Another important spectrum to be expected in the far ultra-violet is that of H_2O. This has been studied under very high resolution by Johns. Similar spectra of H_2S have been obtained by Johns but not yet published. Another spectrum that might be of importance is that of NH_3 which starts to absorb below 2200Å giving rise to a large number of discrete bands. This spectrum was studied at high resolution by Hollas and Douglas, and Douglas.

Recently the vacuum ultra-violet absorption of CH has been studied. This molecule has fairly strong absorption bands at 1690, 1550, 1370 and 1271Å. Of these the absorption at 1370Å is the strongest and is likely to occur in many astrophysical sources. Quite recently a few absorption bands of C_2 between 1400 and 1300Å have been found, but these spectra have not yet been analysed. Finally, one might mention the strong absorption spectra of CH_2 and CH_3 which occur below 1500Å. There is also a weaker absorption of CH_3 at 2160Å which might conceivably be of astrophysical importance.

A number of other molecular spectra in the vacuum ultra-violet have been investigated, but they are not likely to be of astrophysical interest.

REFERENCES

H_2	Herzberg, G., Howe, L. L. *Can. J. Phys.*, **37**, 636, 1959.
H_2, HD, D_2	Herzberg, G., Monfils, A. *J. Mol. Spectr.*, **5**, 482, 1960.
H_2, HD, D_2	Monfils, A. *Bull. Acad. R. Belgique*, **47**, 585, 599, 816, 1961.
H_2O	Johns, J. W. C. *Can. J. Phys.*, **41**, 209, 1963.
NH_3	Douglas, A. E., Hollas, J. M. *Can. J. Phys.*, **39**, 479, 1961.
NH_3	Douglas, A. E. *Disc. Far. Soc. Lond.*, no. 35, 158, 1963.
CH_2, CH_3	Herzberg, G. *Proc. Roy. Soc. Lond.*, **262A**, 291, 1961.
CH	Herzberg, G., Johns, J. W. C. (to be published).

Mme R. Herman and her collaborators at Meudon report investigations on selected molecular spectra as follows:

O_2	Schumann-Runge bands extended to 5700Å (**68**).
O_2^+	New bands of the first negative system observed and analyzed; second negative system being studied (**66, 96, 176**).
N_2	Preliminary results obtained on intensities of first and second positive systems as a function of the mean energy of the electrons (**61**).
N_2^+	First negative system observed in emission in phosphorescence (**65, 66**).
OH, OD	Studies of suitable experimental conditions for observing high level systems; transition probabilities calculated (**48, 49**).

A program on unstable molecules is also in progress.

In Liège, research activity, according to Monfils, includes a detailed study of molecular hydrogen absorption spectra. Refined values of the constants will soon be published for HD, D_2, and H_2 (**115, 116**).

GENERAL WORK ON ATOMIC SPECTRA

At Meudon some experimental work on atomic spectra is also reported by Mme R. Herman.

(*a*) Infra-red observations: Between 1·6μ and 3·7μ, 24 new lines of Cs I have been observed and classified; 13 of Cd I and 2 of He I (**159**).

(*b*) Stark Effect: The observed dissymetry of λ7601 of Kr I may be attributed to Stark Effect (**67**). Stark constants for H have been calculated automatically by an iteration method (**42**).

(*c*) Studies of plasma: A maximum temperature of 15 000 °K and an electron density of $1{\cdot}9 \times 10^{17}$ have been measured in the column of a whirl-stabilized arc. Such a source is useful to study Stark effect (**47**).

An atlas has been prepared giving time-resolved spark spectra produced by a plasma source at 15 000 eV.

(*d*) Various equations are being used to calculate tabular data: Voigt profiles, atomic cross sections for electronic collisions, partition functions, and the Saha-Eggert equation, etc. (**42**).

According to A. H. Cook, the Standards Division at NPL plans to construct a scanning Michelson interferometer for the range 1000 to 2000 Å, and is also constructing a high-resolution échelle instrument, both with photo-electric recording. The purpose is to make interferometric determinations of wavelength and other fundamental spectroscopic data in the vacuum ultra-violet.

Work at Lund has given a much improved description of the C I spectrum, comprising some 350 lines from 3000 to 9000 Å (**88**). It has been of great help in the interpretation of the spectrum of R Cor Bor.

About 100 Si I wavelengths have been measured to $\pm$ 0·01 Å on spectrograms taken with a lead sulphide source (**103**). The multiplet dependence of the difference between laboratory and solar wavelengths, observed by L. Herzberg, disappears when the new laboratory wavelengths are used.

Blaise reports that the program at the Laboratoires de Bellevue includes investigations of (*a*) the isotope shifts of Ba I (**79, 80**); W I, Os I, Ce I, Nd I (**146**) and U I (**145**); (*b*) isotope shift and classification of U I (**16, 39**) and U II (**39**); (*c*) the hyperfine structure of Pr I, Tb I (**105**) and Tm I (**17**).

Excellent progress is also reported with the analyses of Pu I and Pu II (**9, 15, 28**), including work on the Zeeman Effect. More than 3000 lines are classified and 18 configurations have been detected to date. The ionization potential of Pu I (determined from a two-member ns^9F_1 series) is 5·8 eV.

At the National Bureau of Standards, in addition to the large program on transition probabilities and cross sections described above, progress continues with the program of rare-earth spectra. The observation and analyses of these spectra are urgently needed to furnish data for Volume IV of '*Atomic Energy Levels*'. A current summary on these spectra has been given recently and need not be repeated here (**117, 119**).

The pressing question of bringing up-to-date the data in the published volumes has been considered seriously. Detailed bibliographies on individual spectra are in print (**118**), but they do not suffice to meet present demands. It has been decided to prepare revised Tables of '*Atomic Energy Levels*' and of '*Multiplets*' in pamphlet form when the available data on analysis for a given spectrum are definitive for 15 or 20 years. Each pamphlet will have the same monograph number, so that eventually the material can be bound in proper order.

As copy goes to press Codling and Madden report success in observing absorption spectra of Kr and Xe in the region 120 to 200 Å, as observed with the 180 Mev synchrotron. For the first time, energies in excess of 50 eV above the first ionization limits have been observed. The transitions involve the excitation of inner shell *d*-electrons. Series have been found in both spectra (**29**). Earlier work of this type on He, Ne and Ar has been published (**104**).

The activities carried on by Mack and his collaborators at Wisconsin are of three types: a study of the intensities, widths and positions of the components of λ4686 of He II (**154**); determination of the nuclear spin of Ar^{37} as $I = 3/2$ from hyperfine structure study (**152**); detection of Na in the Earth's upper atmosphere by direct observation of the solar spectrum when the Sun is near the horizon (**112**).

J. Junkes and his staff are continuing work on the preparation of an Atlas of thorium lines extending from 2000 to 11 000Å. He and Milazzo are also preparing an Atlas of the Schumann region 1100 to 2250Å. It will include spectra that are important for spectrochemical analysis excited in a hollow-cathode discharge.

SOLAR SPECTROSCOPY

The report of Commission 12 contains an extensive account of research in solar spectroscopy. Only brief remarks pertaining to subjects in common to Commissions 12 and 14 will be presented here.

At the Oxford Observatory Miss Adam reports two investigations of interest to the Commission. The work carried out by G. Smith on collision broadening and shift in atomic spectra is ready for publication. Higgs has continued his study of Fraunhofer line asymmetry (**71**). He finds a pronounced line asymmetry at the extreme limb, of sufficient magnitude to account for the super-gravity wavelength shift which is observed in this region. He suggests that this may be a chromospheric effect.

An analysis of the red CN bands by Rigutti and Drago-Chuderi (**151**) includes extensive revision of CN identifications in the solar spectrum.

Tables have been prepared by Benedict, Swensson and Mohler containing the measurements and identifications of the lines appearing in the *Atlas of the Solar Spectrum between* λ 7498 *and* λ 10216, published in 1963 by Delbouille and Roland (**37**). These tables will appear in the *Mém. Soc. R. Sci. Liège*, 1965.

A series of sunspot spectrum photographs have been made at Lake Angelus for investigation of this interesting spectrum.

The current revision of the 1928 edition of Rowland's '*Table of Solar Spectrum Wavelengths*' is nearing completion. A report on this work was presented at the Utrecht Symposium, 26 to 31 August 1963 (**120**). Minnaert and his staff have completed their measurements of solar equivalent widths for this Monograph. Galley proof has been received for about two-thirds of the publication. It will appear as a Monograph of the National Bureau of Standards.

CHARLOTTE MOORE SITTERLY
President of the Commission

BIBLIOGRAPHY

1. Allen, R. A., Camm, J. C., Kivel, J. C., Keck, J. C. *J. quant. Spectrosc. Rad. Transf.*, **1**, 269, 1961.
2. Aminian, O. *C. R. Acad. Sci. Paris*, **255**, 486, 1962.
3. Armstrong, B. H., Sokoloff, J., Nicholls, R. W., Holland, D. H., Meyerott, R. E. *J. quant. Spectrosc. Rad. Transf.*, **1**, 43, 1961.
4. Baird, K. M., Smith, D. S. *J. opt. Soc. Amer.*, **52**, 507, 1962.
5. Baird, K. M., Smith, D. S., Hart, K. H. *J. opt. Soc. Amer.*, **53**, 717, 1963.
6. Bass, A., Broida, H. P. *Monograph NBS*, **24**, 1961.
7. Batarchukova, N. R., Kartashev, A. I., Efremov, Yu. P. *Fiz. Probl. Spektrosk.* (Moskwa), **1**, 76, 1962.
8. Bates, D. R. ed. *Atomic and Molecular Processes*, Academic Press, New York and London, 1962.
9. Bauche, J., Blaise, J., Fred, M. *C. R. Acad. Sci. Paris*, **256**, 5091, 1963; *ibid.*, **257**, 2260, 1963.
10. Bayer-Helms, F. *Z. angew. Phys.*, **15**, 330, 416, 532, 1963; *ibid.*, **16**, 44, 1963.
11. Bely, O. *C. R. Acad. Sci. Paris*, **254**, 3075, 3167, 1962; Bely, O., Tully, J., Van Regemorter, H. *Ann. Phys.* (Paris), **8**, 303, 1963.
12. Benedict, W. S., Herman, R., Moore, G. E., Silverman, S. *Astrophys. J.*, **135**, 277, 1962.
13. Bennett, R. G., Dalby, F. W. *J. chem. Phys.*, **36**, 399, 1962.

14. Blaha, M. *Bull. astr. Inst. Csl.*, **13,** 81, 1962.
15. Blaise, J., Fred, M., Gerstenkorn, S., Judd, B. R. *C. R. Acad. Sci. Paris,* **255,** 2403, 1962.
16. Blaise, J., Steinhaus, D. W. (unpublished) 1963.
17. Blaise, J., Vetter, R. (Thesis) *C. R. Acad. Sci. Paris,* **256,** 630, 1963.
18. Brewer, L., Engelke, J. L. *J. chem. Phys.*, **36,** 992, 1962.
19. Brink, G. O. *Phys. Rev.*, **127,** 1204, 1962.
20. Burgess, A. *Mém. Soc. R. Sci. Liège,* **4,** 299, 1961.
21. Burgess, A. *Astrophys. J.*, **139,** 776, 1964.
22. Burke, P. G. *Proc. phys. Soc. Lond.*, **82,** 443, 1963.
23. Burke, P. G., Schey, H. M., Smith K. *Phys. Rev.*, **129,** 1258, 1963.
24. Camm, J. C., Kivel, B., Taylor, R. L., Teare, J. D. *J. quant. Spectrosc. Rad. Transf.*, **1,** 53, 1962.
25. Carleton, N. P., Oldenberg, O. *J. chem. Phys. Lond.*, **36,** 3460, 1962.
26. Carleton, N. P., Papalidosis, C. *J. quant. Spectrosc. Rad. Transf.*, **2,** 241, 1962.
27. Chamberlain, J. W. *Physics of the Aurora and the Airglow*, Chapters 9 and 13, Academic Press, New York, 1961.
28. Champeau, R. J., Fred, M., Gerstenkorn, S., Tomkins, F. S. *C. R. Acad. Sci. Paris,* **257,** 1238, 1963.
29. Codling, K., Madden, R. P. *Phys. Rev. Lett.*, **12,** 106, 1964.
29a. Comité Consultatif pour la définition du Mètre, 3ème session, 1962, Gauthier-Villars, Paris, 1964.
30. Cooper, J. W. *Phys. Rev.*, **128,** 681, 1962.
31. Corliss, C. H., Bozman, W. R. *Monograph NBS*, **53,** 1962; Summary in *Astrophys. J.*, **136,** 916, 1962.
32. Czyzak,S. J., Krueger, T. K. *Mon. Not. R. astr. Soc.*, **126,** 177, 1963.
33. Daiber, J. W., Williams, M. T. *J. quant. Spectrosc. Rad. Transf.*, **1,** 135, 1961.
34. Damburg, R. Ya., Peterkop, R. K. *Soviet Phys. JETP*, **16,** 1247, 1962.
35. Davis, S. P., Phillips, J. G. *Berkeley Analyses of Molecular Spectra*, **1,** 214 pp., Univ. Cal. Press, 1963.
36. Davison, A., Giacchetti, A., Stanley, R. W. *J. opt. Soc. Amer.*, **52,** 447, 1962.
37. Delbouille, L., Roland, G. *Mém. Soc. R. Sci. Liège*, Special Volume no. 4, 1963.
38. Dieke, G. H., Crosswhite, H. *J. quant. Spectrosc. Rad. Transf.*, **2,** 97, 1962.
39. Diringer, M. *Thesis*, Paris, 1963; *Ann. Phys.* (Paris), (in press), 1964.
40. Ditchburn, R. W., Young, J. *J. atmos. terr. Phys.*, **24,** 127, 1962.
41. Dolder, K. T., Harrison, M. F. A., Thonemann, P. C. *Proc. Roy. Soc. Lond.*, **A264,** 367, 1961; *ibid.* **A274,** 546, 1963; *Proc. Phys. Soc. Lond.*, **82,** 368, 1963.
42. Drawin, H. W., Felenbok, P. *Group. Rech. Assn. Euratom*, CEA, *Rapport Interne*, 1962; *Rapport Interne, CEA*, Fontenay-aux-Roses, France, 1962, 1963.
43. Edlén, B. *Trans. IAU*, **9,** 201 to 227, 1957.
44. ,, *Trans. IAU*, **10,** 211 to 233, 1960.
45. ,, *Rep. on Progress in Phys.*, **26,** 181, 1963.
46. ,, (unpublished) 1961.
47. Fabre, E., Herman, L. *Rev. opt. théor. instrum. Paris*, **41,** 339, 1962.
48. Felenbok, P. *Ann. Astrophys.*, **26,** 393, 1963.
49. ,, *C. R. Acad. Sci. Paris*, **256,** 2334, 1963.
50. Ferguson, H. I. S. (to be published).
51. Ferri, A., ed. *Fundamental Data Obtained from Shock Tube Experiments*, Pergamon Press, London, 1961. See especially the chapter on *f*-numbers.
52. Fite, W. L., Brackmann, R. T. *Phys. Rev.*, **113,** 815, 1959.
53. Fite, W. L., Stebbings, R. F., Brackmann, R. T. *Phys. Rev.*, **116,** 356, 1959.
54. Fraser, P. A., Haycock, S. (to be published); Haycock, S. *Thesis*, Univ. Western Ontario, 1963.
55. Garstang, R. H. *General Review* in Bates, D. R. **8,** 1962 (See 7, chapter I).
56. Garton, W. R. S. *J. quant. Spectrosc. Rad. Transf.*, **2,** 335, 1962.
57. Garvin, D., Broida, H. P., Kostkowski, H. J. *J. chem. Phys.*, **37,** 193, 1962.

58. Geltman, S., Rudge, M. R. H., Seaton, M. J. *Proc. phys. Soc. Lond.*, **81,** 375, 1963.
59. Glennon, B. M., Wiese, W. L. *Monograph NBS*, **50,** 1962; Addendum up to 1963 is sent out on request.
60. Green, L. C., Kolchin, E. K., Johnson, N. C. *J. opt. Soc. Amer.*, **53,** 1349, *Abstr.* FA 18, 1963.
61. Grenat, H., Herman, L., Hepner, G. *Ann. Geophys.*, **17,** 351, 1961.
62. Gryzinski, M. *Phys. Rev.*, **115,** 374, 1959.
63. Hébert, G. R., Nicholls, R. W. *Proc. phys. Soc. Lond.*, **78,** 1024, 1961.
64. Heddle, D. W. O., Seaton, M. J., Presnyakov, L., Sobelman, I. I., Vainshtein, L. A., Czyzak, S. J., Burgess, A. *Proc. Third Internat. Conf. on Electronic and Atomic Collisions*. M. R. C. McDowell, ed. North-Holland Publ. Co., Amsterdam, 1963.
65. Herman, L., Felenbok, P., Herman, R. *J. Phys. Radium*, **23,** 979, 1962.
66. Herman, L., Ferguson, H. I. S., Nicholls, R. W. submitted to Comm. 14 for this report.
67. Herman, L., Herman, R. *Nature*, London, **195,** 1086, 1962.
68. Herman, L., Herman, R., Rakotoarijimy, D. *J. Phys. Radium*, **22,** 1, 1961.
69. Herzberg, G. *Trans. IAU* **11A,** 97 to 117, 1962.
70. ,, *Trans. IAU* **11B,** 208 to 221, 1962.
71. Higgs, L. A. *Mon. Not. R. astr. Soc.*, **124,** 51, 1962.
72. Houziaux, L. *Bull. Acad. R. Belgique*, **49,** 356, 1963.
73. Houziaux, L., Sadoine, M. P. *Bull. Soc. R. Sci. Liège*, **30,** 287, 1961.
74. Hummer, D. G., Seaton, M. J. *Phys. Rev. Lett.*, **6,** 471, 1961.
75. Humphreys, C. J. *Appl. Opt.*, **2,** 1155, 1963.
76. Humphreys, C. J., Paul, E. *Naval Ord. Lab. Corona, NAVWEPS Report* 7214, 23, 1961.
77. Humphreys, C. J., Paul, E., Adams, K. B. *Naval Ord. Lab. Corona, NAVWEPS Report* 7190, 11, 1961.
78. Humphreys, C. J., Paul, E., Adams, K. B. *Naval Ord. Lab. Corona, NAVWEPS Report* 7205, 25, 1961.
79. Jackson, D. A., Tuan, D. H. *Phys. Rev. Lett.*, **2,** 209, 1963.
80. ,, ,, *Proc. Roy. Soc. Lond.*, **A274,** 145, 1963.
81. Jain, D. C. *Proc. phys. Soc. Lond.*, **81,** 171, 1962.
82. Jain, D. C., Sah, P. *Proc. phys. Soc. Lond.*, **80,** 525, 1962.
83. James T. *J. chem. Phys. Lond.*, **35,** 767, 1962.
84. Jarmain, W. R. *Can. J. Phys.*, **38,** 217, 1960.
85. Jarmain, W. R. *Tabulated Klein-Dunham Potential Energy Functions, Scientific Report* no. 2, *Contract AF* 49(638) –640, 1960; *ibid. Scientific Report* no. 8, *Contract AF* 19(604) –4560, 1961.
86. Jarmain, W. R. *Numerical Solution of the Schroedinger Wave Equation, Report* no. 9, *Contract AF* 19 (604) –4560, 1961.
87. Jarmain, W. R. *Can. J. Phys.*, **41,** 414, 1961; *ibid.*, **41,** 1926, 1963.
88. Johansson, L. *Ark. Fys.*, **25,** no. 31, 425, 1963.
89. Kaufman, M. *Astrophys. J.*, **137,** 1296, 1963.
90. Kaufman, V. *J. opt. Soc. Amer.*, **52,** 866, 1962.
91. Kaufman, V., Andrew, K. L. *J. opt. Soc. Amer.*, **52,** 1223, 1962.
92. King, R. B., Lawrence, G. M., Link, J. K. *Astrophys. J.*, (in press) 1964. See also (**93**).
93. King, R. B. *et al.* *J. quant. Spectrosc. Rad. Transf.* **3,** 299, 1963.
94. Kirichenko, A. P. *Thesis*, Inst. Metrology, Leningrad, 1963.
95. Kostkowski, H., Bass, A. *J. quant. Spectrosc. Rad. Transf.*, **1,** 177, 1961.
96. Kovacs, I., Weniger, S. *J. Phys. Radium*, **23,** 377, 1962.
97. Krindach, N. I., Kudryavtsev, R. M., Sobolev, N. N., Tunitskii, L. N., Faizullov, F. S. *Opt. Spektrosk.* **13,** 188, 1963.
98. Kunisz, M. D. *Acta phys. Polon.* Warszawa, **22,** 99, 1962.
99. Lapp, M. *J. quant. Spectrosc. and Rad. Transf.* **1,** 30, 1961.
100. Layzer, D. 10*th Intern. Confer. Astrophys. Liège*; *Mém. Soc. R. Sci. Liège* [5], **4,** 179, 1961.
101. Lichten, W. *Phys. Rev. Lett.*, **6,** 12, 1961.
101a. Littlefield, T. A., Rowley, W. R. C. *Proc. R. Soc. Lond.*, **A276,** 502, 1963.

102. Littlefield, T. A., Wood, W. A. *Trans. IAU* **11A,** 97, 1962 and private communication, November 1960.
103. Litzén, U. *Ark. Fys.*, in press.
104. Madden, R. P., Codling, K. *Phys. Rev. Lett.*, **10,** 516, 1963.
105. Manheim, C. A. *Thesis*, Paris, 1962.
106. Marr, G. V. *Proc. phys. Soc. Lond.*, **83,** 293, 1964.
107. Marr, G. V. *Can. J. Phys.*, **42,** 382, 1964.
108. Marshall, T. *J. opt. Soc. Amer.*, **53,** 439, 1962.
109. McEwen, D. J., Nicholls, R. W. unpublished work, 1963.
110. McGregor, A. T., Nicholls, R. W., Jarmain, W. R. *Can. J. Phys.*, **39,** 1215, 1961.
111. McLean, E. A. *Fourth Symposium on Temperature, Its Measurement and Control*, Columbus, 1961.
112. McNutt, D., Mack, J. E. *J. geophys. Res.*, **68,** 3419, 1963.
113. Meggers, W. F., Corliss, C. H., Scribner, B. F. *Monograph NBS*, **32,** 1961; Summary in *Spectrochim. Acta*, Lond., N.Y., **17,** 1137, 1961.
114. Meggers, W. F., Stanley, R. W. *J. Res. NBS*, **61,** 95, RP 2891, 1958.
115. Monfils, A. *Bull. Cl. Sci. Acad. Roy. Belgique*, [5], **47,** 585, 816, 1961; *ibid.* [5], **48,** 460, 482, 1962.
116. Monfils, A., Rosen, B. *J. quant. Spectrosc. Rad. Transf.*, **2,** 321, 1962.
117. Moore, C. E. *Appl. Opt.*, **2,** 665, 1963.
118. ,, *J. opt. Soc. Amer.*, **53,** 886, 1963.
119. ,, *Astr. J.*, **68,** 657, 1963.
120. ,, *Proc. Intern. Symp. on The Solar Spectrum*, C. de Jager, ed., Utrecht, Aug. 26–31, 1963, (in press) 1964.
121. Naqvi, A. M. *Conference on Opacity*, Albuquerque, 1963.
122. Nicholls, R. W. *J. Res. NBS*, **65A,** 451, 1961.
123. ,, *Can. J. Phys.*, **40,** 523, 1962.
124. ,, *Can. J. Phys.*, **40,** 1772, 1962.
125. ,, *J. quant. Spectrosc. Rad. Transf.*, **2,** 433, 1962.
126. ,, *J. Res. NBS*, **66A,** 227, 1962.
127. ,, *J. atmos. terr. Phys.*, **25,** 218, 1963.
128. ,, *J. chem. Phys.*, **38,** 1029, 1963.
129. Tyte, D. C., Nicholls, R. W. ed. *Identification Atlas of Molecular Spectra.* 1.—*The A*1Σ *Blue-Green System*, March 1964 (Univ. West. Ont., Phys. Dept.).
130. Nicholls, R. W. London Meeting on Combustion and Propulsion, 1963. Pergamon (in press).
131. ,, *J. Res. NBS*, **68A,** 75, 1964.
132. ,, *Nature*, London, **193,** 966, 1962; *ibid.*, **199,** 794, 1963.
133. Nicholls, R. W., Stewart, A. L. See (8), *Allowed Transitions*, Chapter 2, 1962.
133a. Ochkur, V. I. *Soviet Phys. JETP*, **18,** 503, 1964.
134. Omidvar, K. *Report* X-640-63-54, Goddard Space Flight Center, 1963.
135. Ortenberg, F. S. *Opt. Spektrosk.* **11,** 417, 1961.
136. Pagel, B. E. J. *Mon. Not. R. astr. Soc.*, **119,** 609, 1959.
137. Patch, R. W., Shackelford, W. L., Penner, S. S. *J. quant. Spectrosc. Rad. Transf.*, **2,** 263, 1962.
138. Peach, G. *Mon. Not. R. astr. Soc.*, **124,** 371, 1962.
139. Pearse, R. W. B., Gaydon, A. G. *The identification of Molecular Spectra*, 3rd Edn., Chapman and Hall, London, 1963.
140. Peck, E. R., Khanna, B. N., Anderholm, N. C. *J. opt. Soc. Amer.*, **52,** 536, 1962.
141. Penner, S. S., Sulman, K. G. P., Ludwig, C. B. *J. quant. Spectrosc. Rad. Transf.*, **1,** 96, 1961.
142. Peterkop, R. K. *Soviet Phys. JETP*, **14,** 1377, 1962.
143. Pillow, M. E., Smallwood, J. *Proc. phys. Soc. Lond.*, **80,** 560, 1962.
144. Rank, D. H., Eastman, D. P., Rao, B. S., Wiggins, T. A. *J. opt. Soc. Amer.*, **51,** 929, 1961.
145. Rao, P. R. *Proc. Indian Acad. Sci.*, **58A,** 353, 1963.

146. Rao, P., Gluck, G. *Proc. Roy. Soc. Lond.*, **277,** 540, 1964.
147. Reader, J., Meissner, K. W., Andrew, K. L. *J. opt. Soc. Amer.*, **50,** 221, 1960.
148. Van Regemorter, H. *Ann. Astrophys.*, **23,** 817, 1960.
149. ,, *C. R. Acad. Sci. Paris*, **252,** 2514, 2667, 1961.
150. ,, *Astrophys. J.*, **136,** 906, 1962.
151. Rigutti, M., Drago-Chuderi, F. *Ann. Astrophys.*, **26,** 253, 1963.
152. Robertson, M. *Phys. Rev.* (in press) 1963.
153. Robinson, D., Nicholls, R. W. *J. quant. Spectrosc. Rad. Transf.*, **1,** 76, 1961.
154. Roesler, F. L., Mack, J. E. *Phys. Rev.*, **135,** A58, 1964.
154a. Rowley, W. R. C., Hamon, J. *Rev. Optique* (in press), 1964.
154b. Rowley, W. R. C., Wilson, D. C. *Nature*, **200,** 745, 1963.
155. Rudge, M. R. H., Burgess, A. *Proc. Roy. Soc. Lond.*, **A273,** 372, 1963.
156. Saraph, H. E. *Proc. phys. Soc. Lond.*, **83,** 763, 1963.
157. Schweitzer, Jr., W. G., Kessler, K. G. *J. opt. Soc. Amer.*, **53,** 1382, 1963.
158. Seaton, M. J. *Proc. phys. Soc. Lond.*, **79,** 1105, 1962; see Burgess, A. (to be published) 1963.
159. Seguier, J. *C. R. Acad. Sci. Paris* **255,** 489; *ibid.*, **256,** 1703, 1963.
160. Singh, N. L., Jain, D. C. *Proc. phys. Soc. Lond.*, **78,** 400, 1961.
161. ,, ,, *Proc. phys. Soc. Lond.*, **79,** 274, 1962.
162. Smith, A. C. H., Caplinger, E., Neynaber, R. H., Rothe, E. W., Trujillo, S. N. *Phys. Rev.*, **127,** 1647, 1962.
163. Smith, D. S., Baird, K. M. *Appl. Opt.*, **2,** 177, 1963.
164. Soshnikov, V. *Opt. Spektrosk.* **10,** 229, 1961.
164a. ,, *Uspekhi fiz. Nauk*, Moskwa, **74,** 61, 1961.
164b. ,, *Opt. Spektrosk.* **12,** 123, 1963; *ibid.*, **13,** 328, 1963.
165. Stebbings, R. F., Fite, W. L., Hummer, D. G., Brackmann, R. T. *Phys. Rev.*, **119,** 1939, 1960.
166. Stevens, A. E., Ferguson, H. I. S. *Can. J. Phys.* **41,** 240, 1963.
167. Tawde, N. R., Karwa, V. M. *Proc. phys. Soc. Lond.*, **80,** 794, 1962.
168. Tobias, I., Vanderslice, J. T. *J. chem. Phys.*, **35,** 1852, 1961.
169. Trefftz, E. *Proc. Roy. Soc. Lond.*, **A271,** 379, 1963.
170. Tyte, D. C. *Proc. phys. Soc. Lond.*, **80,** 1349, 1354, 1364, 1962; *ibid.*, **81,** 163, 1963.
171. Vainshtein, L. A., Poluektov, I. A. *Opt. Spektrosk.* **12,** 460, 1962.
172. Varsavsky, C. M. *Astrophys. J. Suppl.*, **6,** 75, 1961.
173. Wallace, L. V. *Astrophys. J. Suppl.*, **6,** 455, 1962; *ibid.*, **7,** 165, 1962.
174. Wallace, L. V., Nicholls, R. W. *J. atmos. terr. Phys.*, **24,** 749, 1962.
175. Weiss, A. W. *Astrophys. J.*, **138,** 1262, 1963.
176. Weniger, S. *J. Phys. Radium*, **23,** 225, 1962.
177. Wiese, W. L. *Xth Colloquium Spectroscopicum Internationale*, p. 37, Spartan Books, Washington, D.C., 1963.
178. Wilkinson, P. G., Andrew, K. L. *J. opt. Soc. Amer.*, **53,** 710, 1963.
179. Wurster, W. H., Treanor, C. E., Thompson, M. *J. chem. Phys.*, **37,** 2560, 1963.