THE ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 41:451–480, 1979 November

RECOMMENDED REST FREQUENCIES FOR OBSERVED INTERSTELLAR MOLECULAR TRANSITIONS

F. J. LOVAS
National Bureau of Standards, Washington
L. E. SNYDER
University of Illinois, Urbana
AND
D. R. JOHNSON
National Bureau of Standards, Washington
Received 1979 February 23; accepted 1979 April 5

ABSTRACT

The most accurate values presently available for the rest frequencies of all known interstellar molecular transitions are presented and recommended for reference in future astronomical observations in the radio and microwave regions. The recommended values have been carefully selected after critical evaluation of the spectroscopic literature. Probable error limits along with the proper molecular and quantum mechanical labels are presented for each observed transition. Representative line antenna temperatures are also presented for a typical source as a convenience to users. References are cited to both the astronomical and the laboratory literature.

Subject headings: interstellar: molecules — line identifications — radio sources: lines

I. INTRODUCTION

Modern radio astronomical techniques allow the detection of molecular rotational and hyperfine transitions from a very large number of stellar and interstellar sources. Forty-six molecular species have been identified and reported in the literature during the past 10 years. Detailed information on the Doppler shifts, line shapes, column densities, and cloud temperatures now makes it possible to begin to correlate the chemistry of these sources. Molecular signals are also now widely used as probes of the overall dynamics of dust clouds to yield detailed information on the kinematic processes.

The present tabulation was stimulated by the obvious need to consolidate the growing body of literature on molecular line observations with respect to rest frequencies used for reference. The primary objective of the present effort is to provide a single list of the most accurate transition frequencies available for the molecular lines already observed and documented in the astronomy literature. It is hoped that the availability of this single easily accessible compilation will reduce the incidence of observations referenced to transition frequencies derived from poorly documented sources with unknown uncertainties. Such practices clearly should be discouraged since they lead to inaccurate or anomalous molecular cloud velocity determinations and cause difficulties in correlating observations of different species in the same molecular cloud. In order to increase the utility of the present tables, we have also included the observed antenna temperature (T_A), or T_A* when available, for a typical source and telescope combination. The values for the antenna temperature are cited directly from the original literature for the convenience of the user only and by no means should be taken as recommended values. The user is urged to consult the original literature for the definition of temperatures quoted. Both the laboratory and the astronomical literature references are listed for each of the lines tabulated, covering observations reported through 1978 October. A more detailed description of the tables and their content follows in the next section.

II. DESCRIPTION OF THE TABLES

At this writing the detection of 46 interstellar molecules in the microwave frequency region has been reported. In Table 1 the molecular formulae and common names are listed for each species. In several cases, where more than one common or trivial name is used, alternative names are listed. Table 2 is a comprehensive list of all interstellar molecular transitions reported in the microwave spectral region. The transitions are listed according to increasing frequency in column (1). Columns (2) and (3) contain the molecular formula and quantum number designations for the states involved in the transition. The frequencies shown were selected as the most accurate values presently available and are recommended to be employed as rest frequencies by the astronomical community. It should be noted that calculated frequencies are given when the particular transition has not been measured in the laboratory or in cases where the calculated value is more accurate than the available measurement. The numbers in parentheses are estimated uncertainties in the measurements from

TABLE 1

FORMULAE AND NAMES OF INTERSTELLAR MOLECULES

Formula	Name	Formula	Names
CH	methyladyne radical	CCCN	cyanoethynyl radical
CN	cyanogen radical	HCCCN	cyanoethyne; cyanoacetylene
CO	carbon monoxide	HCCCCCN	cyanobutadiyne, cyanodiacetylene
CS	carbon monosulfide	$H(C\equiv C)_3CN$	cyanohexatriyne; cyanotriacetylene
NO	nitric oxide	HC_9N	cyanooctatetrayne; cyanotetracetylene
NS	nitric sulfide	CH_3CN	methylcyanide; acetonitrile
OH	hydroxyl radical	CH_2CHCN	vinyl cyanide; acrylonitrile
SO	sulfur monoxide	CH_3CH_2CN	ethyl cyanide; propionitrile
SiO	silicon monoxide	CH_2NH	methylenimine
SiS	silicon monosulfide	CH_3NH_2	methylamine
HCC	ethynyl radical	NH_2CHO	formamide; methanamide
HCN	hydrogen cyanide	HC_4	butadiynyl radical
HNC	hydrogen isocyanide	CH_3CCH	methylacetylene; propyne
HNO	nitroxyl hydride	H_2CO	formaldehyde
HCO	formyl radical	H_2CCO	ketene
HCO^+	formylium	CH_3OH	methyl alcohol; methanol
HN_2^+	diazenylium	CH_3CHO	acetaldehyde
H_2O	water	CH_3CH_2OH	ethyl alcohol; ethanol
H_2S	hydrogen sulfide	CH_3OCH_3	dimethyl ether; methoxy methane
OCS	carbonyl sulfide	HNCO	isocyanic acid
SO_2	sulfur dioxide	HCOOH	formic acid; methanoic acid
NH_3	ammonia	$HCOOCH_3$	methyl formate
NH_2CN	cyanamide	H_2CS	thioformaldehyde

the literature or twice the standard deviation for calculated values. Frequencies which are calculated are denoted with an asterisk. The column labeled "laboratory reference" shows the source of the data quoted. Where two references are given, the first indicates the sources for the frequency or the review article which contains additional information, e.g., transition line strength and energy of the states involved. The second reference given is usually the original source of the laboratory data.

Columns (4)–(6) show the observed line antenna temperature, molecular cloud, and telescope used in the observation, respectively. Typically the intensity of the transition in the Orion or Sagittarius molecular clouds are cited; however, the intensities obtained from other molecular clouds are listed if these appeared to be more representative. For example, the hyperfine structure for many of the lines has only been resolved in cold dark clouds such as L134 or the Taurus Molecular Cloud, which exhibit quite narrow velocity profiles. The underlined astronomical references refer to the original detection of the molecular species since these papers often provide useful background information which is not contained in subsequent studies. When a second reference is listed, it generally refers to the source from which the T_A values were taken. No attempt was made to evaluate the accuracy of the T_A or T_A* values given. The signs preceding the cited intensities indicate emission (+) or absorption (−). Since calibration techniques and accuracy vary from one telescope to another and have changed with time, we felt it necessary to identify the telescope. Abbreviations employed here are defined in Table 3.

This work was partially supported by the NBS Office of Standard Reference Data. The authors are grateful to many astronomers and spectroscopists for their encouragement in carrying out this work and assistance in eliminating errors in earlier drafts of the manuscript. L. E. S. received partial financial support for this work from NSF grant AST 77-01345 to the University of Illinois.

TABLE 2
Recommended Rest Frequencies for Observed Interstellar Molecular Lines

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
0.834 267(2)	CH_3OH	1_1-1_1 A	+0.58	Sgr A	NRAO 140 ft	Lees et al. (1973) Radford (1972)	Ball et al. (1970)
1.065 075(5)	CH_3CHO	$1_{10}-1_{11}$ A	+0.3	Sgr A	NRAO 140 ft	Bauder et al. (1976) Gottlieb (1973)	Gottlieb (1973)
1.371 709(2)*	CH_2CHCN	$2_{11}-2_{12}$ F=1-1	+0.012	Sgr B2	Parkes 64 m	Gardner and Winnewisser (1975a)	Gardner and Winnewisser (1975a)
1.371 794(2)*	CH_2CHCN	$2_{11}-2_{12}$ F=3-3	+0.034	Sgr B2	Parkes 64 m	Gardner and Winnewisser (1975a)	Gardner and Winnewisser (1975a)
1.371 947(2)*	CH_2CHCN	$2_{11}-2_{12}$ F=2-2	+0.019	Sgr B2	Parkes 64 m	Gardner and Winnewisser (1975a)	Gardner and Winnewisser (1975a)
1.538 135(20)	NH_2CHO	$1_{10}-1_{11}$ F=1-1	+0.08	Sgr B2	NRAO 140 ft	Johnson et al. (1972) Gottlieb and Radford (1971)	Gottlieb et al. (1973a)
1.538 693(20)	NH_2CHO	$1_{10}-1_{11}$ F=1-2	+0.09	Sgr B2	NRAO 140 ft	Johnson et al. (1972) Gottlieb and Radford (1971)	Gottlieb et al. (1973a)
1.539 295(20)	NH_2CHO	$1_{10}-1_{11}$ F=2-1	+0.10	Sgr B2	NRAO 140 ft	Johnson et al. (1972) Gottlieb and Radford (1971)	Gottlieb et al. (1973a)
1.539 570(50)	NH_2CHO	$1_{10}-1_{11}$ F=1-0	+0.08	Sgr B2	NRAO 140 ft	Johnson et al. (1972) Gottlieb and Radford (1971)	Gottlieb et al. (1973a)
1.539 851(20)	NH_2CHO	$1_{10}-1_{11}$ F=2-2	+0.36	Sgr B2	NRAO 140 ft	Johnson et al. (1972) Gottlieb and Radford (1971)	Gottlieb et al. (1973a)
1.541 018(20)	NH_2CHO	$1_{10}-1_{11}$ F=0-1	+0.10	Sgr B2	NRAO 140 ft	Johnson et al. (1972) Gottlieb and Radford (1971)	Gottlieb et al. (1973a)
1.610 249(3)	$HCOOCH_3$	$1_{10}-1_{11}$ A	+0.042	Sgr B2	MPI 100 m	Brown et al. (1975)	Brown et al. (1975) Churchwell and Winnewisser (1975)
1.610 906(3)	$HCOOCH_3$	$1_{10}-1_{11}$ E	+0.061	Sgr B2	MPI 100 m	Brown et al. (1975)	Brown et al. (1975) Churchwell and Winnewisser (1975)
1.612 2310(2)	OH	$^2\Pi_{3/2}$ J=3/2 F=1-2	-0.80	Ori B(W12)	NRAO 140 ft	ter Meulen and Dymanus (1972)	Manchester and Gordon (1971)
1.624 518(10)	^{17}OH	$^2\Pi_{3/2}$ J=3/2 F,F_1=7/2,4-7/2,4	-0.045	Sgr A	Parkes 64 m	Beaudet and Poynter (1978) Gottlieb et al. (1974)	Gardner and Whiteoak (1976)
1.626 161(10)	^{17}OH	$^2\Pi_{3/2}$ J=3/2 F,F_1=9/2,4-9/2,4	-0.056	Sgr A	Parkes 64 m	Beaudet and Poynter (1978) Gottlieb et al. (1974)	Gardner and Whiteoak (1976)
1.637 564(2)	^{18}OH	$^2\Pi_{3/2}$ J=3/2 F=1-1	-0.2	Sgr A	Parkes 64 m	Lovas and Tiemann (1974) Gottlieb et al. (1973a)	Gardner et al. (1970) Wilson and Barrett (1970)
1.638 805(3)	HCOOH	$1_{10}-1_{11}$	+0.04	Sgr B2	NRAO 140 ft	Zuckerman et al. (1971)	Zuckerman et al. (1971)
1.639 503(2)	^{18}OH	$^2\Pi_{3/2}$ J=3/2 F=2-2	-0.5	Sgr A	Parkes 64 m	Lovas and Tiemann (1974) Gottlieb et al. (1973a)	Rogers and Barrett (1966) Gardner et al. (1970) Wilson and Barrett (1970)
1.665 4018(1)	OH	$^2\Pi_{3/2}$ J=3/2 F=1-1	-5.15	Ori B(W12)	NRAO 140 ft	ter Meulen and Dymanus (1972)	Weinreb et al. (1963) Manchester and Gordon (1971)
1.667 3590(1)	OH	$^2\Pi_{3/2}$ J=3/2 F=2-2	-6.30	Ori B(W12)	NRAO 140 ft	ter Meulen and Dymanus (1972)	Weinreb et al. (1963) Manchester and Gordon (1971)
1.720 5300(1)	OH	$^2\Pi_{3/2}$ J=3/2 F=2-1	-1.10	Ori B(W12)	NRAO 140 ft	ter Meulen and Dymanus (1972)	Weinreb et al. (1963) Manchester and Gordon (1971)
2.661 61(5)*	HCCCCCN	J=1-0 F=1-1	+0.020	Sgr B2	Parkes 64 m	Broten et al. (1976)	Broten et al. (1976)
2.662 87(5)*	HCCCCCN	J=1-0 F=2-1	+0.036	Sgr B2	Parkes 64 m	Broten et al. (1976)	Broten et al. (1976)
2.664 76(5)*	HCCCCCN	J=1-0 F=0-1	+0.023	Sgr B2	Parkes 64 m	Broten et al. (1976)	Broten et al. (1976)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
3.195 167(10)	CH_3CHO	$2_{11}-2_{12}$ A	+0.2	Sgr B2	Parkes 64 m	Bauder et al. (1976) Fourikis et al. (1974a)	Fourikis et al. (1974a)
3.263 794(3)	CH	$^2\Pi_{1/2}$ J=1/2 F=0-1	+0.24	Cas A	OSO 25.6 m	Rydbeck et al. (1974)	Rydbeck et al. (1976) Zuckerman and Turner (1975)
3.335 481(2)	CH	$^2\Pi_{1/2}$ J=1/2 F=1-1	+0.25	Cas A	OSO 25.6 m	Rydbeck et al. (1974)	Rydbeck et al. (1976) Zuckerman and Turner (1975)
3.349 193(3)	CH	$^2\Pi_{1/2}$ J=1/2 F=1-0	+0.18	Cas A	OSO 25.6 m	Rydbeck et al. (1974)	Rydbeck et al. (1976) Zuckerman and Turner (1975)
4.388 7786(3)	$H_2C^{18}O$	$1_{10}-1_{11}$ F=1-0					
4.388 7960(4)*	$H_2C^{18}O$	$1_{10}-1_{11}$ F=0-1					
4.388 7963(2)	$H_2C^{18}O$	$1_{10}-1_{11}$ F=2-2	n.r.(abs.)[b,c]	Sgr B2	Parkes 64 m	Johnson et al. (1972) Tucker et al. (1971)	Gardner et al. (1971a)
4.388 8011(2)	$H_2C^{18}O$	$1_{10}-1_{11}$ F=2-1					
4.388 8035(3)	$H_2C^{18}O$	$1_{10}-1_{11}$ F=1-2					
4.388 8084(3)	$H_2C^{18}O$	$1_{10}-1_{11}$ F=1-1					
4.592 9563(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=1/2,1/2-1/2,3/2					
4.592 9738(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=1/2,1/2-3/2,3/2					
4.592 9759(3)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,1/2-1/2,3/2	-0.1	W33	MPI 100 m	Johnson et al. (1972) Tucker et al. (1971)	Zuckerman et al. (1969) Wilson et al. (1976b)
4.592 9857(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,1/2-5/2,3/2					
4.592 9934(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,1/2-3/2,3/2					
4.593 0494(2)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=1/2,1/2-1/2,1/2					
4.593 0690(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,1/2-1/2,1/2					
4.593 0800(3)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=1/2,1/2-3/2,1/2					
4.593 0812(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=1/2,3/2-1/2,3/2					
4.593 0864(3)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,3/2-1/2,3/2					
4.593 08654(5)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=5/2,3/2-5/2,3/2	-0.55	W33	MPI 100 m	Johnson et al. (1972) Tucker et al. (1971)	Zuckerman et al. (1969) Wilson et al. (1976b)
4.593 0942(2)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=5/2,3/2-3/2,3/2					
4.593 0961(2)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,3/2-5/2,3/2					
4.593 0985(2)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=1/2,3/2-3/2,3/2					
4.593 0994(3)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,1/2-3/2,1/2					
4.593 1039(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F_1=3/2,3/2-3/2,3/2					

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
4.593 1741(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F$_1$=1/2,3/2-1/2,1/2					
4.593 1795(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F$_1$=3/2,3/2-1/2,1/2					
4.593 2003(1)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F$_1$=5/2,3/2-3/2,1/2	-0.1	W33	MPI 100 m	Johnson et al. (1972) Tucker et al. (1971)	Zuckerman et al. (1969) Wilson et al. (1976b)
4.593 2046(3)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F$_1$=1/2,3/2-3/2,1/2					
4.593 2099(2)	$H_2{}^{13}CO$	$1_{10}-1_{11}$ F,F$_1$=3/2,3/2-3/2,1/2					
4.617 126(12)*	NH_2CHO	$2_{11}-2_{12}$ F=2-2	+0.07	Sgr B2	NRAO 140 ft	Johnson et al. (1972)	Rubin et al. (1971) Ribes et al. (1973)
4.618 966(3)*	NH_2CHO	$2_{11}-2_{12}$ F=3-3	+0.30[d]	Sgr B2	NRAO 140 ft	Johnson et al. (1972)	Rubin et al. (1971) Ribes et al. (1973)
4.619 988(12)*	NH_2CHO	$2_{11}-2_{12}$ F=1-1	~ +0.05	Sgr B2	NRAO 140 ft	Johnson et al. (1972)	Rubin et al. (1971) Ribes et al. (1973)
4.660 242(3)	OH	$^2\Pi_{1/2}$ J=1/2 F=0-1	+0.3	Sgr B2	Parkes 64 m	Radford (1968)	Thacker et al. (1970) Gardner et al. (1971b)
4.750 656(3)	OH	$^2\Pi_{1/2}$ J=1/2 F=1-1	0.3 f.u.[e]	Sgr B2	Parkes 64 m	Radford (1968)	Gardner and Ribes (1971)
4.765 562(3)	OH	$^2\Pi_{1/2}$ J=1/2 F=1-0	+1.7	W3	NRAO 140 ft	Radford (1968)	Zuckerman et al. (1968)
4.829 6412(2)	H_2CO	$1_{10}-1_{11}$ F=1-0	-0.2	Cloud 2	NRAO 140 ft	Johnson et al. (1972) Kukolich (1975)	Snyder et al. (1969) Palmer et al. (1969)
4.829 6587(2)	H_2CO	$1_{10}-1_{11}$ F=0-1					
4.829 6594(2)	H_2CO	$1_{10}-1_{11}$ F=2-2					
4.829 6639(2)	H_2CO	$1_{10}-1_{11}$ F=2-1	-0.8	Cloud 2	NRAO 140 ft	Johnson et al. (1972) Kukolich (1975)	Snyder et al. (1969)
4.829 6664(2)	H_2CO	$1_{10}-1_{11}$ F=1-2					
4.829 6710(2)	H_2CO	$1_{10}-1_{11}$ F=1-1					
4.916 312(8)*	HCOOH	$2_{11}-2_{12}$	+0.04	Sgr B2	MPI 100 m	Winnewisser and Churchwell (1975)	Winnewisser and Churchwell (1975)
5.005 3208(2)*	CH_3OH	3_1-3_1 A	+0.05[d]	Sgr B2	Parkes 64 m	Lees et al. (1973) Heuvel and Dymanus (1973)	Robinson et al. (1974)
5.289 011(26)*	H_2CNH	$1_{10}-1_{11}$ F=0-1	+0.05	Sgr B2	Parkes 64 m	Kirchhoff et al. (1973)	Godfrey et al. (1973)
5.289 685(25)*	H_2CNH	$1_{10}-1_{11}$ F=1-0	+0.15	Sgr B2	Parkes 64 m	Kirchhoff et al. (1973)	Godfrey et al. (1973)
5.289 814(6)*	H_2CNH	$1_{10}-1_{11}$ F=2-2					
5.290 610(13)*	H_2CNH	$1_{10}-1_{11}$ F=2-1	+0.07	Sgr B2	Parkes 64 m	Kirchhoff et al. (1973)	Godfrey et al. (1973)
5.290 880(14)*	H_2CNH	$1_{10}-1_{11}$ F=1-2					
5.291 676(18)*	H_2CNH	$1_{10}-1_{11}$ F=1-1	+0.05	Sgr B2	Parkes 64 m	Kirchhoff et al. (1973)	Godfrey et al. (1973)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
6.016 746(8)	OH	$^2\Pi_{3/2}$ J=5/2 F=3-2	-0.12	G291.3-0.7 (RCW57)	Parkes 64 m	Radford (1968)	Whiteoak and Gardner (1976)
6.030 747(5)	OH	$^2\Pi_{3/2}$ J=5/2 F=2-2	+7	W3(OH)	NRAO 140 ft	Meerts and Dymanus (1975)	Yen et al. (1969) Zuckerman et al. (1972c)
6.035 092(5)	OH	$^2\Pi_{3/2}$ J=5/2 F=3-3	+20	W3(OH)	NRAO 140 ft	Meerts and Dymanus (1975)	Yen et al. (1969) Zuckerman et al. (1972c)
6.278 631(5)*	H_2CS	3_{12}-3_{13}	n.r.(abs)[b]	Sgr B2	ARO 46 m	Johnson et al. (1972)	Macleod and Doherty (1975)
6.389 49(48)	CH_3CHO	3_{12}-3_{13}	n.r.(em)[b]	Sgr B2	ARO 46 m	Bauder et al. (1976)	Macleod and Doherty (1975)
8.135 868(5)[f]	OH	$^2\Pi_{1/2}$ J=5/2 F=2-2	+0.13[f]	W3(OH)	NEROC 120 ft	Ball et al. (1971)	Schwartz and Barrett (1969) Ball et al. (1971)
8.188 83	unknown	unknown	+0.12	Comet Kohoutek(1973f)	NRAO 140 ft		Giguere and Clark (1975)
8.775 06(3)	CH_3NH_2	2_{02}-1_{01} F=1-0 A_a	+0.05	Sgr B2	Parkes 64 m	Fourikis et al. (1974b)	Fourikis et al. (1974b)
8.777 38(3)	CH_3NH_2	2_{02}-1_{01} F=3-2 A_a	+0.18	Sgr B2	Parkes 64 m	Fourikis et al. (1974b)	Fourikis et al. (1974b)
8.778 18(3)	CH_3NH_2	2_{02}-1_{01} F=2-2,1-1 A_a	+0.04	Sgr B2	Parkes 64 m	Fourikis et al. (1974b)	Fourikis et al. (1974b)
8.779 47(3)	CH_3NH_2	2_{02}-1_{01} F=2-1 A_a	+0.1	Sgr B2	Parkes 64 m	Fourikis et al. (1974b)	Fourikis et al. (1974b)
8.815 814(6)*	$H^{13}CCCN$	J=1-0 F=1-1	+0.039	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Churchwell et al. (1977)	Churchwell et al. (1977)
8.817 096(2)*	$H^{13}CCCN$	J=1-0 F=2-1	+0.080	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Churchwell et al. (1977)	Churchwell et al. (1977)
8.819 019(9)*	$H^{13}CCCN$	J=1-0 F=0-1	+0.025	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Churchwell et al. (1977)	Churchwell et al. (1977)
9.058 449(6)*	$HC^{13}CCN$	J=1-0 F=1-1	+0.025	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Churchwell et al. (1977)	Gardner and Winnewisser (1975b) Churchwell et al. (1977)
9.059 318(2)*	$HCC^{13}CN$	J=1-0 F=1-1	n.r.	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Creswell et al. (1977)	Gardner and Winnewisser (1975b) Churchwell et al. (1977)
9.059 736(3)*	$HC^{13}CCN$	J=1-0 F=2-1	+0.055	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Churchwell et al. (1977)	Gardner and Winnewisser (1975b) Churchwell et al. (1977)
9.060 6080(9)*	$HCC^{13}CN$	J=1-0 F=2-1	+0.05	Sgr B2	MPI 100 m	Lafferty and Lovas (1978) Creswell et al. (1977)	Gardner and Winnewisser (1975b) Churchwell et al. (1977)
9.097 0346(3)	HCCCN	J=1-0 F=1-1	+0.82	Sgr B2	MPI 100 m	de Zafra (1971)	Turner (1971) Churchwell et al. (1977)
9.098 3321(3)	HCCCN	J=1-0 F=2-1	+2.11	Sgr B2	MPI 100 m	de Zafra (1971)	Turner (1971) Churchwell et al. (1977)
9.100 2727(5)	HCCCN	J=1-0 F=0-1	+0.16	Sgr B2	MPI 100 m	de Zafra (1971)	Churchwell et al. (1977)
9.118 818(15)	CH_3OCH_3	2_{02}-1_{11} AA					
9.119 670(15)	CH_3OCH_3	2_{02}-1_{11} EE	+0.053[g]	Sgr B2	Parkes 64 m	Winnewisser and Gardner (1976) Lovas et al. (1979)	Winnewisser and Gardner (1976)
9.120 515(15)	CH_3OCH_3	2_{02}-1_{11} AE+EA					
10.152 002(6)*	$H(C{\equiv}C)_3CN$	J=9-8	+0.08	Cloud 2	ARO 46 m	Kroto et al. (1977)	Kroto et al. (1977)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
10.3	see footnote h						
10.458 634	HC_9N	J=18-17	+0.021	Cloud 2	ARO 46 m		Broten et al. (1978)
10.463 970(5)	H_2CS	4_{13}-4_{14}	-0.040	Sgr B2	ARO 46 m	Johnson et al. (1972)	Doherty et al. (1974)
10.650 643(120)*	HCCCCCN	J=4-3	+0.036	Sgr B2	ARO 46 m	Avery et al. (1976)	Avery et al. (1976)
13.043 832(8)*	SO	1,2-1,1	+0.4	Sgr B2	NRAO 140 ft	Tiemann (1974) Clark and De Lucia (1976)	Clark and Johnson (1975)
13.441 4173(2)	OH	$^2\Pi_{3/2}$ J=7/2 F=4-4	+3.2	W3(OH)	NRAO 140 ft	Destombes et al. (1977) ter Meulen et al. (1976)	Turner et al. (1970)
14.488 4589(2)	H_2CO	2_{11}-2_{12} F=1-1					
14.488 4712(2)	H_2CO	2_{11}-2_{12} F=1-2	-1.3[i]	Sgr B2	NRL 185 ft	Johnson et al. (1972) Kukolich (1975)	Evans et al (1970)
14.488 4801(2)	H_2CO	2_{11}-2_{12} F=3-3					
14.488 4899(2)	H_2CO	2_{11}-2_{12} F=2-2					
14.525 862	HC_9N	J=25-24	+0.073	Cloud 2	NRAO 140 ft		Broten et al. (1978)
14.663 986*	HC_7N	J=13-12	+0.6	TMC1	Parkes 64 m	Gardner et al. (1978)	Gardner et al. (1978)
18.194 9206(8)*	HCCCN	J=2-1 F=2-2					
18.195 3176(6)*	HCCCN	J=2-1 F=1-0					
18.196 2183(5)*	HCCCN	J=2-1 F=2-1	+0.36	Sgr B2	Parkes 64 m	Lafferty and Lovas (1978) Creswell et al. (1977)	Dickinson (1972a) McGee et al. (1977)
18.196 3119(7)*	HCCCN	J=2-1 F=3-2					
18.197 0779(11)*	HCCCN	J=2-1 F=1-2					
18.198 3756(9)*	HCCCN	J=2-1 F=1-1					
21.301 247*	HCCCCCN	J=8-7	+0.031	Sgr B2	ARO 46 m	Broten et al. (1976)	Broten et al. (1976)
21.703 3580(2)	NH_3	4,2-4,2	+0.6	Ori A	MPI 100 m	Kukolich and Wofsky (1970)	Nystrom et al. (1978)
21.980 54533(10)	HNCO	1_{01}-0_{00} F=0-1					
21.981 47055(10)	HNCO	1_{01}-0_{00} F=2-1	+0.2	Sgr B2	NRAO 36 ft	Winnewisser et al. (1976) Kukolich et al. (1971)	Buhl et al. (1972)
21.982 08535(10)	HNCO	1_{01}-0_{00} F=1-1					

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
22.235 044(5)	H_2O	$6_{16}-5_{23}$ F=7-6					
22.235 077(5)	H_2O	$6_{16}-5_{23}$ F=6-5					
22.235 120(5)	H_2O	$6_{16}-5_{23}$ F=5-4	+2000[j]	W49	NRAO 140 ft	De Lucia et al. (1974) Kukolich (1969)	Cheung et al. (1969a) Buhl et al. (1969) Moran et al. (1973)[k]
22.235 253(5)	H_2O	$6_{16}-5_{23}$ F=6-6					
22.235 298(5)	H_2O	$6_{16}-5_{23}$ F=5-5					
22.653 022(5)	NH_3	5,4-5,4	+0.6	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
22.688 312(5)	NH_3	4,3-4,3	+1.2	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
22.732 429(5)	NH_3	6,5-6,5	+0.6	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
22.834 1851(1)[l]	NH_3	3,2-3,2	+0.11	Sgr B2	NRAO 36 ft	Kukolich (1965)	Morris et al. (1973)
22.924 940(5)	NH_3	7,6-7,6	+1.0	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
23.098 8190(1)[l]	NH_3	2,1-2,1	+0.29	Sgr B2	NRAO 36 ft	Kukolich and Wofsky (1970)	Morris et al. (1973)
23.232 238(5)	NH_3	8,7-8,7	+0.2	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
23.657 471(5)	NH_3	9,8-9,8	+0.1	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
23.687 890(30)*	$H(C:C)_3CN$	J=21-20	+0.21	Cloud 2	NEROC 120 ft	Kroto et al. (1977)	Kroto et al. (1977)
23.692 9265(2)	NH_3	1,1-1,1 F,F_1=1/2,1-1/2,0	+0.16	L134N	OSO 20 m	Rydbeck et al. (1977)	Rydbeck et al. (1977) Ho et al. (1977)
23.692 9688(1)	NH_3	1,1-1,1 F,F_1=3/2,1-1/2,0	+0.24	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.693 8722(1)	NH_3	1,1-1,1 F,F_1=1/2,1-3/2,2	+0.17	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.693 9051(1)	NH_3	1,1-1,1 F,F_1=3/2,1-5/2,2	+0.30	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.693 9145(1)	NH_3	1,1-1,1 F,F_1=3/2,1-3/2,2					
23.694 4591(1)	NH_3	1,1-1,1 F,F_1=1/2,1-1/2,1					
23.694 4700(1)	NH_3	1,1-1,1 F,F_1=1/2,1-3/2,1	+0.40	L134N	OSO 20 m	Kukolich (1967)	Cheung et al. (1968) Rydbeck et al. (1977) Ho et al. (1977)
23.694 4709(1)	NH_3	1,1-1,1 F,F_1=3/2,2-5/2,2					
23.694 4803(1)	NH_3	1,1-1,1 F,F_1=3/2,2-3/2,2					

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
23.694 5014(1)	NH_3	1,1-1,1 F,F_1=3/2,1-1/2,1					
23.694 5060(1)	NH_3	1,1-1,1 F,F_1=5/2,2-5/2,2	+0.50	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.694 5123(1)	NH_3	1,1-1,1 F,F_1=3/2,1-3/2,1					
23.694 5153(1)	NH_3	1,1-1,1 F,F_1=5/2,2-3/2,2					
23.695 0672(1)	NH_3	1,1-1,1 F,F_1=3/2,2-1/2,1	+0.18	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.695 0782(1)	NH_3	1,1-1,1 F,F_1=3/2,2-3/2,1					
23.695 1132(1)	NH_3	1,1-1,1 F,F_1=5/2,2-3/2,1	+0.25	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.696 0297(2)	NH_3	1,1-1,1 F,F_1=1/2,0-1/2,1	+0.29	L134N	OSO 20 m	Kukolich (1967)	Rydbeck et al. (1977) Ho et al. (1977)
23.696 0406(2)	NH_3	1,1-1,1 F,F_1=1/2,0-3/2,1					
23.720 575(5)	NH_3	2,2-2,2,F_1=1-2					
23.721 336(5)	NH_3	2,2-2,2,F_1=3-2					
23.722 6323(5)	NH_3	2,2-2,2,F_1=2-2					
23.722 6336(1)	NH_3	2,2-2,2,F_1=3-3	+0.43[m]	Ori A	NEROC 120 ft	Kukolich (1967)	Cheung et al. (1968) Barrett et al. (1977)
23.722 6344(5)	NH_3	2,2-2,2,F_1=1-1					
23.723 929(5)	NH_3	2,2-2,2,F_1=2-3					
23.724 691(5)	NH_3	2,2-2,2,F_1=2-1					
23.817 6153(20)	OH	$^2\Pi_{3/2}$ J=9/2 F=4-4	-0.05	W3(OH)	MPI 100 m	Meerts and Dymanus (1975)	Winnberg et al. (1978)
23.826 6211(30)	OH	$^2\Pi_{3/2}$ J=9/2 F=5-5	-0.13	W3(OH)	MPI 100 m	Meerts and Dymanus (1975)	Winnberg et al. (1978)
23.867 805(5)	NH_3	3,3-3,3,F_1=2-3					
23.868 450(5)	NH_3	3,3-3,3,F_1=4-3					
23.870 1279(5)	NH_3	3,3-3,3,F_1=3-3					
23.870 1296(1)	NH_3	3,3-3,3,F_1=4-4	+0.53[m]	Ori A	NEROC 120 ft	Kukolich (1967)	Barrett et al. (1977)
23.870 1302(5)	NH_3	3,3-3,3,F_1=2-2					
23.871 807(5)	NH_3	3,3-3,3,F_1=3-4					
23.872 453(5)	NH_3	3,3-3,3,F_1=3-2					

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory References	Astronomical References
23.963 888(18)*	HCCCCCN	J=9-8	+1.2	Cloud 2	SRCAL 25 m	Alexander et al. (1976)	Little et al. (1977)
24.139 4169(1)[1]	NH_3	4,4-4,4	+0.25[m]	Ori A	NEROC 120 ft	Kukolich and Wofsky (1970)	Barrett et al. (1977)
24.205 287(5)	NH_3	10,9-10,9	+0.1	Ori A	MPI 100 m	Poynter and Kakar (1975)	Nystrom et al. (1978)
24.532 9887(1)[1]	NH_3	5,5-5,5	+0.09[m]	Ori A	NEROC 120 ft	Kukolich and Wofsky (1970)	Barrett et al. (1977)
24.815 870(40)*	$H(C{\equiv}C)_3CN$	J=22-21	+0.24	Cloud 2	SRCAL 25 m	Little et al. (1978)	Little et al. (1978)
24.928 70(10)	CH_3OH	3_2-3_1 E	+1.2	Ori A	NEROC 120 ft	Lees et al. (1973)	Barrett et al. (1975)
24.933 468(2)	CH_3OH	4_2-4_1 E	+1.0[j]	Ori A	NEROC 120 ft	Lees et al. (1973) Gaines et al. (1974)	Barrett et al. (1971)
24.934 382(5)	CH_3OH	2_2-2_1 E	+0.35	Ori A	NEROC 120 ft	Lees et al. (1973) Gaines et al. (1974)	Barrett et al. (1975)
24.959 080(2)	CH_3OH	5_2-5_1 E	+1.1[j]	Ori A	NEROC 120 ft	Lees et al. (1973) Gaines et al. (1974)	Barrett et al. (1971)
25.018 123(2)	CH_3OH	6_2-6_1 E	+1.7[j]	Ori A	NEROC 120 ft	Lees et al. (1973) Gaines et al. (1974)	Barrett et al. (1971)
25.056 025(5)[1]	NH_3	6,6-6,6	+0.17[m]	Ori A	NEROC 120 ft	Kakar and Poynter (1975)	Cheung et al. (1969b) Barrett et al. (1977)
25.124 873(2)	CH_3OH	7_2-7_1 E	+1.5[j]	Ori A	NEROC 120 ft	Lees et al. (1973) Gaines et al. (1974)	Barrett et al. (1971)
25.294 411(3)	CH_3OH	8_2-8_1 E	+0.7[j]	Ori A	NEROC 120 ft	Lees et al. (1973) Gaines et al. (1974)	Barrett et al. (1971)
25.878 18(10)	CH_3OH	10_2-10_1 E	+0.9	Ori A	NRL 85 ft	Lees et al. (1973)	Matsakis et al. (1979)
28.974 781(3)*	H_2CO	3_{12}-3_{13} F=2-2					
28.974 804(2)*	H_2CO	3_{12}-3_{13} F=4-4	n.r.(abs.)[b]	Sgr B2	n.r.	Johnson et al. (1972) Takuma et al. (1959)	Welch (1970)
28.974 814(3)*	H_2CO	3_{12}-3_{13} F=3-3					
30.001 523(10)*	SO	1,0-0,1	+0.44[i]	Sgr B2	NRAO 36 ft	Tiemann (1974) Clark and De Lucia (1976)	Gottlieb et al. (1978)
31.105 26(10)	CH_3OCH_3	2_{11}-2_{02} AE+EA					
31.106 20(5)	CH_3OCH_3	2_{11}-2_{02} EE	+0.2	Ori A	NRL 85 ft	Snyder et al. (1974)	Snyder et al. (1974)
31.107 12(10)	CH_3OCH_3	2_{11}-2_{02} AA					
36.169 24(10)	CH_3OH	4_{-1}-3_0 E	+12.5	Sgr B2	NRAO 36 ft	Lees et al. (1973)	Lovas et al. (1976b)
36.392 2380(10)	HCCCN	J=4-3,F=3-2					
36.392 3316(10)	HCCCN	J=4-3,F=4-3	+1.25	Sgr B2	Parkes 64 m	Lafferty and Lovas (1978)	McGee et al. (1977)
36.392 3654(11)	HCCCN	J=4-3,F=5-4					

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory References	Astronomical References
36.793 739(30)	CH_3CN	2_1-1_1,F=2-1					
36.794 2042(11)*	CH_3CN	2_0-1_0,F=2-2					
36.794 330*	CH_3CN	2_1-1_1,F=2-2					
36.794 396*	CH_3CN	2_0-1_0,F=1-0					
36.795 013(30)	CH_3CN	2_1-1_1,F=3-2	+0.98	Sgr B2	Parkes 64 m	Bauer and Maes (1969) Dubrulle (1978)	Blackman et al. (1977)
36.795 466*	CH_3CN	2_0-1_0,F=2-1					
36.795 5678(8)*	CH_3CN	2_0-1_0,F=3-2					
36.796 344(30)	CH_3CN	2_1-1_1,F=1-0					
36.797 574(30)	CH_3CN	2_0-1_0,F=1-1					
42.519 34(10)	SiO	J=1-0 v=3	+2.0	VX Sgr	IRT 13.7m	Lovas and Krupenie (1974)	Scalise and Lepine (1978)
42.820 539(30)*	SiO	J=1-0 v=2	+15[j]	VY CMa	NRAO 36 ft	Lovas and Krupenie (1974) Manson et al. (1977)	Buhl et al. (1974)
43.122 027(30)*	SiO	J=1-0 v=1	+29[j]	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Manson et al. (1977)	Thaddeus et al. (1974) Snyder and Buhl (1975)
43.423 798(30)*	SiO	J=1-0 v=0	+0.50	Ori A	NEROC 120 ft	Lovas and Krupenie (1974) Manson et al. (1977)	Snyder et al. (1978)
43.963 00(10)[l]	HNCO	2_{02}-1_{01} F=3-2,2-1	∿ +1	Sgr B2	NRAO 36 ft	Winnewisser et al. (1976)	Snyder and Buhl (1972a)
45.490 2637(12)*	HCCCN	J=5-4,F=4-3					
45.490 3161(12)	HCCCN	J=5-4,F=5-4	+2.05[m]	Sgr B2	NRAO 36 ft	Lafferty and Lovas (1978)	Morris et al. (1976)
45.490 3399(13)	HCCCN	J=5-4,F=6-5					
46.247 472(20)	^{13}CS	J=1-0	+0.148	Sgr B2	NRAO 36 ft	Lovas and Krupenie (1974) Mockler and Bird (1955)	Turner et al. (1973)
48.206 948(12)	$C^{34}S$	J=1-0	+0.380	DR21(OH)	NRAO 36 ft	Lovas and Krupenie (1974) Mockler and Bird (1955)	Turner et al. (1973)
48.284 519(7)*	H_2CO	4_{13}-4_{14}	+0.63	Ori A	NRAO 36 ft	Johnson et al. (1972)	Hollis and Ulich (1977)
48.372 4670(2)	CH_3OH	1_0-0_0 A^+	+0.44	Ori A	NRAO 36 ft	Lees et al. (1973) Heuvel and Dymanus (1973)	Barrett et al. (1972) Hollis and Ulich (1977)
48.377 09(50)	CH_3OH	1_0-0_0 E	+0.29	Ori A	NRAO 36 ft	Lees et al. (1973)	Barrett et al. (1972) Hollis and Ulich (1977)
48.583 264(10)	$C^{33}S$	J=1-0 F=1/2-3/2					
48.585 906(10)	$C^{33}S$	J=1-0 F=5/2-3/2	∿ +0.12	Sgr B2	NRAO 36 ft	Lovas and Krupenie (1974) Mockler and Bird (1955)	Turner et al. (1973)
48.589 068(10)	$C^{33}S$	J=1-0 F=3/2-3/2					
48.651 6063(11)*	OCS	J=4-3	+0.45	Sgr B2	NRAO 36 ft	Maki (1974)	Hollis and Ulich (1977)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
48.991 000(12)	CS	J=1-0	+3.53	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Mockler and Bird (1955)	Turner et al. (1973)
68.972 145(12)*	SO_2	6_{15}-6_{06}	+0.8	Ori A	NRAO 36 ft	Lovas (1977)	Johnson et al. (1976a)
69.575 918(12)*	SO_2	1_{11}-0_{00}	+0.6	Ori A	NRAO 36 ft	Lovas (1977)	Johnson et al. (1976a)
72.039 354(40)	DCO^+	1-0	+0.87	L134	NRAO 36 ft	Woods et al. (1976)	Hollis et al. (1976)
72.409 097(15)*	H_2CO	5_{14}-5_{15}	+0.1	Ori A	NRAO 36 ft	Johnson et al. (1972)	Wilson et al. (1973)
72.413 4843(10)	DCN	J=1-0 F'=1-1 F=1-0,1,2					
72.413 5143(10)	DCN	J=1-0 F'=1-1 F=2-1,2	+0.2	Ori A	NRAO 36 ft	Maki (1974) De Lucia and Gordy (1969)	Wilson et al. (1973)
72.413 5584(10)	DCN	J=1-0 F'=1-1 F=0-0,1					
72.414 9054(10)	DCN	J=1-0 F'=2-1 F=1-0,1,2					
72.414 9270(10)	DCN	J=1-0 F'=2-1 F=2-1,2	+0.25	Ori A	NRAO 36 ft	Maki (1974) De Lucia and Gordy (1969)	Wilson et al. (1973)
72.414 9732(10)	DCN	J=1-0 F'=2-1 F=3-2					
72.417 0297(10)	DCN	J=1-0 F'=0-1 F=1-0,1,2	+0.2	Ori A	NRAO 36 ft	Maki (1974) De Lucia and Gordy (1969)	Wilson et al. (1973)
72.758 210(16)*	SO_2	6_{06}-5_{15}	+0.8	Ori A	NRAO 36 ft	Lovas (1977)	Johnson et al. (1976a)
72.783 8238(17)	HCCCN	J=8-7	+2.29[i]	Sgr B2	NRAO 36 ft	Lafferty and Lovas (1978) de Zafra (1971)	Morris et al. (1976)
72.837 974(24)	H_2CO	1_{01}-0_{00}	+0.5	Ori A	TAO 6 m	Johnson et al. (1972) Nerf (1972)	Akabane et al. (1974)
72.976 7845(15)*	OCS	J=6-5	+0.25	Sgr B2	TAO 6 m	Maki (1974)	Akabane et al. (1974)
73.044 01(10)	CH_3NH_2	5_{15}-5_{05} F=4-4					
73.044 20(10)	CH_3NH_2	5_{15}-5_{05} F=6-6	+0.5	Sgr B2	TAO 6 m	Kaifu et al. (1974)	Kaifu et al. (1974)
73.045 15(10)	CH_3NH_2	5_{15}-5_{05} F=5-5					
76.305 727(50)	DNC	J=1-0	+0.34	NGC 2264	NRAO 36 ft	Creswell et al. (1976)	Godfrey et al. (1977)
77.107 86(9)	N_2D^+	J=1-0 F_1=1-1	+0.25	L134N	NRAO 36 ft	Anderson et al. (1977)	Snyder et al. (1977b)
77.109 61(8)	N_2D^+	J=1-0 F_1=2-1	+0.30	L134N	NRAO 36 ft	Anderson et al. (1977)	Snyder et al. (1977b)
77.112 2(1)	N_2D^+	J=1-0 F_1=0-1	+0.15	L134N	NRAO 36 ft	Anderson et al. (1977)	Snyder et al. (1977b)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
79.150 26(90)	CH_3CHO	4_{13}-3_{12} A	+0.3	Sgr B2	NRAO 36 ft	Bauder et al. (1976)	Liszt (1978)
U79.220	unknown	unknown	+0.043	Sgr B2	BTL 7 m		Wannier and Linke (1978)
79.350 4757(90)	$H^{13}CCCN$	J=9-8	+0.56	Sgr B2	BTL 7 m	Lafferty and Lovas (1978)	Wannier and Linke (1978)
79.449 73(9)	NH_2CN	4_{14}-3_{13}	+0.27	Sgr B2	BTL 7 m	Johnson et al. (1976b)	Wannier and Linke (1978)
79.915 101(50)	NH_2CN	4_{04}-3_{03} v=1	+0.1	Sgr B2	NRAO 36 ft	Johnson et al. (1976b)	Turner (1977)
79.979 596(90)	NH_2CN	4_{04}-3_{03} v=0	+0.07	Sgr B2	NRAO 36 ft	Johnson et al. (1976b)	Turner (1977)
80.076 611(26)	H_2CCO	4_{14}-3_{13}	+0.1	Sgr B2	NRAO 36 ft	Johns et al. (1972)	Turner (1977)
U80.484	unknown	unknown	∼ +0.2	Sgr B2	NRAO 36 ft		Turner et al. (1975a)
80.504 60(10)	NH_2CN	4_{13}-3_{12}	+0.36[g]	Sgr B2	NRAO 36 ft	Johnson et al. (1976b)	Turner et al. (1975a)
80.536 24(10)	CH_3OCH_3	5_{23}-5_{14} AE+EA					
80.538 54(10)	CH_3OCH_3	5_{23}-5_{14} EE	+0.2[g]	Sgr B2	NRAO 36 ft	Lovas et al. (1979)	Turner et al. (1975a)
80.540 88(10)	CH_3OCH_3	5_{23}-5_{14} AA					
80.578 283(53)*	HDO	1_{10}-1_{11}	∼ +0.4[g]	Ori A	NRAO 36 ft	De Lucia et al. (1972)	Turner et al. (1975b)
80.832 076(28)	H_2CCO	4_{04}-3_{03}	+0.1	Sgr B2	NRAO 36 ft	Johns et al. (1972)	Turner (1977)
81.447 49(10)	HNO	1_{01}-0_{00}	+0.033	Sgr B2	NRAO 36 ft	Saito and Takagi (1972)	Ulich et al. (1977) Wannier and Linke (1978)
U81.504	unknown	unknown	+0.21	Sgr B2	NRAO 36 ft		Ulich et al (1977) Wannier and Linke (1978)
81.534 125(11)	$HC^{13}CCN$	J=9-8	+0.050	Sgr B2	BTL 7 m	Lafferty and Lovas (1978)	Wannier and Linke (1978)
81.541 9815(54)	$HCC^{13}CN$	J=9-8	+0.052	Sgr B2	BTL 7 m	Lafferty and Lovas (1978)	Ulich et al. (1977) Wannier and Linke (1978)
81.586 193(26)	H_2CCO	4_{13}-3_{12}	+0.15	Sgr B2	NRAO 36 ft	Johns et al. (1972)	Turner (1977)
81.881 458(7)	HCCCN	J=9-8	+2.51	Sgr B2	BTL 7 m	Creswell et al. (1977)	Morris et al. (1976) Wannier and Linke (1978)
82.649 30(10)	CH_3OCH_3	3_{13}-2_{02} AE+EA					
82.650 18(10)	CH_3OCH_3	3_{13}-2_{02} EE	+0.2	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
82.651 08(10)	CH_3OCH_3	3_{13}-2_{02} AA					

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A (K)	Source	Telescope	Laboratory Reference	Astronomical Reference
82.686 50(10)	CH_3OCH_3	$4_{22}-4_{13}$ AE+EA	+0.10	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
82.688 77(10)	CH_3OCH_3	$4_{22}-4_{13}$ EE	+0.12	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
82.691 14(10)	CH_3OCH_3	$4_{22}-4_{13}$ AA	+0.08	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
83.584 26(18)	CH_3CHO	$2_{12}-1_{01}$ E	+0.25	Ori A	NRAO 36 ft	Bauder et al. (1976)	Lovas et al. (1976a)
83.688 071(16)*	SO_2	$8_{17}-8_{08}$	∿ +2	Ori A	NRAO 36 ft	Lovas (1977)	Snyder et al. (1975)
84.505 35	unknown	unknown	+0.08	Ori A	NRAO 36 ft		Kuiper et al. (1977)
84.521 21(8)	CH_3OH	$5_{-1}-4_0$ E	+2.8	Sgr B2	NRAO 36 ft	Lees et al. (1973) Zuckerman et al. (1972b)	Zuckerman et al. (1972b)
84.632 02(10)	CH_3OCH_3	$3_{21}-3_{12}$ AE+EA	+0.14	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
84.634 40(10)	CH_3OCH_3	$3_{21}-3_{12}$ EE	+0.09[n]	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
84.636 80(10)	CH_3OCH_3	$3_{21}-3_{12}$ AA					
84.746 01(10)*	^{30}SiO	J=1-0 v=0	+0.08	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Manson et al. (1977)	Clark and Lovas (1977)
85.139 1081(18)*	OCS	J=7-6	+0.7	Sgr B2	NRAO 36 ft	Maki (1974)	Solomon et al. (1973)
85.162 157(50)	$HC^{18}O^+$	J=1-0	+0.1	L134N	BTL 7 m	Woods et al. (1976)	Langer et al. (1978)
85.265 42(9)*	CH_3CH_2OH	$6_{06}-5_{15}$	+0.25	Sgr B2	NRAO 36 ft	Lovas (1979)	Zuckerman et al. (1975)
85.435[i]	unknown	unknown	+0.2	Sgr B2	NRAO 36 ft		Snyder and Buhl (1973)
85.442 6006(14)*	CH_3CCH	5_3-4_3	+0.2	Sgr B2	NRAO 36 ft	Bauer et al. (1979) Bauer and Burie (1969)	Snyder and Buhl (1973)
85.450 7660(7)*	CH_3CCH	5_2-4_2					
85.455 6665(6)*	CH_3CCH	5_1-4_1	+0.5	Sgr B2	NRAO 36 ft	Bauer et al. (1979) Bauer and Burie (1969)	Snyder and Buhl (1973)
85.457 3002(7)*	CH_3CCH	5_0-4_0					
85.567 6(5)	CH_3OH	$6_{-2}-7_{-1}$ E	+0.3	Ori A	NRAO 36 ft	Lees et al. (1973) Lovas et al. (1976a)	Lovas et al. (1976a)
85.633 9(1)	C_4H	N=9-8	+0.08	IRC+10216	NRAO 36 ft		Guelin et al. (1978)
85.672 4(1)	C_4H	N=9-8	+0.07	IRC+10216	NRAO 36 ft		Guelin et al. (1978)
85.758 953(100)*	^{29}SiO	J=2-1 v=0	+0.13	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Manson et al. (1977)	Lovas et al. (1976a)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
85.926 2(2)	NH_2D	$0^+ 1_{11}-0^- 1_{01}$	+0.14	Ori A	NRAO 36 ft	Lichtenstein et al. (1964)	Turner et al. (1978) Kuiper et al. (1978)
86.054 961(25)	$HC^{15}N$	J=1-0	+0.80[g]	Ori A	NRAO 36 ft	Pearson et al. (1976)	Linke et al. (1977) Kaifu et al. (1974)
86.074 20(10)	CH_3NH_2	$4_{14}-4_{04}$ F=3-3					
86.074 44(10)	CH_3NH_2	$4_{14}-4_{04}$ F=5-5	+0.2	Sgr B2	NRAO 36 ft	Takagi and Kojima (1973)	Kaifu et al. (1974)
86.075 43(10)	CH_3NH_2	$4_{14}-4_{04}$ F=4-4					
86.093 969(18)*	SO	2,2-1,1	∿ +1.7	Ori A	NRAO 36 ft	Tiemann (1974) Clark and De Lucia (1976)	Clark and Johnson (1974)
86.223 76(10)	CH_3OCH_3	$2_{20}-2_{11}$ AE					
86.225 67(12)	CH_3OCH_3	$2_{20}-2_{11}$ EA	+0.28[n]	Ori A	NRAO 36 ft	Snyder et al. (1974) Clark et al. (1979)	Snyder et al. (1974) Clark et al. (1979)
86.226 728(96)	CH_3OCH_3	$2_{20}-2_{11}$ EE					
86.228 72(2)	CH_3OCH_3	$2_{20}-2_{11}$ AA					
86.243 350(40)*	SiO	J=2-1 v=1	+17.4[j]	Ori A	NRAO 36 ft	Manson et al. (1977)	Snyder and Buhl (1974) Ulich and Haas (1976)
86.338 767(30)	$H^{13}CN$	J=1-0 F=1-1					
86.340 184(30)	$H^{13}CN$	J=1-0 F=2-1	∿ +2	Ori A	NRAO 36 ft	Pearson et al. (1976)	Snyder and Buhl (1971a) Linke et al. (1977)
86.342 274(30)	$H^{13}CN$	J=1-0 F=0-1					
86.615 4(5)	CH_3OH	7_2-6_3 A^-	+0.6	Ori A	NRAO 36 ft	Lees et al. (1973) Lovas et al. (1976a)	Snyder et al. (1975) Lovas et al. (1976a)
86.639 138(22)*	SO_2	$8_{3,5}-9_{2,8}$	∿ +0.6	Ori A	NRAO 36 ft	Lovas (1977)	Snyder et al. (1975)
86.670 65(10)	HCO	$1_{01}-0_{00}$ J,F=3/2,2-1/2,1	+0.15	NGC 2024	NRAO 36 ft	Saito (1972) Saito (1975)	Snyder et al. (1976b)
86.754 330(50)	$H^{13}CO^+$	J=1-0	+0.6	Ori A	NRAO 36 ft	Woods et al. (1976)	Snyder et al. (1976a)
U86.756 8	unknown	unknown	+0.7	Sgr B2	NRAO 36 ft		Snyder et al. (1976a)
86.846 891(56)*	SiO	J=2-1 v=0	+0.9	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Manson et al (1977)	Dickinson (1972b)
86.903 5(5)	CH_3OH	7_2-6_3 A^+	+0.2	Ori A	NRAO 36 ft	Lees et al. (1973) Lovas et al. (1976a)	Lovas et al. (1976a)
87.090 851(50)	$HN^{13}C$	J=1-0	+0.95	Sgr B2	NRAO 36 ft	Creswell et al. (1976)	Brown et al. (1976)
87.284 6*[o]	HCC	N=1-0 J,F=3/2,1-1/2,1	+0.4	Ori A (3'N,1'E)	NRAO 36 ft		Tucker and Kutner (1978)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
87.317 05(4)	HCC	N=1-0 J,F=3/2,2-1/2,1	$+3.83^p$	Ori A (2'N)	NRAO 36 ft		Tucker et al. (1974)
87.328 70(7)	HCC	N=1-0 J,F=3/2,1-1/2,0	$+2.11^p$	Ori A (2'N)	NRAO 36 ft		Tucker et al. (1974)
87.402 10(7)	HCC	N=1-0 J,F=1/2,1-1/2,1	$+1.95^p$	Ori A (2'N)	NRAO 36 ft		Tucker et al. (1974)
87.407 23 (15)	HCC	N=1-0 J,F=1/2,0-1/2,1	$+0.95^p$	Ori A (2'N)	NRAO 36 ft		Tucker et al. (1974)
87.4464*[o]	HCC	N=1-0 J,F=1/2,1-1/2,0	+0.7	Ori A (3'N,1'E)	NRAO 36 ft		Tucker and Kutner (1978)
87.925 238(4)*	HNCO	$4_{04}-3_{03}$	+2.4	Sgr B2 (2'N)	NRAO 36 ft	Winnewisser et al. (1976)	Snyder and Buhl (1971a) Snyder and Buhl (1972c)
88.239 027(3)*	HNCO	$4_{13}-3_{12}$	+0.3	Sgr B2	NRAO 36 ft	Winnewisser et al. (1976)	Snyder and Buhl (1973)
88.323 72(8)*	CH_3CH_2CN	$10_{0,10}-9_{09}$	+0.12	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
88.630 4157(10)	HCN	J=1-0 F=1-1	+9.6	Ori A	NRAO 36 ft	Maki (1974) De Lucia and Gordy (1969)	Snyder and Buhl (1971a) Ulich and Haas (1976)
88.631 8473(10)	HCN	J=1-0 F=2-1	+17.2	Ori A	NRAO 36 ft	Maki (1974) De Lucia and Gordy (1969)	Snyder and Buhl (1971a) Ulich and Haas (1976)
88.633 9360(10)	HCN	J=1-0 F=0-1	+6.8	Ori A	NRAO 36 ft	Maki (1974) De Lucia and Gordy (1969)	Snyder and Buhl (1971a) Ulich and Haas (1976)
88.668 06(10)	CH_3NH_2	$2_{02}-1_{01}$ A_a					
88.668 62(10)	CH_3NH_2	$2_{02}-1_{01}$ F_e	+0.15	Sgr B2	NRAO 36 ft	Kaifu et al. (1975)	Kaifu et al. (1975)
88.669 61(10)	CH_3NH_2	$2_{02}-1_{01}$ A_s,E_a					
88.865 692(26)	$H^{15}NC$	J=1-0	+0.15	DR21 (OH)	NRAO 36 ft	Saykally et al. (1976a)	Brown et al. (1977)
89.045 7(3)	CCCN	N=9-8	$+0.13^p$	IRC+10216	NRAO 36 ft		Guélin and Thaddeus (1977)
89.064 4(3)	CCCN	N=9-8	$+0.14^p$	IRC+10216	NRAO 36 ft		Guélin and Thaddeus (1977)
89.188 523(20)	HCO^+	J=1-0	+10.8	Ori A	NRAO 36 ft	Woods et al. (1976)	Buhl and Snyder (1970) Ulich and Haas (1976)
89.505 86(4)	CH_3OH	$8_{-4}-9_{-3}$ E	+0.3	Ori A	NRAO 36 ft	Lees et al. (1973) Lovas and Suenram (1978)	Lovas et al. (1976a)
89.562 24(7)*	CH_3CH_2CN	10_6-9_6	$+0.08^q$	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
89.564 95(8)*	CH_3CH_2CN	10_7-9_7	$+0.05^q$	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
89.568 03(6)*	CH_3CH_2CN	10_5-9_5	$+0.11^q$	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
89.572 98(11)*	CH_3CH_2CN	10_8-9_8	$+0.03^q$	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
89.589 98(6)*	CH_3CH_2CN	$10_{47}-9_{46}$	+0.05[g]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
89.590 96(6)*	CH_3CH_2CN	$10_{46}-9_{45}$	+0.05[g]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
89.628 41(7)*	CH_3CH_2CN	$10_{38}-9_{37}$	+0.13	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
90.117 61(14)*	CH_3CH_2OH	$4_{14}-3_{03}$	+0.25[g]	Sgr B2	NRAO 36 ft	Lovas (1979)	Zuckerman et al. (1975)
90.146	unknown	unknown	~ +0.2[g]	Ori A	NRAO 36 ft		Turner et al. (1975b)
90.593 78(5)	$HC^{13}CCN$	J=10-9	+0.35	Sgr B2	NRAO 36 ft	Lafferty and Lovas (1978)	Ulich (1978)
90.601 7910(58)	$HCC^{13}CN$	J=10-9	+0.18	Sgr B2	NRAO 36 ft	Lafferty and Lovas (1978)	Ulich (1978)
90.663 405(60)	HNC	J=1-0 F=1-1	+1.1	L134	NRAO 36 ft	Creswell et al. (1976) Snyder et al. (1977a)	Snyder and Buhl (1972c) Snyder et al. (1977a)
90.663 525(30)	HNC	J=1-0 F=2-1	+1.6	L134	NRAO 36 ft	Creswell et al. (1976) Snyder et al. (1977a)	Snyder and Buhl (1972c) Snyder et al. (1977a)
90.703 78(5)	CH_3OD	$2_{-1}-1_{-1}$ E	+0.14[f]	Sgr B2	NRAO 36 ft	Lovas and Suenram (1978)	Gottlieb et al. (1979)
90.705 77(5)	CH_3OD	2_0-1_0 A					
90.771 546(26)*	SiS	J=5-4 v=0	+0.35	IRC+10216	NRAO 36 ft	Tiemann (1976)	Morris et al. (1975)
U90.841(3)	unknown	unknown	+0.08	Sgr B2	NRAO 36 ft		Clark et al. (1979)
U90.908(3)	unknown	unknown	+0.05	Sgr B2	NRAO 36 ft		Clark et al. (1979)
U90.928(1)	unknown	unknown	+0.07	Sgr B2	NRAO 36 ft		Clark et al. (1979)
90.937 539(40)	CH_3OCH_3	$6_{06}-5_{15}$ AA					
90.938 099(30)	CH_3OCH_3	$6_{06}-5_{15}$ EE	+0.17	Ori A	NRAO 36 ft	Snyder et al. (1974) Clark et al. (1979)	Snyder et al. (1974)
90.938 674(50)	CH_3OCH_3	$6_{06}-5_{15}$ AE+EA					
90.978 9933(21)*	HCCCN	J=10-9	+1.77	Ori A	NRAO 36 ft	Creswell et al. (1977) Lafferty and Lovas (1978)	Morris et al. (1976)
91.202 607(27)*	HCCCN	J=10-9 v_7 ℓ=1e	+0.2	Ori A	NRAO 36 ft	Lafferty and Lovas (1978)	Clark et al. (1976)
91.333 308(27)*	HCCCN	J=10-9 v_7 ℓ=1f	+0.2	Ori A	NRAO 36 ft	Lafferty and Lovas (1978)	Clark et al. (1976)
91.549 10(7)*	CH_3CH_2CN	$10_{19}-9_{18}$	+0.2	Sgr B2	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
91.959 206(60)	CH_3CN	5_4-4_4 F=6-5,4-3	+0.08	Ori A	NRAO 36 ft	Bauer and Maes (1969)	Lovas et al. (1976a)

TABLE 2—*Continued*

Frequency[a] (MHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
91.971 374(60)	CH_3CN	5_3-4_3 F=6-5,4-3	+0.20	Ori A	NRAO 36 ft	Bauer and Maes (1969)	Lovas et al. (1976a)
91.979 998(60)	CH_3CN	5_2-4_2 F=6-5	+0.16	Ori A	NRAO 36 ft	Bauer and Maes (1969)	Lovas et al. (1976a)
91.985 284(60)	CH_3CN	5_1-4_1 F=6-5	+0.28[q]	Ori A	NRAO 36 ft	Bauer and Maes (1969)	Lovas et al. (1976a)
91.987 054(60)	CH_3CN	5_0-4_0 F=6-5					
U92.352 7	unknown	unknown	? +0.1	Ori A	NRAO 36 ft		Clark et al. (1976)
92.494 084(81)*	^{13}CS	J=2-1	+0.215	Ori A	NRAO 36 ft	Lovas and Krupenie (1974)	Turner et al. (1973)
93.171 67[u]	HNN^+	J=1-0 F_1=1-1 F=0-1	+0.5[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Snyder and Hollis (1979)
93.171 91[u]	HNN^+	J=1-0 F_1=1-1 F=2-2	+0.7[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Snyder et al. (1977b)
93.172 09[u]	HNN^+	J=1-0 F_1=1-1 F=1-1	+0.8[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Turner (1974) Snyder et al. (1977b)
93.173 50[u]	HNN^+	J=1-0 F_1=2-1 F=2-1	+0.9[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Snyder et al. (1977b)
93.173 83[u]	HNN^+	J=1-0 F_1=2-1 F=3-2	+0.9[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Turner (1974) Snyder et al. (1977b)
93.174 01[u]	HNN^+	J=1-0 F_1=2-1 F=1-0	+0.6[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Snyder et al. (1977b)
93.176 32[u]	HNN^+	J=1-0 F_1=0-1 F=1-2	+0.7[u]	L134N	NRAO 36 ft	Snyder and Hollis (1979)[u]	Turner (1974) Snyder et al. (1977b)
93.780(3)[v]	unknown	unknown	+0.14	Ori A	NRAO 36 ft		Clark et al. (1979)
93.844(2)	unknown	unknown	+0.06	Sgr B2	NRAO 36 ft		Clark et al. (1979)
93.854 44(10)	CH_3OCH_3	4_{23}-4_{14} AE+EA	+0.14	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
93.857 11(10)	CH_3OCH_3	4_{23}-4_{14} EE	+0.20	Ori A	NRAO 36 ft	Clark et al (1979)	Clark et al. (1979)
93.859 64(10)	CH_3OCH_3	4_{23}-4_{14} AA	0.03	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
93.871 73(12)*	NH_2CHO	3_{22}-4_{14}	+0.2	Sgr B2	NRAO 36 ft	Johnson et al. (1972)	Clark et al. (1979)
94.276 638(18)*	CH_2CHCN	$10_{0,10}$-$9_{0,9}$	+0.08	Sgr B2	NRAO 36 ft	Gerry et al. (1979)	Johnson et al. (1977)
94.405 17(15)	$^{13}CH_3OH$	2_{-1}-1_{-1} E					
94.407 02(10)	$^{13}CH_3OH$	2_0-1_0 A^+	+0.8	Sgr B2	NRAO 36 ft	Lees et al. (1973)	Gottlieb et al. (1979)
94.410 76(10)	$^{13}CH_3OH$	2_0-1_0 E					
94.540 7(10)	CH_3OH	8_3-9_2 E	+0.35	Ori A	NRAO 36 ft	Lees et al. (1973) Lovas et al. (1976a)	Lovas et al. (1976a)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
95.149 5(1)	C_4H	N=10-9	+0.08	IRC+10216	NRAO 36 ft		Guélin et al. (1978)
95.169 44(10)	CH_3OH	8_0-7_1 A^+	+0.85	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Lovas et al. (1976a)
95.189 0(1)	C_4H	N=10-9	+0.08	IRC+10216	NRAO 36 ft		Guélin et al. (1978)
95.442 44(8)	CH_3CH_2CN	$11_{1,11}$-$10_{1,10}$	+0.20	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
96.368 05(25)	CH_3CHO	5_{32}-4_{31} E, 5_{33}-4_{32} A	+0.07	Sgr B2	NRAO 36 ft	Bauder et al. (1976)	Gottlieb (1978)
96.371 60(13)	CH_3CHO	5_{32}-4_{31} A					
96.384 30(13)	CH_3CHO	5_{33}-4_{32} E	+0.1[t]	Sgr B2	NRAO 36 ft	Bauder et al. (1976)	Gottlieb (1978)
96.412 953(30)	$C^{34}S$	J=2-1	+0.62	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Kewley et al. (1963)	Turner et al. (1973)
96.475 50(13)	CH_3CHO	5_{23}-4_{22} E	+0.08	Sgr B2	NRAO 36 ft	Bauder et al. (1976)	Gottlieb (1978)
96.739 39(10)	CH_3OH	2_{-1}-1_{-1} E	+1.55	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Gottlieb et al. (1979)
96.741 42(10)	CH_3OH	2_0-1_0 A^+	+1.87	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Gottlieb et al. (1979)
96.744 58(10)	CH_3OH	2_0-1_0 E	+1.61	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Gottlieb et al. (1979)
96.755 51(10)	CH_3OH	2_1-1_1 E	+1.12	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Gottlieb et al. (1979)
96.797(3)	unknown	unknown	+0.05	Sgr B2	NRAO 36 ft		Clark et al. (1979)
96.847 25(10)	CH_3OCH_3	5_{24}-5_{15} AE+EA	+0.11	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
96.849 85(10)	CH_3OCH_3	5_{24}-5_{15} EE	+0.14	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
96.852 46(10)	CH_3OCH_3	5_{24}-5_{15} AA	+0.13	Ori A	NRAO 36 ft	Clark et al. (1979)	Clark et al. (1979)
96.919 71(8)*	CH_3CH_2CN	$11_{0,11}$-$10_{0,10}$	+0.08	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
97.301 2130(20)*	OCS	J=8-7	+0.85	Sgr B2	NRAO 36 ft	Maki (1974)	Solomon et al. (1973)
97.702 389(22)*	SO_2	7_{35}-8_{26}	~ +0.3	Ori A	NRAO 36 ft	Lovas (1977)	Snyder et al. (1975)
97.715 39(15)	^{34}SO	3,2-2,1	+0.14	Ori A	NRAO 36 ft	Tiemann (1974)	Snyder et al. (1975) Gottlieb et al. (1978)
97.981 007(16)	CS	J=2-1	+6.94	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Kewley et al. (1963)	Zuckerman et al. (1972a) Turner et al. (1973)
98.177 55(7)	CH_3CH_2CN	$11_{2,10}$-$10_{2,9}$	+0.15	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
98.523 80(7)	CH_3CH_2CN	11_6-10_6	+0.13[q]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.524 58(9)	CH_3CH_2CN	11_7-10_7	+0.10[q]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.532 01(12)	CH_3CH_2CN	11_8-10_8	+0.06[q]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.533 91(6)	CH_3CH_2CN	11_5-10_5	+0.17[q]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.564 78(6)	CH_3CH_2CN	11_{48}-10_{47}	+0.09[q]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.566 74(6)	CH_3CH_2CN	11_{47}-10_{46}	+0.09[q]	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.610 07(6)	CH_3CH_2CN	11_{39}-10_{38}	+0.14	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.701 07(6)	CH_3CH_2CN	11_{38}-10_{37}	+0.12	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
98.939 9(5)	CCCN	N=10-9	+0.18	IRC+10216	NRAO 36 ft		Guélin and Thaddeus (1977)
98.958 6(5)	CCCN	N=10-9	+0.13	IRC+10216	NRAO 36 ft		Guélin and Thaddeus (1977)
99.299 867(26)*	SO	3,2-2,1	+1.59[r]	Ori A	NRAO 36 ft	Tiemann (1974) Clark and De Lucia (1976)	Gottlieb and Ball (1973) Gottlieb et al. (1978)
99.325 25(20)	CH_3OCH_3	4_{14}-3_{03}	+0.2	Ori A	NRAO 36 ft	Lovas et al. (1979)	Clark et al. (1979)
100.029 644(34)*	SO	4,5-4,4	+0.38[r]	Ori A	NRAO 36 ft	Tiemann (1974) Clark and De Lucia (1976)	Gottlieb et al. (1978)
100.094 51(10)	H_2CCO	5_{15}-4_{14}	+0.17	Sgr B2	NRAO 36 ft	Johns et al. (1972)	Turner (1977)
100.157 0	unknown	unknown	+0.07	Sgr B2	NRAO 36 ft		Turner (1977)
100.200 4	unknown	unknown	+0.09	Sgr B2	NRAO 36 ft		Turner (1977)
100.076 392(15)	HCCCN	J=11-10	+1.28	Ori A	NRAO 36 ft	de Zafra (1971)	Morris et al. (1976)
100.466 106(29)*	HCCCN	J=11-10 ν_7 1f	~ 0.2	Ori A	NRAO 36 ft	Lafferty and Lovas (1978)	Wilson and Kakar (1976)
100.614 28(7)*	CH_3CH_2CN	$11_{1,10}$-$10_{1,9}$	+0.10	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
100.629 50(12)	NH_2CN	5_{14}-4_{13}	+0.17	Sgr B2	NRAO 36 ft	Johnson et al. (1976b)	Turner et al. (1975a)
101.036 71(10)	H_2CCO	5_{05}-4_{04}	+0.1	Sgr B2	NRAO 36 ft	Johns et al. (1972)	Turner (1977)
101.139	unknown	unknown	+0.17	Sgr B2	NRAO 36 ft		Turner (1977)
101.981 39(10)	H_2CCO	5_{14}-4_{13}	+0.22	Sgr B2	NRAO 36 ft	Johns et al. (1972)	Turner (1977)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
102.064 353(58)*	NH_2CHO	$5_{14}-4_{14}$	+0.2	Sgr B2	NRAO 36 ft	Johnson et al. (1977)	Turner (1978a)
102.547 9842(10)	CH_3CCH	6_0-5_0	+0.6	Sgr B2	NRAO 36 ft	Bauer et al. (1979)	Turner (1978a)
103.040 399(53)*	H_2CS	$3_{03}-2_{02}$	+0.2	Sgr B2	NRAO 36 ft	Johnson et al. (1972)	Gottlieb (1978)
U103.915	unknown	unknown	+0.1	Ori A	NRAO 36 ft		Kuiper et al. (1977)
104.029 398(20)*	SO_2	$3_{13}-2_{02}$	+3.0	Ori A	NRAO 36 ft	Lovas (1977)	Hollis and Rhodes (1976)
104.051 24(8)*	CH_3CH_2CN	$12_{1,12}-11_{1,11}$	+0.08	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
104.060 76(10)	CH_3OH	$13_{-4}-12_{-3}$	+0.2	Ori A	NRAO 36 ft	Lees and Baker (1968)	Kuiper et al. (1977)
U104.589	unknown	unknown	+0.15	Sgr B2	NRAO 36 ft		Liszt (1978)
104.616 977(51)*	H_2CS	$3_{12}-2_{11}$	+0.77	Sgr B2	NRAO 36 ft	Johnson et al. (1972)	Liszt (1978)
104.667 3	C_4H	N=11-10	+0.10	IRC+10216	NRAO 36 ft		Liszt (1978) Guélin et al. (1978)
104.706 0	C_4H	N=11-10	+0.10	IRC+10216	NRAO 36 ft		Liszt (1978) Guélin et al. (1978)
104.711 416(8)	$^{13}C^{18}O$	J=1-0	n.r.	NGC2024	NRAO 36 ft	Lovas and Krupenie (1974) Rosenblum et al. (1958)	Wannier et al. (1976)
104.808 62(14)*	CH_3CH_2OH	$5_{15}-4_{04}$	+0.18	Sgr B2	NRAO 36 ft	Lovas (1979)	Zuckerman et al. (1975)
105.469 26(8)*	CH_3CH_2CN	$12_{0,12}-11_{0,11}$	+0.2	Ori A	NRAO 36 ft	Lovas (1977)	Kuiper et al. (1977)
U105.577[s]	unknown	unknown	+0.2	Ori A	NRAO 36 ft		Kuiper et al. (1977)
105.972 728(81)*	NH_2CHO	$5_{24}-4_{23}$	+0.1[t]	Sgr B2	NRAO 36 ft	Johnson et al. (1972)	Gottlieb (1978)
106.742 92(15)	^{34}SO	2,3-1,2	+0.16[d]	Ori A	NRAO 36 ft	Tiemann (1974)	Gottlieb et al. (1978)
108.840	C_3N	N=11-10	n.r.	n.r.	NRAO 36 ft		Guélin et al. (1978)
108.860	C_3N	N=11-10	n.r.	n.r.	NRAO 36 ft		Guélin et al. (1978)
108.924 267(48)*	SiS	J=6-5 v=0	+0.28	IRC+10216	NRAO 36 ft	Tiemann (1976)	Morris et al. (1975)
109.173 634(4)	HCCCN	J=12-11	+2.57	Sgr B2	NRAO 36 ft	de Zafra (1971)	Morris et al. (1976)
109.252 226(26)*	SO	2,3-1,2	+2.42[r]	Ori A	MWO 4.9m	Tiemann (1974) Clark and De Lucia (1976)	Wannier and Phillips (1977) Gottlieb et al. (1978)
109.463 079(21)*	OCS	J=9-8	+0.70	Sgr B2	NRAO 36 ft	Maki (1974)	Jefferts et al. (1971)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
109.650 29(6)*	CH_3CH_2CN	$12_{1,11}-11_{1,10}$	+0.07	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
109.782 182(8)	$C^{18}O$	J=1-0	+2.1	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Rosenblum et al (1958)	Penzias et al. (1971a) Ulich and Haas (1976)
109.905 753(5)*	HNCO	$5_{05}-4_{04}$	+1.1	Sgr B2	NRAO 36 ft	Winnewisser et al. (1976)	Solomon et al. (1973)
110.153 4(2)	NH_2D	$0^- 1_{11}-0^+ 1_{01}$	+0.14	Ori A	NRAO 36 ft	Lichtenstein et al. (1964)	Kuiper et al. (1978)
110.201 370(8)	^{13}CO	J=1-0	+9.3	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Rosenblum et al. (1958)	Penzias et al. (1971a) Ulich and Haas (1976)
110.330 728(60)	CH_3CN	6_5-5_5 F=7-6,5-4	+0.2	Sgr B2	NRAO 36 ft	Bauer and Maes (1969)	Solomon et al. (1971)
110.349 706(60)	CH_3CN	6_4-5_4 F=7-6,5-4	+0.45	Sgr B2	NRAO 36 ft	Bauer and Maes (1969)	Solomon et al. (1971) Solomon et al. (1973)
110.364 490(60)	CH_3CN	6_3-5_3 F=7-6,5-4	+0.31	Sgr B2	NRAO 36 ft	Bauer and Maes (1969)	Solomon et al. (1971) Solomon et al. (1973)
110.374 986(60)	CH_3CN	6_2-5_2 F=7-6	+0.81	Sgr B2	NRAO 36 ft	Bauer and Maes (1969)	Solomon et al. (1973)
110.381 362(60)	CH_3CN	6_1-5_1 F=7-6	+1.09	Sgr B2	NRAO 36 ft	Bauer and Maes (1969)	Solomon et al. (1971) Solomon et al. (1973)
110.383 494(60)	CH_3CN	6_0-5_0 F=7-6					
110.709 55(6)	CH_3CN	6_3-5_3 $v_8=1$	+0.4	Comet Kohoutek	NRAO 36 ft	Bauer and Maes (1969)	Ulich and Conklin (1974)
110.712 22(6)	CH_3CN	6_0-5_0 $v_8=1$	+0.6	Comet Kohoutek	NRAO 36 ft	Bauer and Maes (1969)	Ulich and Conklin (1974)
112.248 72(16)	CH_3CHO	$6_{16}-5_{15}$ A	∿ +0.2	Sgr B2	NRAO 36 ft	Bauder et al. (1976) Gilmore et al. (1976)	Gilmore et al. (1976)
112.254 48(16)	CH_3CHO	$6_{16}-5_{15}$ E	∿ +0.2	Sgr B2	NRAO 36 ft	Bauder et al. (1976) Gilmore et al. (1976)	Gilmore et al. (1976)
112.358 72(10)	$C^{17}O$	F=3/2-5/2	+0.35	ρ-Oph	NRAO 36 ft	Lovas and Krupenie (1974) Rosenblum and Nethercot (1957)	Encrenaz et al. (1973)
112.358 980(15)	$C^{17}O$	F=7/2-5/2					
112.360 016(15)	$C^{17}O$	F=5/2-5/2	+0.20	ρ-Oph	NRAO 36 ft	Lovas and Krupenie (1974) Rosenblum and Nethercot (1957)	Encrenaz et al. (1973)
113.144 192(9)	CN	N=1-0 J=1/2-1/2 F=1/2-3/2	+1.14	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Turner and Gammon (1975)
113.170 528(20)	CN	N=1-0 J=1/2-1/2 F=3/2-1/2	+0.97	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Turner and Gammon (1975)
113.191 317(40)	CN	N=1-0 J=1/2-1/2 F=3/2-3/2	+1.38	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Turner and Gammon (1975)
113.488 140(5)	CN	N=1-0 J=3/2-1/2 F=3/2-1/2	+1.04	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Penzias et al. (1974)
113.490 982(3)	CN	N=1-0 J=3/2-1/2 F=5/2-3/2	+3.23	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Jefferts et al. (1970)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
113.499 639(5)	CN	N=1-0 J=3/2-1/2 F=1/2-1/2	+0.79	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Jefferts et al. (1970)
113.508 944(13)	CN	N=1-0 J=3/2-1/2 F=3/2-3/2	+0.94	Ori A	NRAO 36 ft	Dixon and Woods (1977)	Turner and Gammon (1975)
113.520 24(10)*	CN	N=1-0 J=3/2-1/2 F=1/2-3/2	~ +0.2	Ori A	NRAO 36 ft		Allen and Knapp (1978)
113.978 21(10)*	CH_3CH_2CN	$13_{0,13}-12_{0,12}$	+0.12	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
114.182	C_4H	N=12-11	+0.23	IRC+10216	NRAO 36 ft		Scoville and Solomon (1978)
114.221	C_4H	N=12-11	+0.40	IRC+10216	NRAO 36 ft		Scoville and Solomon (1978)
114.939 90(20)	CH_3CHO	$6_{06}-5_{05}$ E	n.r.(em)[b]	Sgr B2	NRAO 36 ft	Bauder et al. (1976)	Kuiper and Kuiper (1975)
114.959 65(10)	CH_3CHO	$6_{06}-5_{05}$ A	n.r.(em)[b]	Sgr B2	NRAO 36 ft	Bauder et al. (1976)	Kuiper and Kuiper (1975)
115.153 835(80)	NS	$^2\Pi_{1/2}$ J=5/2-3/2 F=7/2-5/2 c	~ +0.3	Sgr B2	MMWO 4.9m	Lovas and Suenram (1979)	Gottlieb et al. (1975)
115.156 799(80)	NS	$^2\Pi_{1/2}$ J=5/2-3/2 F=5/2-3/2 c					
115.271 204(5)	CO	J=1-0	+60.0	Ori A	NRAO 36 ft	Lovas and Krupenie (1974) Rosenblum et al. (1958)	Wilson et al. (1970) Ulich and Haas (1976)
115.383(1)	unknown	unknown	+0.3	IRC+10216	NRAO 36 ft		Kuiper et al. (1977)
115.556 312(60)	NS	$^2\Pi_{1/2}$ J=5/2-3/2 F=7/2-5/2 d	+0.24	Sgr B2	NRAO 36 ft	Lovas and Suenram (1979)	Gottlieb et al. (1975)
115.570 762(50)	NS	$^2\Pi_{1/2}$ J=5/2-3/2 F=5/2-3/2 d	+0.28	Sgr B2	NRAO 36 ft	Lovas and Suenram (1979)	Gottlieb et al. (1975)
115.571 93(6)	NS	$^2\Pi_{1/2}$ J=5/2-3/2 F=3/2-1/2 d					
115.894 35(9)	CH_3CH_2CN	$13_{2,12}-12_{2,11}$	+0.09	Ori A	NRAO 36 ft	Johnson et al. (1977)	Johnson et al. (1977)
127.367 666(30)	HCCCN	J=14-13	+1.85	Ori A	MMWO 4.9 m	Creswell et al. (1977)	Morris et al. (1977)
129.363 262(54)*	SiO	J=3-2 v=1	+0.9	Ori A	MMWO 4.9m	Lovas and Krupenie (1974) Manson et al. (1977)	Davis et al. (1974)
130.268 574(72)*	SiO	J=3-2 v=0	+1.34	Ori A	MMWO 4.9m	Lovas and Krupenie (1974) Manson et al. (1977)	Wilson et al. (1971) Dickinson et al. (1976)
132.744 800(26)*	SO_2	$14_{2,12}-14_{1,13}$	+0.57	Ori A	NRAO 36 ft	Lovas (1977)	Pickett and Davis (1979)
134.004 802(24)*	SO_2	$8_{26}-8_{17}$	+0.65	Ori A	MMWO 4.9m	Lovas (1977)	Pickett and Davis (1979)
135.695 985(26)*	SO_2	$5_{15}-4_{04}$	+1.5	ρ-Oph	MMWO 4.9 m	Lovas (1977)	Gottlieb et al. (1978)
136.464 3999(23)*	HCCCN	J=15-14	+1.5	Sgr B2	MMWO 4.9m	Lafferty and Lovas (1978)	Morris et al. (1977)

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
137.449 971(22)*	$H_2{}^{13}CO$	$2_{12}-1_{11}$	+0.2	Ori A	MMWO 4.9m	Johnson et al. (1977)	Kutner et al. (1976)
138.178 645(30)*	SO	4,3-3,2	+2.0[r]	Ori A	MMWO 4.9m	Tiemann (1974) Clark and De Lucia (1976)	Gottlieb and Ball (1973)
138.738 97(13)*	^{13}CS	J=3-2	+0.5	Ori A	MMWO 4.9m	Lovas and Krupenie (1974)	Wilson et al. (1971)
140.306 160(24)*	SO_2	$6_{24}-6_{15}$	+0.75	Ori A	MMWO 4.9m	Lovas (1977)	Pickett and Davis (1974)
140.839 526(30)	H_2CO	$2_{12}-1_{11}$	+4.5	Ori A	MMWO 4.9m	Johnson et al. (1972) Nerf (1972)	Kutner et al. (1971) Kutner et al. (1976)
143.057 045(30)*	SO_2	$16_{2,14}-16_{1,15}$	+0.57	Ori A	MMWO 4.9m	Lovas (1977)	Pickett and Davis (1979)
144.0773*	DCO^+	J=2-1	+0.3	Ori A	MMWO 4.9m		Guélin et al. (1977)
144.617 117(16)	$C^{34}S$	J=3-2	+1.2	Ori A	MMWO 4.9m	Lovas and Krupenie (1974) Kewley et al. (1963)	Wilson et al. (1976a)
144.826 5727(17)*	DCN	J=2-1 F'=2-2					
144.826 8097(10)	DCN	J=2-1 F'=1-0 F=2-1					
144.826 8414(10)	DCN	J=2-1 F'=1-0 F=1-1	+0.9	Ori A	MMWO 4.9m	Maki (1974) De Lucia and Gordy (1969)	Jefferts et al. (1973) Penzias et al. (1977)
144.828 0003(15)*	DCN	J=2-1 F'=2-1					
144.828 1093(17)*	DCN	J=2-1 F'=3-2					
144.830 3358(17)*	DCN	J=2-1 F'=1-1					
145.093 75(10)	CH_3OH	3_0-2_0 E	+1.25	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Kutner et al. (1973)
145.097 47(10)	CH_3OH	$3_{-1}-2_{-1}$ E	+1.45	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Kutner et al. (1973)
145.103 23(10)	CH_3OH	3_0-2_0 A^+	+1.35	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Kutner et al. (1973)
145.124 41(10)	CH_3OH	3_2-2_2 A^-	+1.45	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Kutner et al. (1973)
145.126 37(10)	CH_3OH	3_2-2_2 E, $3_{-2}-3_{-2}$ E					
145.131 88(10)	CH_3OH	3_1-2_1 E	+1.25	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Kutner et al. (1973)
145.133 46(10)	CH_3OH	3_2-2_2 A^+					
145.560 946(2)*	HCCCN	J=16-15	+0.8	Sgr B2	MMWO 4.9 m	Lafferty and Lovas (1978)	Morris et al. (1977)
145.602 966(33)	H_2CO	$2_{02}-1_{01}$	+1.9	Ori A	NRAO 36 ft	Johnson et al. (1972) Nerf (1972)	Thaddeus et al. (1971)

						Helminger et al. (1970)	

TABLE 2—*Continued*

Frequency[a] (GHz)	Molecule	Transition	T_A(K)	Source	Telescope	Laboratory Reference	Astronomical Reference
145.755 617(132)*	$C^{33}S$	J=3-2 F=7/2-5/2					
145.755 635(132)*	$C^{33}S$	J=3-2 F=9/2-7/2	+0.2	Ori A	MWO 4.9 m	Lovas and Krupenie (1974)	Wilson et al. (1976a)
145.756 374(132)*	$C^{33}S$	J=3-2 F=3/2-1/2					
145.756 392(132)*	$C^{33}S$	J=3-2 F=5/2-3/2					
145.946 8205(26)*	OCS	J=12-11	+0.45	Sgr B2	NRAO 36 ft	Maki (1974)	Solomon et al. (1973)
146.635 689(33)	$H_2{}^{13}CO$	$2_{11}-1_{10}$	n.r.[b]	Ori A	MWO 4.9 m	Johnson et al. (1972)	Wannier et al. (1976)
146.969 039(60)	CS	J=3-2	+8.1	Ori A	MWO 4.9 m	Lovas and Krupenie (1974) Kewley et al. (1963)	Penzias et al. (1971b) Liszt and Linke (1975)
150.176 54(25)	NO	$^2\Pi^+_{1/2}$ J=3/2-1/2 F=5/2-3/2	+0.25	Sgr B2	NRAO 36 ft	Burrus and Gordy (1953)	Liszt and Turner (1978)
150.498 355(34)	H_2CO	$2_{11}-1_{10}$	+2.7	Ori A	NRAO 36 ft	Johnson et al. (1972) Nerf (1972)	Thaddeus et al. (1971)
150.546 50(25)	NO	$^2\Pi^-_{1/2}$ J=3/2-1/2 F=5/2-3/2	+0.25	Sgr B2	NRAO 36 ft	Burrus and Gordy (1953)	Liszt and Turner (1978)
152.609 774(50)	DNC	J=2-1	+0.5	L134	MWO 4.9 m	Creswell et al. (1976)	Snell and Wootten (1977)
168.762 76237(2)	H_2S	$1_{10}-1_{01}$	+2.3	Ori A	NRAO 36 ft	Helminger et al. (1973) Cupp et al. (1968)	Thaddeus et al. (1972)
169.335 34(10)	CH_3OH	$1 0_1-1 0_0$ E	+0.7	Ori A	NRAO 36 ft	Lees et al. (1973) Lees and Baker (1968)	Wilson et al. (1972)
172.107 956(45)	$HC^{15}N$	J=2-1	+0.45	Ori A	NRAO 36 ft	Pearson et al. (1976)	Wilson et al. (1972)
172.676 573(50)	$H^{13}CN$	J=2-1 F=1-0,2-2					
172.677 959(50)	$H^{13}CN$	J=2-1 F=2-1,3-2	+0.91	Ori A	NRAO 36 ft	Pearson et al. (1976)	Wilson et al. (1972)
172.680 209(50)	$H^{13}CN$	J=2-1 F=1-1					
183.310 0906(15)	H_2O	$3_{13}-2_{20}$	+10	Ori A	KAO 1 m	De Lucia et al. (1974) Huiszoon (1971)	Waters et al. (1977)
203.407 52(2)	$H_2{}^{18}O$	$3_{13}-2_{20}$	+0.6	Ori A	NRAO 36 ft	De Lucia et al. (1972) De Lucia et al. (1974)	Phillips et al. (1978)
217.238 531(10)*	DCN	J=3-2	+0.7	Ori A	NRAO 36 ft	Maki (1974)	Phillips et al. (1974)
219.560 369(50)*	$C^{18}O$	J=2-1	+3.5	DR 21	NRAO 36 ft	Lovas and Krupenie (1974)	Phillips and Huggins (1977)
220.398 714(50)*	^{13}CO	J=2-1	+17	Ori A	NRAO 36 ft	Lovas and Krupenie (1974)	Phillips et al. (1973) Phillips and Huggins (1977)
230.538 001(9)*	CO	J=2-1	+70	Ori A	NRAO 36 ft	Lovas and Krupenie (1974)	Phillips et al. (1973) Phillips and Huggins (1977)
265.886 432(10)*	HCN	J=3-2	+20	Ori A	Hale 5 m		Huggins et al. (1979)
267.557(2)*	HCO^+	J=3-2	+12	Ori A	Hale 5 m		Huggins et al. (1979)
271.9811(15)*	HNC	J=3-2	+10	Ori A	Hale 5 m		Huggins et al. (1979)

[l] Only the central hyperfine component is listed.

[m] Astronomical reference shows partially resolved hyperfine structure.

[v] The frequency for this unidentified line reported by Clark *et al.* (1979) was in error. The correct frequency is 93.780 GHz as shown here.

NOTES TO TABLE 2

[a] The asterisk following a rest frequency indicates that the frequency is a calculated value.

[b] n.r. = not reported; abs. = absorption; em = emission.

[c] Line-to-continuum ratio (T_L/T_C) = 0.0095.

[d] Blended with a recombination line.

[e] 1 fu = 1 flux unit = 10^{-26} W m^{-2} Hz^{-1} = Jansky (Jy).

[f] This observation has not been confirmed.

[g] Beam brightness temperature.

[h] The report of the detection of a CH_3NHD line by Fourikis *et al.* (1977) appears to be a spurious detection (Lockman and Rickard, 1977). McLeod *et al.* (1978) have also attempted to confirm this observation without success.

[i] See astronomical reference.

[j] Intensity varies with time.

[k] Contains good discussion of observed H_2O hyperfine structure.

[n] Anomalous symmetry state excitation. See astronomical reference.

[o] From Tucker *et al.* (1974).

[p] Peak line radiation temperature.

[q] Blended with adjacent transitions, see astronomical reference.

[r] Only the strongest of several velocity components is listed.

[s] Possibly assignable to the CH_3OH line measured at 105.57635 GHz by Lees and Baker (1968).

[t] The acetaldehyde and formamide lines were observed in different sidebands and are blended in this observation.

[u] The rest frequencies and intensities are from observations by Snyder and Hollis (1979) toward L134N employing 2.6 km s^{-1} for the source velocity based on observation of other molecules. The relative uncertainty between hyperfine components is ± 30 kHz while the absolute uncertainty is not known. Comparison of these values with the partially resolved laboratory spectrum (Saykally *et al.* [1976a]) suggests an absolute uncertainty of ~ ± 0.2 MHz.

TABLE 3

LIST OF THE RADIO TELESCOPES REFERENCED IN TABLE 2

ARO 46 m	Algonquin Radio Observatory Lake Traverse Ontario, Canada
BTL 7 m	Bell Telephone Laboratory Holmdel, New Jersey
Hale 5 m	Hale Telescope Mount Palomar, California
IRT 13.7 m	Itapetinga Radio Telescope Sao Paulo, Brazil
KAO 1 m	G. P. Kuiper Airborne Observatory
MMWO 4.9 m	McDonald Millimeter Wave Observatory Fort Davis, Texas
MPI 100 m	Max-Planck-Institut für Radioastronomie Effelsberg, Germany
NEROC 120 ft (37 m)	Northwest Radio Observatory Corporation Haystack Observatory Westford, Massachusetts
NRAO 36 ft (11 m)	National Radio Astronomy Observatory Kitt Peak, Arizona
NRAO 140 ft (43 m)	National Radio Astronomy Observatory Greenbank, West Virginia
NRL 85 ft (26 m)	Naval Research Laboratory Maryland Point Observatory, Maryland
OSO 25.6 m	Onsala Space Observatory Onsala, Sweden
OSO 20 m	Onsala Space Observatory Onsala, Sweden
Parkes 64 m	Division of Radiophysics CSIRO Parkes, Australia
SRCAL 25 m	SRC Appleton Laboratory Chilbolton Observatory Stockbridge, Hants, England
TAO 6 m	Tokyo Astronomical Observatory Tokyo, Japan

REFERENCES

Akabane, K., *et al.* 1974, *Pub. Astr. Soc. Japan*, **26**, 1.

Alexander, A. J., Kroto, H. W., and Walton, D. R. M. 1976, *J. Molec. Spectrosc.*, **62**, 175.

Allen, M., and Knapp, G. R. 1978, *Ap. J.*, **225**, 843.

Amano, T., Saito, S., Hirota, E., and Morino, Y. 1969, *J. Molec. Spectrosc.*, **32**, 97.

Anderson, T. G., Dixon, T. A., Piltch, N. D., Saykally, R. J., Szanto, P. G., and Woods, R. C. 1977, *Ap. J.* (*Letters*), **216**, L85.

Avery, L. W., Broten, N. W., MacLeod, J. M., Oka, T., and Kroto, H. W. 1976, *Ap. J.* (*Letters*), **205**, L173.

Ball, J. A., Gottlieb, C. A., Lilley, A. E., and Radford, H. E. 1970, *Ap. J.* (*Letters*), **162**, L203.

Ball, J. A., Gottlieb, C. A., Meeks, M. L., and Radford, H. E. 1971, *Ap. J.* (*Letters*), **163**, L33.

Barrett, A. H., Ho, P., and Martin, R. N. 1975, *Ap. J.* (*Letters*), **198**, L119.

Barrett, A. H., Ho, P. T. P., and Myers, P. C. 1977, *Ap. J.* (*Letters*), **211**, L39.

Barrett, A. H., Martin, R. N., Myers, P. C., and Schwartz, P. R. 1972, *Ap. J.* (*Letters*), **178**, L23.

Barrett, A. H., Schwartz, P. R., and Waters, J. W. 1971, *Ap. J.* (*Letters*), **168**, L101.

Bauder, A., Lovas, F. J., and Johnson, D. R. 1976, *J. Phys. Chem. Ref. Data*, **5**, 53.

Bauer, A., Boucher, D., Burie, J., Demaison, J., and Dubrulle, A. 1979, *J. Phys. Chem. Ref. Data*, **8**, 537.

Bauer, A., and Burie, J. 1969, *C.R. Acad. Sci., Paris*, **268**, 800.

Bauer, A., and Maes, S. 1969, *J. Phys.*, **30**, 169.

Beaudet, R. A., and Poynter, R. L. 1978, *J. Phys. Chem. Ref. Data*, **7**, 311.

Blackman, G. L., Brown, R. D., Godfrey, P. D., Bassez, M. P., Ottrey, A. L., Winkler, D., and Robinson, B. J. 1977, *M.N.R.A.S.*, **180**, 1P.

Broten, N. W., MacLeod, J. M., Oka, T., Avery, L. W., Brooks, J. W., McGee, R. X., and Newton, L. M. 1976, *Ap. J.* (*Letters*), **309**, L143.

Broten, N. W., Oka, T., Avery, L. W., MacLeod, J. M., and Kroto, H. W. 1978, *Ap. J.* (*Letters*), **223**, L105.

Brown, R. D., Crofts, J. G., Gardner, F. F., Godfrey, P. D., Robinson, B. J., and Whiteoak, J. B. 1975, *Ap. J.* (*Letters*), **197**, L29.

Brown, R. D., Godfrey, P. D., Gunn, H. I., Blackman, G. L., and Storey, J. W. V. 1977, *M.N.R.A.S.*, **180**, 87P.

Brown, R. D., Godfrey, P. D., Storey, J. W. V., and Clark, F. O. 1976, *Nature*, **262**, 672.

Buhl, D., and Snyder, L. E. 1970, *Nature*, **228**, 267.

Buhl, D., Snyder, L. E., and Edrich, J. 1972, *Ap. J.*, **177**, 625.

Buhl, D., Snyder, L. E., Lovas, F. J., and Johnson, D. R. 1974, *Ap. J.* (*Letters*), **192**, L97.

Buhl, D., Snyder, L. E., Schwartz, P. R., and Barrett, A. H. 1969, *Ap. J.* (*Letters*), **158**, L97.

Burrus, C. A., and Gordy, W. 1953, *Phys. Rev.*, **92**, 1437.

Cheung, A. C., Rank, D. M., Townes, C. H., Thorton, D. D., and Welch, W. J. 1968, *Phys. Rev. Letters*, **21**, 1701.

———. 1969*a*, *Nature*, **221**, 626.

Cheung, A. C., Rank, D. M., Townes, C. H., and Welch, W. J. 1969*b*, *Nature*, **221**, 917.

Churchwell, E., Walmsley, C. M., and Winnewisser, G. 1977, *Astr. Ap.*, **54**, 925.

Churchwell, E., and Winnewisser, G. 1975, *Astr. Ap.*, **45**, 229.

Churchwell, E., Winnewisser, G., and Walmsley, C. M. 1978, *Astr. Ap.*, **67**, 139.
Clark, F. O., Brown, R. D., Godfrey, P. D., Storey, J. W. V., and Johnson, D. R. 1976, *Ap. J. (Letters)*, **210**, L139.
Clark, F. O., and Johnson, D. R. 1974, *Ap. J. (Letters)*, **191**, L87.
———. 1975, *Bull. AAS*, **7**, 264.
Clark, F. O., and Lovas, F. J. 1977, *Ap. J. (Letters)*, **217**, L47.
Clark, F. O., Lovas, F. J., and Johnson, D. R. 1979, *Ap. J.*, **229**, 553.
Clark, W. W., and De Lucia, F. C. 1976, *J. Molec. Spectrosc.*, **60**, 332.
Creswell, R. A., Pearson, E. F., Winnewisser, M., and Winnewisser, G. 1976, *Zs. Naturforschung*, **31a**, 221.
Creswell, R. A., Winnewisser, G., and Gerry, M. C. L. 1977, *J. Molec. Spectrosc.*, **65**, 420.
Cupp, R. E., Kempf, R. A., and Gallagher, J. J. 1968, *Phys. Rev.*, **171**, 60.
Davis, J. H., Blair, G. N., Van Till, H., and Thaddeus, P. 1974, *Ap. J. (Letters)*, **190**, L117.
De Lucia, F. C., and Gordy, W. 1969, *Phys. Rev.*, **187**, 58.
De Lucia, F. C., Helminger, P., Cook, R. L., and Gordy, W. 1972, *Phys. Rev. A*, **6**, 1324.
De Lucia, F. C., Helminger, P., and Kirchhoff, W. H. 1974, *J. Phys. Chem. Ref. Data*, **3**, 211.
Destombes, J. L., Marliere, C., Baudry, A., and Brillet, J. 1977, *Astr. Ap.*, **60**, 55.
de Zafra, R. L. 1971, *Ap. J.*, **170**, 165.
Dickinson, D. F. 1972*a*, *Ap. Letters*, **12**, 235.
———. 1972*b*, *Ap. J. (Letters)*, **175**, L43.
Dickinson, D. F., Gottlieb, C. A., Gottlieb, E. W., and Litvak, M. M. 1976, *Ap. J.*, **206**, 79.
Dixon, T. A., and Woods, R. C. 1977, *J. Chem. Phys.*, **67**, 3956.
Doherty, L. H., MacLeod, J. M., and Oka, T. 1974, *Ap. J. (Letters)*, **192**, L157.
Dubrulle, A. 1978, private communication.
Encrenaz, P. J., Wannier, P. G., Jefferts, K. B., Penzias, A. A., and Wilson, R. W. 1973, *Ap. J. (Letters)*, **186**, L77.
Evans, N. J., II, Cheung, A. C., and Sloanaker, R. M. 1970, *Ap. J. (Letters)*, **159**, L9.
Fourikis, N., Sinclair, M. W., Robinson, B. J., Godfrey, P. D., and Brown, R. D. 1974*a*, *Australian J. Phys.*, **27**, 425.
Fourikis, N., Takagi, K., and Morimoto, M. 1974*b*, *Ap. J. (Letters)*, **191**, L139.
Fourikis, N., Takagi, K., and Saito, S. 1977, *Ap. J. (Letters)*, **212**, L33.
Gaines, L., Casleton, K. H., and Kukolich, S. G. 1974, *Ap. J. (Letters)*, **191**, L99.
Gardner, F. F., McGee, R. X., and Sinclair, M. W. 1970, *Ap. Letters*, **5**, 67.
Gardner, F. F., and Ribes, J. C. 1971, *Ap. Letters*, **9**, 175.
Gardner, F. F., Ribes, J. C., and Cooper, B. F. C. 1971*a*, *Ap. Letters*, **9**, 181.
Gardner, F. F., Ribes, J. C., and Sinclair, M. W. 1971*b*, *Ap. J. (Letters)*, **169**, L109.
Gardner, F. F., and Whiteoak, J. B. 1976, *M.N.R.A.S.*, **176**, 57P.
Gardner, F. F., Whiteoak, J. B., and Winnewisser, G. 1978, *Astr. Ap.*, **67**, L23.
Gardner, F. F., and Winnewisser, G. 1975*a*, *Ap. J. (Letters)*, **195**, L127.
———. 1975*b*, *Ap. J. (Letters)* **197**, L73.
Gerry, M. C. L., Yamada, K., and Winnewisser, G. 1979, *J. Phys. Chem. Ref. Data*, **8**, 107.
Giguere, P. T., and Clark, F. O. 1975, *Ap. J.*, **198**, 761.
Gilmore, W., Morris, M., Johnson, D. R., Lovas, F. J., Zuckerman, B., Turner, B. E., and Palmer, P. 1976, *Ap. J.*, **204**, 43.
Godfrey, P. D., Brown, R. D., Gunn, H. I., Blackman, G. L., and Storey, J. W. V. 1977, *M.N.R.A.S.*, **180**, 83P.
Godfrey, P. D., Brown, R. D., Robinson, B. J., and Sinclair, M. W. 1973, *Ap. Letters*, **13**, 119.
Gordy, W., and Cowan, M. J. 1957, *Bull. Am. Phys. Soc.*, **2**, 212.
Gottlieb, C. A. 1973, in *Molecules in the Galactic Environment*, ed., M. A. Gordon and L. E. Snyder (New York: Interscience), p. 181.
Gottlieb, C. A. 1978, private communication.
Gottlieb, C. A., and Ball, J. A. 1973, *Ap. J. (Letters)*, **184**, L59.
Gottlieb, C. A., Ball, J. A., Gottlieb, E. W., and Dickinson, D. F. 1979, *Ap. J.*, **227**, 422.
Gottlieb, C. A., Ball, J. A., Gottlieb, E. W., Lada, C. J., and Penfield, H. 1975, *Ap. J. (Letters)*, **200**, L147.
Gottlieb, C. A., Gottlieb, E. W., Litvak, M. M., Ball, J. A., and Penfield, H. 1978, *Ap. J.*, **219**, 77.
Gottlieb, C. A., Palmer, P., Rickard, L. J., and Zuckerman, B. 1973*a*, *Ap. J.*, **182**, 699.
Gottlieb, C. A., and Radford, H. E. 1971, private communication.
Gottlieb, C. A., Radford, H. E., and Smith, B. P. 1973*b*, private communication.
———. 1974, unpublished data.
Guélin, M., Green, S., and Thaddeus, P. 1978, *Ap. J. (Letters)*, **224**, L27.
Guélin, M., Langer, W. D., Snell, R. L., and Wootten, H. A. 1977, *Ap. J. (Letters)*, **217**, L165.
Guélin, M., and Thaddeus, P. 1977, *Ap. J. (Letters)*, **212**, L81.
Helminger, P., De Lucia, F. C., and Gordy, W. 1970, *Phys. Rev. Letters*, **25**, 1397.
Helminger, P., De Lucia, F. C., and Kirchhoff, W. H. 1973, *J. Phys. Chem. Ref. Data*, **2**, 215.
Heuvel, J. E. M., and Dymanus, A. 1973, *J. Molec. Spectrosc.*, **45**, 282.
Ho, P. T. P., Martin, R. N., Myers, P. C., and Barrett, A. H. 1977, *Ap. J. (Letters)*, **215**, L29.
Hollis, J. M., and Rhodes, P. J. 1976, NRAO Documentation Memo No. 1, "Spectral Line Calibrations," Tucson, Arizona.
Hollis, J. M., Snyder, L. E., Lovas, F. J., and Buhl, D. 1976, *Ap. J. (Letters)*, **209**, L83.
Hollis, J. M., and Ulich, B. L. 1977, *Ap. J.*, **214**, 699.
Huggins, P. J., Phillips, T. G., Neugebauer, G., Werner, M. W., Wannier, P. G., and Ennis, D. 1979, *Ap. J.*, **227**, 441.
Huiszoon, C. 1971, *Rev. Sci. Instr.*, **42**, 477.
Jefferts, K. B., Penzias, A. A., and Wilson, R. W. 1970, *Ap. J. (Letters)*, **161**, L87.
———. 1973, *Ap. J. (Letters)*, **179**, L57.
Jefferts, K. B., Penzias, A. A., Wilson, R. W., and Solomon, P. M. 1971, *Ap. J. (Letters)*, **168**, L111.
Johns, J. W. C., Stone, J. M. R., and Winneswisser, G. 1972, *J. Molec. Spectrosc.*, **42**, 523.
Johnson, D. R., Lovas, F. J., Gottlieb, C. A., Gottlieb, E. W., Litvak, M. M., Guélin, M., and Thaddeus, P. 1977, *Ap. J.*, **218**, 370.
Johnson, D. R., Lovas, F. J., and Kirchhoff, W. H. 1972, *J. Phys. Chem. Ref. Data*, **1**, 1011.
Johnson, D. R., Snyder, L. E., and Lovas, F. J. 1976*a*, *Bull AAS*, **8**, 349.
Johnson, D. R., Suenram, R. D., and Lafferty, W. J. 1976*b*, *Ap. J.*, **208**, 245.
Kaifu, N., Morimoto, M., Nagane, K., Akabane, K., Iguchi, T., and Takagi, K. 1974, *Ap. J. (Letters)*, **191**, L135.
Kaifu, N., Takagi, K., and Kojima, T. 1975, *Ap. J. (Letters)*, **198**, L85.
Kakar, R. K., and Poynter, R. L. 1975, *J. Molec. Spectrosc.*, **54**, 475.
Kewley, R., Sastry, K. V. L. N., Winnewisser M., and Gordy, W. 1963, *J. Chem. Phys.*, **39**, 2856.
Kirchhoff, W. H., Johnson, D. R., and Lovas, F. J. 1973, *J. Phys. Chem. Ref. Data*, **2**, 1.
Kroto, H. W., Kirby, C., Walton, D. R. M., Avery, L. W., Broton, N. W., MacLeod, J. M., and Oka, T. 1977, *Bull. AAS*, **9**, 303. See also Kroto *et al.* (1978).
———. 1978, *Ap. J. (Letters)*, **219**, L133.
Kuiper, E. N. R., and Kuiper, T. 1975, private communication to Gilmore *et al.* (1976).
Kuiper, E. N. R., Kuiper, T. B. H., Zuckerman, B., and Kakar, R. K. 1977, *Ap. J.*, **214**, 394.
Kuiper, E. N. R., Zuckerman, B., and Kuiper, T. B. H. 1978, *Ap. J. (Letters)*, **219**, L49.
Kukolich, S. G. 1965, *Phys. Rev.*, **138**, A1322.
———. 1967, *Phys. Rev.*, **156**, 83.
———. 1969, *J. Chem. Phys.*, **50**, 3751.
———. 1975, *J. Am. Chem. Soc.*, **97**, 5704.

Kukolich, S. G., Nelson, A. C., and Yamanashi, B. S. 1971, *J. Am. Chem. Soc.*, **93**, 6769.
Kukolich, S. G., and Wofsky, S. G. 1970, *J. Chem. Phys.*, **52**, 5477.
Kutner, M. L., Evans, N. J., II, and Tucker, K. D. 1976, *Ap. J.*, **209**, 452.
Kutner, M., Thaddeus, P., Jefferts, K. B., Penzias, A. A., and Wilson, R. W. 1971, *Ap. J. (Letters)*, **164**, L49.
Kutner, M. L., Thaddeus, P., Penzias, A. A., Wilson, R. W., and Jefferts, K. B. 1973, *Ap. J. (Letters)*, **183**, L27.
Lada, C. J., Gottlieb, C. A., Litvak, M. M., and Lilley, A. E. 1974, *Ap. J.*, **194**, 609.
Lafferty, W. J., and Lovas, F. J. 1978, *J. Phys. Chem. Ref. Data*, **7**, 441.
Langer, W. D., Wilson, R. W., Henry, P. S., and Guélin, M. 1978, *Ap. J. (Letters)*, **225**, L139.
Lees, R. M., and Baker, J. G. 1968, *J. Chem. Phys.*, **48**, 5299.
Lees, R. M., Lovas, F. J., Kirchhoff, W. H., and Johnson, D. R. 1973, *J. Phys. Chem. Ref. Data*, **2**, 205.
Lichtenstein, M., Gallagher, J. J., and Deer, V. E. 1964, *J. Molec. Spectrosc.*, **12**, 87.
Linke, R. A., Goldsmith, P. F., Wannier, P. G., Wilson, R. W., and Penzias, A. A. 1977, *Ap. J.*, **214**, 50.
Liszt, H. S. 1978, *Ap. J.*, **219**, 454.
Liszt, H. S., and Linke, R. A. 1975, *Ap. J.*, **196**, 709.
Liszt, H. S., and Turner, B. E. 1978, *Ap. J. (Letters)*, **224**, L73.
Little, L. T., Macdonald, G. H., Riley, P. W., and Matheson, D. N. 1978, *M.N.R.A.S.*, **183**, 45P.
Little, L. T., Riley, P. W., and Matheson, D. N. 1977, *M.N.R.A.S.*, **181**, 33P.
Lockman, F. J., and Rickard, L. J. 1977, NRAO Electronics Division Internal Rept., No. 183.
Lovas, F. J. 1977, unpublished work.
———. 1979, in preparation.
Lovas, F. J., Dreizler, H., and Lutz, H. 1979, *J. Phys. Chem. Ref. Data*, in press.
Lovas, F. J., Johnson, D. R., Buhl, D., and Snyder, L. E. 1976*a*, *Ap. J.*, **209**, 770.
Lovas, F. J., and Krupenie, P. H. 1974, *J. Phys. Chem. Ref. Data*, 3, 245.
Lovas, F. J., Snyder, L. E., and Buhl, D. 1976*b*, private communication.
Lovas, F. J., and Suenram, R. D. 1978, unpublished measurements.
———. 1979, in preparation.
Lovas, F. J., and Tiemann, E. 1974, *J. Phys. Chem. Ref. Data*, **3**, 609.
MacLeod, J. M., Avery, L. W., Broten, N. W., and Oka, T. 1978, private communication.
MacLeod, J. M., and Doherty, L. H. 1975, *Bull. AAS*, **7**, 265.
Maki, A. G. 1974, *J. Phys. Chem. Ref. Data*, **3**, 221.
Manchester, R. N., and Gordon, M. A. 1971, *Ap. J.*, **169**, 507.
Manson, E. L., Jr., Clark, W. W., De Lucia, F. D., and Gordy, W. 1977, *Phys. Rev. A*, **15**, 223.
Matsakis, D. N., Cheung, A. C., Wright, M. C. H., Welch, W. J., Askne, J. A., and Townes, C. H. 1979, in preparation.
McGee, R. X., Balister, M., and Newton, L. M. 1977, *M.N.R.A.S.*, **180**, 585.
Meerts, W. L., and Dymanus, A. 1975, *Canadian J. Phys.*, **53**, 2123.
Mockler, R. C., and Bird, G. R. 1955, *Phys. Rev.*, **98**, 1837.
Moran, J. M., *et al.* 1973, *Ap. J.*, **185**, 535.
Morris, M., Gilmore, W., Palmer, P., Turner, B. E., and Zuckerman, B. 1975, *Ap. J. (Letters)*, **199**, L47.
Morris, M., Snell, R. L., and Vanden Bout, P. 1977, *Ap. J.*, **216**, 738.
Morris, M., Turner, B. E., Palmer, P., and Zuckerman, B. 1976, *Ap. J.*, **205**, 82.
Morris, M., Zuckerman, B., Palmer, P., and Turner, B. E. 1973, *Ap. J.*, **186**, 501.
Nerf, R. 1972, *Ap. J.*, **174**, 467.
Nystrom, H. J., Palmer, P., and Zuckerman, B. 1978, *Bull. AAS*, **10**, 393.
Palmer, P., Zuckerman, B., Buhl, D., and Snyder, L. E. 1969, *Ap. J. (Letters)*, **156**, L147.
Pearson, E. F., Creswell, R. A., Winnewisser, M., and Winnewisser, G. 1976, *Zs. Naturforschung*, **A31**, 1394.
Penzias, A. A., Jefferts, K. B., and Wilson, R. W. 1971*a*, *Ap. J.*, **165**, 229.
Penzias, A. A., Solomon, P. M., Wilson, R. W., and Jefferts, K. B. 1971*b*, *Ap. J. (Letters)*, **168**, L53.
Penzias, A. A., Wannier, P. G., Wilson, R. W., and Linke, R. A. 1977, *Ap. J.*, **211**, 108.
Penzias, A. A., Wilson, R. W., and Jefferts, K. B. 1974, *Phys. Rev. Letters*, **32**, 701.
Phillips, T. G., and Huggins, P. J. 1977, *Ap. J.*, **211**, 798.
Phillips, T. G., Huggins, P. J., Neugebauer, G., and Werner, M. W. 1977, *Ap. J. (Letters)*, **217**, L161.
Phillips, T. G., Jefferts, K. B., and Wannier, P. G. 1973, *Ap. J. (Letters)*, **186**, L19.
———. 1974, *Ap. J. (Letters)*, **192**, L153.
Phillips, T. G., Scoville, N. Z., Kwan, J., Huggins, P. J., and Wannier, P. G. 1978, *Ap. J. (Letters)*, **222**, L59.
Pickett, H. M., and Davis, J. H. 1979, *Ap. J.*, **227**, 446.
Poynter, R. L., and Kakar, R. K. 1975, *Ap. J. Suppl.*, **29**, 87.
Radford, H. E. 1968, *Rev. Sci. Instr.*, **39**, 1687.
———. 1972, *Ap. J.*, **174**, 207.
Ribes, J. C., Ables, J. G., Godfrey, P. D., and Brown, R. D. 1973, *Australian J. Phys.*, **26**, 79.
Robinson, B. J., Brooks, J. W., Godfrey, P. D., and Brown, R. D. 1974, *Australian J. Phys.*, **27**, 865.
Rogers, A. E. E., and Barrett, A. H. 1966, *A.J.*, **71**, 868.
Rosenblum, B., and Nethercot, A. H., Jr. 1957, *J. Chem. Phys.*, **27**, 828.
Rosenblum, B., Nethercot, A. H., and Townes, C. H. 1958, *Phys. Rev.*, **109**, 400.
Rubin, R. H., Swenson, G. W., Jr., Benson, R. C., Tigelaar, H. L., and Flygare, W. H. 1971, *Ap. J. (Letters)*, **169**, L39.
Rydbeck, O. E. H., Elldér, J., Irvine, W. M., Sume, A., and Hjalmarson, Å. 1974, *Astr. Ap.*, **34**, 479.
Rydbeck, O. E. H., Kollberg, E., Hjalmarson, Å., Sume, A., Elldér, J., and Irvine, W. M. 1976, *Ap. J. Suppl.*, **31**, 333.
Rydbeck, O. E. H., Sume, A., Hjalmarson, Å., Elldér, J., Rönnäng, B. O., and Kollberg, E. 1977, *Ap. J. (Letters)*, **215**, L35.
Saito, S. 1972, *Ap. J. (Letters)*, **178**, L95.
———. 1975, private communication.
Saito, S., and Takagi, K. 1972, *Ap. J. (Letters)*, **175**, L47.
Saykally, R. J., Dixon, T. A., Anderson, T. G., Szanto, P. G., and Woods, R. C. 1976*a*, *Ap. J. (Letters)*, **205**, L101.
Saykally, R. J., Szanto, P. G., Anderson, T. G., and Woods, R. C. 1976*b*, presentation at the 31st Symposium Molecular Spectroscopy, Columbus, Ohio.
Scalise, E., Jr., and Lepine, J. R. D. 1978, *Astr. Ap.* **65** L7.
Schwartz, P., and Barrett, A. H. 1969, *Ap. J. (Letters)*, **157**, L109.
Scoville, N. Z., and Solomon, P. M. 1978, *Ap. J. (Letters)*, **220**, L103.
Sinclair, M. W., Fourikis, N., Ribes, J. C., Robinson, B. J., Brown, R. D., and Godfrey, P. D. 1973, *Australian J. Phys.*, **26**, 85.
Snell, R. L., and Wootten, H. A. 1977, *Ap. J. (Letters)*, **216**, L111.
Snyder, L. E., and Buhl, D. 1971*a*, *Bull. AAS*, **3**, 388.
———. 1971*b*, *Ap. J. (Letters)*, **163**, L47.
———. 1972*a*, private communication.
———. 1972*b*, *Ann. NY Acad. Sci.*, **194**, 17
———. 1972*c*, *Ap. J.*, **177**, 619.
———. 1973, *Nature*, **243**, 45.
———. 1974, *Ap. J. (Letters)*, **189**, L31.
———. 1975, *Ap. J.*, **197**, 329.
Snyder, L. E., Buhl, D., Schwartz, P. R., Clark, F. O., Johnson, D. R., Lovas, F. J., and Giguere, P. T. 1974, *Ap. J. (Letters)*, **191**, L79.
Snyder, L. E., Buhl, D., Zuckerman, B., and Palmer, P. 1969, *Phys. Rev. Letters*, **22**, 679.
Snyder, L. E., Dickinson, D. F., Brown, L. W., and Buhl, D. 1978, *Ap. J.*, **224**, 512.
Snyder, L. E., and Hollis, J. M. 1979, private communication.
Snyder, L. E., Hollis, J. M., and Buhl, D. 1977*a*, *Ap. J. (Letters)*, **215**, L87.
Snyder, L. E., Hollis, J. M., Buhl, D., and Watson, W. D. 1977*b*, *Ap. J. (Letters)*, **218**, L61.
Snyder, L. E., Hollis, J. M., Lovas, F. J., and Ulich, B. L. 1976*a*, *Ap. J.*, **209**, 67.

Snyder, L. E., Hollis, J. M., and Ulich, B. L. 1976*b*, *Ap. J.* (*Letters*), **208**, L91.
Snyder, L. E., Hollis, J. M., Ulich, B. L., Lovas, F. J., Johnson, D. R., and Buhl, D. 1975, *Ap. J.* (*Letters*), **198**, L81.
Solomon, P. M., Jefferts, K. B., Penzias, A. A., and Wilson, R. W. 1971, *Ap. J.* (*Letters*), **168**, L107.
Solomon, P. M., Penzias, A. A., Jefferts, K. B., and Wilson, R. W. 1973, *Ap. J.* (*Letters*), **185**, L63.
Takagi, K., and Kojima, T. 1973, *Ap. J.* (*Letters*), **181**, L91.
Takuma, H., Schimizu, T., and Shimoda, K. 1959, *J. Phys. Soc. Japan*, **14**, 1595.
ter Meulen, J. J., and Dymanus, A. 1972, *Ap. J.* (*Letters*), **172**, L21.
ter Meulen, J. J., Meerts, W. L., van Mierlo, G. W. M., and Dymanus, A. 1976, *Phys. Rev. Letters*, **36**, 1031.
Thacker, D. L., Wilson, W. J., and Barrett, A. H. 1970, *Ap. J.* (*Letters*), **161**, L191.
Thaddeus, P., Krisher, L. C., and Loubser, J. H. N. 1964, *J. Chem. Phys.*, **40**, 257.
Thaddeus, P., Kutner, M. L., Penzias, A. A., Wilson, R. W., and Jefferts, K. B. 1972, *Ap. J.* (*Letters*), **176**, L73.
Thaddeus, P., Mather, J., Davis, J. H., and Blair, G. N. 1974, *Ap. J.* (*Letters*), **192**, L33.
Thaddeus, P., and Turner, B. E. 1975, *Ap. J.* (*Letters*), **201**, L25.
Thaddeus, P., Wilson, R. W., Kutner, M., Penzias, A. A., and Jefferts, K. B. 1971, *Ap. J.* (*Letters*), **168**, L59.
Tiemann, E. 1974, *J. Phys. Chem. Ref. Data*, **3**, 259.
———. 1976, *J. Phys. Chem. Ref. Data*, **5**, 1147.
Tiemann, E., Renwanz, E., Hoeft, J., and Torring, T. 1972, *Zs. Naturforschung*, **27a**, 1566.
Tucker, K. D., and Kutner, M. L. 1978, *Ap. J.*, **222**, 859.
Tucker, K. D., Kutner, M. L., and Thaddeus, P. 1974, *Ap. J.* (*Letters*), **193**, L115.
Tucker, K. D., Tomasevich, G. R., and Thaddeus, P. 1971, *Ap. J.*, **169**, 429.
Turner, B. E. 1971, *Ap. J.* (*Letters*), **163**, L35.
———. 1974, *Ap. J.* (*Letters*), **193**, L83.
———. 1977, *Ap. J.* (*Letters*), **213**, L75.
———. 1978*a*, private communication.
Turner, B. E., and Gammon, R. H. 1975, *Ap. J.*, **198**, 71.
Turner, B. E., Gordon, M. A., and Wrixon, G. T. 1972, *Ap. J.*, **177**, 609.
Turner, B. E., Kislyakov, A. G., Liszt, H. S., and Kaifu, N. 1975*a*, *Ap. J.* (*Letters*), **201**, L149.
Turner, B. E., Palmer, P., and Zuckerman, B. 1970, *Ap. J.* (*Letters*), **160**, L125.
Turner, B. E., Zuckerman, B., Fourikis, N., Morris, M., and Palmer, P. 1975*b*, *Ap. J.* (*Letters*), **198**, L125.
Turner, B. E., Zuckerman, B., Morris, M., and Palmer, P. 1978, *Ap. J.* (*Letters*), **219**, L43.
Turner, B. E., Zuckerman, B., Palmer, P., and Morris, M. 1973, *Ap. J.*, **186**, 123.
Ulich, B. L. 1978, private communication.
Ulich, B. L., and Conklin, E. K. 1974, *Nature*, **248**, 121.
Ulich, B. L., and Haas, R. W. 1976, *Ap. J. Suppl.*, **30**, 247.
Ulich, B. L., Hollis, J. M., and Snyder, L. E. 1977, *Ap. J.* (*Letters*), **217**, L105.
Wannier, P. G., and Linke, R. A. 1978, *Ap. J.*, **226**, 817.
Wannier, P. G., Penzias, A. A., Linke, R. A., and Wilson, R. W. 1976, *Ap. J.*, **204**, 26.
Wannier, P. G., and Phillips, T. G. 1977, *Ap. J.*, **215**, 796.
Waters, J. W., Gustinic, J. J., Kakar, R. K., Kuiper, T. B. H., Swanson, P. N., Kerr, A. R., and Thaddeus, P. 1977, *Bull. AAS*, **9**, 564.
Weinreb, S., Barrett, A. H., Meeks, M. L., and Henry, J. C. 1963, *Nature*, **200**, 829.
Welch, W. J. 1970, *Bull. AAS*, **2**, 355.
Whiteoak, J. B., and Gardner, F. F. 1976, *M.N.R.A.S.*, **174**, 21P.
Wilson, R. W., Jefferts, K. B., and Penzias, A. A. 1970, *Ap. J.* (*Letters*), **161**, L43.
Wilson, R. W., Penzias, A. A., Jefferts, K. B., Kutner, M., and Thaddeus, P. 1971, *Ap. J.* (*Letters*), **167**, L97.
Wilson, R. W., Penzias, A. A., Jefferts, K. B., and Solomon, P. M. 1973, *Ap. J.* (*Letters*), **179**, L107.
Wilson, R. W., Penzias, A. A., Jefferts, K. B., Thaddeus, P., and Kutner, M. L. 1972, *Ap. J.* (*Letters*), **176**, L77.
Wilson, R. W., Penzias, A. A., Wannier, P. G., and Linke, R. 1976*a*, *Ap. J.* (*Letters*), **204**, L135.
Wilson, T. L., Bieging, J., Downes, D., and Gardner, F. F. 1976*b*, *Astr. Ap.*, **51**, 303.
Wilson, W. J., and Barrett, A. H. 1970, *Ap. Letters*, **6**, 231.
Wilson, W. J., and Kakar, R. 1976, private communication to Clark *et al.* (1976).
Winnberg, A., Walmsley, C. M., and Churchwell, E. 1978, *Astr. Ap.*, **66**, 431.
Winnewisser, G., and Churchwell, E. 1975, *Ap. J.* (*Letters*), **200**, L33.
Winnewisser, G., and Gardner, F. F. 1976, *Astr. Ap.*, **48**, 159.
Winnewisser, G., Hocking, W. H., and Gerry, M. C. L. 1976, *J. Phys. Chem. Ref. Data*, **5**, 79.
Woods, R. C., Saykally, R. J., Dixon, T. A., Szanto, P. G., and Anderson, T. G. 1976, private communication.
Yen, J. L., Zuckerman, B., Palmer, P., and Penfield, H. 1969, *Ap. J.* (*Letters*), **156**, L27.
Zuckerman, B., Ball, J. A., and Gottlieb, C. A. 1971, *Ap. J.* (*Letters*), **163**, L41.
Zuckerman, B., Evans, N. J., Morris, G., and Sato, T. 1973, *Bull. AAS*, **5**, 420.
Zuckerman, B., Morris, M., Palmer, P., and Turner, B. E. 1972*a*, *Ap. J.* (*Letters*), **173**, L125.
Zuckerman, B., Palmer, P., Penfield, H., and Lilley, A. E. 1968, *Ap. J.* (*Letters*), **153**, L69.
Zuckerman, B., Palmer, P., Snyder, L. E., and Buhl, D. 1969, *Ap. J.* (*Letters*), **157**, L167.
Zuckerman, B., and Turner, B. E. 1975, *Ap. J.*, **197**, 123.
Zuckerman, B., *et al.* 1975, *Ap. J.* (*Letters*), **196**, L99.
Zuckerman, B., Turner, B. E., Johnson, D. R., Palmer, P., and Morris, M. 1972*b*, *Ap. J.*, **177**, 601.
Zuckerman, B., Yen, J. L., Gottlieb, C. A., and Palmer, P. 1972*c*, *Ap. J.*, **177**, 59.

Note added in proof.—There appears to be uncertainty in the assignment of the hyperfine quantum numbers for HNC. In a preprint on the study of $NH^{13}C$ and HNC in L134 N and Heiles Cloud 2, Frerking, Langer, and Wilson suggest that the splitting observed by Snyder *et al.* (1977*a*) for HNC in L134 is affected by self-absorption and that the lower-frequency line shown in Table 2 at 90.663405(60) GHz should be assigned to the weakest component; i.e., $F = 0$–1, with the $F = 1$–1 lying higher in frequency, but blended with the $F = 2$–1 component. Frerking *et al.* present the following rest frequencies for $HN^{13}C$: $F = 0$–1 87.090735(46) GHz, $F = 2$–1 87.090859(46) GHz, and $F = 1$–1 87.090542(46) GHz; and for HNC: $F = 0$–1 90.663450 GHz, $F = 2$–1 90.663574 GHz, and $F = 1$–1 90.663656 GHz.

D. R. Johnson: National Measurement Laboratory, National Bureau of Standards, Building 223, Room B 354, Washington, DC 20234

F. J. Lovas: Molecular Spectroscopy Divison, National Bureau of Standards, Building 221, Room B 268, Washington, DC 20234

L. E. Snyder: Department of Astronomy, University of Illinois, Urbana, IL 61801