Selected Tables of Atomic Spectra

A Atomic Energy Levels - Second Edition

B Multiplet Tables

O VI, O VII, O VIII

Data Derived from the Analyses of Optical Spectra

Charlotte E. Moore

Office of Standard Reference Data
National Bureau of Standards
Washington, D.C. 20234

U.S. Naval Research Laboratory
E. O. Hulbert Center for Space Research
Washington, D.C. 20375

U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, Secretary

Dr. Sidney Harman, Under Secretary

Jordan J. Baruch, Assistant Secretary for Science and Technology

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

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Abstract

The present publication is the eighth section of a series being prepared in response to the need for a current revision of two sets of the author's tables containing data on atomic spectra as derived from analyses of optical spectra. As in the previous Sections, Part A contains the atomic energy levels and Part B the multiplet tables. Section 8 includes these data for O VI, O VII, O VIII, thereby completing the spectra of oxygen. The form of presentation is described in detail in the text to Section 1.

Key words: Atomic energy levels, O VI–O VIII; atomic spectra, O VI–O VIII; multiplet tables, O VI–O VIII; oxygen spectra, O VI–O VIII; spectra, O VI–O VIII; wavelengths, O VI–O VIII.

Foreword

The National Standard Reference Data System provides access to the quantitative data of physical science, critically evaluated and compiled for convenience and readily accessible through a variety of distribution channels. The System was established in 1963 by action of the President's Office of Science and Technology and the Federal Council for Science and Technology, and responsibility to administer it was assigned to the National Bureau of Standards.

NSRDS receives advice and planning assistance from a Review Committee of the National Research Council of the National Academy of Sciences-National Academy of Engineering. A number of Advisory Panels, each concerned with a single technical area, meet regularly to examine major portions of the program, assign relative priorities, and identify specific key problems in need of further attention. For selected specific topics, the Advisory Panels sponsor subpanels which make detailed studies of users' needs, the present state of knowledge, and existing data resources as a basis for recommending one or more data compilation activities. This assembly of advisory services contributes greatly to the guidance of NSRDS activities.

The System now includes a complex of data centers and other activities in academic institutions and other laboratories. Components of the NSRDS produce compilations of critically evaluated data, reviews of the state of quantitative knowledge in specialized areas, and computations of useful functions derived from standard reference data. The centers and projects also establish criteria for evaluation and compilation of data and recommend improvements in experimental techniques. They are normally associated with research in the relevant field.

The technical scope of NSRDS is indicated by the categories of projects active or being planned: nuclear properties, atomic and molecular properties, solid state properties, thermodynamic and transport properties, chemical kinetics, and colloid and surface properties.

Reliable data on the properties of matter and materials are a major foundation of scientific and technical progress. Such important activities as basic scientific research, industrial quality control, development of new materials for building and other technologies, measuring and correcting environmental pollution depend on quality reference data. In NSRDS, the Bureau's responsibility to support American science, industry, and commerce is vitally fulfilled.

E. Ambler.

ERNEST AMBLER, *Director*

Preface

The present publication is the eighth section of a series that is being prepared in response to the increasing demand for a current revision of two sets of tables containing data on atomic spectra as derived from analyses of optical spectra.

The first set, Atomic Energy Levels, NBS Circular 467, consists of three volumes published, respectively, in 1949, 1952 and 1958. This Circular has been reprinted as NSRDS-NBS 35, Volumes I, II and III.

The second set consists of two Multiplet Tables; one published in 1945 by the Princeton University Observatory, containing multiplets having wavelengths longer than 3000 Å; the other, An Ultraviolet Multiplet Table, NBS Circular 488, appearing in five Sections, the first in 1950, the second in 1952, and the others in 1962. The Princeton Multiplet Table was reprinted in 1972 as NSRDS-NBS 40.

The present series includes both sets of data, the energy levels and multiplet tables, as Parts A and B, respectively, for selected spectra contained in Volume I of "Atomic Energy Levels." The sections are being published at irregular intervals as revised analyses become available. A flexible paging permits the arrangement of the various sections by atomic number, regardless of the order in which the separate spectra are published. Section 1 includes three spectra of silicon, Z=14: Si II, Si III, Si IV. Section 2 contains similar data for Si I. Section 3 covers all spectra of carbon, Z=6: C I, C II, C III, C IV, C V, C VI. Section 4 includes the last four spectra of nitrogen, Z=7: N IV, N V, N VI, N VII. Section 5 completes the spectra of nitrogen, N I, N II, N III. Section 6 contains the spectra of hydrogen, Z=1: H I, D, T. Section 7 contains the first spectrum of oxygen, Z=8: O I. The present Section, 8, contains the last three spectra of oxygen, Z=8: O VI, O VII, O VIII. The form of presentation of the data is described in detail in the text of Section 1. All sections are arranged identically, and the same conversion factor, cm^{-1} to eV, 0.000123981 is used throughout.

The manuscript has been prepared by Charlotte E. Moore, who published the earlier tables. She appreciates the cordial cooperation of numerous atomic spectroscopists. She is particularly indebted to B. Edlén and I. Martinson in Lund, Sweden, W. C. Martin and V. Kaufman in the Spectroscopy Section of this Bureau, and to D. R. Lide and his staff for their cordial collaboration in publishing this material.

Washington, D. C., June 1978.

Contents

Part A—Atomic Energy Levels

Part B—Multiplet Tables

NSRDS-NBS 3, SECTION 8

OXYGEN Z=8

A O VI Atomic Energy Levels

B O VI Multiplet Table

Part A

OXYGEN

O VI

Li I sequence; 3 electrons $Z=8$

Ground state $1s^2\ 2s\ ^2S_{0½}$

$2s\ ^2S_{0½}$ **1114010** cm^{-1}; 89.766 Å (Vac) I P 138.116 eV

The analysis by Edlén published in "Atomic Energy Levels" is essentially unchanged. From additional observations by various authors it has been extended and slightly revised with regard to calculated wavelengths.

The present list of energy levels has been derived from a square array based on the 1974 analysis and extended by means of a current list of classified lines compiled from the literature. The limit is from the 1963 paper by Bockasten, Hallin, and Hughes.

The observations are not homogeneous, and predicted wavelengths are subject to considerable error. The extrapolated levels by Edlén, entered in brackets in the earlier list, have been adjusted in some cases to conform to the present array of energy levels. This may not be an improvement, but it provides a self-contained summary that includes the present observations.

Some special comments on individual papers should be noted. The resonance lines have been measured by Ryabtsev at: λλ 1031.924±0.005 and 1037.614±0.005 Å. Three lines reported by Pospieszczyk are not entered in part B: λλ 21.63, 21.66, and 21.70 Å. They are classified as $1s^2\ nl\ ^2L-1s\ 2p^2\ ^2(L\pm1)$. Similarly, three lines listed by Matthews and his associates have been omitted from the Multiplet Table:

λ(Å)	Designation
15.572	$1s\ 3s^2\ ^2S$ — $3s^2\ 4p\ ^2P^\circ$
16.350	$1s\ 3p^2$ — $3p^3$
18.092	$1s^2 3s$ — $1s\, 3s\ 4p$

More observations are needed to connect the designated levels with the known levels.

Gabriel and Jordan have observed a number of O VI lines in laboratory plasmas as long wavelength satellites to the He-like ion resonance lines.

The observations reported by Pegg and others on "Electron Decay-in-Flight Spectra, etc." have not been included here. Classifications in the "Spectra of Autoionization Electrons, etc." by Berry and others have also been omitted.

The assignment of higher limit terms in the list of energy levels is somewhat arbitrary and may require revision.

An effort has been made to indicate the present interpretation of the spectrum by various authors, including term designations in some cases where only general configuration assignments have meaning. As work goes on, a more suitable format can doubtless be developed.

Note added in press: The 1978 reference on "The Quartet Term System of Doubly Excited O VI."

O VI—Continued

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O VI

Config.	Desig.	*J*	Level	Interval
$1s^2\ 2s$	$2s\ ^2S$	0½	0.0	
$1s^2\ 2p$	$2p\ ^2P^\circ$	0½	96375.0	532.5
		1½	96907.5	
$1s^2\ 3s$	$3s\ ^2S$	0½	640039.8	
$1s^2\ 3p$	$3p\ ^2P^\circ$	0½	666113.2	156.6
		1½	666269.8	
$1s^2\ 3d$	$3d\ ^2D$	1½	674625.7	51.1
		2½	674676.8	
$1s^2\ 4s$	$4s\ ^2S$	0½	852696	
$1s^2\ 4p$	$4p\ ^2P^\circ$	0½	863333.8	63.9
		1½	863397.7	
$1s^2\ 4d$	$4d\ ^2D$	1½	866880.1	21.4
		2½	866901.5	
$1s^2\ 4f$	$4f\ ^2F^\circ$	2½	867077.7	9.3
		3½	867087.0	
$1s^2\ 5s$	$5s\ ^2S$	0½	948690	
$1s^2\ 5p$	$5p\ ^2P^\circ$	0½ 1½	954080	
$1s^2\ 5d$	$5d\ ^2D$	1½	955851	9
		2½	955860	
$1s^2\ 5f$ etc.	$5f\ ^2F^\circ$ $5g\ ^2G$	2½ to 4½	955985	
$1s^2\ 6s$	$6s\ ^2S$	0½	1000080	
$1s^2\ 6p$	$6p\ ^2P^\circ$	0½ 1½	1003130	
$1s^2\ 6d$	$6d\ ^2D$	1½	1004170	14
		2½	1004184	
$1s^2\ 6f$	$6f\ ^2F^\circ$	2½ 3½	[1004265]	
$1s^2\ 6g$ etc.	$6g\ ^2G$ $6h\ ^2H^\circ$	3½ to 5½	[1004276]	
$1s^2\ 7s$ etc.	$7s\ ^2S$	0½	1030780	
$1s^2\ 7p$	$7p\ ^2P^\circ$	0½ 1½	1032630	
$1s^2\ 7d$	$7d\ ^2D$	1½	1033310	24
		2½	1033334	
$1s^2\ 7f$	$7f\ ^2F^\circ$	2½ 3½	[1033382]	
$1s^2\ 7g$ etc.	$7g\ ^2G$ $7h\ ^2H^\circ$ $7i\ ^2I$	3½ to 6½	[1033389]	
$1s^2\ 8s$	$8s\ ^2S$	0½	[1050543]	
$1s^2\ 8p$	$8p\ ^2P^\circ$	0½ 1½	1051724	
$1s^2\ 8f$	$8f\ ^2F^\circ$	2½ 3½	[1052280]	
$1s^2\ 8g$ etc.	$8g\ ^2G$ $8h\ ^2H^\circ$ $8i\ ^2I$ $8k\ ^2K^\circ$	3½ to 7½	[1052285]	
$1s^2\ 8d$	$8d\ ^2D$	1½	1052288	13
		2½	1052301	

O VI—Continued

Config.	Desig.	J	Level	Interval
1s² 9p	9p ²P°	0½, 1½	1064793	
1s² 9h etc.	9h ²H°, 9i ²I, 9k ²K°	4½ to 7½	[1065207]	
1s² 9d	9d ²D	1½	1065311	26
		2½	1065337	
1s² 10d	10d ²D	1½, 2½	1074425	
1s² 10h etc.	10h ²H°, ²I, ²K°	4½ to 7½	[1074532]	
1s² 10p	10p ²P°	0½, 1½	[1074922]	
1s² 11d	11d ²D	1½, 2½	1081451	
1s² 12h etc.	12h ²H° etc.	4½ etc.	[1086514]	
	....	......	....	
O VII (¹S₀)	***Limit***	....	**1114010**	
1s 2s (³S) 2p	2p′ ⁴P°	0½, 1½, 2½	4470270	
1s 2s (³S) 2p	2p′ ²P°	0½, 1½	4537620	
1s 2s (¹S) 2p	2p″ ²P°	0½, 1½	4541330	
1s 2p²	2p² ⁴P	0½, 1½, 2½	[4575010]	
1s 2p (³P°) 2s	2p 2s ²P°	0½, 1½	4582950	
1s 2p (¹P°) 2s	2p 2s′ ²P°	0½, 1½	4591370	
1s 2p²	2p² ²D	1½, 2½	4617530	
1s 2p²	2p² ²P	0½, 1½	4643820	
1s 2p²	2p² ²S	0½	4696550	
1s 2s 3s	2s 3s ⁴S	1½	5129900	
1s 2s 3d	2s 3d ⁴D	0½ to 3½	5182010	
1s 2d 3d	2d 3d ⁴D	0½ to 3½	5197910	
1s 2p 3s	2p 3s ⁴P°	0½ to 2½	[5202760]	
1s 2s 4d	2s 4d ⁴D	0½ to 3½	5214870	
1s 2p 3d	2p 3d ²D°	1½, 2½	5254130	
1s 2p 3d	2p 3d ⁴D°	0½ to 3½	[5254360]	
1s 2p 3d	2p 3d ⁴P°	0½, 1½, 2½	[5260970]	
1s 2p(¹P°)3p	2p 3p ²D	1½, 2½	5272390	
1s 2p(¹P°)3p	2p 3p ²S	0½	5272390	
1s 2p 4d	2p 4d ⁴D°	0½ to 3½	[5450280]	
1s 2s 8p	2s 8p ⁴P°	0½, 1½, 2½	[5450280]	
1s 2s 9p	2s 9p ⁴P°	0½, 1½, 2½	[5490170]	
2p³	2p³ ²P°	0½, 1½	9732880	

June 1978.

Multiplet Table

Part B OXYGEN

O VI (Z=8)

I P 138.116 eV   Limit 1114010 cm^{-1} 89.766 Å (Vac)

Anal A   List A   June 1978

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K J. P. Buchet, A. Denis, J. Desesquelles, M. Druetta, and J. L. Subtil, Beam-Foil Spectroscopy **1**, 355-365 (1976). C L; W L 114 Å–159 Å.

P Predicted wavelength

[P] A theoretical value of either or both energy levels of the transition has been used in deriving the predicted wavelength.

‡ Raie Ultime

* and § Blend of O VI and O VII

O VI

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac 1031.928‡ 1037.618	 B B	 10 9	 0.00 0.00	 12.01 11.95	 0½ -1½ 0½ -0½	 $2s\ ^2S-2p\ ^2P^\circ$ UV 1
150.089 150.124	A A	13 12	0.00 0.00	82.60 82.59	0½ -1½ 0½ -0½	$2s\ ^2S-3p\ ^2P^\circ$ UV 2
148.218	A	1*d*	0.00	83.65	0½ -2½	$2s\ ^2S-3d\ ^2D$ UV 1F
115.822 115.830	A A	9 8	0.00 0.00	107.04 107.04	0½ -1½ 0½ -0½	$2s\ ^2S-4p\ ^2P^\circ$ UV 2.01
104.813	A	7	0.00	118.29	0½-	$2s\ ^2S-5p\ ^2P^\circ$ UV 2.02
99.688	A	5*d*	0.00	124.37	0½-	$2s\ ^2S-6p\ ^2P^\circ$ UV 2.03
96.840	A	4*d*	0.00	128.03	0½-	$2s\ ^2S-7p\ ^2P^\circ$ UV 2.04
95.082	A	3*d*	0.00	130.39	0½-	$2s\ ^2S-8p\ ^2P^\circ$ UV 2.05
93.915	A	2*d*	0.00	132.01	0½-	$2s\ ^2S-9p\ ^2P^\circ$ UV 2.06
93.03	H	2	0.00	133.27	0½-	$2s\ ^2S-10p\ ^2P^\circ$ UV 2.07
22.370	D		0.00	554.23	0½-	$2s\ ^2S-2p'\ ^4P^\circ$ UV 2.08
22.038	D		0.00	562.58	0½-	$2s\ ^2S-2p'\ ^2P^\circ$ UV 2.09
22.02	G		0.00	563.04	0½-	$2s\ ^2S-2p''\ ^2P^\circ$ UV 2.10
21.82	C		0.00	568.20	0½-	$2s\ ^2S-2p\ 2s\ ^2P^\circ$ UV 2.11
21.78	G		0.00	569.24	0½-	$2s^2S-2p\,2s'\,^2P^\circ$ UV 2.12
184.117 183.937	A A	10 9	12.01 11.95	79.35 79.35	1½ -0½ 0½ -0½	$2p\ ^2P^\circ-3s\ ^2S$ UV 3
173.082 172.935	A A	14 13	12.01 11.95	83.65 83.64	1½ -2½ 0½ -1½	$2p\ ^2P^\circ-3d\ ^2D$ UV 4
132.312 132.219	A A	6 5	12.01 11.95	105.72 105.72	1½ -0½ 0½ -0½	$2p\ ^2P^\circ-4s\ ^2S$ UV 4.01
129.871 129.785	A A	11 10	12.01 11.95	107.48 107.48	1½ -2½ 0½ -1½	$2p\ ^2P^\circ-4d\ ^2D$ UV 5
117.401 117.327	A A	3 2	12.01 11.95	117.62 117.62	1½ -0½ 0½ -0½	$2p\ ^2P^\circ-5s\ ^2S$ UV 6
116.666	A	1	12.01	118.29	1½-	$2p\ ^2P^\circ\ 5p\ ^2P^\circ$ UV 2F

O VI

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac 116.421 116.350	 A A	 7*d* 6*d*	 12.01 11.95	 118.51 118.51	 1½ -2½ 0½ -1½	 $2p\ ^2P^\circ-5d\ ^2D$ UV 7
110.721 110.655	A A	2 1	12.01 11.95	123.99 123.99	1½ -0½ 0½ -0½	$2p\ ^2P^\circ-6s\ ^2S$ UV 8
110.220 110.157	A A	5*d* 4*d*	12.01 11.95	124.50 124.50	1½ -2½ 0½ -1½	$2p\ ^2P^\circ-6d\ ^2D$ UV 9
107.081	A	1	12.01	127.80	1½ -0½	$2p\ ^2P^\circ-7s\ ^2S$ UV 10
106.789 106.731	A A	4*d* 3*d*	12.01 11.95	128.11 128.11	1½ -2½ 0½ -1½	$2p\ ^2P^\circ-7d\ ^2D$ UV 11
[104.862]	P		12.01	130.25	1½ -0½	$2p\ ^2P^\circ-8s\ ^2S$ UV 12
104.669 104.612	A A	3*d* 2*d*	12.01 11.95	130.47 130.46	1½ -2½ 0½ -1½	$2p\ ^2P^\circ-8d\ ^2D$ UV 13
103.260 103.206	A A	2*d* 1*d*	12.01 11.95	132.08 132.08	1½ -2½ 0½ -1½	$2p\ ^2P^\circ-9d\ ^2D$ UV 14
102.30	H	3	12.01	133.21	1½ -2½	$2p\ ^2P^\circ-10d^2D$ UV 15
101.57	H	2	12.01	134.08	1½ -2½	$2p\ ^2P^\circ-11d^2D$ UV 16
22.33	P		11.99	567.21		$2p\ ^2P^\circ-2p^2\ ^4$] UV 17
22.12	G		11.99	572.49		$2p\ ^2P^\circ-2p^2\ ^2$] UV 18
21.74	G		11.99	582.28	-0½	$2p\ ^2P^\circ-2p^2\ ^2S$ UV 19
Air 3811.35 3834.24	 B B	 2 1	 79.35 79.35	 82.60 82.59	 0½ -1½ 0½ -0½	 $3s\ ^2S-3p\ ^2P^\circ$ 1
Vac 447.712 447.840	 B B	 0 0-	 79.35 79.35	 107.04 107.04	 0½ -1½ 0½ -0½	 $3s\ ^2S-4p\ ^2P^\circ$ UV 20
498.431 498.090	B B	1*d* 0*d*	82.60 82.59	107.48 107.48	1½ -2½ 0½ -1½	$3p\ ^2P^\circ-4d\ ^2D$ UV 21
21.71	G		82.60	653.68		$3p\ ^2P^\circ-2p\ 3p\ ^2$ UV 22
519.723 519.610	B B	2+*d* 2*d*	83.65 83.64	107.50 107.50	2½ -3½ 1½ -2½	$3d\ ^2D-4f\ ^2F^\circ$ UV 23
1125	I		107.48 107.50	118.52 118.52		$4d\ ^2D-5f\ ^2F^\circ$ $4f\ ^2F^\circ-5g\ ^2G$ UV 24

O VI—Continued

I A	Ref	Int	E P Low	E P High	*J*	Multiplet No.
Vac 729	I		107.48 107.50	124.51 124.51		$4d\,^2D-6f\,^2F^\circ$ $4f\,^2F^\circ-6g\,^2G$ UV 25
601	I		107.48 107.50	128.12 128.12		$4d\,^2D-7f\,^2F^\circ$ $4f\,^2F^\circ-7g\,^2G$ UV 26
Air 2069.92	C	5	118.52	124.51		$5f\,^2F^\circ-6g\,^2G$
2070.29	C	4	118.52	124.51		$5g\,^2G-6h\,^2H^\circ$ UV 27
3071	P		123.99	128.03	0½-	$6s\,^2S-7p\,^2P^\circ$ 2
3616	P		124.37	127.80	-0½	$6p\,^2P^\circ-7s\,^2S$ 3
3311	P		124.37	128.11		$6p\,^2P^\circ-7d\,^2D$ 4
3514	P		124.50	128.03		$6d\,^2D-7p\,^2P^\circ$ 5
[3423]	P		124.50	128.12		$6d\,^2D-7f\,^2F^\circ$ 6
[3440]	P		124.51	128.11		$6f\,^2F^\circ-7d\,^2D$ 7
3433.69	C	5	124.51	128.12		$6f\,^2F^\circ-7g\,^2G$ $6g\,^2G-7h\,^2H^\circ$ $6h\,^2H^\circ-7i\,^2I$ 8
2082.18	C	2	124.51	130.46		$6f\,^2F^\circ-8g\,^2G$ $6g\,^2G-8h\,^2H^\circ$ $6h\,^2H^\circ-8i\,^2I$ UV 28
4773	P		127.80	130.39	0½-	$7s\,^2S-8p\,^2P^\circ$ 9
[5581]	P		128.03	130.25	-0½	$7p\,^2P^\circ-8s\,^2S$ 10
5084	P		128.03	130.47		$7p\,^2P^\circ-8d\,^2D$ 11
5433	P		128.11	130.39		$7d\,^2D-8p\,^2P^\circ$ 12

O VI—Continued

I A	Ref	Int	E P Low	E P High	*J*	Multiplet No.
Air [5274]	P		128.11	130.46		$7d\,^2D-8f\,^2F^\circ$ 13
[5289]	P		128.12	130.46		$7f\,^2F^\circ-8g\,^2G$ 14
[5286]	P		128.12	130.47		$7f\,^2F^\circ-8d\,^2D$ 15
5290.60	C	5	128.12	130.46		$7g\,^2G-8h\,^2H^\circ$ $7h\,^2H^\circ-8i\,^2I$ $7i\,^2I-8k\,^2K^\circ$ 16
3142	E		128.12	132.07		$7g\,^2G-9h\,^2H^\circ$ etc.-etc. 17
2428	E		128.12	133.22		$7g\,^2G-10h\,^2H^\circ$ etc.-etc. UV 29
4500	E		130.46	133.22		$8g\,^2G-10h\,^2H^\circ$ etc.-etc. 18
4692	E		132.07	134.71		$9g\,^2G-12h\,^2H^\circ$ etc.-etc. 19
Vac 151.6	K		554.23	636.01		$2p'\,^4P^\circ-2s\,3s\,^4S$ UV 30
140.5	K		554.23	642.47		$2p'\,^4P^\circ-2s\,3d\,^4D$ UV 31
*137.43§	J	(80)	554.23	644.44		$2p'\,^4P^\circ-2d\,3d\,^4D$ UV 32
134.3	J	(30)	554.23	646.54		$2p'\,^4P^\circ-2s\,4d\,^4D$ UV 33
159.3	K		567.21	645.04		$2p^2\,^4P-2p\,3s\,^4P^\circ$ UV 34
147.2	K		567.21	651.44		$2p^2\,^4P-2p\,3d\,^4D^\circ$ UV 35
145.78	J	(160)	567.21	652.26		$2p^2\,^4P-2p\,3d\,^4P^\circ$ UV 36
*114.25§	J	(50)	567.21	675.73		$2p^2\,^4P-2p\,4d\,^4D^\circ$ UV 37

O VI—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
*114.25§	J	(50)	567.21	673.73		$2p^2\ ^4P-2s\ 8p\ ^4P^o$ UV 38
*109.27§	J	(40)	567.21	680.78		$2p^2\ ^4P-2s\ 9p\ ^4P^o$ UV 39
19.549	D		572.49	1207		$2p^2\ ^2D-2p^3\ ^2P^o$ UV 40

O VI—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
*163.85§	J	(150)	575.75	651.41		$2p^2\ ^2P-2p\ 3d\ ^2I$ UV 41
19.650	D		575.75	1207		$2p^2\ ^2P-2p^3\ ^2P^o$ UV 42

NSRDS-NBS 3, SECTION 8

OXYGEN $Z=8$

Part A

OXYGEN

O VII

He I sequence; 2 electrons $Z=8$

Ground state $1s^2\ ^1S_0$

$1s^2\ ^1S_0$ **5962800±300** cm^{-1}; 16.771 Å (Vac) I P 739.274±0.037 eV

The observations are from various sources, but the analysis is confirmed by theory. A. M. Cantú and his associates have extended the early work of Tyrén and Edlén in the grazing-incidence region by "Focusing a Q-switched 1-GW ruby laser on a solid target and detecting the emitted radiation." From these observations they derive the ionization limit quoted above, which agrees well with Tyrén's early value 5963000±600 cm^{-1}.

The writer has prepared a line list from the wavelengths quoted in Part B and derived the tabulated energy levels from a square array of combinations based on this list. Except for three lines near 1600 Å, the line list extends from 137 Å to 15 Å. Most energy levels might well be listed to fewer significant figures.In the paper by Cantú and others a probable error of 0.007 Å is given for most of their observed lines. The data are not homogeneous but provide a general summary of the analysis.

Brackets denote calculated energy levels. The entries for the terms $np\ ^3P^o(n=8-10)$ and $10d\ ^3D$ are from calculated wavelengths listed by Fawcett. The values for the terms $nd\ ^3D(n=4-10)$ have been determined from combinations with $2p\ ^3P^o$ by using the center of gravity, 4585980 cm^{-1}, for this term.

The levels above the ionization limit involve two-electron excitation. They are based on the observations between 15 Å and 19 Å reported by Matthews and his associates. One line, 19.069 Å, classified by these authors as $1s\ 3p-2p\ 3p$ has not been utilized in the present compilation, pending further clarification. The term that they designate as $2p^2\ ^1P$ is entered here as $2p^2\ ^1D$.

Hallin and others have reported eight lines of O VII between 2306 Å and 4562 Å observed in beam-foil spectra of oxygen ions at beam energies of 6-42 MeV. They define these lines by the principal quantum numbers n and n' as follows:

λ(Å)exp	n	n'	λ(Å)exp	n	n'
* 2522	6	7	* 2522	8	11
3892	7	8	* 4562	9	11
2306	7	9	3435	9	12
3308	8	10	* 4562	10	13

* Blend

The agreement between the observed and their quoted theoretical wavelengths for these lines is good.

In their 1976 paper, Buchet and others report some of these observed hydrogenic transitions and two lines at λ 2562 Å and λ 2452 Å which they designate as having the respective transitions 6*d*–7*p* and 6*p*–7*d*.

Accad, Pekeris, and Schiff have published theoretical wavelengths for the transitions $2s\ ^3S–np\ ^3P°$ (n=3 to 5) and, also, find satisfactory agreement with experimental values.

Buchet and his associates report the following new lines excited by the beam-foil technique "at an energy of 1.15 MeV/nucleon".

λ (Å)	Transition
382	1*s* 3*d*–1*s* 4*f*
442	1*s* 4*f*–1*s* 7*g*
535	1*s* 4*f*–1*s* 6*g*
826	1*s* 4*f*–1*s* 5*g*
949	1*s* 5*g*–1*s* 7*h*

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O VII

Config.	Desig.	*J*	Level	Interval
1s^2	1s^2 ^{1}S	0	0	
1s 2s	2s ^{3}S	1	4524640	
1s 2p	2p ^{3}P°	0 1 2	4585620 4585680 4586230	60 550
1s 2s	2s ^{1}S	0	4587340+*x*	
1s 2p	2p ^{1}P°	1	4629200	
1s 3s	3s ^{3}S	1	5338820	
1s 3p	3p ^{3}P°	0,1,2	5355670	
1s 3s	3s ^{1}S	0	5356420	
1s 3d	3d ^{3}D	1 2 3	5364370 5364430 5364440	60 10
1s 3d	3d ^{1}D	2	5365470	
1s 3p	3p ^{1}P°	1	5368550	
1s 4s	4s ^{3}S	1	5616100	
1s 4p	4p ^{3}P°	0,1,2	5622600	
1s 4d	4d ^{3}D	1,2,3	5626280	
1s 4d	4d ^{1}D	2	5626670	
1s 4p	4p ^{1}P°	1	5628100	
1s 5p	5p ^{3}P°	0,1,2	5745440	
1s 5d	5d ^{3}D	1,2,3	5747420	
1s 5d	5d ^{1}D	2	5748230	
1s 5p	5p ^{1}P°	1	5748450	
1s 6p	6p ^{3}P°	0,1,2	5811730	
1s 6d	6d ^{3}D	1,2,3	5813070	
1s 6d	6d ^{1}D	2	5813680	
1s 6p	6p ^{1}P°	1	5813950	
1s 7p	7p ^{3}P°	0,1,2	5851890	
1s 7p	7p ^{1}P°	1	5852740	
1s 7d	7d ^{3}D	1,2,3	5853660	
1s 8p	8p ^{3}P°	0,1,2	[5877800]	
1s 8d	8d ^{3}D	1,2,3	5878400	
1s 9d	9d ^{3}D	1,2,3	5892950	
1s 9p	9p ^{3}P°	0,1,2	[5894500]	
1s 10p	10p ^{3}P°		[5907800]	
1s 10d	10d ^{3}D	1,2,3,	[5910500]	
O VIII (^{2}S$_{1/2}$)	***Limit***		**5962800**	
2p^2	2p^2 ^{3}P	0,1,2	9745140	
2p^2	2p^2 ^{1}D	2	9788360	
2p^2	2p^2 ^{1}S	0	9836180	
2p 3p	^{1}P	1	10592230	
2s 2p	^{3}P°	0,1,2	10593340	
2s 2p	^{1}P°	1	10593340+*x*	
2p 3p	^{3}P		10616980	
2p 3d	^{3}D°		10620410	
2s 4p	^{3}P°		10873850	
2p 3p	^{3}D		11508500+*x*	
3p^2	^{3}P		11533850	
3p 4p	^{3}P		11832770	
3p 4p	^{1}P		11845650	

June 1978.

Multiplet Table

Part B

OXYGEN

O VII (Z=8)

I P 739.274±0.037 eV. Limit 5962800±300 cm^{-1} 16.771 Å (Vac)

Anal B List A June 1978

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P Predicted Wavelength

‡ Raie Ultime

* Blend

* and † Blend of O VII and Be III

* and § Blend of O VII and O VI

Multiplet Table

O VII

I A	Ref	Int	E P Low	E P High	*J*	Multiplet No.
Vac 22.10	H		0.00	560.97	0-1	$1s^2\ ^1S-2s\ ^3S$ IF
21.807	A	3	0.00	568.54	0-1	$1s^2\ ^1S-2p\ ^3P^o$ 1
21.6020‡	C		0.00	573.93	0-1	$1s^2\ ^1S-2p\ ^1P^o$ 2
18.627	E		0.00	665.60	0-1	$1s^2\ ^1S-3p\ ^1P^o$ 3
17.768	E		0.00	697.78	0-1	$1s^2\ ^1S-4p\ ^1P^o$ 4
17.396	E		0.00	712.70	0-1	$1s^2\ ^1S-5p\ ^1P^o$ 5
17.200	E		0.00	720.82	0-1	$1s^2\ ^1S-6p\ ^1P^o$ 6
17.086	A	1	0.00	725.63	0-1	$1s^2\ ^1S-7p\ ^1P^o$ 7
1623.63	D		560.97	568.61	1-2	$2s\ ^3S-2p\ ^3P^o$ 8
1638.30	D		560.97	568.54	1-1	
1639.87	D		560.97	568.53	1-0	
120.333	A	66	560.97	664.00	1	$2s\ ^3S\ \ 3p\ ^3P^o$ 9
91.078	A	30	560.97	697.10	1-	$2s\ ^3S-4p\ ^3P^o$ 10
81.914	A	10	560.97	712.33	1-	$2s\ ^3S-5p\ ^3P^o$ 11
77.695	A	3	560.97	720.54	1-	$2s\ ^3S-6p\ ^3P^o$ 12
75.344	A	2	560.97	725.52	1-	$2s\ ^3S-7p\ ^3P^o$ 13
73.9	G	P	560.97	728.74	1-	$2s\ ^3S-8p\ ^3P^o$ 14
73.0	G	P	560.97	730.81	1-	$2s\ ^3S-9p\ ^3P^o$ 15
72.3	G	P	560.97	732.45	1-	$2s\ ^3S-10p\ ^3P^o$ 16
16.478	B		560.97	1313	1-	$2s\ ^3S-2s\ 2p\ ^3P^o$ 17
15.750	B		560.97	1348	1-	$2s\ ^3S-2s\ 4p\ ^3P^o$ 18

O VII

I A	Ref	Int	E P Low	E P High	*J*	Multiplet No.
Vac 132.831	A	13	568.51	661.91	-1	$2p\ ^3P^o-3s\ ^3S$ 19
128.500	F	(0)	568.61	665.09	2-3	$2p\ ^3P^o-3d\ ^3D$ 20
*128.412	F	(00)	568.54	665.09	1-2	
*128.412	F	(00)	568.53	665.08	0-1	
97.076	A	1	568.58	696.29	-1	$2p\ ^3P^o-4s\ ^3S$ 21
96.126	A	68	568.58	697.55	-	$2p\ ^3P^o-4d\ ^3D$ 22
86.100	A	29	568.58	712.57		$2p\ ^3P^o-5d\ ^3D$ 23
81.494	A	10	568.58	720.71		$2p\ ^3P^o-6d\ ^3D$ 24
78.884	A	4	568.58	725.74		$2p\ ^3P^o-7d\ ^3D$ 25
77.374	A	1	568.58	728.81		$2p\ ^3P^o-8d\ ^3D$ 26
76.513	A	1	568.58	730.61		$2p\ ^3P^o-9d\ ^3D$ 27
75.5	G	P	568.58	732.79		$2p\ ^3P^o-10d\ ^3D$ 28
*19.383	B		568.58	1208		$2p\ ^3P^o-2p^2\ ^3P$ 29
16.581	B		568.58	1316		$2p\ ^3P^o-2p\ 3p\ ^3P$ 30
16.650	B		568.74	1313	0-1	$2s\ ^1S-2s\ 2p\ ^1P^o$ 31
137.51	I		573.93	664.09	1-0	$2p\ ^1P^o-3s\ ^1S$ 32
135.820	A	48	573.93	665.22	1-2	$2p\ ^1P^o-3d\ ^1D$ 33
*100.254†	A		573.93	697.60	1-2	$2p\ ^1P^o-4d\ ^1D$ 34
89.363	A	10	573.93	712.67	1-2	$2p\ ^1P^o-5d\ ^1D$ 35
84.425	A	1	573.93	720.79	1-2	$2p\ ^1P^o-6d\ ^1D$ 36
*19.383	B		573.93	1213	1-2	$2p\ ^1P^o-2p^2\ ^1D$ 37

O VII—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
/ac						
.205	B		573.93	1220	1-0	$2p\ ^1P^o-2p^2\ ^1S$ 38
.770	B		573.93	1313	1-1	$2p\ ^1P^o-2p\ 3p\ ^1P$ 39
.186	B		664.00	1430		$3p\ ^3P^o-3p^2\ ^3P$ 40
.439	B		664.00	1467		$3p\ ^3P^o-3p\ 4p\ ^3P$ 41

O VII—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
*15.439	B		665.60	1469	1-1	$3p\ ^1P^o-3p\ 4p\ ^1P$ 42
*114.25§	J		1208	1317		$2p^2\ ^3P-2p\ 3d\ ^3D^o$ 43
*109.27§	J		1313	1427		$2s\ 2p\ ^1P^o-2p\ 3p\ ^1D$ 44

NSRDS-NBS 3, SECTION 8

OXYGEN $Z=8$

Part A

OXYGEN

O VIII

H I sequence; 1 electron $Z=8$

Ground state $1s\ ^2S_{0 1/2}$

$1s\ ^2S_{0 1/2}$ **7028394** cm^{-1}; 14.228 Å (Vac) I P 871.387 eV

In 1940, F. Tyrén reported the Lyman line $1s\ ^2S$–$2p\ ^2P^o$ as observed for the first time.

The terms in the table are those derived by J.D. Garcia and J.E. Mack as part of their extensive calculations of H-like spectra to Ca XX. Their values refer to the isotope ^8O for which they used R=109733.54530.

B. Edlén has, also, calculated centre-of-gravity wavelengths of the Lyman lines $1s$–np, n=2 to 7, for the natural isotope mixture, but the difference is negligible in the case of O VIII.

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O VIII

Config.	Desig.		J	Level	Interval
1s	$1s\ ^2S$		0½	0	
2p		$2p\ ^2P^o$	0½	5270782	73
2s	$2s\ ^2S$		0½	5270855	1429
2p		$2p\ ^2P^o$	1½	5272284	
3p		$3p\ ^2P^o$	0½	6247399	22
3s	$3s\ ^2S$		0½	6247421	423
3p, 3d	$3d\ ^2D$	$3p\ ^2P^o$	1½	6247844	148
3d	$3d\ ^2D$		2½	6247992	
4p		$4p\ ^2P^o$	0½	6589154	10
4s	$4s\ ^2S$		0½	6589164	178
4p, 4d	$4d\ ^2D$	$4p\ ^2P^o$	1½	6589342	62
4d, 4f	$4d\ ^2D$	$4f\ ^2F^o$	2½	6589404	32
4f		$4f\ ^2F^o$	3½	6589436	
5p		$5p\ ^2P^o$	0½	6747312	5
5s	$5s\ ^2S$		0½	6747317	91
5p, 5d	$5d\ ^2D$	$5p\ ^2P^o$	1½	6747408	32
5d, 5f	$5d\ ^2D$	$5f\ ^2F^o$	2½	6747440	16
5f, 5g	$5g\ ^2G$	$5f\ ^2F^o$	3½	6747456	10
5g	$5g\ ^2G$		4½	6747466	
6p		$6p\ ^2P^o$	0½	6833214	3
6s	$6s\ ^2S$		0½	6833217	53
6p, 6d	$6d\ ^2D$	$6p\ ^2P^o$	1½	6833270	18
6d, 6f	$6d\ ^2D$	$6f\ ^2F^o$	2½	6833288	9
6f, 6g	$6g\ ^2G$	$6f\ ^2F^o$	3½	6833297	6
6g, 6h	$6g\ ^2G$	$6h\ ^2H^o$	4½	6833303	4
		$6h\ ^2H^o$	5½	6833307	

O VIII

Config.	Desig.		J	Level	Interval
7p		$7p\ ^2P^o$	0½	6885005	2
7s	$7s\ ^2S$		0½	6885007	33
7p, 7d	$7d\ ^2D$	$7p\ ^2P^o$	1½	6885040	12
7d, 7f	$7d\ ^2D$	$7f\ ^2F^o$	2½	6885052	6
7f, 7g	$7g\ ^2G$	$7f\ ^2F^o$	3½	6885058	3
7g, 7h	$7g\ ^2G$	$7h\ ^2H^o$	4½	6885061	2
7h, 7i	$7i\ ^2I$	$7h\ ^2H^o$	5½	6885063	2
7i	$7i\ ^2I$		6½	6885065	
8p		$8p\ ^2P^o$	0½	6918617	1
8s	$8s\ ^2S$		0½	6918618	22
8d	$8d\ ^2D$		1½	6918640	1
8p		$8p\ ^2P^o$	1½	6918641	7
8d, 8f	$8d\ ^2D$	$8f\ ^2F^o$	2½	6918648	4
8f, 8g	$8g\ ^2G$	$8f\ ^2F^o$	3½	6918652	3
8g, 8h	$8g\ ^2G$	$8h\ ^2H^o$	4½	6918655	1
8h, 8i	$8i\ ^2I$	$8h\ ^2H^o$	5½	6918656	1
8i, 8k	$8i\ ^2I$	$8k\ ^2K^o$	6½	6918657	1
8k		$8k\ ^2K^o$	7½	6918658	
9p		$9p\ ^2P^o$	0½	6941660	1
9s	$9s\ ^2S$		0½	6941661	15
9p, 9d	$9d\ ^2D$	$9p\ ^2P^o$	1½	6941676	6
9d, 9f	$9d\ ^2D$	$9f\ ^2F^o$	2½	6941682	3
9f, 9g	$9g\ ^2G$	$9f\ ^2F^o$	3½	6941685	1
9g, 9h	$9g\ ^2G$	$9h\ ^2H^o$	4½	6941686	1
9h, 9i	$9i\ ^2I$	$9h\ ^2H^o$	5½	6941687	1
9i, 9k	$9i\ ^2I$	$9k\ ^2K^o$	6½	6941688	1
9k, 9l	$9l\ ^2L$	$9k\ ^2K^o$	7½	6941689	0
9l	$9l\ ^2L$		8½	6941689	

O VIII—Continued

Config.	Desig.		J	Level	Interval
10*p*		10*p* $^2P^\circ$	$0\frac{1}{2}$	6958141	1
10*s*	10*s* ^2S		$0\frac{1}{2}$	6958142	11
10*p*, 10*d*	10*d* ^2D	10*p* $^2P^\circ$	$1\frac{1}{2}$	6958153	4
10*d*, 10*f*	10*d* ^2D	10*f* $^2F^\circ$	$2\frac{1}{2}$	6958157	2
10*f*, 10*g*	10*g* ^2G	10*f* $^2F^\circ$	$3\frac{1}{2}$	6958159	2
10*g*, 10*h*	10*g* ^2G	10*h* $^2H^\circ$	$4\frac{1}{2}$	6958161	0
10*h*, 10*i*	10*i* ^2I	10*h* $^2H^\circ$	$5\frac{1}{2}$	6958161	1
10*i*, 10*k*	10*i* ^2I	10*k* $^2K^\circ$	$6\frac{1}{2}$	6958162	0
10*k*, 10*l*	10*l* ^2L	10*k* $^2K^\circ$	$7\frac{1}{2}$	6958162	1
10*l*, 10*m*	10*l* ^2L	10*m* $^2M^\circ$	$8\frac{1}{2}$	6958163	0
10*m*		10*m* $^2M^\circ$	$9\frac{1}{2}$	6958163	
11*p*		11*p* $^2P^\circ$	$0\frac{1}{2}$	6970335	1
11*s*	11*s* ^2S		$0\frac{1}{2}$	6970336	16
etc.			$10\frac{1}{2}$	to 52	
12*s*, 12*p*	12*s* ^2S	12*p* $^2P^\circ$	$0\frac{1}{2}$	6979610	12
etc.			$11\frac{1}{2}$	to 22	
13*s*, 13*p*	13*s* ^2S	13*p* $^2P^\circ$	$0\frac{1}{2}$	6986827	10
etc.			$12\frac{1}{2}$	to 37	
14*p*		14*p* $^2P^\circ$	$0\frac{1}{2}$	6992553	1
14*s*	14*s* ^2S		$0\frac{1}{2}$	6992554	8
etc.			$13\frac{1}{2}$	to 62	

O VIII—Continued

Config.	Desig.		J	Level	Interval
15*s*, 15*p*	15*s* ^2S	15*p* $^2P^\circ$	$0\frac{1}{2}$	6997173	7
etc.			$14\frac{1}{2}$	to 80	
16*s*, 16*p*	16*s* ^2S	16*p* $^2P^\circ$	$0\frac{1}{2}$	7000954	6
etc.			$15\frac{1}{2}$	to 60	
17*s*, 17*p*	17*s* ^2S	17*p* $^2P^\circ$	$0\frac{1}{2}$	7004088	4
etc.			$16\frac{1}{2}$	to 92	
18*s*, 18*p*	18*s* ^2S	18*p* $^2P^\circ$	$0\frac{1}{2}$	7006713	4
etc.			$17\frac{1}{2}$	to 17	
19*s*, 19*p*	19*s* ^2S	19*p* $^2P^\circ$	$0\frac{1}{2}$	7008936	3
etc.			$18\frac{1}{2}$	to 39	
20*s*, 20*p*	20*s* ^2S	20*p* $^2P^\circ$	$0\frac{1}{2}$	7010833	3
etc.			$19\frac{1}{2}$	to 36	
	....		......	....	
	∞=*Limit*		......	**7028394**	

March 1971.

Multiplet Table

Part B

OXYGEN

O VIII (Z=8)

I P 871.387 eV Limit 7028394 cm^{-1} 14.228 Å (Vac)

Anal A List B March 1971

REFERENCES

A J. D. Garcia and J. E. Mack, J. Opt. Soc. Am. **55**, No. 6, 654 to 685 (1965). I P, T, C L; W L 14 Å to 13865 Å (all wavelengths are from theoretical calculations of H-like spectra. For unresolved groups the wavelength has been derived from "the wave number of the statistically-weighed mean of all components."

B. Edlén, Ark. Fys. (Stockholm) **31**, No. 35, 509-510 (1966). C L.

O VIII

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
18.9671	A		0.00	653.66	0½-1½	1s ^{2}S-2p ^{2}P°
18.9725	A		0.00	653.48	0½-0½	1
16.0055	A		0.00	774.61	0½-0½	1s ^{2}S-3p ^{2}P°
16.0067	A		0.00	774.56	0½-0½	2
15.1760	A		0.00	816.95	0½-1½	1s ^{2}S-4p ^{2}P°
15.1765	A		0.00	816.93	0½-0½	3
14.8205	A		0.00	836.55	0½-1½	1s ^{2}S-5p ^{2}P°
14.8207	A		0.00	836.54	0½-0½	4
14.6343	A		0.00	847.20	0½-1½	1s ^{2}S-6p ^{2}P°
14.6344	A		0.00	847.19	0½-0½	5
14.5242	A		0.00	853.61	0½-1½	1s ^{2}S-7p ^{2}P°
14.5243	A		0.00	853.61	0½-0½	6
14.4537	A		0.00	857.78	0½-1½	1s ^{2}S-8p ^{2}P°
14.4538	A		0.00	857.78	0½-0½	7
14.4057	A		0.00	860.64	0½-1½	1s ^{2}S-9p ^{2}P°
14.4058	A		0.00	860.63	0½-0½	8
14.3716	A		0.00	862.68	0½-1½	1s ^{2}S-10p ^{2}P°
14.3717	A		0.00	862.68	0½-0½	9
14.3465	A		0.00	864.19	0½-	1s ^{2}S-11p ^{2}P° 10
14.3274	A		0.00	865.34	0½-	1s ^{2}S-12p ^{2}P° 11
14.3126	A		0.00	866.23	0½-	1s ^{2}S-13p ^{2}P° 12
14.3009	A		0.00	866.94	0½-	1s ^{2}S-14p ^{2}P° 13

O VIII

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
14.2915	A		0.00	867.52	0½-	1s ^{2}S-15p ^{2}P° 14
14.2838	A		0.00	867.99	0½-	1s ^{2}S-16p ^{2}P° 15
14.2774	A		0.00	868.37	0½-	1s ^{2}S-17p ^{2}P° 16
14.2720	A		0.00	868.70	0½-	1s ^{2}S-18p ^{2}P° 17
14.2675	A		0.00	868.97	0½-	1s ^{2}S-19p ^{2}P° 18
14.2636	A		0.00	869.21	0½-	1s ^{2}S-20p ^{2}P° 19
102.550	A		653.66	774.56	1½-0½	2p ^{2}P°-3s ^{2}S
102.392	A		653.48	774.56	0½-0½	20
102.490	A		653.66	774.63	1½-2½	2p ^{2}P°-3d ^{2}D
102.348	A		653.48	774.61	0½-1½	21
102.505	A		653.66	774.61	1½-1½	
75.937	A		653.66	816.93	1½-0½	2p ^{2}P°-4s ^{2}S
75.851	A		653.48	816.93	0½-0½	22
75.886	A		653.60	816.96		2p ^{2}P°-4d ^{2}D etc. 23 etc.
67.795	A		653.66	836.54	1½-0½	2p ^{2}P°-5s ^{2}S
67.726	A		653.48	836.54	0½-0½	24
67.758	A		653.60	836.55		2p ^{2}P°-5d ^{2}D etc. 25 etc.

O VIII—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
64.064	A		653.66	847.19	1½-0½	$2p\ ^2P^\circ-6s\ ^2S$
64.003	A		653.48	847.19	0½-0½	26
64.032	A		653.60	847.20		$2p\ ^2P^\circ-6d\ ^2D$
						etc. 27 etc.
62.007	A		653.66	853.61	1½-0½	$2p\ ^2P^\circ-7s\ ^2S$
61.949	A		653.48	853.61	0½-0½	28
61.977	A		653.60	853.62		$2p\ ^2P^\circ-7d\ ^2D$
						etc. 29 etc.
60.741	A		653.66	857.78	1½-0½	$2p\ ^2P^\circ-8s\ ^2S$
60.686	A		653.48	857.78	0½-0½	30
60.713	A		653.60	857.78		$2p\ ^2P^\circ-8d\ ^2D$
						etc. 31 etc.
59.903	A		653.66	860.63	1½-0½	$2p\ ^2P^\circ-9s\ ^2S$
59.849	A		653.48	860.63	0½-0½	32
59.875	A		653.60	860.64		$2p\ ^2P^\circ-9d\ ^2D$
						etc. 33 etc.
59.317	A		653.66	862.68	1½-0½	$2p\ ^2P^\circ-10s\ ^2S$
59.264	A		653.48	862.68	0½-0½	34
59.290	A		653.60	862.68		$2p\ ^2P^\circ-10d\ ^2D$
						etc. 35 etc.
58.891	A		653.66	864.19	1½-0½	$2p\ ^2P^\circ-11s\ ^2S$
58.839	A		653.48	864.19	0½-0½	36
58.865	A		653.60	864.19		$2p\ ^2P^\circ-11d\ ^2D$
						etc. 37 etc.
58.571	A		653.66	865.34	1½-0½	$2p\ ^2P^\circ-12s\ ^2S$
58.520	A		653.48	865.34	0½-0½	38
58.545	A		653.60	865.34		$2p\ ^2P^\circ-12d\ ^2D$
						etc. 39 etc.
58.325	A		653.66	866.23	1½-0½	$2p\ ^2P^\circ-13s\ ^2S$
58.274	A		653.48	866.23	0½-0½	40
58.299	A		653.60	866.24		$2p\ ^2P^\circ-13d\ ^2D$
						etc. 41 etc.
58.130	A		653.66	866.94	1½-0½	$2p\ ^2P^\circ-14s\ ^2S$
58.080	A		653.48	866.94	0½-0½	42
58.105	A		653.60	866.94		$2p\ ^2P^\circ-14d\ ^2D$
						etc. 43 etc.
57.975	A		653.66	867.52	1½-0½	$2p\ ^2P^\circ-15s\ ^2S$
57.924	A		653.48	867.52	0½-0½	44
57.950	A		653.60	867.52		$2p\ ^2P^\circ-15d\ ^2D$
						etc. 45 etc.
102.355	A		653.49	774.61	0½-1½	$2s\ ^2S-3p\ ^2P^\circ$
102.402	A		653.49	774.56	0½-0½	46

O VIII—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
75.845	A		653.49	816.95	0½-1½	$2s\ ^2S-4p\ ^2P^\circ$
75.855	A		653.49	816.93	0½-0½	47
67.725	A		653.49	836.55	0½-1½	$2s\ ^2S-5p\ ^2P^\circ$
67.730	A		653.49	836.54	0½-0½	48
64.003	A		653.49	847.20	0½-1½	$2s\ ^2S-6p\ ^2P^\circ$
64.006	A		653.49	847.19	0½-0½	49
61.951	A		653.49	853.61	0½-1½	$2s\ ^2S-7p\ ^2P^\circ$
61.952	A		653.49	853.61	0½-0½	50
60.687	A		653.49	857.78	0½-1½	$2s\ ^2S-8p\ ^2P^\circ$
60.688	A		653.49	857.78	0½-0½	51
59.851	A		653.49	860.64	0½-	$2s\ ^2S-9p\ ^2P^\circ$
						52
59.266	A		653.49	862.68	0½-1½	$2s\ ^2S-10p\ ^2P^\circ$
59.267	A		653.49	862.68	0½-0½	53
292.980	A		774.61	816.93	1½-0½	$3p\ ^2P^\circ-4s\ ^2S$
292.599	A		774.56	816.93	0½-0½	54
200.211	A		774.61	836.54	1½-0½	$3p\ ^2P^\circ-5s\ ^2S$
200.033	A		774.56	836.54	0½-0½	55
170.831	A		774.61	847.19	1½-0½	$3p\ ^2P^\circ-6s\ ^2S$
170.701	A		774.56	847.19	0½-0½	56
156.946	A		774.61	853.61	1½-0½	$3p\ ^2P^\circ-7s\ ^2S$
156.836	A		774.56	853.61	0½-0½	57
149.082	A		774.61	857.78	1½-0½	$3p\ ^2P^\circ-8s\ ^2S$
148.983	A		774.56	857.78	0½-0½	58
144.130	A		774.61	860.63	1½-0½	$3p\ ^2P^\circ-9s\ ^2S$
144.038	A		774.56	860.63	0½-0½	59
140.786	A		774.61	862.68	1½-0½	$3p\ ^2P^\circ-10s\ ^2S$
140.698	A		774.56	862.68	0½-0½	60
292.465	A		774.56	816.95	0½-1½	$3s\ ^2S-4p\ ^2P^\circ$
292.626	A		774.56	816.93	0½-0½	61
200.005	A		774.56	836.55	0½-1½	$3s\ ^2S-5p\ ^2P^\circ$
200.044	A		774.56	836.54	0½-0½	62
170.692	A		774.56	847.20	0½-1½	$3s\ ^2S-6p\ ^2P^\circ$
170.709	A		774.56	847.19	0½-0½	63
156.833	A		774.56	853.61	0½-1½	$3s\ ^2S-7p\ ^2P^\circ$
156.842	A		774.56	853.61	0½-0½	64
292.775			774.62	816.96		$3d\ ^2D-4f\ ^2F^\circ$
						etc. 65 etc.
200.151			774.62	836.56		$3d\ ^2D-5f\ ^2F^\circ$
						etc. 66 etc.

O VIII—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
170.798			774.62	847.20		$3d\,^2\mathrm{D}-6f\,^2\mathrm{F}^\circ$ etc. 67 etc.
156.922			774.62	853.62		$3d\,^2\mathrm{D}-7f\,^2\mathrm{F}^\circ$ etc. 68 etc.
149.062			774.62	857.78		$3d\,^2\mathrm{D}-8f\,^2\mathrm{F}^\circ$ etc. 69 etc.
144.113			774.62	860.64		$3d\,^2\mathrm{D}-9f\,^2\mathrm{F}^\circ$ etc. 70 etc.
140.770			774.62	862.68		$3d\,^2\mathrm{D}-10f\,^2\mathrm{F}^\circ$ etc. 71 etc.
633.012	A		816.95	836.54	1½-0½	$4p\,^2\mathrm{P}^\circ-5s\,^2\mathrm{S}$
632.259	A		816.93	836.54	0½-0½	72
410.046	A		816.95	847.19	1½-0½	$4p\,^2\mathrm{P}^\circ-6s\,^2\mathrm{S}$
409.730	A		816.93	847.19	0½-0½	73
338.221	A		816.95	853.61	1½-0½	$4p\,^2\mathrm{P}^\circ-7s\,^2\mathrm{S}$
338.006	A		816.93	853.61	0½-0½	74
303.697	A		816.95	857.78	1½-0½	$4p\,^2\mathrm{P}^\circ-8s\,^2\mathrm{S}$
303.523	A		816.93	857.78	0½-0½	75
283.834	A		816.95	860.63	1½-0½	$4p\,^2\mathrm{P}^\circ-9s\,^2\mathrm{S}$
283.682	A		816.93	860.63	0½-0½	76
271.150	A		816.95	862.68	1½-0½	$4p\,^2\mathrm{P}^\circ-10s\,^2\mathrm{S}$
271.012	A		816.93	862.68	0½-0½	77
632.653	A		816.96	836.56		$4d\,^2\mathrm{D}-5f\,^2\mathrm{F}^\circ$ etc. 78 etc.
409.971	A		816.96	847.20		$4d\,^2\mathrm{D}-6f\,^2\mathrm{F}^\circ$ etc. 79 etc.
338.194	A		816.96	853.62		$4d\,^2\mathrm{D}-7f\,^2\mathrm{F}^\circ$ etc. 80 etc.
303.685	A		816.96	857.78		$4d\,^2\mathrm{D}-8f\,^2\mathrm{F}^\circ$ etc. 81 etc.
283.830	A		816.96	860.64		$4d\,^2\mathrm{D}-9f\,^2\mathrm{F}^\circ$ etc. 82 etc.

O VIII—Continued

I A	Ref	Int	E P Low	E P High	J	Multiplet No.
Vac						
271.149	A		816.96	862.68		$4d\,^2\mathrm{D}-10f\,^2\mathrm{F}^\circ$ etc. 83 etc.
1165.379	A		836.55	847.19	1½-0½	$5p\,^2\mathrm{P}^\circ-6s\,^2\mathrm{S}$
1164.077	A		836.54	847.19	0½-0½	84
726.749	A		836.55	853.61	1½-0½	$5p\,^2\mathrm{P}^\circ-7s\,^2\mathrm{S}$
726.243	A		836.54	853.61	0½-0½	85
584.078	A		836.55	857.78	1½-0½	$5p\,^2\mathrm{P}^\circ-8s\,^2\mathrm{S}$
583.751	A		836.54	857.78	0½-0½	86
514.793	A		836.55	860.63	1½-0½	$5p\,^2\mathrm{P}^\circ-9s\,^2\mathrm{S}$
514.538	A		836.54	860.63	0½-0½	87
474.532	A		836.55	862.68	1½-0½	$5p\,^2\mathrm{P}^\circ-10s\,^2\mathrm{S}$
474.316	A		836.54	862.68	0½-0½	88
1164.77	A		836.55	847.20		$5d\,^2\mathrm{D}-6f\,^2\mathrm{F}^\circ$ 89
726.644			836.55	853.62		$5d\,^2\mathrm{D}-7f\,^2\mathrm{F}^\circ$ 90
584.054			836.55	857.78		$5d\,^2\mathrm{D}-8f\,^2\mathrm{F}^\circ$ 91
514.796			836.55	860.64		$5d\,^2\mathrm{D}-9f\,^2\mathrm{F}^\circ$ 92
474.545			836.55	862.68		$5d\,^2\mathrm{D}-10f\,^2\mathrm{F}^\circ$ 93
1932.853	A		847.20	853.61	1½-0½	$6p\,^2\mathrm{P}^\circ-7s\,^2\mathrm{S}$
1930.763	A		847.19	853.61	0½-0½	94
1171.674	A		847.20	857.78	1½-0½	$6p\,^2\mathrm{P}^\circ-8s\,^2\mathrm{S}$
1170.905	A		847.19	857.78	0½-0½	95
922.586	A		847.20	860.63	1½-0½	$6p\,^2\mathrm{P}^\circ-9s\,^2\mathrm{S}$
922.109	A		847.19	860.63	0½-0½	96
800.820	A		847.20	862.68	1½-0½	$6p\,^2\mathrm{P}^\circ-10s\,^2\mathrm{S}$
800.461	A		847.19	862.68	0½-0½	97

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