OD", J. Chem. Phys. **63,** 5252 (1975).

[75F] W. L. Meerts and A. Dymanus, "Molecular Beam Electric Resonance Study of Hyperfine Λ Doubling of OH, OD, SH, and SD", Can. J. Phys. **53,** 2123 (1975).

[75G] W. L. Meerts, "Properties of Diatomic Open-Shell Molecule by the Molecular Beam Electric-Resonance Spectroscopy", Thesis, Department of Physics, University of Nijmegen, Nijmegen, The Netherlands.

[75H] I. Yamashita, "Crossed Beam Experiment on Rotational Population Distribution of OH($A\ ^2\Sigma^+$)", J. Phys. Soc. Japan **39,** 205 (1975).

[76A] S. I. Chu, "Collisionally-Induced Hyperfine-Structure Transitions of OH", Astrophys. J. **206,** 640 (1976).

[76B] Cohen, E. A., unpublished results.

[76C] K. R. German, "Collision and Quenching Cross-Sections in the $A\ ^2\Sigma^+$ State of OH and OD", J. Chem. Phys. **64,** 4065 (1976).

[76D] R. K. Lengel, D. R. Crosley, P. Hogan, and D. D. Davis, "Comments on Electronic Quenching and Vibrational Relaxation of the OH ($A\ ^2\Sigma^+$, $V'=1$) State", J. Chem. Phys. **64,** 3900 (1976).

[76E] J. E. Spencer and G. P. Glass, "The Reaction of Atomic Hydrogen with NO_2", Chem. Phys. **15,** 35 (1976).

[76F] G. E. Streit and H. S. Johnston, "Reactions and Quenching of Vibrationally Excited OH Radicals", J. Chem. Phys. **64,** 95 (1976).

[76G] J. J. ter Meulen, W. L. Meerts, G. W. M. van Mierlo, and A. Dymanus, "Observations of Population Inversion Between the Λ-Doublet States of OH", Phys. Rev. Lett. **36,** 1031 (1976).

[76H] R. C. Woods and T. A. Dixon, "Comment on the Quadrupole Coupling Constants in the $A\ ^2\Sigma^+$ States of OD and NO", J. Chem. Phys. **64,** 5319 (1976).

b. Astrophysical References

[57A] A. H. Barrett and A. E. Lilley, "A Search for the 18-cm Line of OH in the Interstellar Medium", Astron. J. **62,** 5 (1957).

[63D] S. Weinreb, A. H. Barrett, M. L. Meeks, and J. C. Henry, "Radio Observations of OH in the Interstellar Medium", Nature **200,** 829 (1963).

[64C] A. H. Barrett,"The Detection of the OH and Other Molecular Lines in the Radio Spectrum of the Interstellar Medium", IEEE Trans. Military Electronics, MIL-8, #3–4, 156 (1964).

[64D] A. H. Barrett, M. L. Meeks, and S. Weinreb, "High Resolution Microwave Spectra of H and OH Absorption Lines of Cassiopeia A", Nature **202,** 475 (1964).

[64E] A. H. Barrett and A. E. E. Rogers, "Spectrum and Relative Intensities of Interstellar OH Lines", Nature **204,** 62 (1964).

[64F] J. G. Bolton, F. F. Gardner, and M. B. Mackey,"The Parkes Catalogue of Radio Sources Declination Zone −20° to −60°", Aust. J. Phys. **17,** 340 (1964).

[64G] J. G. Bolton, F. F. Gardner, R. X. McGee, and B. J. Robinson, "Distribution and Motions of OH Near the Galactic Centre", Nature **204,** 30 (1964).

[64H] J. G. Bolton, K. J. Van Damme, F. F. Gardner, and B. J. Robinson, "Observation of OH Absorption Lines in the Radio Spectrum of the Galactic Centre", Nature **201,** 279 (1964).

[64I] N. H. Dieter and H. I. Ewen, "Radio Observations of the Interstellar OH Line at 1,667 Mc/s", Nature **201,** 279 (1964).

[64J] F. F. Gardner, B. J. Robinson, J. G. Bolton, and K. J. van Damme, "Detection of the Interstellar OH Lines at 1612 and 1720 Mc/sec", Phys. Rev. Lett. **13,** 3 (1964).

[64K] S. J. Goldstein, Jr., E. J. Gundermann, A. A. Penzias, and A. E. Lilley,"OH Absorption Spectra in Sagittarius", Nature **203,** 65 (1964).

[64L] K. i. Kellermann, "Measurements of the Flux Density of Discrete Radio Sources at Decimeter Wavelengths", Astro. J. **69,** 205 (1964).

[64M] B. J. Robinson, F. F. Gardner, K. J. van Damme, and J. G. Bolton, "An Intense Concentration of OH Near the Galactic Centre", Nature **202,** 989 (1964).

[64N] H. F. Weaver and D. R. W. Williams, "OH Absorption Profile in the Direction of Sagittarius A", Nature **201,** 380 (1964).

[65C] N. W. Broten, B. F. C. Cooper, F. F. Gardner, H. C. Minnett, R. M. Price, F. G Tonking, and E. D. Yabsley, "Some Observations at 6 cm Wavelength with the Australian 210-ft. Radio Telescope", Aust. J. Phys. **18,** 85 (1965).

[65D] R. X. McGee, B. J. Robinson, F. F. Gardner and J. G. Bolton, "Anomalous Intensity Ratios of the Interstellar Lines of OH in Absorption and Emission", Nature **208,** 1193 (1965).

[65E] D. McNally, "The Detection of the Radical OH in Interstellar Space", Sci. Progr. (GB), **53,** 83 (1965).

[65F] T. K. Menon and Yervant Terzian, "Radio Observations of Panetary Nebulae", Astrophys. J. **141,** 745 (1965).

[65G] J. L. Symonds, "Formation of Hydroxyl Molecules in Interstellar Space", Nature **208,** 1195 (1965).

[65H] H. Weaver, D. R. W. Williams, N. H. Dieter, and W. T. Lum, "Observations of a Strong Unidentified Microwave Line and of Emission from the OH Molecule", Nature **208,** 29 (1965).

[65I] S. Weinreb, M. L. Meeks, J. C. Carter, A. H. Barrett, and A. E. E. Rogers, "Observations of Polarized OH Emission", Nature **208,** 440 (1965).

[65J] B. Zuckerman, A. E. Lilley, and H. Penfield, "OH Emission in the Direction of Radio Source W49", Nature **208,** 441 (1965).

[66D] A. H. Barrett and A. E. E. Rogers, "Observations of Circularly Polarized OH Emission and Narrow Spectral Features", Nature **210,** 188 (1966).

[66E] T. O. Carroll and E. E. Saltpeter, "On the Abundance of Interstellar OH", Astrophys. J. **143,** 609 (1966).

[66F] A. H. Cook, "Determination of Direction, Frequency and Polarization of Radio Emission from Galactic OH", Nature **211,** 503 (1966).

[66G] A. H. Cook, "Suggested Mechanism for the Anomalous Excitation of OH Microwave Emissions from H-II Regions", Nature **210,** 611 (1966).

[66H] D. D. Cudaback, R. B. Read, and G. W. Rougoor, "Diameters and Positions of Three Sources of 18-cm OH Emission", Phys. Rev. Lett. **17,** 452 (1966).

[66I] R. D. Davies, G. de Jager, and G. L. Verschuur, "Detection of Circular and Linear Polarization in the OH Emission Sources Near W3 and W49", Nature **209,** 974 (1966).

[66J] N. H. Dieter and W. M. Goss, "Recent Work on the Interstellar Medium", Rev. Mod. Phys. **38,** 256 (1966).

[66K] N. H. Dieter, H. Weaver, and D. R. W. Williams, "The Interstellar Hydroxyl Radio Emission", Sky and Telescope **31,** 132 (1966).

[66L] N. H. Dieter, H. Weaver, and D. R. W. Williams, "Secular Variations in the Radio-Frequency Emission of OH", Astron. J. **71,** 160 (1966).

[66M] D. Downes and R. Rinehart,"Microwave Observations of the Cygnus X Region", Astrophys. J. **144,** 937 (1966).

[66N] C. V. Heer, "Theory for the Polarization of Cosmic OH⁻ 18 cm Radiation", Phys. Rev. Lett. **17,** 774 (1966).

[66O] M. M. Litvak, A. L. McWhorter, M. L. Meeks, and H. J. Zeiger, "Maser Model for Interstellar OH Microwave Emission", Phys. Rev. Lett. **17,** 821 (1966).

[66Q] M. L. Meeks, J. A. Ball, J. C. Carter, and R. P. Ingalls, "Stokes Parameters for 1665-Megacycles-per-second Emission from OH Near Source W3", Science **153,** 978 (1966).

[66S] F. P. Perkins, T. Gold, and E. E. Salpeter, "Maser Action in Interstellar OH", Astrophys. J. **145,** 361 (1966).

[66T] A. E. E. Rogers, J. M. Moran, P. P. Crowther, B. F. Burke, M. L. Meeks, J. A. Ball, and G. M. Hyde, "Interferometric Study of Cosmic Line Emission at OH Frequencies", Phys. Rev. Lett. **17,** 450 (1966).

[66U] H. Weaver, D. R. W. Williams, and N. H. Dieter, "OH Radio-Frequency Emission Near Very Bright H II Regions", Astron. J. **71,** 184 (1966).

[66V] D. R. W. Williams, N. H. Dieter, and H. Weaver, "Linear Polarization of the Emission from the OH Molecule", Astron. J. **71,** 186 (1966).

[67G] A. H. Barrett, "Radio Observations of Interstellar Hydroxyl Radicals", Science 157, 881 (1967).

[67H] A. H. Cook, "Brightness and Temporal Variation of Radio Emission from Galactic OH", Nature **214,** 689 (1967).

[67I] R. D. Davies, B. Rowson, R. S. Booth, A. J. Cooper, H. Gent, R. L. Adgie, and J. H. Crowther, "Measurements of OH Emission Sources with an Interferometer of High Resolution", Nature **213,** 1109 (1967).

[67J] F. F. Gardner, R. X. McGee, and B. J. Robinson, "18 cm OH-Line Radiation from NGC 6334", Aust. J. Phys. **20,** 309 (1967).

[67K] C. V. Heer and R. A. Settles, "Theory for the Anomalous Polarization of Cosmic OH-18 cm Radiation and for Hyperfine Lasers", J. Mol. Spectrosc. **23,** 448 (1967).

[67L] C. V. Heer and R. A. Settles, "Theory for the Polarization of the Four Cosmic OH 18-cm Lines", Phys. Lett. A, **24A,** 484 (1967).

[67M] V. A. Hughes, "Mechanism for Anomalous OH Emission from H^{II} Regions", Nature **215,** 942 (1967).

[67N] I. D. Johnston, "A Mechanism for Maser Action of OH Molecules in Interstellar Space", Astrophys. J. **150,** 33 (1967).

[67O] T. K. Menon, "The Nature of OH Emission Sources in the Galaxy", Astrophys. J. **150,** L167 (1967).

[67P] P. G. Mezger, W. Altenhoff, J. Schraml, B. F. Burke, E. C. Reifenstein, III, and T. L. Wilson, "A New Class of Compact H II Regions Associated with OH Emission Sources", Astrophys. J. **150,** L157 (1967).

[67Q] P. G. Mezger, J. Schraml, and Y. Terzian, "Galactic H II Regions. III. The Nature of the Radio Source W49", Astrophys. J. **150,** 807 (1967).

[67R] R. X. McGee, F. F. Gardner, and B. J. Robinson, "OH Observations in the Directions of Galactic Thermal Sources", Aust. J. Phys. **20,** 407 (1967).

[67S] J. M. Moran, A. H. Barrett, A. E. E. Rogers, B. F. Burke, B. Zuckerman, H. Penfield, and M. L. Meeks, "Observations of OH Emission in the H II Region W3 with a 74400 λ Interferometer", Astrophys. J. **148,** L69 (1967).

[67T] J. M. Moran, P. P. Crowther, B. F. Burke, A. H. Barrett, A. E. E. Rogers, J. A. Ball, J. C. Carter, and C. C. Bare, "Spectral Line Interferometry with Independent Time Standards at Stations Separated by 845 Kilometers", Science **157,** 676 (1967).

[67U] P. Palmer and B. Zuckerman, "Observations of Galactic OH", Astrophys. J. **148,** 727 (1967).

[67V] E. Raimond and B. Eliasson, "Possible Relation Between an OH Source and an Infrared Object in the Orion Nebula", Astrophys. J. **150,** L171 (1967).

[67W] B. J. Robinson and R. X. McGee,"OH Molecules in the Interstellar Medium", Ann. Rev. Astron. Astrophys. **5,** 183 (1967).

[67X] A. E. E. Rogers, J. M. Moran, P. P. Crowder, B. F. Burke, M. L. Meeks, J. A. Ball, and G. M. Hyde, "The Positions and Angular Extent of OH Emission Associated with the H II Regions W3, W24, W49, and NGC 6334", Astrophys. J. **147,** 369 (1967).

[67Y] H. G. Van Bueren and A. D. Fokker, "The Radio Emission of Interstellar OH-Molecules", Ned. Tijdschrift Natuurkde (Netherlands), **32,** 108 (1967).

[67Z] B. Zuckerman, Patrick Palmer, and H. Penfield, "A Search for the Λ-Doublet Transition in the $^2\Pi_{1/2}$, $J = 1/2$ State of OH", Nature **213,** 1217 (1967).

[68D] A. H. Barrett, "Radio Signals From Hydroxyl Radicals", Sci. Amer. **219,** 36 (1968).

[68E] J. A. Ball and M. L. Meeks, "Observations of Galactic OH Emission", Astrophys. J. **153,** 577 (1968).

[68F] J. A. Ball and D. H. Staelin, "Classification of OH Radio Emission Sources", Astrophys. J. **153,** L41 (1968).

[68G] A. H. Cook, "Elementary Models for Stimulated Radio Emission from Interstellar OH", Mon. Not. Roy. Astron. Soc. **140,** 299 (1968).

[68H] J. Czarny and P. Felenbok, "Very High Resolution Study of the Transition $B\ ^2\Sigma^+$–$A\ ^2\Sigma^-$ of OH and OD Using a High Frequency Source Designed for the Purpose", Ann. Astrophys. **31,** 141 (1968).

[68I] J. Ellder, "OH Spectral Line Measurements of Radiation From the Galactic H II Regions W3 and W49 at 1665 MHz", Res. Lab. Electronics, Chalmers Univ. Tech., Gothenburg, Sweden, Res. Rept. # 87, 3 (1968).

[68J] G. B. Field, P. A. Aannestad, and P. M. Solomon, "Production of OH Molecules in Interstellar Shock Waves", Nature 217, 435 (1968).

[68K] T. Gold, "Maser Action in Space", Interstellar Ionized Hydrogen, Y. Terzian, Ed., W. A. Benjamin, Inc. New York, 747 (1968).

[68L] W. M. Goss, "OH Absorption in the Galaxy", Astrophys. J. Supp. **15,** 131 (1968).

[68M] W. M. Goss and B. J. Robinson, "OH Emission at 1720 MHz in the Direction of Non-Thermal Galactic Sources", Astrophys. Lett. **2,** 81 (1968).

[68N] C. E. Heiles, "Normal OH Emission and Interstellar Dust Clouds", Astrophys. J. **151,** 919 (1968).

[68O] M. M. Litvak, "Ultraviolet and Infrared Pumping of OH Molecules", Interstellar Ionized Hydrogen, Y. Terzian, Ed., W. A. Benjamin, Inc. New York, p. 713 (1968).

[68P] J. M. Moran, Jr., "Interferometry of OH Sources", Interstellar Ionized Hydrogen, Y. Terzian, Ed., W. A. Benjamin, Inc. New York, j. 681 (1968).

[68Q] J. M. Moran, Jr., B. F. Burke and A. H. Barrett, "Long Baseline OH Interferometry", Astron. J. **73,** S108 (1968).

[68R] J. M. Moran, B. F. Burke, A. H. Barrett, A. E. E. Rogers, J. A. Ball, J. C. Carter, and D. D. Cudaback, "The Structure of the OH Source in W3", Astrophys. J. **152,** L97 (1968).

[68S] B. J. Robinson and W. M. Goss, "Interplanetary Scintillation of the OH Emission at 1665 MHz from Sagittarius B2", Astrophys. Lett. **2,** 5 (1968).

[68T] A. E. E. Rogers, "Theory of Non-Thermal Emission from Interstellar OH", Interstellar Ionized Hydrogen, Y. Terzian, Ed., W. A. Benjamin, Inc. New York, p. 605 (1968).

[68U] P. M. Solomon, "Formation and Chemical Pumping of OH Molecules", Nature **217,** 334 (1968).

[68V] K. Takakubo, "OH Emission and Nebular Filaments", Sci. Rep. Tohoku Univ. First Ser. (Japan), **51,** 15 (1968).

[68W] H. Weaver, "OH in the Galaxy", Interstellar Ionized Hydrogen, Y.Terzian, Ed., W.A. Benjamin, Inc. New York, 645 (1968).

[68X] H. Weaver, N. H. Dieter, and D. R. W. Williams, "Observations of OH Emission in W3, NGC 6334, W49, W51, W75, and Ori A," Astrophys. J. Suppl. **16,** 219 (1968).

[68Y] W. J. Wilson and A. H. Barrett, "Discovery of Hydroxyl Radio Emission from Infrared Stars", Science **161,** 778 (1968).

[68Z] B. Zuckerman, P. Palmer, H. Penfield, and A. E. Lilley, "Detection of Microwave Radiation from $^2\Pi_{1/2}$, $J = 1/2$ State of OH", Astrophys. J. **153,** L69 (1968).

[69H] R. S. Booth, "OH Emission and the Infrared Star in VY Canis Majoris", Nature **224,** 783 (1969).

[69I] A. H. Cook, "The Hydroxyl Molecule in Interstellar Space", Physica 41, 1 (1969).

[69J] A. H. Cook, "Pumping Mechanisms for Maser Action in Galactic OH", Nature **220,** 44 (1969).

[69K] D. D. Cudaback and C. Heiles, "A Survey of Dust Clouds for OH Emission", Astrophys. J. **155,** L21 (1969).

[69L] B. Eliasson and J. F. Bartlett, "Discovery of an Intense OH Emission Source", Astrophys. J. **155,** L79 (1969).

[69M] J. Ellder, B. Ronnang, and A. Winnberg,"New OH Radio Emission Sources in Cygnus", Nature **222,** 67 (1969).

[69N] G. F. Gahm and R. R. Zappala, "The Possible OH Source BC Cygni", Publ. Astron. Soc. Pacific, **81,** 887 (1969).

[69O] W. M. Goss, B. J. Robinson, and R. N. Manchester, "Time Variation in the Polarization of OH Emission from NGC 6334B", Proc. Astron. Soc. Australia, **1,** 214 (1969).

[69P] C. Heiles, "Temperatures and OH Optical Depths in Dust Clouds," Astrophys. J. **157,** 123 (1969).

[69Q] A. R. Hyland, E. E. Becklin, G. Neugebauer, and G. Wallerstein, "Observations of the Infrared Object, VY Canis Majoris", Astrophys. J. **158,** 619 (1969).

[69R] M. M. Litvak, "Hydroxyl and Water Masers in Protostars", Science **165,** 855 (1969).

[69S] M. M. Litvak, "Infrared Pumping of Interstellar OH", Astrophys. J. **156,** 471 (1969).

[69T] M. M. Litvak, B. Zuckerman, and D. F. Dickinson, "Conditions for Microwave Radiation from Excited OH Λ-Doublet States", Astrophys. J. **156,** 875 (1969).

[69U] R. N. Manchester, W. M. Goss, and B. J. Robinson, "A New Type of Wideband 1665 MHz OH Emission", Astrophys. Lett. **3,** 11 (1969).

[69V] R. N. Manchester, W. M. Goss, and B. J. Robinson,"Occultation Positions of the 1665 MHz OH Emission From G 0.7–0.0", Astrophys. Lett. **4,** 93 (1969).

[69W] R. N. Manchester, W. M. Goss, and B. J. Robinson, "A Wideband OH Emission Course", Proc. Astron. Soc. Australia, **1,** 212 (1969).

[69X] P. Palmer and B. Zuckerman, "Observations of Excited State OH", Bulletin of the American Astronomical Society **1,** 358 (1969).

[69Y] J. M. Pasachoff, G. A. Gottlieb, L. E. Snyder, D. Buhl, P. Palmer, B. Zuckerman, and D. F. Dickinson, "Search for New Microwave Spectral Lines From Interstellar Molecules and Atoms", Am. Astronomical Soc. Mtg., New York (1969).

[69Z] E. Raimond and B. Eliasson, "Positions and Stokes Parameters of Seven OH-Emission Sources", Astrophys. J. **155,** 817 (1969).

[69AA] B. J. Robinson, W. M. Goss, and R. N. Manchester,"A Thermal Source With Strong 1612 MHz OH Emission", Proc. Astron. Soc. Australia, **1,** 211 (1969).

[69AB] R. H. Rubin and B. E. Turner, "Radio Observations of Nebulae K3-50 and NGC 6857", Astrophys. J. **157,** L41 (1969).

[69AC] O. E. H. Rydbeck, J. Ellder, and E. Kollberg, "OH and Formaldehyde Radiation Properties of the W75 Region", Astrophys. J. **156,** L141 (1969).

[69AD] P. R. Schwartz and A. H. Barrett, "Observations of the $^2H_{1/2}$, $J = 5/2$ Excited State of OH in W3", Astrophys. J. **157,** L109 (1969).

[69AE] J. S. Shklovskii, "The Nature of Sources of Maser Radiation in OH Lines", Astron. Zhurn. Akad. Nauk. SSSR **46,** 3 (1969), Sov. Astron. **13,** 1 (1969).

[69AF] B. E. Turner, "47 New Galactic OH Sources-Distribution and Preliminary Properties", Bulletin of the American Astronomical Society **1,** 263 (1969).

[69AG] B. E. Turner, "Observations of Satellite-Anomalous OH Emission Sources", Astrophys. J. **157,** 103 (1969).

[69AH] B. E. Turner, "Search for Microwave Emission from the $^2\Pi_{1/2}$, $J = 3/2$ State of OH", Astron. & Astrophys. **2,** 453 (1969).

[69AI] B. E. Turner,"A Survey for Galactic OH Emission Sources", Astron. J. **74,** 985 (1969).

[69AJ] J. L. Yen, B. Zuckerman, P. Palmer, and H. Penfield, "Detection of the $^2\Pi_{3/2}$, $J = 5/2$ State of OH at 5-centimeter Wavelength", Astrophys. J. **156,** L27 (1969).

[69AK] B. Zuckerman, J. A. Ball, D. F. Dickinson, and H. Penfield,"Time Variations in Galactic OH Emission Sources", Astrophys. Lett. **3,** 97 (1969).

[70E] J. A. Ball, D. F. Dickinson, C. A. Gottlieb, and H. E. Radford, "The 3.8-cm Spectrum of OH: Laboratory Measurement and Low-Noise Search in W3 (OH)", Astron. J. **75,** 762 (1970).

[70F] J. A. Ball and H. Penfield, "Search for ^{18}OH in Emission", Astrophys. J. **160,** 349 (1970).

[70G] J. A. Ball, B. M. Zuckerman, C. A. Gottlieb, and H. E. Radford, "18-cm Transitions in $O^{17}H$ and $O^{18}H$—Laboratory and Astronomical Measurements", Bull. Amer. Astron. Soc. **2,** 293 (1970).

[70H] A. G. Bromley, "On the Polarization of the 18-cm OH Emission", Proc. Astron. Soc. Australia, **1,** 347 (1970).

[70I] N. V. Bystrova, I. V. Gosachinskii, T. M. Egorova, N. V. Karlov, B. B. Krynetskii, and N. F. Ryzhkov, "Determination of the Coordinate (R.A.) of Some Galactic Sources of Anomalously Excited Hydroxyl," Dokl. Akad. Nauk. SSSR, Ser. Mat. Fiz., **191,** 791 (1970).

[70J] J. L. Caswell and B. J. Robinson, "OH Emission at 1612 MHz from VX Sagittarii", Astrophys. Lett. **7,** 75 (1970).

[70K] W. A. Coles and V. H. Rumsey, "Stokes Parameters for OH Sources", Astrophys. J. **159,** 247 (1970).

[70L] D. Downes, "New OH Sources Associated With H II Regions", Astrophys. Lett. **5,** 53 (1970).

[70M] J. Ellder, "Some OH and Formaldehyde Properties of W3 and W51 Regions", Res. Lab. Electronics, Chalmers Univ. Technology, Gotherburg, Sweden, Res. Rept. #96 (1970).

[70N] K. M. Evenson, J. S. Wells and H. E. Radford, "Infrared Resonance of OH With the H_2O Laser: A Galactic Maser Pump?", Phys. Rev. Lett. **25,** 199 (1970).

[70O] F. F. Gardner, R. X. McGee, and M. W. Sinclair, "$O^{18}H$ in Sagittarius", Astrophys. Lett. **5,** 67 (1970).

[70P] F. F. Gardner, J. C. Ribes, and W. M. Goss, "Emission of the Excited State of OH at 6035 MHz from NGC 6334", Astrophys. Lett. **7,** 51 (1970).

[70Q] W. M. Goss, R. N. Manchester, and B. J. Robinson, "18-cm Observations of Galactic OH from Longitudes 305° to 334°", Aust. J. Phys. **23,** 559 (1970).

[70R] C. Heiles, "Motions and Physical Conditions Inside Dust Clouds", Astrophys. J. **160,** 51 (1970).

[70S] M. M. Litvak, "Polarized Maser Emission From Interstellar OH and H_2O", Phys. Rev. A **2,** 937 (1970).

[70T] R. N. Manchester and M. A. Gordon, "Astronomical Measurement of the 18-cm OH Transition Frequencies", Astrophys. Lett. **6,** 243 (1970).

[70U] R. N. Manchester, B. J. Robinson, and W. M. Goss, "18-cm Observations of Galactic OH From Longitudes 128° to 300°", Aust. J. Phys. **23,** 751 (1970).

[70V] R. X. McGee, "Atlas of OH_{1667} Line Profiles Near the

Galactic Centre", Aust. J. Phys. Astrophys. Suppl. **17**, 1 (1970).

[70W] R. X. McGee, "Hydroxyl Gas Clouds Near the Galactic Centre", Aust. J. Phys. **23,** 541 (1970).

[70X] R. X. McGee, J. W. Brooks, M. W. Sinclair, and R. A. Batchelor, "OH_{1667} Line Absorption at $2° < \ell^{II} < 4°$, $-0° 30' < b^{II} < 1°$", Aust. J. Phys. **23,** 777 (1970).

[70Y] R. X. McGee, F. F. Gardner, and M. W. Sinclair, "Measurements of OH in Sagittarius A and B2", Proc. Astron. Soc. Australia **1,** 334 (1970).

[70Z] P. Palmer and B. Zuckerman, "Observations of Interstellar OH at 4660 MHz", Astrophys. J. **161,** L199 (1970).

[70AA] B. J. Robinson, J. L. Caswell, and W. M. Goss, "Linear Polarization and Variability in the OH-Emission Form VY Canis Majoris", Astrophys. Lett. **7,** 79 (1970).

[70AB] B. J. Robinson, W. M. Goss, and R. N. Manchester, "18-cm Observations of Galactic OH From Longitudes 350° to 50°", Aust. J. Phys. **23,** 363 (1970).

[70AC] B. J. Robinson and R. X. McGee, "OH Absorption at 1667 MHz Near the Galactic Centre", Aust. J. Phys. **23,** 405 (1970).

[70AD] B. O. Ronnang, O. E. H. Rydbeck, and J. M. Moran, "Very Long Baseline Interferometry of Galactic OH Sources", Radio Sci. 5, 1227 (1970).

[70AE] B. O. Ronnang, O. E. H. Rydbeck, and J. M. Moran, "Very Long Baseline Interferometry of Galactic OH Sources", Res. Lab. Electronics, Chalmers Univ. Technology, Gothenburg, Sweden, Res. Rept. #100 (1970).

[70AF] O. E. H. Rydbeck, E. Kollberg, and J. Ellder, "OH Excited-State Emission from W75 B and W3 OH", Astrophys. J. **161,** L25 (1970)

[70AG] O. E. H. Rydbeck, E. Kollberg, and J. Ellder, "OH Excited State Emissions From W75B and W3, OH", Res. Lab. Electronics, Chalmers Univ. Technology, Gothenburg, Sweden, Res. Rept. #97 (1970).

[70AH] A. A. Sandqvist, "High-Frequency-Resolution Studies of H I, OH, and CH_2O Absorption Spectra in Sagittarius A", Astron. J. **75,** 135 (1970).

[70AI] D. L. Thacker, W. J. Wilson, and A. H. Barrett, "Observations of the $^2\Pi_{1/2}$, $J = 1/2$ State of OH", Astrophys. J. **161,** L191 (1970).

[70AJ] B. E. Turner, "Anomalous Emission From Interstellar Hydroxyl and Water", J. Roy. Astron. Soc. Canada **64,** 221 (1970).

[70AK] B. E. Turner, "Anomalous Emission From Interstellar Hydroxyl and Water", J. Roy. Astron. Soc. Canada **64,** 282 (1970).

[70AL] B. E. Turner,"Fifty New OH Sources Associated With H II Regions", Astrophys. Lett. **6,** 99 (1970).

[70AM] B. E. Turner, "Masers in Space", Publ. Astron. Soc. Pacific **82,** 996 (1970).

[70AN] B. E. Turner, P. Palmer, and B. Zuckerman, "Detection of the $^2\Pi_{3/2}$, $J = 7/2$ State of Interstellar OH at a Wavelength of 2.2 Centimeters", Astrophys. J. **160,** L125 (1970).

[70AO] B. E. Turner and G. L. Verschuur, "An Attempt to Measure the Zeeman Splitting of 'Normal' Interstellar OH Lines", Astrophys. J. **162,** 341 (1970).

[70AP] W. J. Wilson and A. H. Barrett, "Observations of Interstellar $O^{18}H$", Astrophys. Lett. **6,** 231 (1970).

[70AQ] W. J. Wilson, A. H. Barrett, and J. M. Moran, "OH Radio Emission Associated With Infrared Stars", Astrophys. J. Astrophys. J. **160,** 545 (1970).

[70AR] A. Winnberg, "Further Observations of Some OH Sources in Cygnus", Astron. & Astrophys. **9,** 259 (1970).

[70AS] A. Winnberg and L. Lundahl, "A Search for OH 18-cm Emission in the Cepheus IV Association", Astron. and Astrophys. **9,** 321 (1970).

[70AT] B. Zuckerman and P. Palmer, "Observations of the $^2\Pi_{1/2}$, $J = 1/2$ State of Interstellar OH", Astrophys. J. **159,** L197 (1970).

[70AU] A. Zytkow, "Anomalous Interstellar OH Lines", Postepy Astron. **18,** 226 (1970).

[70AV] A. Zytkow, "Maser Mechanism for the OH Lines", Postepy Astron. **18,** 383 (1970).

[71I] J. A. Ball, "Observations of OH Radio Emission Sources", Report TR 458, MIT, Lexington, Mass. Contract AF19 (628)-5167 (1971).

[71J] J. A. Ball, C. A. Gottlieb, M. L. Meeks, and H. E. Radford, "Search for the $^2\Pi_{1/2}$, $J = 5/2$ Excited State of OH in W3", Astrophys. J. **163,** L33 (1971).

[71K] J. L. Caswell, B. J. Robinson, and H. R. Dickel, "A Search for Southern OH-IR Objects", Astrophys. Lett. **9,** 61 (1971).

[71L] A. J. Cooper, R. D. Davies, and R. S. Booth, "Interferometric Investigations of Sources of OH Emission—I. Observations With an Interferometer Baseline of 7×10^5 Wavelengths", Mon. Not. Roy. Astron. Soc. **152,** 383 (1971).

[71M] G. F. Gahm and A. Winnberg, "OH Observations at the Positions of T Tauri Stars in the Taurus-Auriga Region", Astron. & Astrophys. **13,** 489 (1971).

[71N] F. F. Gardner and R. X. McGee, "OH-Line Absorption at 1665 and 1667 MHz in the Direction of the Omega Nebula", Astrophys. Lett. **8,** 83 (1971).

[71O] F. F. Gardner and J. C. Ribes, "Observations of the Excited Lines of OH Near 4700 MHz", Astrophys. Lett. **9,** 175 (1971).

[71P] F. F. Gardner, J. C. Ribes, and M. W. Sinclair, "Observations of the $^2\Pi_{1/2}$, $J = 1/2$ Line of OH at 4660 MHz in Sagittarius B2", Astrophys. J. **169,** L109 (1971).

[71Q] W. M. Goss, J. L. Caswell, and B. J. Robinson, "OH Absorption in the Direction of W44", Astron. Astrophys. **14,** 481 (1971).

[71R] E. G. Hardebeck,"Accurate Position Measurements in the 1720-MHz Line of OH", Astrophys. J. **170,** 281 (1971).

[71S] E. G. Hardebeck and W. J. Wilson, "Position Measurements of Main-Line OH/Infrared Stars", Astrophys. J. **169,** L123 (1971).

[71T] L. A. Higgs, "A Survey of Microwave Radiation from Planetary Nebulae", Mon. Not. Roy. Astron. Soc. **153,** 315 (1971).

[71U] P. S. Julienne, M. Krauss, and B. Donn, "Formation of OH Through Inverse Predissociation", Astrophys. J. **170,** 65 (1971).

[71V] F. J. Keer and G. R. Knapp, "A Search for OH in Nine High-Latitude Selected Areas", Astron. J. **76,** 993 (1971).

[71W] A. Kudo, "Pumping of Interstellar OH Molecules by Polarized Infrared Radiation", Sci. Rep. Tohoku Univ. First Ser., **54,** 120 (1971).

[71X] M. M. Litvak, "The Meaning of the OH–H_2O Maser Maps", Astrophys. J. **170,** 71 (1971).

[71Y] R. N. Manchester and M. A. Gordon, "Excitation Temperatures of the 18-cm OH Transitions in an Absorbing Cloud", Astrophys. J. **169,** 507 (1971).

[71Z] M. I. Paschenko, G. M. Rudnitskij, V. I. Slysh, and R. Fillit, "Measurement of the One-Dimensional Distribution Function of the Signals from Some Galactic OH Radio Sources", Astron. Tsirk., #626 (1971).

[71AA] M. Paschenko, V. Slysh, I. Strukov, R. Fillit, M. Gheudin, and N. Q. Rieu, "A Search for OH Emission From Infrared Objects at 1612 MHz", Astron. & Astrophys. 11, 482 (1971).

[71AB] N. Q. Rieu, R. Fillit, and M. Gheudin, "OH Emission Sources Associated With Long-Period Variable Infrared Stars", Astron. & Astrophys. **14,** 154 (1971).

[71AC] B. J. Robinson, J. L. Caswell, and H. R. Dickel, "Similarity of the OH Emissions from VX Sagittarii and VY Canis Majoris", Astrophys. Lett. **8,** 171 (1971).

[71AD] B. J. Robinson, J. L. Caswell, and W. M. Goss, "New OH Emission Sources", Proc. Astron. Soc. Aust. **2,** 36 (1971).

[71AE] B. J. Robinson, J. L. Caswell, and W. M. Goss, "A 1665 MHz OH Survey of the Southern Milky Way", Astrophys. Lett. **9,** 5 (1971).

[71AF] B. J. Robinson, J. L. Caswell, and W. M. Goss, "Unusual

OH Emission From a Mira Variable", Astrophys. Lett. **7**, 163 (1971).

[71AG] B. E. Turner, "Anomalous OH Emission From New Types of Galactic Objects", Astrophys. Lett. **8**, 73 (1971).

[71AH] B. E. Turner and C. Heiles,"Nonthermal OH Emission in Interstellar Dust Clouds," Astrophys. J. **170**, 453 (1971).

[71AI] G. L. Verschuur, "OH Emission From Interstellar H I Clouds", Astrophys. Lett. **7**, 217 (1971).

[71AJ] G. Wallerstein, "The Optical Spectrum of the OH and Infrared Emitter VX Sagittarii", Astrophys. Lett. **7**, 199 (1971).

[71AK] L. Weliachew, "Detection of Interstellar OH in Two External Galaxies", Astrophys. J. **167**, L47 (1971).

[71AL] B. Zuckerman, "Λ Doublet Radiation From OH Excited Rotational States", Highlights of Astronomy **2**, 391 (1971).

[72G] L. Allen and G. I. Peters, "Amplified Spontaneous Emission and OH Molecules in the Interstellar Medium", Nature, Phys. Sci. **235**, 143 (1972).

[72H] V. V. Burdyuzha and D. A. Varshalovich, "The Probabilities of Infrared and Radio Transitions of Molecules OH and CH", Astro. Zh. **49**, 1211 (1972).

[72I] E. J. Chaisson and D. F. Dickinson,"OH in the Hoffman Infrared Sources", Astrophys. Lett. **12**, 119 (1972).

[72J] R. D. Davies, M. R. W. Masheder, and R. S. Booth, "Structure of the OH Infrared Object NML Cygnus", Nature, Phys. Sci. **237**, 21 (1972).

[72K] R. D. Davies and H. E. Matthews, "Physical Conditions in Interstellar Hydroxyl and Formaldehyde Clouds", Mon. Not. Roy. Astron. Soc. **156**, 253 (1972).

[72L] D. F. Dickinson and B. E. Turner, "Classification of New OH Sources", Astrophys. Lett. **11**, 1 (1972).

[72M] N. J. Evans, II, R. E. Hills, O. E. H. Rydbeck, and E. Kollberg,"Statistics of the Radiation From Astronomical Masers", Phys. Rev. A **6**, 1643 (1972).

[72N] R. Fillit, M. Gheudin, N.-Q. Rieu, M. Paschenko, and V. Slysh, "New OH Sources Associated With IR-Late-Type Stars", Astron. Astrophys. **21**, 317 (1972).

[72O] P. Goldreich and J. Y. Kwan, "On Parametric Down-Conversion in Astrophysical Masers," Astrophys. J. **176**, 345 (1972).

[72P] H. J. Habing, F. P. Israel, and T. de Jong, "On the Coincidence of OH Emission Sources and Bright Knots in H II Regions", Astron. Astrophys. **17**, 329 (1972).

[72Q] E. G. Hardebeck, "Interferometer Positions of Eighteen OH Emission Sources", Astrophys. J. **172**, 583 (1972).

[72R] A. R. Hyland, E. E. Becklin, J. A. Frogel, and G. Neugebauer, "Infrared Observations of 1612 MHz IR/OH Sources", Astron. & Astrophys. **16**, 204 (1972).

[72S] A. R. Hyland, R. A. Hirst, G. Robinson, and J. A. Thomas, "Infrared Observations of Some Southern IR-OH Sources", Astrophys. Lett. **11**, 7 (1972).

[72T] G. R. Knapp and F. J. Kerr, "An Upper Limit on the OH Abundance in the Intercloud Medium", Astron. J. **77**, 649 (1972).

[72U] V. S. Letokhov, "Cosmic Maser With Feedback", Astron. Zhurn. Akad. Nauk., SSSR, **49**, 737 (1972); Sov. Astron. **16**, 604 (1973).

[72V] M. M. Litvak and D. F. Dickinson, "OH Infrared Stars", Astrophys. Lett. **12**, 113 (1972).

[72W] N.-Q. Rieu,"A Radical, Its Radiation and the Maser", Sci. Prog. Decouverte (France), #3442, p. 24 (1972).

[72X] M. I. Pashchenko, "18-cm OH Absorption in the Direction of Cygnus X", Astron. Tsirk. #733, 1 (1972).

[72Y] M. I. Pashchenko, "18-cm OH Emission From W 49A at Negative Velocities", Astron. Tsirk. #721, 3 (1972).

[72Z] G. I. Peters and L. Allen, "Models for OH Radiation From the Interstellar Medium", Astrophys. J. **176**, L23 (1972).

[72AA] K. W. Riegel and R. M. Crutcher, "OH Observations of the Open Cluster NGC 2264", Astrophys. J. **172**, L107 (1972).

[72AB] B. O. Ronnang,"High Resolution Spectra of Some Strong Galactic OH Emission Sources", Res. Lab. Electronics, Onsala Space Obs., Chalmers Univ. Technology, Gothenburg, Sweden, Res. Rept. #101 (1972).

[72AC] G. M. Rudnitskij, V. S. Strel'nitskij, "Restrictions on Cosmic Maser Intensity and the Possibility of Detecting New OH and H_2O Radio Sources in a Short-Term Sky Survey", Astron. Zhurn. Akad. Nauk. SSSR, **49**, 1323 (1972), Sov. Astron. **16**, 1049 (1973).

[72AD] O. E. H. Rydbeck, J. Elldér, E. Kollberg and B. Höglund, "OH Excited State Emissions and Their Temporal Variations in W3(OH) and W75B", Mem. Soc. R. Sci. Liege **3**, 507 (1972).

[72AE] A. C. Selden, "Gain Parameters of Interstellar Masers", Phys. Lett. A, **40A**, 355 (1972).

[72AF] B. E. Turner, "OH and Formaldehyde Absorption in the Direction of Cygnus X-3", Nature, Phys. Sci. **239**, 132 (1972).

[72AG] B. E. Turner, "On the Distribution of OH in the Galaxy. I. Correlation With Continuum Sources and With Formaldehyde", Astrophys. J. **171**, 503 (1972).

[72AH] A. J. Wilson, R. D. Davies, and J. Elldér,"The Variability of the OH Source W3", Mon. Not. Roy. Astron. Soc. **157**, 21P (1972).

[72AI] W. J. Wilson and A. H. Barrett, "Characteristics of OH Emission from Infrared Stars", Astron. & Astrophys. **17**, 385 (1972).

[72AJ] W. J. Wilson, P. R. Schwartz, G. Neugebauer, P. M. Harvey and E. E. Becklin,"Infrared Stars with Strong 1665/1667-MHz OH Microwave Emission", Astrophys. J. **177**, 523 (1972).

[72AK] B. Zuckerman, J. L. Yen, C. A. Gottlieb and P. Palmer,"Observations of the $^2\Pi_{3/2}$, $J = 5/2$ State of Interstellar OH", Astrophys. J. **177**, 59 (1972).

[73L] J. W. M. Baars and H. J. Wendker, "The Radio Continuum Emission of the OH/IR-Source ON-4", Astrophys. Lett. **13**, 139 (1973).

[73M] P. F. Bowers and R. H. Cornett, "Search for OH Emission from RV Tauri Stars", Astrophys. Lett. **15**, 181 (1973).

[73N] V. V. Burdyuzha and D. A. Varshalovich, "Infrared Pumping for Maser OH Sources Associated With H II Regions", Astron. Zhurn. Akad. Nauk. SSSR, **50**, 481 (1973); Sov. Astron. **17**, 308 (1973).

[73O] M. Cohen and A. Baudry,"The Possible Nature of Some Unusual OH Sources", Astrophys. Lett. **15**, 151 (1973).

[73P] R. M. Crutcher, "OH Observations of a Rotating Dust Cloud", Astrophys. Lett. **14**, 147 (1973).

[73Q] R. M. Crutcher, "Observations of OH Molecules in Interstellar Dust Clouds", Astrophys. J. **185**, 857 (1973).

[73R] A. Dymanus, "Interstellar Masers", Ned. Tijdschr. Natuurk (Netherlands) **39**, 193 (1973).

[73S] J. Elldér, "On a Transient OH Ground State Source in W 75B", Res. Lab. Electronics, Onsala Space Obs., Chalmers Univ. Technology, Gottenburg, Sweden, Res. Rept. #116 (1973).

[73T] J. Eller, O. E. H. Rydbeck, and A. Sume, "Temporal Variations of OH Ground State Emissions in W51", Res. Lab. Electronics, Onsala Space Obs., Chalmers Univ. Technology, Gothenburg, Sweden, Res. Rept. #117 (1973).

[73U] W. M. Goss, L. E. B. Johansson, J. Elldér, B. Höglund, N.-Q. Rieu, and A. Winnberg, "Extended OH Emission at 1720 MHz", Astron. Astrophys. **28**, 89 (1973).

[73V] W. M. Goss, I. A. Lockhart, E. B. Fomalont, and E. G. Hardebeck, "Accurate Positions of OH Emission Sources at 1665 and 1667 MHz", Astrophys. J. **183**, 843 (1973).

[73W] W. M. Goss, N.-Q. Rieu and A. Winnberg, "Microwave Characteristics of OH 0739-14 and the Planetary Nebula NGC 2438", Astron. & Astrophys. **29**, 435 (1973).

[73X] W. D. Gwinn, B. E. Turner, W. M. Goss, and G. L. Blackman, "Excitation of Interstellar OH by the Collisional Dissociation of Water", Astrophys. J. **179**, 789 (1973).

[73Y] L. M. Hall and D. ter Haar, "On the Polarization of the

Interstellar OH-Emission", Mon. Not. Roy. Astron. Soc. **162,** 97 (1973).

[73Z] L. A. Higgs, "A Study of the Radio Continuum Spectra of Planetary Nebulae", Mon. Not. Roy. Astron. Soc. **161,** 313 (1973).

[73AA] G. R. Knapp and F. J. Kerr, "OH Observations of Sixteen Interstellar Dust Clouds", Astron. J. **78,** 453 (1973).

[73AB] S. H. Knowles, K. J. Johnston, J. M. Moran, and J. A. Ball, "Interferometric Observations of the $^2\Pi_{3/2}$, J = 5/2 State of Interstellar OH", Astrophys. J. **180,** L117 (1973).

[73AC] L. T. Little, "Interstellar Scattering and the Angular Diameters of OH Components", Astrophys. Lett. **13,** 115 (1973).

[73AD] K. Y. Lo and K. P. Bechis, "Anomalous 1720-MHz OH Emission from V1057 Cygni", Astrophys. J. **185,** L71 (1973).

[73AE] W. D. Metz, "Interstellar Molecules: New Theory of Formation from Gases", Science **182,** 466 (1973).

[73AF] P. C. Myers, "Observations of OH and H_2CO Toward Galactic Dust Clouds", Astrophys. J. Suppl. Ser. #229, **26,** 83 (1973).

[73AG] M. I. Pashchenko, "The Distribution of Interstellar Hydroxyl in the Cygnus X Region", Astron. Zhurn. Akad. Nauk. SSSR, **50,** 685 (1973), Sov. Astron. **17,** 438 (1973).

[73AH] M. I. Paschenko and V. I. Slysh, "18-cm OH Absorption of W 49A and W 49B", Astron. & Astrophys. **26,** 349 (1973).

[73AI] M. I. Pashchenko, G. M. Rudnitskij, and V. I. Slysh, "Study of Probability Density of a Signal From Interstellar Hydroxyl Radio Lines", Izv. Vyssh. Ucheb. Zavedenij. Radiofizika **16,** 1344 (1973).

[73AJ] L. J. Rickard, B. Zuckerman, and P. Palmer, "Detection of Thermal Absorption and Emission by OH in the $^2\Pi_{3/2}$, J = 5/2 Excited State", Bull. Amer. Astron. Soc. **5,** 331 (1973).

[73AK] V. I. Slysh, "Resonance Stark Effect in OH and H_2O Interstellar Masers", Astrophys. Lett. **14,** 213 (1973).

[73AL] V. I. Slysh, "Two New OH Emission Sources in the W43 Region", Astron. Tsirk. #798, 1 (1973).

[73AM] B. E. Turner, "Nonthermal OH Emission in Interstellar Dust Clouds", Astrophys. J. **186,** 357 (1973).

[73AN] G. Wallerstein, "The Nature of the New OH Sources Discovered by Winnberg et al. at 1612 MHz", Astrophys. Lett. **15,** 83 (1973).

[73AO] T. L. Wilson, "A Minimum Kinematic Distance Estimate to the Non-Thermal Source in W 51 Based on OH Absorption Line Measurements", Astron. Astrophys. **25,** 329 (1973).

[73AP] W. J. Wilson and K. W. Riegel, "The New Main-Line OH/IR Stars", Astron. Astrophys. **22,** 473 (1973).

[73AQ] J. E. Wink, W. J. Altenhoff, and W. J. Webster, Jr., "Interferometer Observations of W3(OH) at 2.695 GHz and 8.085 GHz", Astron. Astrophys. **22,** 251 (1973).

[73AR] A. Winnberg, W. M. Goss, B. Höglund, and L. E. B. Johansson, "New OH Sources Discovered at 1612 MHz", Astrophys. Lett. **13,** 125 (1973).

[73AS] A. Winnberg, H. J. Habing, and W. M. Goss, "Compact Radio Source Associated With the OH Source ON-1 (OH69.5–1.0)", Nature, Phys. Sci. **243,** 78 (1973).

[74J] M. Allen, D. A. Cesarsky and R. M. Crutcher, "A Search for OD in the Galactic Center", Astrophys. J. **188,** 33 (1974).

[74K] C. Andersson, L. E. B. Johansson, W. M. Goss, A. Winnberg, and N.-Q. Rieu, "OH 26.5 + 0.6—a Strong OH Source at 1612 MHz", Astron. Astrophys. **30,** 475 (1974).

[74L] A. Baudry, "The $^2\Pi_{1/2}$, J = 1/2 State of OH, and the Infrared Stars Associated With H_2O/OH Microwave Emission", Astron. Astrophys. **32,** 191 (1974).

[74M] A. Baudry, "Observations of the Excited Lines of OH at a Wavelength of 6.3 cm", Astron. Astrophys. **33,** 381 (1974).

[74N] P. F. Bowers, S. C. Simonson, III, and F. J. Kerr, "Initial Results of an OH Sky Survey at 1612 MHz", Bull. Amer. Astron. Soc. **6,** 426 (1974).

[74O] V. V. Burdjuzha, "The Cause of the Maximum Intensity of the 1665-MHz Radio Line in the OH Maser Sources Associated with H II Regions", Astrophys. Lett. **15,** 189 (1974).

[74P] V. V. Burdyuzha and T. V. Ruzmajkina, "A Possible Mechanism of the Formation of Maser OH and H_2O Sources Associated With Compact H II Zones", Astron. Zhurn. Akad. Nauk. SSSR, **51,** 346 (1974), Sov. Astron. **18** (1974).

[74Q] V. V. Burdyuzha and S. Ya Umanskii, "Chemical and Collisional Pumping of an Interstellar OH Maser", Astron. Zhurn. Akad. Nauk. SSSR **51,** 669 (1974), Sov. Astron. **18,** 394 (1974).

[74R] J. L. Caswell and B. J. Robinson, "A 1667 MHz OH Absorption Survey of the Southern Milky Way", Aust. J. Phys. **27,** 597 (1974).

[74S] J. L. Caswell and B. J. Robinson, "Positions and 1665 MHz Line Profiles for 10 Northern OH Emission Sources", Aust. J. Phys. **27,** 629 (1974).

[74T] E. J. Chaisson, "A Correlation Study of Carbon Ions and Hydroxyl Molecules Toward Galactic Nebulae", Astron. J. **79,** 555 (1974).

[74U] H. R. Dickel and J. V. Wall, "The OH Absorption Against the Carina Nebula", Astron. Astrophys. **31,** 5 (1974).

[74V] D. F. Dickinson and E. J. Chaisson, "An OH Survey of the Hoffman 100-μ Sources", Astron. J. **79,** 938 (1974).

[74W] W. M. Goss, A. Winnberg, and H. J. Habing, "Detection of NML Cygnus at 2.8 cm", Astron. & Astrophys. **30,** 349 (1974).

[74X] H. J. Habing, W. M. Goss, H. E. Matthews, and A. Winnberg, "Identification of Type I OH Masers With Very Small H II Regions", Astron. Astrophys. **35,** 1 (1974).

[74Y] S. Harris, "5 GHz Observations of Six OH Objects", Mon. Not. Roy. Astron. Soc. **166,** 29P (1974).

[74Z] P. J. Harvey, R. S. Booth, R. D. Davies, D. C. B. Whittet, and W. McLaughlin, "Interferometric Observations of the Structure of Main-Line OH Sources", Mon. Not. Roy. Astron. Soc. **169,** 545 (1974).

[74AA] B. Höglund and C. Andersson, "Formaldehyde and OH Observations in the Direction of H I 21-cm Self-Absorption Features", Astron. Astrophys. **33,** 389 (1974).

[74AB] V. A. Hughes and M. R. Viner, "W3(OH)", J. Roy. Astron. Soc. Canada **68,** 266 (1974).

[74AC] L. E. B. Johansson, B. Höglund, A. Winnberg, N.-Q. Rieu, and W. M. Goss, "OH Observations Near the Reflection Nebulae NGC 2068 and NGC 2071", Astrophys. J. **189,** 455 (1974).

[74AD] D. A. Keeley, "The Saturation Behavior of Nonuniformly Pumped Masers", Astrophys. J. **192,** 601 (1974).

[74AE] W. H. Kegel, "Can OH-Sources Be Chemical Masers?", Astron. Astrophys. **32,** 227 (1974).

[74AF] F. J. Kerr and P. F. Bowers, "New OH Sources at 1612 MHz", Astron. Astrophys. **36,** 225 (1974).

[74AG] E. E. Lekht, "Absorption of Maser Emission of W 75S in a Hydroxyl Cloud", Astron. Zhurn. Akad. Nauk. SSSR, **51,** 1113 (1974), Sov. Astron. **18,** 657 (1975).

[74AH] E. E. Lekht, G. A. Aitova, and G. M. Rudnitskii, "OH Absorption in the Galactic Centre Direction", Astron. Zhurn. Akad. Nauk. SSSR **51,** 681 (1974), Sov. Astron. **18,** 403 (1975).

[74AI] J. R. D. Lépine and N.-Q. Rieu, "OH Emission Associated With Early-Type Stars", Astron. Astrophys. **36,** 469 (1974).

[74AJ] M. M. Litvak, "Coherent Molecular Radiation", Ann. Rev. Astron. Astrophys. **12,** 97 (1974).

[74AK] M. R. W. Masheder, R. S. Booth, and R. D. Davies, "The Structure of Four 1612 MHz OH Emission Sources", Mon. Not. Roy. Astron. Soc. **166,** 561 (1974).

[74AL] M. I. Pashchenko and V. I. Slysh, "A Map of the OH

Absorption in the Direction of W 28", Astron. Astrophys. **35,** 153 (1974).

[74AM] S. A. Pustil'nik, "On the Nature of OH Sources Near Supernova Remnants", Astrofiz. Issled. Izv. Spets. Astrofiz. Obs. **6,** 16 (1974).

[74AN] B. J. Robinson, J. L. Caswell, and W. M. Goss, "18-cm Observations of 19 New Southern OH Emission Sources", Aust. J. Phys. **27,** 575 (1974).

[74AO] R. Sancisi, W. M. Goss, C. Anderson, L. E. B. Johansson, and A. Winnberg, "OH and HI Observations of the Perseus OB 2 Dust Cloud", Astron. Astrophys. **35,** 445 (1974).

[74AP] V. I. Slysh, "OH Absorption in the Direction of W51. I. Observations", Astron. Zhurn. Akad. Nauk. SSSR. 51, 470 (1974), Sov. Astr. 18, 278 (1974).

[74AQ] V. I. Slysh, "OH Absorption in the Radio Source W51. II. Distribution of Absorbing Gas", Astron. Zhurn. Akad. Nauk. SSSR, **51,** 685 (1974), Sov. Astron. **18,** 405 (1975).

[74AR] V. I. Slysh, "OH Absorption in the Source W22", Astron. Zhurn. Akad. Nauk. SSSR, **51,** 912 (1974), Sov. Astron. **18,** 537 (1975).

[74AS] D. ter Haar and M. A. Pelling, "Interstellar Hydroxyl and Water Masers and Formaldehyde Masers and Dasars", Rep. Prog. Phys. **37,** 481 (1974).

[74AT] B. E. Turner,"Detection of OH at 18-cm Wavelength in Comet Kohoutek", Astrophys. J. **189,** L137 (1974).

[74AU] B. E. Turner and C. E. Heiles, "On the Relationship of OH and Formaldehyde With Interstellar Extinction", Astrophys. J. **194,** 525 (1974).

[74AV] J. B. Whiteoak and F. F. Gardner, "Observations of OH in NGC 4945 and NGC 253", Astrophys. Lett. **15,** 211 (1974).

[74AW] D. A. Williams, "Hydroxyl and Formaldehyde Production in the Interstellar Clouds Observed by Davies and Matthews", Observatory, **94,** 66 (1974).

[74AX] C. G. Wynn-Williams, M. W. Werner, and W. J. Wilson, "Accurate Positions of OH Sources", Astrophys. J. **187,** 41 (1974).

[74AY] B. Zuckerman and P. Palmer, "Radio Radiation From Interstellar Molecules", Ann. Rev. Astron. Astrophys. **12,** 279 (1974).

[75I] B. Baud, H. J. Habing, H. E. Matthews, J. D. O'Sullivan, and A. Winnberg, "A Very High Velocity 1,612-MHz OH Source Near the Galactic Centre", Nature **258,** 406 (1975).

[75J] P. F. Bowers, "The Galactic Distribution and Kinematics of OH Stars (A Preliminary Discussion)", Proc. Astron. Soc. Australia **2,** 362 (1975).

[75K] P. F. Bowers, "On the Light Curves of OH—Mira Variables", Astron. Astrophys. **39,** 473 (1975).

[75L] P. F. Bowers, "1612-MHz Survey of M Supergiants", Astron. J. **80,** 512 (1975).

[75M] V. V. Burdjuzha and T. V. Ruzmaikina, "On the Nature of Maser Sources in Infrared Stars", Astron. Astrophys. **40,** 233 (1975).

[75N] J. Caswell and R. Haynes,"New 1612 MHz OH Emission Sources", Mon. Not. Roy. Astron. Soc. **173,** 649 (1975).

[75O] B. T. Cato, B. O. Ronnang, P. T. Lewin, O. E. H. Rydbeck, K. S. Yngvesson, A. G. Cardiasmenos, and J. F. Shanley, "Maser Radiometer Observations of Water Vapor Emission From H II Regions and IR Stars", Res. Lab. Electronics, Onsala Space Obs., Chalmers Univ. Techn., Gothenburg, Sweden, Res. Rep. #123 (1975).

[75P] E. J. Chaisson and R. F. Wilson, "A Microwave Investigation of the Trifid Nebula and Its Surrounding Environment", Astrophys. J. **199,** 647 (1975).

[75Q] A. H. Cook, "On the Structure of Hydroxyl Maser Sources", Mon. Not. Roy. Astron. Soc. **171,** 605 (1975).

[75R] D. R. Crosley and R. K. Lengel, "Relative Transition Probabilities and the Electronic Transition Moment in the Z–X System of OH", J. Quant. Spect. Rad. Trans. **15,** 579 (1975).

[75S] J. Crovisier, R. Fillit, I. Kazes, and A. Baudry, "HI and OH Observations Toward W3", Astron. Astrophys. **45,** 97 (1975).

[75T] R. M. Crutcher, N. J. Evans, II, T. Troland, and C. Heiles, "OH Zeeman Observations of Interstellar Dust Clouds", Astrophys. J. **198,** 91 (1975).

[75U] D. Downes, A. Winnberg, W. M. Goss, and L. E. B. Johansson, "Radio Sources Near Reflection Nebulae in Monoceros", Astron. Astrophys. **44,** 243 (1975).

[75V] M. Elitzur, P. Goldreich, and N. Scoville, "A Model for the 1612 MHz Masers in OH-IR Stars", Report 1974-13, Owens Valley Radio Observatory, Pasadena, California (1975).

[75W] F. Gardner and J. Whiteoak, "The Groundstate OH Spectrum of the Galaxy NGC 253", Mon. Not. Roy. Astron. Soc. **173,** 77P (1975).

[75X] F. F. Gardner and J. B. Whiteoak, "G0.55–0.85, an H II Region-Molecular Cloud Complex". Mon. Not. Roy. Astron. Soc. **171,** 29P (1975).

[75Y] P. T. Giguere and F. O. Clark, "Radio Search for HC_3N, HCN, OH, and Detection of U8.19 in Comet Kohoutek", Astrophys. J. **198,** 761 (1975).

[75Z] A. G. Gorshkov, M. G. Larionov, and M. V. Popov, "Apparent Distribution of Radio Sources", Pis'ma v Astron. Zhurn. **1,** 19 (1975).

[75AA] W. M. Goss, I. A. Lockhart, and E. B. Fomalont, "An Improved 1665 MHz Position for W3 (OH)", Astron. Astrophys. **40,** 439 (1975).

[75AB] C. Heiles and M. A. Gordon, "A Comparative Study of H_2CO, OH, and H I in the Dark Taurus Dust Cloud", Astrophys. J. **199,** 361 (1975).

[75AC] V. A. Hughes and M. R. Viner, "The Companion Object to W3(OH)", Mon. Not. Roy. Astron. Soc. **173,** 73P (1975).

[75AD] R. M. Humphreys, "On the Distances and Velocities of M Supergiants Associated with OH and H_2O Emission Sources", Publ. Astron. Soc. Pacific **87,** 433 (1975).

[75AE] B. Huron and F. Tran Minh,"On OH Formation in Collision Between H and O^-", Astron. Astrophys. **38,** 165 (1975).

[75AF] W. H. Kegel, "On the Influence of Dust on the Effectiveness of OH Maser Sources", Astron. Astrophys. **44,** 95 (1975).

[75AG] E. E. Lekht, "Absorption of Maser Radiation of W75S in the Hydroxyl Cloud", Sov. Astron. Zh. **18,** 657 (1975).

[75AH] E. E. Lekht, G. A. Aitova, and G. M. Rudnitskii, "OH Absorption in the Direction of the Galactic Center", Sov. Astron. AJ (USA) **18,** 403 (1975).

[75AI] E. E. Lekht, G. M. Rudnitskii, O. Franquelio, and J.-P. Drouhin, "Statistical Properties of the Emission of OH Maser Sources", Sov. Astron. Lett. **1,** 37 (1975).

[75AJ] E. E. Lekht, G. M. Rudnitskii, O. Franquelin, and J.-P Drouhin, "Study of Statistical Properties of Emission of OH Maser Sources", Pis'ma v Astron. Zhurn **1,** 29 (1975).

[75AK] K. Y. Lo, R. C. Walker, B. F. Burke, J. M. Moran, K. J. Johnston, and M. S. Ewing, "Evidence for Zeeman Splitting in 1720-MHz OH Line Emission", Astrophys. J. **202,** 650 (1975).

[75AL] G. L. Mader, K. J. Johnston, and J. M. Moran, "The Relative Positions of the OH and H_2O Masers in W49N, W3(OH), and W51", Bull. Amer. Astron. Soc. **7,** 417 (1975).

[75AM] G. L. Mader, K. J. Johnston, J. M. Moran, S. H. Knowles, S. A. Mango, P. R. Schwartz, and W. B. Waltman,"The Relative Positions of the OH and H_2O Masers in W49N and W3(OH)", Astrophys. J. **200,** L111 (1975).

[75AO] M. I. Pashchenko, "New OH-Emission Source W33C", Astron. Tsirk, #885 (1975).

[75AP] M. I. Pashchenko, "Observations of the OH Source in W 44 at 18 cm Wavelength", Pis'ma v Astron. Zhurn. **1,** 23 (1975).

[75AQ] M. J. Reid and D. O. Muhleman, "VLBI Observations of OH/IR Stars", Report 1974-14, Owens Valley Radio Observatory, Pasadena, California.

[75AR] L. J. Rickard, B. Zuckerman, and P. Palmer, "Observations of Quasi-Thermal and Maser Phenomena in Rotationally Excited OH I", Astrophys. J. **200,** 6 (1975).

[75AS] V. I. Slysh,"Investigation of OH Absorption in the Trifid Nebula (M20)", Pis'ma v Astron. Zhurn. **1,** 12 (1975).

[75AT] V. I. Slysh, "OH Radio Absorption in the Trifio Nebula M20", Sov. Astron. Lett. **1,** 161 (1975).

[75AU] V. I. Slysh, "Spatial Distribution of OH Absorption in the Source NGC 6334", Astron. Zhurn. Akad. Nauk. SSSR **52,** 26 (1975); Sov. Astron. **19,** 14 (1975).

[75AV] D. A. Varshalovich and V. V. Burdyuzha, "Polarization of Cosmic OH Maser Emission", Astron. Zhurn. Akad. Nauk. SSSR **52,** 1178 (1975).

[75AW] J. B. Whiteoak and F. F. Gardner, "Anomalies in the 18 cm OH Lines in the Galaxy NGC 4945", Astrophys. J. **195,** L81 (1975).

[75AX] J. B. Whiteoak and F. F. Gardner, "A Narrow Emission Line Near 1720 MHz in the Direction of Sgr. A", Mon. Not. Roy. Astron. Soc. **173,** 25P (1975).

[75AY] A. Winnberg, N.-Q. Rieu, L. E. B. Johansson, and W. M. Goss, "Positions of OH Sources Discovered at 1612 MHz", Astron. Astrophys. **38,** 145 (1975).

[75AZ] K. S. Yngvesson, A. G. Cardiasmenos, J. F. Shanley, O. E. H. Rydbeck, and J. Ellder, "Maser Radiometer Observations of Water Vapor and OH in Weak Galactic OH Sources", Astrophys. J. **195,** 91 (1975).

[76I] M. Bertojo, A. C. Cheung, and C. H. Townes, "Collisional Excitation of Lambda Doublet Transitions in CH and OH", Astrophys. J. **208,** 914 (1976).

[76J] J. H. Bieging, "Aperture Synthesis of 1667 MHz OH Absorption in the Direction of the Galactic Center", Astron. Astrophys. **51,** 289 (1976).

[76K] R. J. Cohen and R. W. Few, "Observations of OH in the Galactic Center", Mon. Not. Roy. Astron. Soc. **176,** 495 (1976).

[76L] R. M. Crutcher and W. D. Watson, "Detection of Significance of the Interstellar OH Line, Lambda 3078", Astrophys. J. **203,** L123 (1976).

[76M] M. Elitzur, "Inversion of the OH 1720 MHz Line", Astrophys. J. **203,** 124 (1976).

[76N] M. Elitzur, P. Goldreich, and N. Scoville, "OH-IR Stars, Part II, A Model for the 1612 MHz Masers", Astrophys. J. **205,** 384 (1976).

[76O] N. J. Evans, II, R. M. Crutcher, and W. J. Wilson, "Accurate Positions of OH Emission Sources", Astrophys. J. **206,** 440 (1976).

[76P] W. M. Goss, A Winnberg, L. E. Johansson, and A. Fournier, "OH Observations of the Dust Complex Lynds 1630 and of NGC 2024", Astron. Astrophys. **46,** 1 (1976).

[76Q] G. M. Gruder and G. de Jager, "Time Variations in OH Emission of NGC 7538", Astron. Astrophys. **50,** 313 (1976).

[76S] R. H. Harten, "Observations of W3(OH) (G133.9+1)", Astron. Astrophys. **46,** 109 (1976).

[76T] J. A. Hughes and M. R. Viner, "Recombination-Line Observations of W3-OH. Part I—A Model for OH + H_2O Emission", Astrophys. J. **204,** 55 (1976).

[76U] G. R. Knapp and R. L. Brown, "OH and H_2O Masers in the Monoceros R2 Molecular Cloud", Astrophys. J. **204,** 21 (1976).

[76V] S. H. Knowles, J. L. Caswell, and W. M. Goss, "Excited OH Radiation from the $^2\Pi_{3/2}, J = 5/2$ State in Southern H II Regions", Mon. Not. Roy. Astron. Soc. **175,** 537 (1976).

[76X] M. I. Paschenko, "Observations of the OH Source in W44 at 18 cm", Sov. Astr. Lett. **1,** 24 (1976).

[76Z] N.-Q. Rieu, A. Winnberg, J. Guibert, J. R. D. Lepine, L. E. B. Johansson, and W. M. Goss, "OH Radiation from the Interstellar Cloud Medium", Astron. Astrophys. **46,** 413 (1976), (Erratum: Astron. Astrophys. **49,** 157 (1976).

[76AB] W. H. Smith and E. G. Zweibel, "Radiative Processes Affecting the Abundance of Interstellar OH", Astrophys. J. **207,** 758 (1976).

[76A] T. P. Snow, "The Detection of Interstellar OH Absorption in the Zeta-Ophiuchi Cloud", Astrophys. J. **204,** L127 (1976).

[76AC] L. E. Snyder, J. C. Webber, R. M. Crutcher, and G. W. Swenson, Jr., "Radio Observations of OH in Comet West 1975N", Astrophys. J. **209,** L49 (1976).

[76AD] W. T. Sullivan, III and J. H. Kerstholt, "Time Variations in 18-cm OH Emission Profiles Over the Period 1965–1972", Astron. Astrophys. **51,** 427 (1976).

[76AE] D. A. Varshalovich and V. V. Elroyuzha, "Polarization of Cosmic OH Masers", Sov. Astron. **19,** 705 (1976).

[76AF] J. B. Whiteoak and F. F. Gardner, "The Detection of OH in the Large Magellanic Cloud", Mon. Not. Roy. Astron. Soc. **176,** 25P (1976).

[76AG] J. B. Whiteoak and F. F. Gardner, "OH Anomalies in the Direction of the Galactic Center", Mon. Not. Roy. Astron. Soc. **174,** 627 (1976).