

HARVARD UNIVERSITY

Department of Chemistry  
12 Oxford Street  
Cambridge, Massachusetts 02138

April 4, 1967

Dear Contributor:

This is the tenth microwave spectroscopy information letter and is being sent to those who contributed:

1. UNIVERSITY OF BOLOGNA  
Chemical Institute "G. Ciamician"  
P. G. Favero

$F_3N$ ( $NF_3$ )	Nitrogen trifluoride	A. Mirri G. Cazzoli	Millimeter wave spectrum; centrifugal effects and force constants.
$FNO_2$	Nitryl fluoride	A. Mirri G. Cazzoli	Millimeter wave spectrum; centrifugal effects and force constants.
$ClNO_2$	Nitryl chloride	A. Mirri G. Cazzoli	Millimeter wave spectrum; centrifugal effects and force constants.

2. UNIVERSITY OF BRISTOL  
Department of Physical Chemistry  
A. Peter Cox

$HNO_2$	Nitrous acid	A. H. Brittain	Further measurements on trans isomer - centrifugal distortion in progress.
$C_5H_5NiO$ ( $C_5H_5NiNO$ )	Cyclopentadienyl nitrosyl nickel	A. H. Brittain	Six isotopic species - manuscript in preparation.

$C_5H_5NO$ Pt ( $C_5H_5Pt$ NO)	Cyclopentadienyl nitrosyl platinum	C. Roberts	Samples prepared - in progress.
$C_5H_5NO$ Pd ( $C_5H_5Pd$ NO)	Cyclopentadienyl nitrosyl palladium	C. Roberts	Samples prepared - in progress.
$C_4H_9NS$ Si ( $(CH_3)_3Si$ NCS)	trimethyl silicon isothiocyanate	C. C. Young	Assigned.
$C_4H_9NO$ Si ( $(CH_3)_3Si$ NCO)	trimethyl silicon isocyanate	C. C. Young	In progress.

3. University of California, Santa Barbara  
Chemistry Department  
D. O. Harris

$C_6H_6O_2$	1-3 dioxolane		Assignment in progress.
$C_5H_7N$	Cyclobutyl cyanide		Assignment in progress.

4. Cambridge University  
Department of Theoretical Chemistry  
Alan Carrington and Donald Levy

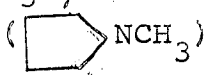
ClO	Chlorine oxide		Paper in preparation.
BrO	Bromine oxide		Spectrum observed; Dipole moment measured.
FS	Sulfur fluoride		Spectrum observed and assigned.
NS	Sulfur nitride		Spectrum observed and assigned; Dipole moment measured.

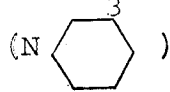
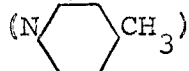
5. University of Copenhagen  
Department of Chemical Physics  
Børge Bak and Lise Nygaard

$C_2H_2N_2O$	1,3,4-Oxadiazole	$^{13}C$ -, $^{15}N$ -, D- species assigned. Quadrupole coupling constants.
$C_2H_3NO$ ( $CH_3OCN$ )	Methyl cyanate	Spectrum assigned.
$C_4H_5N$	Pyrrole	Refined $r_s$ -structure, manuscript being prepared.
$C_4H_6$	Cyclobutene	Two $^{13}C$ -species assigned.
$C_5H_5N$	Pyridine	Refined $r_s$ -structure, manuscript being prepared.
1,2- $C_6H_4F_2$	Ortho-difluorobenzene	Manuscript submitted for publication.
1,3- $C_6H_4F_2$	Meta-difluorobenzene	Manuscript submitted for publication.
$C_6H_5F$	Fluorobenzene	Four $^{13}C$ -species assigned.

6. University of Freiburg  
Physikalisches Institut  
H. D. Rudolph and H. Dreizler

$C_8H_{10}$ ( $CH_3C_6H_4CH_3$ )	o-Xylene	H. D. Rudolph	Spectrum assigned hindering potential determined.
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$C_4H_6O$ $(CH_3)_2C=C=O$	Dimethylketene	H. Dreizler H. D. Rudolph	Normal, $D_1$ , $D_3$ , $D_6$ , methyl $C^{13}$ assigned, hindering potential, dipole moment finished. Other isotopic species in progress.
$C_2H_3NS$ $(CH_3SCN)$	Methyl thiocyanate	H. Dreizler P. Heimburger	Vibration-internal rotation interaction in press, $D_3$ spectrum assigned.
$C_2H_4O_2$ $(HCOOCH_3)$	Methyl formiate	H. Dreizler	Torsional excited state in progress.
$C_7H_7F$ $(CH_3C_6H_4F)$	m-Fluorotoluene	A. Trinkaus	Rotational constants, dipole moment, hindered rotation $V_3$ , $V_6$ . Manuscript in preparation.
$C_5H_7N$ 	N-Methyl pyrrole	W. Arnold	Normal, $D_3$ , spectrum assigned, dipole moment internal rotation $V_6$ , $V_{12}$ . Manuscript in preparation.
$C_7H_7Cl$ $(ClC_6H_4CH_3)$	p-Chlorotoluene	G. Herberich	Hindered rotation, quadrupole coupling constant, partial $r_0$ -structure. In press.

$\begin{matrix} C_4H_7N \\ ((CH_3)_2CHCN) \end{matrix}$	isopropyl cyanide	G. Herberich	Rotational constants, quadrupole coupling constant. In press.
$\begin{matrix} CF_2S \\ (CSF_2) \end{matrix}$	Thiocarbonyle difluoride	G. Herberich	Spectrum assigned
$\begin{matrix} C_2H_6OS \\ ((CH_3)_2SO) \end{matrix}$	Dimethyl sulphoxide	W. D. Feder V. Typke	$S^{34}$ , $D_1$ , $D_3$ , $C^{13}$ , $O^{18}$ spectra assigned. $r_2$ structure determined. $CH_3CD_3SO$ hindered rotation in progress.
$\begin{matrix} C_6H_7N \\ (N \text{---} \text{CH}_3) \end{matrix}$ 	2-Methyl pyridine	H. Maeder	Spectrum assigned, hindered rotation in progress.
$\begin{matrix} C_6H_7N \\ (N \text{---} \text{CH}_3) \end{matrix}$ 	4-Methyl pyridine	H. Seiler H. D. Rudolph	Rotational constants, dipole moment, quadrupole coupling constant, hindered rotation $V_6$ . Manuscript in preparation.
$\begin{matrix} C_2H_6S_2 \\ ((CH_3)_2S_2) \end{matrix}$	Dimethyl disulphide	D. Sutter	Interaction between internal rotation and vibration in progress.
$\begin{matrix} C_4H_4O_2 \\ (CH_2 = C - CH_2) \\ \quad \quad   \quad \quad   \\ \quad \quad O - C = O \end{matrix}$	Diketene	F. Mönnig	Rotational constants, excited ring-puckering vibration, dipole moment. Manuscript in preparation.

$C_7H_8$ ( $CH_3C_6H_5$ )	Toluene	A. Jaeschke P. Wendling	Rotational constants, dipole moment, hindered rotation $V_6$ . Paper in press.
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7. Georgia Institute of Technology  
School of Physics  
Dr. T. L. Weatherly

$Cl_3P$ ( $PCl_3$ )	Phosphorus trichloride	C. R. Nave	Analysis of quadrupole interaction complete. Manuscript in preparation.
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$ClOP$ ( $POCl$ )	Phosphoryl chloride	C. R. Nave	Analysis of quadrupole interaction complete. Manuscript in preparation
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$CCl_3F$	Trichlorofluoromethane	A. Wolf	Analysis of quadrupole interaction complete. Manuscript in preparation.
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$CHCl_3$	Chloroform	A. Wolf	Analysis of quadrupole interaction complete. Manuscript in preparation.
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$HBr_3$	Bromoform	P. Reinhart	Studying quadrupole interactions.
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$Cl_2S$ ( $SCl_2$ )	Sulfur dichloride	J. T. Murray	Manuscript in preparation.
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8. University of Glasgow  
Department of Chemistry  
J. K. Tyler

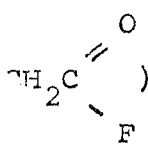
$\text{CH}_2\text{N}_2$ ( $\text{NH}_2\text{CN}$ )	Cyanamide	J. N. McDonald	Quadrupole coupling work complete.
$\text{H}_2\text{N}_2\text{O}_2$ ( $\text{NH}_2\text{NO}_2$ )	Nitramide	J. N. McDonald	Quadrupole coupling in progress.
$\text{C}_5\text{H}_4\text{O}_2$	$\gamma$ -Pyrone	J. N. McDonald	Normal species complete.
$\text{C}_6\text{H}_7\text{N}$ ( $\text{C}_6\text{H}_5\text{NH}_2$ )	Aniline	D. G. Lister	$^{15}\text{N}$ measurements complete. Ring deuterated species in progress.
$\text{C}_3\text{H}_2\text{O}_2$	Propiolic acid	D. G. Lister	Normal and acid deuterated species assigned. Distortion treatment in hand.
$\text{C}_6\text{H}_4\text{N}_2\text{O}$	Benzfurazan	D. G. Lister	Normal species analysed.

9. Harvard University  
Chemistry Department  
E. B. Wilson, Jr.

$\text{C}_2\text{HF}_3\text{O}$ ( $\text{CF}_3\text{CHO}$ )	fluoral	R. C. Woods	Manuscript accepted for publication.
$\text{C}_2\text{H}_2\text{F}_2\text{O}$ ( $\text{CFH}_2\text{FO}$ )	fluoroacetyl fluoride	E. Saegebarth	Manuscript accepted for publication.

$\text{CH}_3\text{GeN}$ ( $\text{GeH}_3\text{CN}$ )	germyl cyanide	R. Varma K. Buckton	Manuscript accepted for publication.
$\text{C}_2\text{H}_5\text{FO}$ ( $\text{CH}_2\text{FCH}_2\text{OH}$ )	2-fluoroethanol	K. Buckton R. Azrak	Main species assigned.
$\text{C}_3\text{H}_6\text{O}$ ( $\text{CH}_3\text{OC}_2\text{H}_3$ )	methyl vinyl ether	N. Owen	Manuscript submitted for publication.
$\text{C}_3\text{H}_6\text{O}_2$ ( $\text{C}_2\text{H}_5\text{OCHO}$ )	ethyl formate	J. Riveros	Manuscript submitted for publication.
$\text{C}_4\text{H}_8\text{O}$ ( $\text{CH}_3\text{CHCHCH}_3$ ) O	t-2,3-epoxybutane	M. Emptage	Manuscript submitted for publication.
$\text{C}_2\text{H}_3\text{ClF}_2$ ( $\text{CH}_3\text{CF}_2\text{Cl}$ )	1,1-difluoro-1-chloro-ethane	G. Graner C. Thomas	Spectrum assigned.
$\text{C}_2\text{H}_5\text{BrO}$ ( $^{79,81}\text{BrCH}_2\text{CH}_2\text{OH}$ )	2-bromoethanol	R. Azrak	Spectrum assigned.
$\text{CF}_5\text{N}$ ( $\text{CF}_3\text{NF}_2$ )	pentafluoromethyl-amine	J. Martins	Some lines observed.
$\text{F}_2\text{O}_3$	ozone difluoride	J. Martins	Search in progress.
$\text{C}_2\text{H}_5\text{ClO}$ ( $\text{CH}_2\text{ClCH}_2\text{OH}$ )	2-chloroethanol	R. Azrak	Several isotopes assigned.



$\text{CH}_4\text{Se}$ ( $\text{CH}_3\text{SeH}$ )	methyl selenol	C. Thomas	Manuscript in preparation.
$\text{C}_3\text{H}_6\text{O}_2$ ( $\text{C}_2\text{H}_5\text{COOH}$ )	propionic acid	O. Stiefvater	One rotamer and many excited states assigned. Dipole moment and $V_3$ determined.
$\text{C}_3\text{H}_5\text{FO}$ 	propionyl fluoride	O. Stiefvater	Cis- and gauche-form and many excited states analysed. Dipole and $V_3$ determined.
$\text{F}_5\text{HSi}_2$ ( $\text{Si}_2\text{F}_5\text{H}$ )	Penta fluoro disilane	R. Varma	Some low J transitions observed.

10. Jet Propulsion Laboratory  
Physics Section  
R. L. Pynter and R. A. Beaudet

$\text{C}_3\text{H}_6\text{F}_2$ ( $(\text{CH}_3)_2\text{CF}_2$ )	2,2 difluoro propene	R. L. Poynter R. A. Beaudet	Note in preparation. Studying torsional states.
$\text{C}_2\text{H}_6\text{B}_4$ ( $\text{B}_4\text{C}_2\text{H}_6$ )	2,3 dicarban hexaborane (6)	R. L. Poynter R. A. Beaudet	Finishing $\text{C}^{13}$ isotopes.

11. University of Kansas  
Department of Chemistry  
Marlin D. Harmony

$\text{C}_4\text{H}_6$	Biocyclobutane	K. Cox	Isotopic species being investigated; normal species completed.
$\text{C}_3\text{H}_7\text{N}$	N-methyl ethyleneimine	M. Sancho	Manuscript in preparation.

$C_3H_7N$	Propyleneimine	Y. S. Li	Manuscript in preparation.
$C_3H_7N$	Cyclopropylamine	M. Sancho M. Harmony	Work on normal species suspended; work on $-ND_2$ species underway.

12. Université Catholique de Louvain  
D<sup>t</sup> Centre de Physique Nucléaire  
M. de Hemptinne

$C_2HD_5O$ ( $C_2D_5OH$ )	Ethyl alcohol	J. P. Culot	Double-resonance experiments and spectrum assigned.
$C_2D_6O$ ( $C_2D_5OD$ )	Ethyl alcohol	J. P. Culot	Double-resonance experiments and spectrum assigned.
$C_2H_6O$ ( $C_2H_5OH$ )	Ethyl alcohol	J. Michielsens-Effinger	Centrifugal distortion analysis - Many $b_R$ and $b_P$ lines assigned.
$C_2H_3Br$ ( $CH_2-CHBr$ )	Vinyl bromides	G. A. Savariraj	Ann. Soc. Scient. Bx <u>80</u> , II, 88 (1966).
$C_2H_3Cl$ ( $CH_2-CHCl$ )	Vinyl chlorides	G. A. Savariraj	Ann. Soc. Scient. Bx <u>80</u> , II, 120 (1966).
$O_2S$ ( $S_{33}O_{17}O_{16}$ )	Sulfure oxyde	R. Van Riet	Well in progress.
$O_2S$ ( $S_{33}O_{17}O_{17}$ )	Sulfure oxyde	R. Van Riet	Well in progress.
$O_2S$ ( $S_{33}O_{17}O_{18}$ )	Sulfure oxyde	R. Van Riet	Well in progress.

13. University of Manchester, England  
Atomic and Molecular Physics Group  
J. G. Baker

$\text{CH}_4\text{O}$ ( $\text{CH}_3\text{OH}$ )	Methyl alcohol	R. M. Lees	$V_6$ and structure determined. Paper in preparation. Stark measurements in progress
$\text{C}_{12}\text{H}_{10}\text{O}$ ( $(\text{C}_6\text{H}_5)_2\text{O}$ )	Diphenyl ether	M. J. Whittle	Spectrum measured and partly assigned.
$\text{C}_7\text{H}_8\text{O}$ ( $\text{C}_6\text{H}_5\text{OCH}_3$ )	Anisole	S. Fewster	Spectrum of $\text{CH}_3$ and $\text{CD}_3$ forms measured.

14. University of Maryland  
Institute for Molecular Physics  
Lawrence C. Krisher

$\text{C}_3\text{H}_5\text{FO}$ ( $\text{CH}_2\text{FCOCH}_3$ )	Fluoro-acetone	E. Saegbarth	One rotamer assigned and $\text{CH}_3$ barrier established. Search for other rotamer in progress.
$\text{C}_2\text{H}_5\text{NO}$ ( $\text{CH}_3\text{CONH}_2$ )	Acetamide	L. Krisher	No assignment. Encyclopedic spectra for both species.
$\text{C}_2\text{H}_2\text{D}_3\text{NO}$ ( $\text{CD}_3\text{CONH}_2$ )	Acetamide	L. Krisher	No assignment. Encyclopedic spectra for both species.
$\text{KOH}$ ( $\text{KOH}$ )	Potassium hydroxide	L. Krisher	Preliminary results published in J. Chem. Phys.

15. Medizinisch-Naturwissenschaftliche Hochschule Ulm  
 Lehrstuhl für Physikalische Chemie  
 Werner Zeil

$C_3H_9ClSi$ $((CH_3)_3SiCl)$	Trimethylsilylchlorid	Wilfried Muhr Hans-Karl Bodenseh	Several isotopic combinations measured. Structure and quadrupole coupling constants determined.
$C_4H_9ClD_6$ $(CH_3(CD_3)_2CCl)$	Tertiärbutylchlorid- $(d_6)$	Werner Zeil	Several lines measured and partially assigned.

16. Michigan State University  
 Department of Chemistry  
 R. H. Schwendeman

$C_2H_5NO$ $(CH_3CHNOH)$	Acetaldoxime	R. Rogowski	Nearly complete.
$C_4H_6O$ $(CH_2CH_2CHCHO)$	Cyclopropyl- carboxaldehyde	H. Volltrauer	Cis and trans species and several excited states assigned.
$C_4H_5FO$ $(CH_2CH_2CHCOF)$	Cyclopropylcarboxylic acid fluoride	H. Volltrauer	Cis species assigned
$C_3H_4O_2$ $(CH_2OCHCHO)$	Glycidaldehyde	R. Assink	Trans species assigned.

17. University of Michigan  
Department of Chemistry  
R. L. Kuczkowski

$F_2HP$	Difluorophosphine	R. Kuczkowski	Spectrum assigned.
$N_2O_3$	Dinitrogen trioxide	R. Kuczkowski	Vibrational satellites assigned.

18. Monash University  
Chemistry Department  
R. D. Brown

$C_4H_4Se$	Selenophene	P. D. Godfrey	Manuscript in preparation.
$C_6H_6$	dimethylenecyclobutene	F. R. Burden	In progress but not assigned.
$C_6H_6$	Fulvene	J. Kent	In progress but not assigned.
$F_2OSe$ ( $SeOF_2$ )	Selenium oxyfluoride	I. C. Bowater	Paper in press.
$F_4Se$ ( $SeF_4$ )	selenium tetrafluoride	I. C. Bowater	Partially assigned.

19. National Bureau of Standards  
Infrared and Microwave Spectroscopy Section  
D. R. Lide

$BF_2H$	Difluoroborine	W. Lafferty	Almost complete.
$C_2H_3N$ ( $CH_3CN$ )	Methyl cyanide	W. Lafferty	$\ell$ -type doublets, manuscript in preparation.

CFN (FCN)	Fluorine cyanide	W. Lafferty	$\lambda$ -type doublets, manuscript in preparation; vibrational satellites in press.
C <sub>3</sub> HN (HCCCN)	Cyanoacetylene	W. Lafferty	$\lambda$ -type doublets.
CHNO (HNOCO)	Cyanic acid	W. Lafferty	Vibrational states; abandoned.
CHN (HCN)	Hydrogen cyanide	A. Maki	$\lambda$ -type resonance transition in press, vibrational satellites assigned.
COS (OCS)	Carbonyl sulfide	A. Maki	<sup>13</sup> C vibrational satellites assigned.
C <sub>3</sub> H <sub>8</sub> Si	Silocyclobutane	W. Pringle	Tentative assignment.
ClF <sub>4</sub> P		M. K. Wilson	Spectrum observed.
FNS (NSF)		W. Kirchhoff	Dipole moment and centrifugal distortion, manuscript in preparation.
HNCS (HNSO)		W. Kirchhoff	Manuscript in preparation.
ClF <sub>5</sub>	Chlorine pentafluoride	W. Kirchhoff	Manuscript in preparation.
H <sub>2</sub> O	Water	W. Kirchhoff	Dipole moment measured.
CsHO (CsOH)	Cesium hydroxide	D. Lide	In press.

20. State University of New York at Buffalo  
 Physics Department  
 T. N. Sarachman

$C_4H_4N_2$	Pyridazine	T. N. Sarachman	Manuscript in collaboration with W. Werner, H. Drezler, H. Rudolph.
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21. University College of North Wales, Bangor  
 Department of Chemistry  
 J. Sheridan

$C_3H_3NO$	oxazole	A. Wardley	Preliminary results published. Work continuing.
$C_3H_3NO$	isoxazole	A. Wardley	Preliminary results published. Work continuing.
$C_3H_5N$	ethyl isocyanide	K. Bolton	Preliminary results published. Work continuing.
$C_2HBr$	bromo-acetylene	H. Jones	Preliminary results published. Work continuing.
$C_2H_2N_2O$	2,4-oxadiazole	Valerie Williams	Assigned. N-coupling.
$C_3H_3NS$	isothiazole	A. Wardley	Assigned. N-coupling. Dipole.
$C_4H_2O_3$	maleic anhydride	Valerie Williams	Assigned.
$C_3H_4N_2$	imidazole	J. H. Griffiths	Provisional assignment in heated spectrometer.

$C_4H_7N$	3-pyrroline	C. R. Nave	Provisional analysis of spectra and satellites.
$C_3H_7F$	isopropyl fluoride	J. H. Griffiths	Assigned in ground and vibrational states. Internal rotor splittings.
$C_2H_3FO_2$	methyl fluoroformate	G. Williams	Assigned. Barrier.
$C_4H_4O_2$	methyl propiolate	G. Williams	Assigned.
$C_4H_8O$	ethyl vinyl ether	N. I. Owen	One rotamer assigned.
$C_4H_5N$	allyl cyanide	C. R. Nave	Spectrum of cis-rotamer.
$C_3H_4O$	propargyl alcohol	K. Bolton	Two states assigned. Work on deuterated species.

22. Rice University  
Department of Chemistry  
R. F. Curl

$C_3H_6O$	Allyl alcohol	A. N. Murty	Paper submitted.
$C_3H_6S$	Methyl vinyl sulfide	R. E. Penn	Barrier not done.



23. Saha Institute of Nuclear Physics  
 Microwave Spectroscopy Laboratory  
 D. K. Ghosh

$C_2H_7N$ $(C_2H_5NH_2)$	Ethylamine	D. K. Ghosh A. Chatterjee A. K. Saha	The sample has been studied in the 18.5 - 26.0 kMc/s. As reported earlier, work is still in progress in trying to assign the spectrum to the C-N torsion coupled with inversion in the two rotational isomers of ethylamine.
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24. University of Southern California  
 Chemistry Department  
 Robert A. Beaudet

$trans\ C_3H_5Br$ $(trans\ CH_3-CH=CH\ Br)$	$trans$ bromopropylene	R. A. Beaudet	Manuscript in preparation.
$cis\ C_3H_5Br$ $(cis\ CH_3-CH=CH\ Br)$	$cis$ bromopropylene	R. A. Beaudet	Manuscript in preparation.
$^4H^6F_2$ $(CH_3-CH-CH_2-CF_2)$	1,1 difluoro-2-methyl cyclopropane	R. Ford	Manuscript in preparation.
$^5H^6F_2$ $CF_2=C(CH_3)-CH=CH_2$	1,1 difluoro-2-methyl butadiene	W. Cumming	Manuscript in preparation.
$^5H^6F_2$ $CF_2=C(H)C(CH_3)=CH_2$	1,1 difluoro-3-methyl butadiene	Y. Huang	Studying with satellites

$C_2H_6BF$ ( $(CH_3)_2BF$ )	dimethyl boron fluoride	S. Cheung	Not completely assigned.
$CH_{11}B_5$ ( $CH_3B_5H_8$ )	methyl pentsborane (9)	E. Cohen	Manuscript in preparation.

25. Swiss Federal Institute of Technology  
Laboratory of Physical Chemistry  
Hs. H. Günthard

$Cl_2OS$ ( $SOCl_2$ )	Thionyl chloride	H. U. Wenger	Spectrum measured.
$C_3H_5Cl$ ( $CH_2 = CClCH_3$ )	2-Chloropropene	W. Good R. Cozart	Manuscript in preparation.

26. University of Texas  
Department of Chemistry  
James E. Soggs

$CH_2F_3P$ ( $CF_3PH_2$ )	Trifluoromethyl phosphine	Irene Wang	Spectrum assigned for normal and deuterated species.
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27. Texas Woman's University  
Chemistry Department  
Lewis C. Sams, Jr.

$CH_3Sn$ ( $SnH_3Cl$ )	Chlorostannane	Lewis C. Sams	Spectra has been observed.
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28. The University of Tokyo  
Department of Chemistry  
Yonezo Morino

$\text{COS}$ ( $\text{COS}$ )	Carbonyl sulfide	C. Matsumura	In press. (Bull. Chem. Soc. Japan)
$\text{COSe}$ ( $\text{COSe}$ )	Carbonyl selenide	C. Matsumura	In press. (Bull. Chem. Soc. Japan)
$\text{F}_3\text{N}$ ( $\text{NF}_3$ )	Nitrogen trifluoride	M. Otake	Vib - rot interaction and $r_e$ structure, manuscript in preparation.
$\text{F}_3\text{P}$ ( $\text{PF}_3$ )	Phosphorous trifluoride	M. Otake	Vib - rot interaction, work almost completed.
$\text{O}_2\text{S}$ ( $\text{SO}_2$ )	Sulfur dioxide	S. Saito	Higher excited vib. states, work almost completed.
$\text{FNO}_2$	Nitryl fluoride	T. Tanaka	Centrifugal distortion and Coriolis interaction, work completed.
$\text{O}_3$	Ozone	T. Tanaka	Vib - rot interaction and $r_e$ structure, work almost completed.
$\text{CH}_3\text{Br}, \text{CD}_3\text{Br}$	Methyl bromide	C. Hirose	Excited vib. states, manuscript prepared.
$\text{CH}_3\text{I}$	Methyl iodide	C. Hirose	Excited vib. states, in press (J. Mol. Spectry.)
$\text{C}_4\text{H}_8$	Butene-1	S. Kondo R. Hirata	Rotational isomerism in cis and gauche forms, work almost completed.

$C_3H_5Cl$	Allyl chloride	E. Hirota	Rotational spectrum in cis and gauche forms work almost completed.
$C_3H_8$	Propane	E. Hirota C. Matsumura	Internal rotation, in press (J. Chem. Soc. Japan)
$CH_2F_2, CD_2F_2$	Methylene fluoride	K. Sakakibara E. Hirota	Centrifugal distortion and vib. rot interaction, work in progress
$C_3H_5D$ ( $CH_2DCH=CH_2$ )	Deuterated propylene	E. Hirota T. Hirooka	Internal rotation, work almost completed.
$C_3H_4O$	Propargyl alcohol	E. Hirota	Internal rotation, work in progress.
OS (SO)	Sulfur monoxide	T. Anano E. Hirota	Excited vib. state and $^{33}SO$ species, manuscript in press (J. Phys. Soc. Japan)
$O_2Se$ ( $SeO_2$ )	Selen dioxide	H. Takeo	Spectrum assigned; excited vib. states, work in progress.
$C_2H_4SO$ ( $(CH_2)_2SO$ )	Ethylene episulfoxide	S. Saito	$r_0$ structure, manuscript prepared.

29. University College, London  
Chemistry Department  
D. J. Millen

$FNO_2$ ( $NO_2F$ )	Nitryl fluoride	A. C. Legon	Isotopic species studied. Structure obtained. Paper being prepared.
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30. State University Utrecht  
 Laboratory of Organic Chemistry  
 D. den Engelsen

$C_3H_4O$ ( $HC \equiv COCH_3$ )	methoxy ethyne	D. den Engelsen	Constants calculated for first exc. tors. vibrational state.
$C_3H_4S$ ( $HC \equiv CSCH_3$ )	methylthioethyne	D. den Engelsen	Paper in print for $HC \equiv C^{32}SCH_3$ and $HC \equiv C^{34}SCH_3$ . Analysis finished of $DC \equiv CSCH_3$ and $HC \equiv C^{13}CH_3$ .

31. University of Wisconsin  
 Department of Chemistry  
 C. D. Cornwell

$CF_7P$ ( $CF_3PF_4$ )	Trifluoromethyl tetrafluoro phosphorane	E. A. Cohen	Satellite analysis in progress
$H_5B_2Br$ ( $B_2H_5Br$ )	Bromodiborane	A. C. Ferguson	Isotopic measurements in progress.
$F_4HP$ ( $HPF_4$ )	Monofluorophosphorane	S. B. Pierce	Manuscript in preparation.
$F_5IO$ ( $IOF_5$ )	Iodine oxide pentafluoride	S. B. Pierce	Manuscript in preparation.

## FORMULA INDEX

(Arrangement as in Townes and Schawlow  
Numbers refer to Institution)

- $\text{BF}_2\text{H}$  difluoroborane - 19  
 $\text{B}_2\text{BrH}_5$  ( $\text{B}_2\text{H}_5\text{Br}$ ) bromodiborane - 31  
 $\text{BrO}$  bromine oxide - 4  
 $\text{CBrD}_3$  methyl bromide - 28  
 $\text{CCl}_3\text{F}$  trichlorofluoromethane - 7  
 $\text{CD}_2\text{F}_2$  methylene fluoride - 28  
 $\text{CFN}$  ( $\text{FCN}$ ) fluorine cyanide - 19  
 $\text{CF}_2\text{S}$  ( $\text{CSF}_2$ ) thiocarbonyl difluoride - 6  
 $\text{CF}_5\text{N}$  ( $\text{CF}_3\text{NF}_2$ ) pentafluoromethylamine - 9  
 $\text{CF}_7\text{P}$  ( $\text{CF}_3\text{PF}_4$ ) trifluoromethyl tetrafluorophosphorane - 31  
 $\text{CHBr}_3$  bromoform - 7  
 $\text{CHCl}_3$  chloroform - 7  
 $\text{CHN}$  ( $\text{HCN}$ ) hydrogen cyanide - 19  
 $\text{CHNO}_2$  ( $\text{HNOCO}$ ) cyanic acid - 19  
 $\text{CH}_2\text{F}_2$  methylene fluoride - 28  
 $\text{CH}_2\text{F}_3\text{P}$  ( $\text{CF}_3\text{PH}_2$ ) trifluoromethyl phosphine - 26  
 $\text{CH}_2\text{N}_2$  ( $\text{NH}_2\text{CN}$ ) cyanamide - 8  
 $\text{CH}_3\text{Br}$  methyl bromide - 28  
 $\text{CH}_3\text{GeN}$  ( $\text{GeH}_3\text{CN}$ ) germyl cyanide - 9  
 $\text{CH}_3\text{I}$  methyl iodide - 28  
 $\text{CH}_4\text{O}$  ( $\text{CH}_3\text{OH}$ ) methyl alcohol - 12  
 $\text{CH}_4\text{O}$  ( $\text{CH}_3\text{OH}$ ) methyl alcohol - 13  
 $\text{CH}_4\text{Se}$  ( $\text{CH}_3\text{SeH}$ ) methyl selenide - 9  
 $\text{CH}_{11}\text{B}_5$  ( $\text{CH}_3\text{B}_5\text{H}_8$ ) methyl pentaborane (9) - 24  
 $\text{COS}$  ( $\text{OCS}$ ) carbonyl sulfide - 19  
 $\text{COS}$  ( $\text{OCS}$ ) carbonyl sulfide - 28  
 $\text{COSe}$  ( $\text{OCSe}$ ) carbonyl selenide - 28  
 $\text{C}_2\text{HBr}$  bromo-acetylene - 21  
 $\text{C}_2\text{H}_2\text{D}_3\text{NO}$  ( $\text{CD}_3\text{CONH}_2$ ) acetamide - 14  
 $\text{C}_2\text{D}_6\text{O}$  ( $\text{C}_2\text{D}_5\text{OD}$ ) ethyl alcohol - 12  
 $\text{C}_2\text{HD}_5\text{O}$  ( $\text{C}_2\text{D}_5\text{OH}$ ) ethyl alcohol - 12  
 $\text{C}_2\text{HF}_3\text{O}$  ( $\text{CF}_3\text{CHO}$ ) fluoral - 9  
 $\text{C}_2\text{H}_2\text{F}_2\text{O}$  ( $\text{CFH}_2\text{FO}$ ) fluoroacetyl fluoride - 9  
 $\text{C}_2\text{H}_2\text{N}_2\text{O}$  2,4-oxadiazole - 21

- $C_2H_2N_2O$  1,3,4-oxadiazole - 5  
 $C_2H_3Br$  ( $CH_2 - CHBr$ ) vinyl bromides - 12  
 $C_2H_3Cl$  ( $CH_2 - CHCl$ ) vinyl chlorides - 12  
 $C_2H_3ClF_2$  ( $CH_3CF_2Cl$ ) 1,1-difluoro-1-chloroethane - 9  
 $C_2H_3FC_2$  methyl fluorocarbonate - 21  
 $C_2H_3N$  ( $CH_3CN$ ) methyl cyanide - 19  
 $C_2H_3NO$  ( $CH_3CCN$ ) methyl cyanate - 5  
 $C_2H_3NS$  ( $CH_3SCN$ ) methyl thiocyanate - 6  
 $C_2H_4OS$  ( $(CH_2)_2SO$ ) ethylene episulfoxide - 28  
 $C_2H_4O_2$  ( $HCOOCH_3$ ) methyl formate  
 $C_2H_5BrO$  ( $^{79,81}BrCH_2CH_2OH$ ) 2-bromoethanol - 9  
 $C_2H_5ClO$  ( $CH_2ClCH_2OH$ ) 2-chloroethanol - 9  
 $C_2H_5FO$  ( $CH_2FCH_2OH$ ) 2-fluoroethanol - 9  
 $C_2H_5NO$  ( $CH_3CHNOH$ ) acetaldoxime - 16  
 $C_2H_5NO$  ( $CH_3CONH_2$ ) acetamide - 14  
 $C_2H_6BF$  ( $(CH_3)_2BF$ ) dimethyl boron fluoride - 24  
 $C_2H_6B_4$  ( $B_4C_2H_6$ ) 2,3 dicarban hexaborane - 10  
 $C_2H_6O$  ( $C_2H_5OH$ ) ethyl alcohol - 12  
 $C_2H_6OS$  ( $(CH_3)_2SO$ ) dimethyl sulphoxide - 6  
 $C_2H_6S_2$  ( $(CH_3)_2S_2$ ) dimethyl disulphide - 6  
 $C_2H_7N$  ( $C_2H_5NH_2$ ) ethylamine - 23  
 $C_3H_3N$  ( $HCCCN$ ) cyanoacetylene - 19  
 $C_3H_2O_2$  propiolic acid - 8  
 $C_3H_3NO$  isoxazole - 21  
 $C_3H_3NO$  oxazole - 21  
 $C_3H_3NS$  isothiazole - 21  
 $C_3H_4N_2$  imidazole - 21  
 $C_3H_4O$  ( $HC \equiv COCH_3$ ) methoxy ethyne - 30  
 $C_3H_4O$  propargyl alcohol - 21  
 $C_3H_4O$  propargyl alcohol - 28  
 $C_3H_4O_2$  ( $CH_2OCHCHO$ ) glycidaldehyde - 16  
 $C_3H_4S$  ( $HC \equiv CSCH_3$ ) methylthio-ethyne - 30  
cis  $C_3H_5Br$  ( $CH_3-CH=CHBr$ ) cis-bromopropylene - 24  
trans  $C_3H_5Br$  ( $CH_3-CH=CHBr$ ) trans-bromopropylene - 24  
 $C_3H_5Cl$  allyl chloride - 28  
 $C_3H_5Cl$  ( $CH_2=CClCH_3$ ) 2-chloropropene - 25  
 $C_3H_5D$  ( $CH_2DCH=CH_2$ ) deuterated propylene - 28  
 $C_3H_5FO$  ( $CH_2FCOCH_3$ ) fluoracetone - 14

- $C_3H_5FO$   $(CH_3CH_2C \begin{array}{l} // O \\ \backslash F \end{array})$  propionyl fluoride - 9  
 $C_3H_5N$  ethyl isocyanide - 21  
 $C_3H_6F_2$   $((CH_3)_2CF_2)$  2,2 difluoro propene - 10  
 $C_3H_6O$  allyl alcohol - 22  
 $C_3H_6O$   $(CH_3OC_2H_3)$  methyl vinyl ether - 9  
 $C_3H_6O_2$  1-3 dioxolane - 3  
 $C_3H_6O_2$   $(C_2H_5OCHO)$  ethyl formate - 9  
 $C_3H_6O_2$  propionic acid - 9  
 $C_3H_6S$  methyl vinyl sulfide - 22  
 $C_3H_7F$  isopropyl fluoride - 21  
 $C_3H_7N$  cyclopropylamine - 11  
 $C_3H_7N$  N-methyl ethyleneimine - 11  
 $C_3H_7N$  propyleneimine - 11  
 $C_3H_8$  propane - 28  
 $C_3H_8Si$  silocyclobutane - 19  
 $C_3H_9ClSi$   $((CH_3)_3SiCl)$  trimethylsilyl-chloride - 15  
 $C_4H_2O_3$  maleic anhydride - 21  
 $C_4D_6H_3Cl$   $(CH_3(CD_3)_2CCl)$  trimethyl butyl chloride- $(d_6)$  15  
 $C_4H_4N_2$  pyridazine - 20  
 $C_4H_4O_2$   $(CH_2 = \begin{array}{l} C - CH_2 \\ | \quad | \\ O - C = O \end{array})$  diketene - 6  
 $C_4H_4O_2$  methyl propiolate - 21  
 $C_4H_4Se$  selenophene - 18  
 $C_4H_5FO$   $(CH_2CH_2CH \begin{array}{l} // O \\ \backslash F \end{array})$  cyclopropyl-carboxylic acid fluoride - 16  
 $C_4H_5N$  allyl cyanide - 21  
 $C_4H_5N$  pyrrole - 5  
 $C_4H_6$  bicyclobutane - 11  
 $C_4H_6$  cyclobutene - 5  
 $C_4H_6F_2$   $(CH_3 - CH - CF_2)$  1,1 difluoro-2-  
 $CH_2$   
methyl cyclopropane - 24  
 $C_4H_6O$   $(CH_2CH_2CHCHO)$  cyclopropyl-carboxaldehyde - 16  
 $C_4H_6O$   $(CH_3)_2 C=O$  dimethylketene - 6  
 $C_4H_7N$   $((CH_3)_2CHCN)$  isopropyl cyanide - 6  
 $C_4H_7N$  3-pyrroline - 21  
 $C_4H_8$  butene-1 - 28  
 $C_4H_8O$   $(t-CH_3CHCHCH_3)$  trans-2,3-  
 $C$   
epoxybutane - 9  
 $C_4H_8O$  ethyl vinyl ether - 21  
 $C_4H_9NOSi$   $((CH_3)_3SiNO)$  trimethyl silicon isocyanate - 2  
 $C_4H_9NSSi$   $((CH_3)_3SiNCS)$  trimethyl silicon isothiocyanate - 2



$C_5H_4C_2$   $\gamma$ -Pyrone - 8

$C_5H_5N$  pyridine - 5

$C_5H_5NNiO$  ( $C_5H_5NiNO$ ) cyclopentadienyl  
nitrosyl nickel - 2

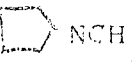
$C_5H_5NCPd$  ( $C_5H_5PdNO$ ) cyclopentadienyl  
nitrosyl palladium - 2

$C_5H_5NCPt$  ( $C_5H_5PtNO$ ) cyclopentadienyl  
nitrosyl platinum - 2

$C_5H_6F_2$  ( $CF_2 = C - CH = CH_2$ ) 1,1-difluoro-  
2-methyl butadiene - 24

$C_5H_6F_2$  ( $CF_2 = C - C = CH_2$ ) 1,1 difluoro-  
3-methyl butadiene - 24

$C_5H_7N$  cyclobutyl cyanide - 3

$C_5H_7N$  () N-methyl pyrrole - 6

1,3- $C_6H_4F_2$  meta-difluorobenzene - 5

1,2- $C_6H_4F_2$  ortho-difluorobenzene - 5

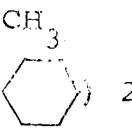
$C_6H_4N_2O$  benzfurazan - 8

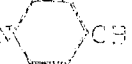
$C_6H_5F$  fluorobenzene - 5

$C_6H_6$  dimethylenecyclobutene - 18

$C_6H_6$  fulvene - 18

$C_6H_7N$  ( $C_6H_5NH_2$ ) aniline - 8

$C_6H_7N$  () 2-methyl pyridine - 6

$C_6H_7N$  () 4-methyl pyridine

$C_7H_7Cl$  ( $ClC_6H_4CH_3$ ) p-chlorotoluene - 6

$C_7H_7F$  ( $CH_3C_6H_4F$ ) m-fluorotoluene - 6

$C_7H_8$  ( $CH_3C_6H_5$ ) toluene - 6

$C_7H_8O$  ( $C_6H_5OCH_3$ ) anisole - 13

$C_8H_{10}$  ( $CH_3C_6H_4CH_3$ ) o-xylene - 6

$C_{12}H_{10}O$  ( $(C_6H_5)_2O$ ) diphenyl ether - 13

$Cl_4P$  - 19

$Cl_5F$  chlorine pentafluoride - 19

$ClH_3Sn$  ( $SnH_3Cl$ ) chlorostannane - 27

$ClNO_2$  nitryl chloride - 1

$ClO$  chlorine oxide - 4

$ClOP$  ( $POCl$ ) phosphoryl chloride - 7

$Cl_2OS$  ( $SOCl_2$ ) thionyl chloride - 25

$Cl_2S$  ( $SCL_2$ ) sulfur dichloride - 7

$Cl_3P$  ( $PCl_3$ ) phosphorus trichloride - 7

$CsOH$  cesium hydroxide - 19

$FNO_2$  nitryl fluoride - 1

$FNO_2$  ( $NO_2F$ ) nitryl fluoride - 29

$FNO_2$  nitryl fluoride - 28

$FNS$  ( $NSF$ ) - 19

$FS$  sulfur fluoride - 4