ATOMIC ENERGY LEVELS

As Derived From the Analyses of Optical Spectra

Volume II
24Cr—41Nb

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NATIONAL BUREAU OF STANDARDS, A. V. Astin, Director

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Volume II

The Spectra of Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Gallium, Germanium, Arsenic, Selenium, Bromine, Krypton, Rubidium, Strontium, Yttrium, Zirconium, and Niobium

By Charlotte E. Moore

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Preface

The present volume is the second of a series being prepared at the National Bureau of Standards as part of a general program on the compilation of atomic energy levels derived from analyses of optical spectra. Since the publication in 1932 of "*Atomic Energy States as Derived from the Analyses of Optical Spectra*" by Robert F. Bacher and Samuel Goudsmit, the data on atomic spectra have accumulated in sufficient quantity to fill several volumes.

The first volume appeared in print June 15, 1949. That work contains the energy levels of 206 spectra of the first 23 elements, Hydrogen through Vanadium. The present volume includes similar data for 152 spectra of the elements having atomic numbers 24 through 41, Chromium through Niobium. The date of completion of the manuscript for each spectrum is entered at the end of the separate tables of energy levels. At present, structure is recognized in more than 500 spectra of 85 elements, so the program is still far from completion.

The general arrangement of Volumes I and II is identical. The adopted form of presentation is that recommended by the majority of interested workers who received a questionnaire proposed by the National Research Council Committee on Line Spectra of the Elements.

The manuscript has been prepared by Charlotte E. Moore under the direction of William F. Meggers, Chief of the Spectroscopy Section of the Atomic and Radiation Physics Division. A number of important gaps among the spectra of elements 24 to 41 have been filled, owing to the efforts of many spectroscopists to furnish data in advance of publication. The cordial cooperation of these individuals as well as that of National Research Council Committee as a whole, is greatly appreciated. This program was initiated while E. U. Condon was Director of the Bureau, and the present Volume was practically completed during his tenure.

A. V. Astin, *Director.*

Washington, D. C., June 30, 1952.

Contents

A List of additions and corrections to Volume I is appended facing blank page 228.

List of Tables

Index to Spectra

1. Introduction

The present work is a continuation of a project started in 1946 at the National Bureau of Standards. Because Bacher and Goudsmit did not contemplate revising their extremely useful book on "*Atomic Energy States as Derived from the Analyses of Optical Spectra*" published in 1932, it was decided to prepare a critical compendium of Atomic Energy Levels, in the Spectroscopy Section of this Bureau. The National Research Council Committee on Line Spectra of the Elements met at that time to discuss details, and this Committee has continued its enthusiastic support of the program.

2. Scope of the Present Tables

Requests to extend the scope of the tables are still being received. A critical compilation of data on X-ray spectra is needed.

No attempt has been made here to include data on hyperfine structure ascribed to atomic nuclei, except for H, D, and T. In Volume II reference is made under the individual spectra to the bibliography on this subject by Mack.[1] The earlier bibliography by Meggers[2] was mentioned in the references to relevant spectra in Volume I. In addition, selected papers are listed for a few spectra, particularly if they are not included in these two references summarizing hyperfine structure data. The present Volumes are, however, definitely not adequate for serious workers in this field.

Since the present tables include only the atomic energy levels derived from the analyses of optical spectra, the users must consult the separate references for lists of the lines observed in the various spectra, for line intensities, and for line classifications. To simplify this situation the writer is preparing an "Ultraviolet Multiplet Table"[3] of selected spectra, along with the tabulation of energy levels. For each Volume of Atomic Energy Levels (called AEL for brevity) there is a corresponding Section of the Ultraviolet Multiplet Table (abbreviated as UVMT in the text that follows). For example, Volume I (AEL) contains the energy levels of spectra of elements with atomic numbers 1 to 23, i. e., Hydrogen through Vanadium. Section 1 of the UVMT contains selected multiplets from spectra of these same elements. Similarly, just as the present Volume (AEL) covers the range of elements of atomic numbers 24 through 41, so will Section 2 of the UVMT contain multiplets of spectra of these same elements.

The UVMT, together with the "Revised Multiplet Table"[4] (which is limited to lines of wavelength longer than 3000 A), will to some extent fulfill the requests for tables of leading lines of selected spectra to accompany the energy levels.

3. Arrangement

The Introduction to Volume I (AEL) describes in detail the arrangement of the data, the notation, and the columns of the tables. Since Volume II is arranged in exactly the same style, the description need not be repeated here.† For convenience, the meaning of the letters in parentheses following the literature references is, however, repeated. These letters denote the following:

I P	Ionization potential.
T	Terms.
C L	Classified lines.
G D	Grotrian diagram.
Z E	Zeeman effect.
I S	Isotope shift.
hfs	Hyperfine structure.

Briefly stated, these letters describe the scope and content of the paper in question. If no letters follow a reference, the paper is referred to in the remarks on the individual spectrum. For example, this is generally true of theoretical papers.

[1] J. E. Mack, Rev. Mod. Phys. 22, No. 1, 64–76 (1950).

[2] W. F. Meggers, J. Opt. Soc. Am. 36, 431 (1946).

† One minor change has been introduced for technical reasons. In Volume I the inner quantum number $J=½$ is entered as "½." In successive volumes this quantity is entered as "0½" throughout.

[3] C. E. Moore, Circ. Nat. Bur. Std. 488; Section 1, H to V (1950); Section 2, Cr to Nb, in press (1952).

[4] C. E. Moore, Princeton Univ. Obs. Contr. No. 20 (1945).

4. Tables of Predicted and Observed Arrays of Terms

As in Volume I, arrays of observed terms follow the individual tables of energy levels for the more complex spectra in cases where the analysis is not seriously incomplete. Similar arrays of terms predicted from theory for spectra of the different isoelectronic sequences are included in Tables 1 to 17 (pages XII to XXVII) as follows:

Table	Sequence	Table	Sequence	Table	Sequence
1	Cr I	7	Zn I	13	Kr I
2	Mn I	8	Ga I	14	Sr I
3	Fe I	9	Ge I	15	Y I
4	Co I	10	As I	16	Zr I
5	Ni I	11	Se I	17	Nb I
6	Cu I	12	Br I		

These tables follow exactly the same pattern as was used for the sequences in Volume I.

For the Kr I sequence, as for Ne I and A I, the table gives both predicted terms (*LS*-coupling) and predicted pairs of levels (*jl*-coupling). The spectra of the inert-gas type have an interesting history. Meissner in 1919 [5] pointed out that well known series in Ne I converge to different limits. In the present notation, the separate limits, representing the two components of the limit term of the ion are clearly indicated. The pair-coupling notation in the general form suggested by Racah has been adopted [6] on the recommendation of Edlén, to take into account the departure from *LS*-coupling. Shortley has prepared an array of the theoretical arrangement of the pairs, for the writer to use as a guide in listing the energy levels of spectra of this type. This is discussed in Volume I. The Paschen notation is also retained in the table of levels of Kr I.

[5] K. W. Meissner, Ann. der Phys. [4] 58, 356 (1919).

[6] G. Racah, Phys. Rev. 61, 537 (L) (1942).

5. The Periodic Table

5.1 The Chemical Elements by Atomic Number; Ionization Potentials (Table 18)

In Volume I, Table 23, the ionization potentials and ground states were recorded for the first spectra throughout the periodic table. Some revisions of these data are given at the end of Volume II. Further revisions have resulted during the course of the work on Volume II. All ionization potentials in both Volumes as revised to date are entered in Table 18. Column one gives the atomic number Z; column two the chemical symbol of the element. Successive columns contain the ionization potentials of the atoms or ions in successive stages of ionization, I denoting first spectra (neutral atoms); II, second spectra (singly ionized atoms); etc.

Throughout these Volumes the ionization potentials are derived by multiplying the limit in cm^{-1} by the factor 0.00012395, to express it in electron volts. This factor was recommended by Birge in 1941 (See Volume I, page IX.)

5.2 The Chemical Elements by Chemical Symbol (Table 19)

In Table 24 of Volume I the chemical elements were arranged in alphabetical order of their chemical symbols to facilitate cross reference to the book by Bacher and Goudsmit, "*Atomic Energy States.*" This table is repeated in Volume II as Table 19, with elements 97 (Bk)[7] and 98 (Cf)[8] added, together with the changes recently adopted by the International Union of Chemistry.[9] The additions and corrections are as follows:

Older			Corrected		
Symbol	Element	Z	Symbol	Element	Z
------	----------------		Bk	Berkelium	97
------	----------------		Cf	Californium	98
Fa	Francium	87	Fr	Francium	87
Lu	Lutecium	71	Lu	Lutetium	71
Cb	Columbium	41	Nb	Niobium	41
Pm	Prometheum	61	Pm	Promethium	61
W	Tungsten	74	W	Wolfram	74

[7] S. G. Thompson, A. Ghiorso, and G. T. Seaborg, Phys. Rev. 77, 838 (L) (1950).

[8] S. G. Thompson, K. Street, Jr., A. Ghiorso, and G. T. Seaborg, Phys. Rev. 80, 790 (1950).

[9] See Report by E. Wichers, J. Am. Chem. Soc. 72, No. 4, 1431 (1950).

5.3 The Periodic System (Table 20)

For convenience, the Periodic System as given on page XLII of Volume I is repeated here as Table 20. Three changes have been made: The chemical symbol of element 41, formerly Cb is now Nb; elements 97 (Bk), and 98 (Cf) are added. The general arrangement is similar to that given on page 333 of "*The Theory of Atomic Spectra*" by Condon and Shortley.[10]

5.4 Index—Isoelectronic Sequences (Table 21)

This table contains the index to the data in Volume II, i. e., the spectra from Cr through Nb. The arrangement is identical with that of the corresponding Index, Table 26, in Volume I.

Column 1 contains the atomic number, followed by the chemical symbol. Across the top the successive stages of ionization are indicated, I denoting first spectra (neutral atoms), II second spectra (singly ionized atoms), III third spectra, etc. The numbers indicate the page on which the data for the individual spectra may be found.

In this table, isoelectronic spectra appear on the diagonals. Alternate diagonals are printed in bold face type to emphasize the spectra of each sequence. Blanks occur for spectra in which structure has not yet been recognized.

No sequences are carried beyond Nb in this Volume, but they will be continued in later Volumes for spectra of elements with $Z > 41$. The sequences started but not completed in Volume II are as follows:

Sequence	Spectrum
Co I	Mo XVI, Pd XX—Sn XXIV
Cu I	Pd XVII—Sb XXIII
Br I	Mo VIII
Kr I	Mo VII
Rb I	Mo VI
Sr I	Mo V
Y I	Mo IV
Zr I	Mo III
Nb I	Mo II

[10] E. U. Condon and G. H. Shortley, *The Theory of Atomic Spectra*, (The Macmillan Co., New York, N. Y., The University Press, Cambridge, Eng., Corrected edition, 1951).

6. Acknowledgments

It was stated in the Introduction to Volume I that "Many scientific workers and many institutions at home and abroad are represented in this work." The same comment applies emphatically to Volume II. The inspiration to carry on such a project may be attributed directly to the large number of interested workers who have been supporting this program. At the National Bureau of Standards, E. U. Condon, during his tenure as Director, took a keen personal interest in the entire project. W. F. Meggers, Chief of the Spectroscopy Section, and Chairman of the Committee on Line Spectra, has spared no effort in giving expert advice on all difficult problems. He has carefully supervised the work and provided much spectroscopic material for inclusion here. Similarly, C. C. Kiess has arranged his entire schedule of work to meet the demands of this program. His splendid analyses of the very complex spectra Cr I and Cr II are lasting tributes illustrative of his interest in the work. The infrared observations of atomic spectra by C. J. Humphreys, Chief of the Infrared Spectroscopy Section, have already added important data, and promise to yield much more in the near future.

The writer has also received most valuable assistance from Princeton. H. N. Russell has been an active and interested consultant. Reference has been made to his work on binding energies, and in addition, he has read most of the manuscript. A. G. Shenstone has not only placed on his program the spectra most urgently needed to fill serious gaps in this Volume, but has also stimulated similar programs in other laboratories. For example, the third spectra of the elements Mn to Cu would have been seriously incomplete without his collaboration.

Three other members of the Committee on Line Spectra have also responded generously. J. E. Mack has provided unpublished data on Rb I. G. R. Harrison has supplied a number of workers with plates and films of Zeeman patterns observed at the Massachusetts Institute of Technology. W. E. Albertson has discussed some of the future problems, particularly in regard to rare earth spectra.

The international cooperation has also been gratifying. Edlén has read a large part of the manuscript, contributed valuable suggestions on a number of spectra in the iron group, and furnished unpublished data on high ionization spectra of the elements from Se through Zr, as well as on Kr I. M. A. Catalán has made two visits to the United States in the interest of this program. His extensive work on Mn I and his study of the Mn III spectrum represent only a part of his contributions. Through the cordial collaboration of Harrison, Meggers, and Shenstone, he has also secured enough material to enable him and his staff in Madrid to continue this work.

Other analyses have been carried out especially for inclusion here. At Lehigh University C. W. Curtis has made an extensive study of Mn II, and N. E. Hager Jr., is extending the analysis of Co II. At Dartmouth and Cornell, F. L. Moore, Jr., has continued work on Cr III and Cr IV and expects to start Mn IV soon—all done in collaboration with Shenstone. Miss Dorothy W. Weeks of Wilson College, has furnished g-values for a number of spectra, with the aid of films from Harrison's laboratory. Unpublished material has also been received from R. A. Fisher (Fe I), S. Glad (Fe III), C. W. Gartlein (Ge II, As II), K. W. Meissner, K. L. Andrew (Ge I, Ge II), and F. W. Paul (Kr IX). Miss Olga García-Riquelme in Madrid (Mn); and L. Wilets (Cu III) and L. E. Gibson (Zn II), in Princeton, have also assisted.

The American Philosophical Society and the American Academy of Arts and Sciences have granted funds for work in connection with this program.

The users of this book owe a debt of gratitude to every one of these individuals and institutions for the material recorded in advance of publication.

The writer could never have prepared these Volumes without the services of experts in many fields of activity. Miss Sarah A. Jones, the Librarian at the Bureau, and her staff have continued their competent assistance with the many literature references. J. L. Mathusa and his staff in the Publications Section of the Bureau, have handled the difficult problems entailed in publishing this material with skill that has attracted the attention of many users. The personnel in the Government Printing Office have been equally cooperative. Mrs. Isabel D. Murray has provided much technical assistance in the preparation of the manuscript. Mrs. Marion W. Maddox has carefully typed the text accompanying the separate spectra.

The writer enjoys a lasting pleasure in recalling and recording the generous assistance she has received from all who have so willingly contributed to this compilation of Atomic Energy Levels.

Tables

Predicted Terms Cr I to Nb I

Ionization Potentials

The Periodic System

Index—Isoelectronic Sequence

Table 1. Predicted Terms of the Cr i Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Predicted Terms			
$3d^4\ 4s^2$	^{5}D ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{3}P ^{3}F ^{1}S ^{1}D ^{1}F ^{1}G ^{1}I ^{1}S ^{1}D ^{1}G			
$3d^6$	^{5}D ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{3}P ^{3}F ^{1}S ^{1}D ^{1}F ^{1}G ^{1}I ^{1}S ^{1}D ^{1}G			
	$ns\ (n \geq 4)$	$np\ (n \geq 4)$	$nd\ (n \geq 4)$	....
$3d^5(^6S)nx$	^{7}S ^{5}S	^{7}P° ^{5}P°	^{7}D ^{5}D	....
$3d^4\ 4s(^6D)nx$	^{7}D ^{5}D	^{7}P° ^{7}D° ^{7}F° ^{5}P° ^{5}D° ^{5}F°	^{7}S ^{7}P ^{7}D ^{7}F ^{7}G ^{5}S ^{5}P ^{5}D ^{5}F ^{5}G	....
$3d^4\ 4s(^4D)nx$	^{5}D ^{3}D	^{5}P° ^{5}D° ^{5}F° ^{3}P° ^{3}D° ^{3}F°	^{5}S ^{5}P ^{5}D ^{5}F ^{5}G ^{3}S ^{3}P ^{3}D ^{3}F ^{3}G	....
$3d^5(^4G)nx$	^{5}G ^{3}G	^{5}F° ^{5}G° ^{5}H° ^{3}F° ^{3}G° ^{3}H°	^{5}D ^{5}F ^{5}G ^{5}H ^{5}I ^{3}D ^{3}F ^{3}G ^{3}H ^{3}I	....
$3d^5(^4P)nx$	^{5}P ^{3}P	^{5}S° ^{5}P° ^{5}D° ^{3}S° ^{3}P° ^{3}D°	^{5}P ^{5}D ^{5}F ^{3}P ^{3}D ^{3}F	....
$3d^5(^4D)nx$	^{5}D ^{3}D	^{5}P° ^{5}D° ^{5}F° ^{3}P° ^{3}D° ^{3}F°	^{5}S ^{5}P ^{5}D ^{5}F ^{5}G ^{3}S ^{3}P ^{3}D ^{3}F ^{3}G	....
$3d^4\ 4s(^4P)nx$	^{5}P ^{3}P	^{5}S° ^{5}P° ^{5}D° ^{3}S° ^{3}P° ^{3}D°	^{5}P ^{5}D ^{5}F ^{3}P ^{3}D ^{3}F	....
$3d^5(^2I)nx$	^{3}I ^{1}I	^{3}H° ^{3}I° ^{3}K° ^{1}H° ^{1}I° ^{1}K°	^{3}G ^{3}H ^{3}I ^{3}K ^{3}L ^{1}G ^{1}H ^{1}I ^{1}K ^{1}L	....
$3d^4\ 4s(^4H)nx$	^{5}H ^{3}H	^{5}G° ^{5}H° ^{5}I° ^{3}G° ^{3}H° ^{3}I°	^{5}F ^{5}G ^{5}H ^{5}I ^{5}K ^{3}F ^{3}G ^{3}H ^{3}I ^{3}K	....
$3d^4\ 4s(^4F)nx$	^{5}F ^{3}F	^{5}D° ^{5}F° ^{5}G° ^{3}D° ^{3}F° ^{3}G°	^{5}P ^{5}D ^{5}F ^{5}G ^{5}H ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H	....
$3d^5(^2D)nx$	^{3}D ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}S ^{3}P ^{3}D ^{3}F ^{3}G ^{1}S ^{1}P ^{1}D ^{1}F ^{1}G	....
$3d^5(^2F)nx$	^{3}F ^{1}F	^{3}D° ^{3}F° ^{3}G° ^{1}D° ^{1}F° ^{1}G°	^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{1}P ^{1}D ^{1}F ^{1}G ^{1}H	....

$3d^5(^4F)nx$				^{5}F ^{3}F						^{5}D° ^{3}D°	^{5}F° ^{3}F°	^{5}G° ^{3}G°					^{5}P ^{3}P	^{5}D ^{3}D	^{5}F ^{3}F	^{5}G ^{3}G	^{5}H ^{3}H				....
$3d^4\,4s(^4G)nx$					^{5}G ^{3}G						^{5}F° ^{3}F°	^{5}G° ^{3}G°	^{5}H° ^{3}H°					^{5}D ^{3}D	^{5}F ^{3}F	^{5}G ^{3}G	^{5}H ^{3}H	^{5}I ^{3}I			....
$3d^4\,4s(^2H)nx$						^{3}H ^{1}H						^{3}G° ^{1}G°	^{3}H° ^{1}H°	^{3}I° ^{1}I°					^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I	^{3}K ^{1}K		....
$3d^4\,4s(^2P)nx$		^{3}P ^{1}P						^{2}S° ^{1}S°	^{3}P° ^{1}P°	^{3}D° ^{1}D°							^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F						....
$3d^5(^2F)nx$				^{3}F ^{1}F						^{3}D° ^{1}D°	^{3}F° ^{1}F°	^{3}G° ^{1}G°					^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H				....
$3d^5(^2H)nx$						^{3}H ^{1}H						^{3}G° ^{1}G°	^{3}H° ^{1}H°	^{3}I° ^{1}I°					^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I	^{3}K ^{1}K		....
$3d^4\,4s(^2G)nx$					^{3}G ^{1}G						^{3}F° ^{1}F°	^{3}G° ^{1}G°	^{3}H° ^{1}H°					^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I			....
$3d^4\,4s(^4D)nx$			^{5}D ^{3}D						^{5}P° ^{3}P°	^{5}D° ^{3}D°	^{5}F° ^{3}F°					^{5}S ^{3}S	^{5}P ^{3}P	^{5}D ^{3}D	^{5}F ^{3}F	^{5}G ^{3}G					....
$3d^5(^2G)nx$					^{3}G ^{1}G						^{3}F° ^{1}F°	^{3}G° ^{1}G°	^{3}H° ^{1}H°					^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I			....
$3d^4\,4s(^2G)nx$					^{3}G ^{1}G						^{3}F° ^{1}F°	^{3}G° ^{1}G°	^{3}H° ^{1}H°					^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I			....
$3d^4\,4s(^2F)nx$				^{3}F ^{1}F						^{3}D° ^{1}D°	^{3}F° ^{1}F°	^{3}G° ^{1}G°					^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H				....
$3d^4\,4s(^2I)nx$							^{3}I ^{1}I						^{3}H° ^{1}H°	^{3}I° ^{1}I°	^{3}K° ^{1}K°					^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I	^{3}K ^{1}K	^{3}L ^{1}L	....
$3d^5(^2S)nx$	^{3}S ^{1}S								^{3}P° ^{1}P°									^{3}D ^{1}D							....
$3d^4\,4s(^2D)nx$			^{3}D ^{1}D						^{3}P° ^{1}P°	^{3}D° ^{1}D°	^{3}F° ^{1}F°					^{3}S ^{1}S	^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G					....
$3d^4\,4s(^2S)nx$	^{3}S ^{1}S								^{3}P° ^{1}P°									^{3}D ^{1}D							....
$3d^5\,(^2D)n$			^{3}D ^{1}D						^{3}P° ^{1}P°	^{3}D° ^{1}D°	^{3}F° ^{1}F°					^{3}S ^{1}S	^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G					....
$3d^4\,4s(^2D)nx$			^{3}D ^{1}D						^{3}P° ^{1}P°	^{3}D° ^{1}D°	^{3}F° ^{1}F°					^{3}S ^{1}S	^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G					....
$3d^4\,4s(^2F)nx$				^{3}F ^{1}F						^{3}D° ^{1}D°	^{3}F° ^{1}F°	^{3}G° ^{1}G°					^{3}P ^{1}P	^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H				....
$3d^5(^2G)nx$					^{3}G ^{1}G						^{3}F° ^{1}F°	^{3}G° ^{1}G°	^{3}H° ^{1}H°					^{3}D ^{1}D	^{3}F ^{1}F	^{3}G ^{1}G	^{3}H ^{1}H	^{3}I ^{1}I			....

TABLE 2. PREDICTED TERMS OF THE Mn I ISOELECTRONIC SEQUENCE*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Predicted Terms						
$3d^5\,4s^2$	^{6}S ^{2}S	^{4}P ^{2}P	^{4}D ^{2}D ^{2}D ^{2}D	^{4}F ^{2}F ^{2}F	^{4}G ^{2}G ^{2}G	^{2}H	^{2}I
$3d^7$		^{4}P ^{2}P	^{2}D ^{2}D	^{4}F ^{2}F	^{2}G	^{2}H	
$3d^5\,4p^2$†	^{6}S	^{8}P ^{6}P ^{4}P	^{6}D				

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	ns $(n\geq4)$					np $(n\geq4)$						nd $(n\geq4)$						
$3d^5\,4s(^7S)nx$	^{8}S ^{6}S						^{8}P° ^{6}P°							^{8}D ^{6}D				
$3d^5\,4s(^5S)nx$	^{6}S ^{4}S						^{6}P° ^{4}P°							^{6}D ^{4}D				
$3d^6\,(^5D)nx$			^{6}D ^{4}D				^{6}P° ^{4}P°	^{6}D° ^{4}D°	^{6}F° ^{4}F°			^{6}S ^{4}S	^{6}P ^{4}P	^{6}D ^{4}D	^{6}F ^{4}F	^{6}G ^{4}G		
$3d^5\,4s(^5G)nx$					^{6}G ^{4}G				^{6}F° ^{4}F°	^{6}G° ^{4}G°	^{6}H° ^{4}H°			^{6}D ^{4}D	^{6}F ^{4}F	^{6}G ^{4}G	^{6}H ^{4}H	^{6}I ^{4}I
$3d^5\,4s(^5P)nx$		^{6}P ^{4}P				^{6}S° ^{4}S°	^{6}P° ^{4}P°	^{6}D° ^{4}D°					^{6}P ^{4}P	^{6}D ^{4}D	^{6}F ^{4}F			
$3d^5\,4s(^5D)nx$			^{6}D ^{4}D				^{6}P° ^{4}P°	^{6}D° ^{4}D°	^{6}F° ^{4}F°			^{6}S ^{4}S	^{6}P ^{4}P	^{6}D ^{4}D	^{6}F ^{4}F	^{6}G ^{4}G		
$3d^5\,4s(^3G)nx$					^{4}G ^{2}G				^{4}F° ^{2}F°	^{4}G° ^{2}G°	^{4}H° ^{2}H°			^{4}D ^{2}D	^{4}F ^{2}F	^{4}G ^{2}G	^{4}H ^{2}H	^{4}I ^{2}I
$3d^5\,4s(^3P)nx$		^{4}P ^{2}P				^{4}S° ^{2}S°	^{4}P° ^{2}P°	^{4}D° ^{2}D°					^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F			
$3d^5\,4s(^3D)nx$			^{4}D ^{2}D				^{4}P° ^{2}P°	^{4}D° ^{2}D°	^{4}F° ^{2}F°			^{4}S ^{2}S	^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F	^{4}G ^{2}G		
$3d^5\,4s(^5F)nx$				^{6}F ^{4}F				^{6}D° ^{4}D°	^{6}F° ^{4}F°	^{6}G° ^{4}G°			^{6}P ^{4}P	^{6}D ^{4}D	^{6}F ^{4}F	^{6}G ^{4}G	^{6}H ^{4}H	

$3d^5\,4s(^3I)nx$							^{4}I ^{2}I						^{4}H° ^{2}H°	^{4}I° ^{2}I°	^{4}K° ^{2}K°					^{4}G ^{2}G	^{4}H ^{2}H	^{4}I ^{2}I	^{4}K ^{2}K	^{4}L ^{2}L
$3d^6(^3P)nx$		^{4}P ^{2}P						^{4}S° ^{2}S°	^{4}P° ^{2}P°	^{4}D° ^{2}D°							^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F					
$3d^6(^3H)nx$						^{4}H ^{2}H						^{4}G° ^{2}G°	^{4}H° ^{2}H°	^{4}I° ^{2}I°					^{4}F ^{2}F	^{4}G ^{2}G	^{4}H ^{2}H	^{4}I ^{2}I	^{4}K ^{2}K	
$3d^6(^3F)nx$				^{4}F ^{2}F						^{4}D° ^{2}D°	^{4}F° ^{2}F°	^{4}G° ^{2}G°					^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F	^{4}G ^{2}G	^{4}H ^{2}H			
$3d^6(^3G)nx$					^{4}G ^{2}G						^{4}F° ^{2}F°	^{4}G° ^{2}G°	^{4}H° ^{2}H°					^{4}D ^{2}D	^{4}F ^{2}F	^{4}G ^{2}G	^{4}H ^{2}H	^{4}I ^{2}I		
$3d^6(^1I)nx$							^{2}I						^{2}H°	^{2}I°	^{2}K°					^{2}G	^{2}H	^{2}I	^{2}K	^{2}L
$3d^6(^3D)nx$			^{4}D ^{2}D						^{4}P° ^{2}P°	^{4}D° ^{2}D°	^{4}F° ^{2}F°					^{4}S ^{2}S	^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F	^{4}G ^{2}G				
$3d^6(^1G)nx$					^{2}G						^{2}F°	^{2}G°	^{2}H°					^{2}D	^{2}F	^{2}G	^{2}H	^{2}I		
$3d^6(^1S)nx$	^{2}S								^{2}P°									^{2}D						
$3d^6(^1D)nx$			^{2}D						^{2}P°	^{2}D°	^{2}F°					^{2}S	^{2}P	^{2}D	^{2}F	^{2}G				
$3d^6(^1F)nx$				^{2}F						^{2}D°	^{2}F°	^{2}G°					^{2}P	^{2}D	^{2}F	^{2}G	^{2}H			
$3d^6(^3P)nx$		^{4}P ^{2}P						^{4}S° ^{2}S°	^{4}P° ^{2}P°	^{4}D° ^{2}D°							^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F					
$3d^6(^3F)nx$				^{4}F ^{2}F						^{4}D° ^{2}D°	^{4}F° ^{2}F°	^{4}G° ^{2}G°					^{4}P ^{2}P	^{4}D ^{2}D	^{4}F ^{2}F	^{4}G ^{2}G	^{4}H ^{2}H			
$3d^4\,4s^2(^5D)nx$			^{6}D ^{4}D						^{6}P ^{4}P°	^{6}D° ^{4}D°	^{6}F° ^{4}F°					^{6}S ^{4}S	^{6}P ^{4}P	^{6}D ^{4}D	^{6}F ^{4}F	^{6}G ^{4}G				
	nf $(n \geq 4)$							ng $(n \geq 5)$								....								
$3d^5\,4s(^7S)nx$				^{8}F° ^{6}F°								^{8}G ^{6}G				....								
$3d^5\,4s(^5S)nx$				^{6}F° ^{4}F°								^{6}G ^{4}G				....								
$3d^6(^5D)nx$		^{6}P° ^{4}P°	^{6}D° ^{4}D°	^{6}F° ^{4}F°	^{6}G° ^{4}G°	^{6}H° ^{4}H°				^{6}D ^{4}D	^{6}F ^{4}F	^{6}G ^{4}G	^{6}H ^{4}H	^{6}I ^{4}I		....								

*The general arrangement of the limit terms in this table is in order of increasing value of the terms of Mn II, where the terms from the configuration $3d^5\,4s$ are low; followed by the terms from $3d^6$, which are low in Fe III, listed in order of increasing value in this spectrum.

†Incomplete, only the limit ^{6}S considered.

TABLE 3. PREDICTED TERMS OF THE Fe I ISOELECTRONIC SEQUENCE

Config. $1s^2\ 2s^2\ 2p^6$ $3s^2\ 3p^6+$	Predicted Terms			
$3d^6\ 4s^2$	^{5}D ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{3}P ^{3}F ^{1}S ^{1}D ^{1}F ^{1}G ^{1}I ^{1}S ^{1}D ^{1}G			
$3d^8$	^{3}P ^{3}F ^{1}S ^{1}D ^{1}G			
	$ns\ (n \geq 4)$	$np\ (n \geq 4)$	$nd\ (n \geq 4)$	....
$3d^6\ 4s(^6D)nx$	^{7}D ^{5}D	^{7}P° ^{7}D° ^{7}F° ^{5}P° ^{5}D° ^{5}F°	^{7}S ^{7}P ^{7}D ^{7}F ^{7}G ^{5}S ^{5}P ^{5}D ^{5}F ^{5}G	....
$3d^7(^4F)nx$	^{5}F ^{3}F	^{5}D° ^{5}F° ^{5}G° ^{3}D° ^{3}F° ^{3}G°	^{5}P ^{5}D ^{5}F ^{5}G ^{5}H ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H	....
$3d^6 4s(^4D)nx$	^{5}D ^{3}D	^{5}P° ^{5}D° ^{5}F° ^{3}P° ^{3}D° ^{3}F°	^{5}S ^{5}P ^{5}D ^{5}F ^{5}G ^{3}S ^{3}P ^{3}D ^{3}F ^{3}G	....
$3d^7(^4P)nx$	^{5}P ^{3}P	^{5}S° ^{5}P° ^{5}D° ^{3}S° ^{3}P° ^{3}D°	^{5}P ^{5}D ^{5}F ^{3}P ^{3}D ^{3}F	....
$3d^7(^2G)nx$	^{3}G ^{1}G	^{3}F° ^{3}G° ^{3}H° ^{1}F° ^{1}G° ^{1}H°	^{3}D ^{3}F ^{3}G ^{3}H ^{3}I ^{1}D ^{1}F ^{1}G ^{1}H ^{1}I	....
$3d^7(^2P)nx$	^{3}P ^{1}P	^{3}S° ^{3}P° ^{3}D° ^{1}S° ^{1}P° ^{1}D°	^{3}P ^{3}D ^{3}F ^{1}P ^{1}D ^{1}F	....
$3d^7(^2H)nx$	^{3}H ^{1}H	^{3}G° ^{3}H° ^{3}I° ^{1}G° ^{1}H° ^{1}I°	^{3}F ^{3}G ^{3}H ^{3}I ^{3}K ^{1}F ^{1}G ^{1}H ^{1}I ^{1}K	....
$3d^7(^2D)nx$	^{3}D ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}S ^{3}P ^{3}D ^{3}F ^{3}G ^{1}S ^{1}P ^{1}D ^{1}F ^{1}G	....
$3d^6\ 4s(^4P)nx$	^{5}P ^{3}P	^{5}S° ^{5}P° ^{5}D° ^{3}S° ^{3}P° ^{3}D°	^{5}P ^{5}D ^{5}F ^{3}P ^{3}D ^{3}F	....
$3d^6\ 4s(^4H)nx$	^{5}H ^{3}H	^{5}G° ^{5}H° ^{5}I° ^{3}G° ^{3}H° ^{3}I°	^{5}F ^{5}G ^{5}H ^{5}I ^{5}K ^{3}F ^{3}G ^{3}H ^{3}I ^{3}K	....
$3d^6\ 4s(^4F)nx$	^{5}F ^{3}F	^{5}D° ^{5}F° ^{5}G° ^{3}D° ^{3}F° ^{3}G°	^{5}P ^{5}D ^{5}F ^{5}G ^{5}H ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H	....
$3d^5\ 4s^2(^4S)nx$	^{7}S ^{5}S	^{7}P° ^{5}P°	^{7}D ^{5}D	....
$3d^6\ 4s(^4G)nx$	^{5}G ^{3}G	^{5}F° ^{5}G° ^{5}H° ^{3}F° ^{3}G° ^{3}H°	^{5}D ^{5}F ^{5}G ^{5}H ^{5}I ^{3}D ^{3}F ^{3}G ^{3}H ^{3}I	....
$3d^6\ 4s(^2P)nx$	^{3}P ^{1}P	^{3}S° ^{3}P° ^{3}D° ^{1}S° ^{1}P° ^{1}D°	^{3}P ^{3}D ^{3}F ^{1}P ^{1}D ^{1}F	....
$3d^6\ 4s(^2H)nx$	^{3}H ^{1}H	^{3}G° ^{3}H° ^{3}I° ^{1}G° ^{1}H° ^{1}I°	^{3}F ^{3}G ^{3}H ^{3}I ^{3}K ^{1}F ^{1}G ^{1}H ^{1}I ^{1}K	....
$3d^6\ 4s(^2F)nx$	^{3}F ^{1}F	^{3}D° ^{3}F° ^{3}G° ^{1}D° ^{1}F° ^{1}G°	^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{1}P ^{1}D ^{1}F ^{1}G ^{1}H	....
$3d^6\ 4s(^2G)nx$	^{3}G ^{1}G	^{3}F° ^{3}G° ^{3}H° ^{1}F° ^{1}G° ^{1}H°	^{3}D ^{3}F ^{3}G ^{3}H ^{3}I ^{1}D ^{1}F ^{1}G ^{1}H ^{1}I	....
$3d^6\ 4s(^4D)nx$	^{5}D ^{3}D	^{5}P° ^{5}D° ^{5}F° ^{3}P° ^{3}D° ^{3}F°	^{5}S ^{5}P ^{5}D ^{5}F ^{5}G ^{3}S ^{3}P ^{3}D ^{3}F ^{3}G	....
$3d^7(^2F)nx$	^{3}F ^{1}F	^{3}D° ^{3}F° ^{3}G° ^{1}D° ^{1}F° ^{1}G°	^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{1}P ^{1}D ^{1}F ^{1}G ^{1}H	....

TABLE 4. PREDICTED TERMS OF THE Co I ISOELECTRONIC SEQUENCE*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Predicted Terms																				
$3d^7\,4s^2$	^4P ^2P	^2D ^2D	^4F ^2F	^2G	^2H																
$3d^9$		^2D																			
	$ns\ (n\geq 4)$					$np\ (n\geq 4)$							$nd\ (n\geq 4)$								....
$3d^8\,(^3F)\,nx$			^4F ^2F					$^4D°$ $^2D°$	$^4F°$ $^2F°$	$^4G°$ $^2G°$				^4P ^2P	^4D ^2D	^4F ^2F	^4G ^2G	^4H ^2H			....
$3d^8(^3P)nx$	^4P ^2P					$^4S°$ $^2S°$	$^4P°$ $^2P°$	$^4D°$ $^2D°$						^4P ^2P	^4D ^2D	^4F ^2F					....
$3d^8(^1G)nx$				^2G					$^2F°$	$^2G°$	$^2H°$				^2D	^2F	^2G	^2H	^2I		....
$3d^8(^1D)nx$		^2D					$^2P°$	$^2D°$	$^2F°$				^2S	^2P	^2D	^2F	^2G				....
$3d^7\,4s(^5F)nx$			^6F ^4F					$^6D°$ $^4D°$	$^6F°$ $^4F°$	$^6G°$ $^4G°$				^6P ^4P	^6D ^4D	^6F ^4F	^6G ^4G	^6H ^4H			....
$3d^7\,4s(^5P)nx$	^6P ^4P					$^6S°$ $^4S°$	$^6P°$ $^4P°$	$^6D°$ $^4D°$						^6P ^4P	^6D ^4D	^6F ^4F					....
$3d^7\,4s(^3F)nx$			^4F ^2F					$^4D°$ $^2D°$	$^4F°$ $^2F°$	$^4G°$ $^2G°$				^4P ^2P	^4D ^2D	^4F ^2F	^4G ^2G	^4H ^2H			....
$3d^7\,4s(^3P)nx$	^4P ^2P					$^4S°$ $^2S°$	$^4P°$ $^2P°$	$^4D°$ $^2D°$						^4P ^2P	^4D ^2D	^4F ^2F					....
$3d^7\,4s(^3H)nx$					^4H ^2H					$^4G°$ $^2G°$	$^4H°$ $^2H°$	$^4I°$ $^2I°$				^4F ^2F	^4G ^2G	^4H ^2H	^4I ^2I	^4K ^2K	....
$3d^7\,4s(^3G)nx$				^4G ^2G					$^4F°$ $^2F°$	$^4G°$ $^2G°$	$^4H°$ $^2H°$				^4D ^2D	^4F ^2F	^4G ^2G	^4H ^2H	^4I ^2I		....
$3d^7\,4s(^3F)nx$			^4F ^2F					$^4D°$ $^2D°$	$^4F°$ $^2F°$	$^4G°$ $^2G°$				^4P ^2P	^4D ^2D	^4F ^2F	^4G ^2G	^4H ^2H			....
$3d^7\,4s(^3D)nx$		^4D ^2D					$^4P°$ $^2P°$	$^4D°$ $^2D°$	$^4F°$ $^2F°$				^4S ^2S	^4P ^2P	^4D ^2D	^4F ^2F	^4G ^2G				....
$3d^7\,4s(^3P)nx$	^4P ^2P					$^4S°$ $^2S°$	$^4P°$ $^2P°$	$^4D°$ $^2D°$						^4P ^2P	^4D ^2D	^4F ^2F					....

*Within a given configuration the limit terms are listed in the general order predicted by the Hund theory.

TABLE 5. PREDICTED TERMS OF THE Ni I ISOELECTRONIC SEQUENCE

Config. $1s^2 2s^2 2p^6 3s^2 3p^6+$	Predicted Terms		
$3d^8 4s^2$	^{3}P ^{3}F ^{1}S ^{1}D ^{1}G		
$3d^{10}$	^{1}S		
	ns ($n \geq 4$)	*np* ($n \geq 4$)	*nd* ($n \geq 4$)
$3d^9(^2D)nx$	^{3}D ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}S ^{3}P ^{3}D ^{3}F ^{3}G ^{1}S ^{1}P ^{1}D ^{1}F ^{1}G
$3d^8 4s(^4F)nx$	^{5}F ^{3}F	^{5}D° ^{5}F° ^{5}G° ^{3}D° ^{3}F° ^{3}G°	^{5}P ^{5}D ^{5}F ^{5}G ^{5}H ^{3}P ^{3}D ^{3}F ^{3}G ^{3}H
$3d^8 4s(^2F)nx$	^{3}F ^{1}F	^{3}D° ^{3}F° ^{3}G° ^{1}D° ^{1}F° ^{1}G°	^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{1}P ^{1}D ^{1}F ^{1}G ^{1}H
$3d^8 4s(^2D)nx$	^{3}D ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}S ^{3}P ^{3}D ^{3}F ^{3}G ^{1}S ^{1}P ^{1}D ^{1}F ^{1}G
$3d^8 4s(^4P)nx$	^{5}P ^{3}P	^{5}S° ^{5}P° ^{5}D° ^{3}S° ^{3}P° ^{3}D°	^{5}P ^{5}D ^{5}F ^{3}P ^{3}D ^{3}F
$3d^8 4s(^2P)nx$	^{3}P ^{1}P	^{3}S° ^{3}P° ^{3}D° ^{1}S° ^{1}P° ^{1}D°	^{3}P ^{3}D ^{3}F ^{1}P ^{1}D ^{1}F
$3d^8 4s(^2G)nx$	^{3}G ^{1}G	^{3}F° ^{3}G° ^{3}H° ^{1}F° ^{1}G° ^{1}H°	^{3}D ^{3}F ^{3}G ^{3}H ^{3}I ^{1}D ^{1}F ^{1}G ^{1}H ^{1}I
$3d^8 4s(^2S)nx$	^{3}S ^{1}S	^{3}P° ^{1}P°	^{3}D ^{1}D
	nf ($n \geq 4$)	*ng* ($n \geq 5$)	....
$3d^9(^2D)nx$	^{3}P° ^{3}D° ^{3}F° ^{3}G° ^{3}H° ^{1}P° ^{1}D° ^{1}F° ^{1}G° ^{1}H°	^{3}D ^{3}F ^{3}G ^{3}H ^{3}I ^{1}D ^{1}F ^{1}G ^{1}H ^{1}I	....
$3d^8 4s(^4F)nx$	^{5}D° ^{5}F° ^{5}G° ^{5}H° ^{5}I° ^{3}D° ^{3}F° ^{3}G° ^{3}H° ^{3}I°	^{5}F ^{5}G ^{5}H ^{5}I ^{5}K ^{3}F ^{3}G ^{3}H ^{3}I ^{3}K	....
$3d^8 4s(^2F)nx$	^{3}D° ^{3}F° ^{3}G° ^{3}H° ^{3}I° ^{1}D° ^{1}F° ^{1}G° ^{1}H° ^{1}I°	^{3}F ^{3}G ^{3}H ^{3}I ^{3}K ^{1}F ^{1}G ^{1}H ^{1}I ^{1}K	....
$3d^8 4s(^2D)nx$	^{3}P° ^{3}D° ^{3}F° ^{3}G° ^{3}H° ^{1}P° ^{1}D° ^{1}F° ^{1}G° ^{1}H°	^{3}D ^{3}F ^{3}G ^{3}H ^{3}I ^{1}D ^{1}F ^{1}G ^{1}H ^{1}I	....
$3d^8 4s(^4P)nx$	^{5}D° ^{5}F° ^{5}G° ^{3}D° ^{3}F° ^{3}G°	^{5}F ^{5}G ^{5}H ^{3}F ^{3}G ^{3}H	....
$3d^8 4s(^2P)nx$	^{3}D° ^{3}F° ^{3}G° ^{1}D° ^{1}F° ^{1}G°	^{3}F ^{3}G ^{3}H ^{1}F ^{1}G ^{1}H	....
$3d^8 4s(^2G)nx$	^{3}F° ^{3}G° ^{3}H° ^{3}I° ^{3}K° ^{1}F° ^{1}G° ^{1}H° ^{1}I° ^{1}K°	^{3}G ^{3}H ^{3}I ^{3}K ^{3}L ^{1}G ^{1}H ^{1}I ^{1}K ^{1}L	....
$3d^8 4s(^2S)nx$	^{3}F° ^{1}F°	^{3}G ^{1}G	....

Table 6. Predicted Terms of the Cu I Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Predicted Terms					
$3d^9\ 4s^2$	^2D					
	ns $(n \geq 4)$	*np* $(n \geq 4)$	*nd* $(n \geq 4)$	*nf* $(n \geq 4)$	*ng* $(n \geq 5)$	....
$3d^{10}(^1S)nx$	^2S	$^2P^\circ$	^2D	$^2F^\circ$	^2G	....
$3d^9\ 4s(^3D)nx'$	{ ^4D ^2D	$^4P^\circ$ $^4D^\circ$ $^4F^\circ$ $^2P^\circ$ $^2D^\circ$ $^2F^\circ$	^4S ^4P ^4D ^4F ^4G ^2S ^2P ^2D ^2F ^2G	$^4P^\circ$ $^4D^\circ$ $^4F^\circ$ $^4G^\circ$ $^4H^\circ$ $^2P^\circ$ $^2D^\circ$ $^2F^\circ$ $^2G^\circ$ $^2H^\circ$	^4D ^4F ^4G ^4H ^4I ^2D ^2F ^2G ^2H ^2I	....
$3d^9\ 4s(^1D)nx''$	^2D	$^2P^\circ$ $^2D^\circ$ $^2F^\circ$	^2S ^2P ^2D ^2F ^2G	$^2P^\circ$ $^2D^\circ$ $^2F^\circ$ $^2G^\circ$ $^2H^\circ$	^2D ^2F ^2G ^2H ^2I	....

Table 7. Predicted Terms of the Zn I Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Predicted Terms					
$3d^{10}\ 4s^2$	^1S					
$3d^{10}\ 4p^2$	{ ^3P ^1S ^1D					
$3d^{10}\ 4d^2$	{ ^3P ^3F ^1S ^1D ^1G					
	ns $(n \geq 4)$	*np* $(n \geq 4)$	*nd* $(n \geq 4)$	*nf* $(n \geq 4)$	*ng* $(n \geq 5)$	. . . .
$3d^{10}\ 4s(^2S)nx$	{ ^3S ^1S	$^3P^\circ$ $^1P^\circ$	^3D ^1D	$^3F^\circ$ $^1F^\circ$	^3G ^1G	. . . .
$3d^{10}\ 4p(^2P^\circ)nx$	{ $^3P^\circ$ $^1P^\circ$	^3S ^3P ^3D ^1S ^1P ^1D	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$ $^1P^\circ$ $^1D^\circ$ $^1F^\circ$	^3D ^3F ^3G ^1D ^1F ^1G	$^3F^\circ$ $^3G^\circ$ $^3H^\circ$ $^1F^\circ$ $^1G^\circ$ $^1H^\circ$	. . . .
$3d^9\ 4s^2(^2D)nx'$	{ ^3D ^1D	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$ $^1P^\circ$ $^1D^\circ$ $^1F^\circ$	^3S ^3P ^3D ^3F ^3G ^1S ^1P ^1D ^1F ^1G	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$ $^3G^\circ$ $^3H^\circ$ $^1P^\circ$ $^1D^\circ$ $^1F^\circ$ $^1G^\circ$ $^1H^\circ$	^3D ^3F ^3G ^3H ^3I ^1D ^1F ^1G ^1H ^1I	. . . .

Table 8. Predicted Terms of the Ga I Isoelectronic Sequence

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Predicted Terms
$4s^2(^1S)4p$	^{2}P°
$4s\,4p^2$	^{4}P ^{2}S ^{2}P ^{2}D
$4p^3$	^{4}S° ^{2}P° ^{2}D°

Config.	ns $(n\geq 5)$	np $(n\geq 5)$	nd $(n\geq 4)$	nf $(n\geq 4)$	ng $(n\geq 5)$	....
$4s^2(^1S)nx$	^{2}S	^{2}P°	^{2}D	^{2}F°	^{2}G	....
$4s\,4p(^3P^\circ)nx$	^{4}P° ^{2}P°	^{4}S ^{4}P ^{4}D ^{2}S ^{2}P ^{2}D	^{4}P° ^{4}D° ^{4}F° ^{2}P° ^{2}D° ^{2}F°	^{4}D ^{4}F ^{4}G ^{2}D ^{2}F ^{2}G	^{4}F° ^{4}G° ^{4}H° ^{2}F° ^{2}G° ^{2}H°	....
$4s\,4p(^1P^\circ)nx'$	^{2}P°	^{2}S ^{2}P ^{2}D	^{2}P° ^{2}D° ^{2}F°	^{2}D ^{2}F ^{2}G	^{2}F° ^{2}G° ^{2}H°	....

Table 9. Predicted Terms of the Ge I Isoelectronic Sequence

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Predicted Terms
$4s^2\,4p^2$	^{3}P ^{1}S ^{1}D
$4s\,4p^3$	^{5}S° ^{3}S° ^{3}P° ^{3}D° ^{1}P° ^{1}D°

Config.	ns $(n\geq 5)$	np $(n\geq 5)$	nd $(n\geq 4)$	nf $(n\geq 4)$	....
$4s^2\,4p(^2P^\circ)nx$	^{3}P° ^{1}P°	^{3}S ^{3}P ^{3}D ^{1}S ^{1}P ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}D ^{3}F ^{3}G ^{1}D ^{1}F ^{1}G	....
$4s\,4p^2(^4P)nx$	^{5}P ^{3}P	^{5}S° ^{5}P° ^{5}D° ^{3}S° ^{3}P° ^{3}D°	^{5}P ^{5}D ^{5}F ^{3}P ^{3}D ^{3}F	^{5}D° ^{5}F° ^{5}G° ^{3}D° ^{3}F° ^{3}G°	....

Table 10. Predicted Terms of the As I Isoelectronic Sequence

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Predicted Terms
$4s^2\,4p^3$	^{4}S° ^{2}P° ^{2}D°
$4s\,4p^4$	^{4}P ^{2}S ^{2}P ^{2}D
$4p^5$	^{2}P°

Config.	ns $(n\geq 5)$	np $(n\geq 5)$	nd $(n\geq 4)$	nf $(n\geq 4)$	....
$4s^2\,4p^2(^3P)nx$	^{4}P ^{2}P	^{4}S° ^{4}P° ^{4}D° ^{2}S° ^{2}P° ^{2}D°	^{4}P ^{4}D ^{4}F ^{2}P ^{2}D ^{2}F	^{4}D° ^{4}F° ^{4}G° ^{2}D° ^{2}F° ^{2}G°	....
$4s^2\,4p^2(^1D)nx'$	^{2}D	^{2}P° ^{2}D° ^{2}F°	^{2}S ^{2}P ^{2}D ^{2}F ^{2}G	^{2}P° ^{2}D° ^{2}F° ^{2}G° ^{2}H°	....
$4s^2\,4p^2(^1S)nx''$	^{2}S	^{2}P°	^{2}D	^{2}F°	....

Table 11. Predicted Terms of the Se I Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Predicted Terms				
$4s^2\ 4p^4$	^{3}P ^{1}S ^{1}D				
$4s\ 4p^5$	^{3}P° ^{1}P°				
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$	$nf\ (n \geq 4)$	....
$4s^2\ 4p^3(^4S°)nx$	^{5}S° ^{3}S°	^{5}P ^{3}P	^{5}D° ^{3}D°	^{5}F ^{3}F	....
$4s^2\ 4p^3(^2D°)nx'$	^{3}D° ^{1}D°	^{3}P ^{3}D ^{3}F ^{1}P ^{1}D ^{1}F	^{3}S° ^{3}P° ^{3}D° ^{3}F° ^{3}G° ^{1}S° ^{1}P° ^{1}D° ^{1}F° ^{1}G°	^{3}P ^{3}D ^{3}F ^{3}G ^{3}H ^{1}P ^{1}D ^{1}F ^{1}G ^{1}H	....
$4s^2\ 4p^3(^2P°)nx''$	^{3}P° ^{1}P°	^{3}S ^{3}P ^{3}D ^{1}S ^{1}P ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}D ^{3}F ^{3}G ^{1}D ^{1}F ^{1}G	....

Table 12. Predicted Terms of the Br I Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Predicted Terms					
$4s^2\ 4p^5$	^{2}P°					
$4s\ 4p^6$	^{2}S					
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$	$nf\ (n \geq 4)$	$ng\ (n \geq 5)$	....
$4s^2\ 4p^4(^3P)nx$	^{4}P ^{2}P	^{4}S° ^{4}P° ^{4}D° ^{2}S° ^{2}P° ^{2}D°	^{4}P ^{4}D ^{4}F ^{2}P ^{2}D ^{2}F	^{4}D° ^{4}F° ^{4}F° ^{2}D° ^{2}F° ^{2}G°	^{4}F ^{4}G ^{4}H ^{2}F ^{2}G ^{2}H	....
$4s^2\ 4p^4(^1D)nx'$	^{2}D	^{2}P° ^{2}D° ^{2}F°	^{2}S ^{2}P ^{2}D ^{2}F ^{2}G	^{2}P° ^{2}D° ^{2}F° ^{2}G° ^{2}H°	^{2}D ^{2}F ^{2}G ^{2}H ^{2}I	....
$4s^2\ 4p^4(^1S)nx''$	^{2}S	^{2}P°	^{2}D	^{2}F°	^{2}G	....
$4s\ 4p^5(^3P°)nx'''$	^{4}P° ^{2}P°	^{4}S ^{4}P ^{4}D ^{2}S ^{2}P ^{2}D	^{4}P° ^{4}D° ^{4}F° ^{2}P° ^{2}D° ^{2}F°	^{4}D ^{4}F ^{4}G ^{2}D ^{2}F ^{2}G	^{4}F° ^{4}G° ^{4}H° ^{2}F° ^{2}G ^{2}H°	....

Table 13. Predicted Levels of the Kr I Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Predicted Terms				
$4s^2\ 4p^6$	^1S				
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$	$nf\ (n \geq 4)$	------
$4s^2\ 4p^5(^2P^\circ)nx$	$^3P^\circ$ $^1P^\circ$	^3S ^3P ^3D ^1S ^1P ^1D	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$ $^1P^\circ$ $^1D^\circ$ $^1F^\circ$	^3D ^3F ^3G ^1D ^1F ^1G	------ ------
$4s\ 4p^6(^2S)nx'$	^3S ^1S	$^3P^\circ$ $^1P^\circ$	^3D ^1D	$^3F^\circ$ $^1F^\circ$	------ ------

jl-Coupling Notation

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2+$	Predicted Pairs				
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$	$nf\ (n \geq 4)$	------
$4p^5(^2P^\circ_{1\frac{1}{2}})nx$	[1½]°	[0½] [2½] [1½]	[0½]° [3½]° [1½]° [2½]°	[1½] [4½] [2½] [3½]	------ ------ ------ ------
$4p^5(^2P^\circ_{0\frac{1}{2}})nx'$	[0½]°	[1½] [0½]	[2½]° [1½]°	[3½] [2½]	------ ------

Table 14. Predicted Terms of the Sr I Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$ +	Predicted Terms		
$5s^2$	^{1}S		
$4d^2$	^{3}P ^{3}F ^{1}S ^{1}D ^{1}G		
$5p^2$	^{3}P ^{1}S ^{1}D		
	ns ($n \geq 5$)	*np* ($n \geq 5$)	*nd* ($n \geq 4$)
$5s(^2S)nx$	^{3}S ^{1}S	^{3}P° ^{1}P°	^{3}D ^{1}D
$4d(^2D)nx'$	^{3}D ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°	^{3}S ^{3}P ^{3}D ^{3}F ^{3}G ^{1}S ^{1}P ^{1}D ^{1}F ^{1}G
$5p(^2P°)nx''$	^{3}P° ^{1}P°	^{3}S ^{3}P ^{3}D ^{1}S ^{1}P ^{1}D	^{3}P° ^{3}D° ^{3}F° ^{1}P° ^{1}D° ^{1}F°
	nf ($n \geq 4$)	*ng* ($n \geq 5$)	------
$5s(^2S)nx$	^{3}F° ^{1}F°	^{3}G ^{1}G	------ ------
$4d(^2D)nx'$	^{3}P° ^{3}D° ^{3}F° ^{3}G° ^{3}H° ^{1}P° ^{1}D° ^{1}F° ^{1}G° ^{1}H°	^{3}D ^{3}F ^{3}G ^{3}H ^{3}I ^{1}D ^{1}F ^{1}G ^{1}H ^{1}I	------ ------
$5p(^2P°)nx''$	^{3}D ^{3}F ^{3}G ^{1}D ^{1}F ^{1}G	^{3}F° ^{3}G° ^{3}H° ^{1}F° ^{1}G° ^{1}H°	------ ------

TABLE 15. PREDICTED TERMS OF THE Y I ISOELECTRONIC SEQUENCE

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Predicted Terms			
$4d\ 5s^2$	^{2}D			
$4d^3$	^{4}P ^{4}F ^{2}P ^{2}D ^{2}F ^{2}G ^{2}H ^{2}D			
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$	--------
$5s^2(^1S)nx$	^{2}S	^{2}P°	^{2}D	--------
$4d\ 5s(^3D)nx$	^{4}D ^{2}D	^{4}P° ^{4}D° ^{4}F° ^{2}P° ^{2}D° ^{2}F°	^{4}S ^{4}P ^{4}D ^{4}F ^{4}G ^{2}S ^{2}P ^{2}D ^{2}F ^{2}G	-------- --------
$4d\ 5s(^1D)nx$	^{2}D	^{2}P° ^{2}D° ^{2}F°	^{2}S ^{2}P ^{2}D ^{2}F ^{2}G	--------
$4d^2(^3F)nx$	^{4}F ^{2}F	^{4}D° ^{4}F° ^{4}G° ^{2}D° ^{2}F° ^{2}G°	^{4}P ^{4}D ^{4}F ^{4}G ^{4}H ^{2}P ^{2}D ^{2}F ^{2}G ^{2}H	-------- --------
$4d^2(^3P)nx$	^{4}P ^{2}P	^{4}S° ^{4}P° ^{4}D° ^{2}S° ^{2}P° ^{2}D°	^{4}P ^{4}D ^{4}F ^{2}P ^{2}D ^{2}F	--------
$4d^2(^1G)nx$	^{2}G	^{2}F° ^{2}G° ^{2}H°	^{2}D ^{2}F ^{2}G ^{2}H ^{2}I	--------
$4d^2(^1D)nx$	^{2}D	^{2}P° ^{2}D° ^{2}F°	^{2}S ^{2}P ^{2}D ^{2}F ^{2}G	--------
$4d^2(^1S)nx$	^{2}S	^{2}P°	^{2}D	--------
$5p^2(^3P)nx$	^{4}P ^{2}P	^{4}S° ^{4}P° ^{4}D° ^{2}S° ^{2}P° ^{2}D°	^{4}P ^{4}D ^{4}F ^{2}P ^{2}D ^{2}F	-------- --------
$5p^2(^1D)nx$	^{2}D	^{2}P° ^{2}D° ^{2}F°	^{2}S ^{2}P ^{2}D ^{2}F ^{2}G	--------
$5p^2(^1S)nx$	^{2}S	^{2}P°	^{2}D	--------

Table 16. Predicted Terms of the Zr i Isoelectronic Sequence

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Predicted Terms
$4d^2\ 5s^2$	^3P ^3F
	^1S ^1D ^1G
$4d^4$	^5D
	^3P ^3D ^3F ^3G ^3H
	^3P ^3F
	^1S ^1D ^1F ^1G ^1I
	^1S ^1D ^1G
$4d^2\ 5p^2$†	^5D ^5F ^5G

Config.	$ns\ (n\geq 5)$	$np\ (n\geq 5)$	$nd\ (n\geq 5)$	--------
$4d^2\ 5s(^4F)nx$	^5F	$^5D^\circ$ $^5F^\circ$ $^5G^\circ$	^5P ^5D ^5F ^5G ^5H	--------
	^3F	$^3D^\circ$ $^3F^\circ$ $^3G^\circ$	^3P ^3D ^3F ^3G ^3H	--------
$4d^3(^4F)nx$	^5F	$^5D^\circ$ $^5F^\circ$ $^5G^\circ$	^5P ^5D ^5F ^5G ^5H	--------
	^3F	$^3D^\circ$ ^3F $^3G^\circ$	^3P ^3D ^3F ^3G ^3H	--------
$4d^2\ 5s(^2D)nx$	^3D	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$	^3S ^3P ^3D ^3F ^3G	--------
	^1D	$^1P^\circ$ $^1D^\circ$ $^1F^\circ$	^1S ^1P ^1D ^1F ^1G	--------
$4d^2\ 5s(^2P)nx$	^3P	$^3S^\circ$ $^3P^\circ$ $^3D^\circ$	^3P ^3D ^3F	--------
	^1P	$^1S^\circ$ $^1P^\circ$ $^1D^\circ$	^1P ^1D ^1F	--------
$4d\ 5s(^2F)nx$	^3F	$^3D^\circ$ $^3F^\circ$ $^3G^\circ$	^3P ^3D ^3F ^3G ^3H	--------
	^1F	$^1D^\circ$ $^1F^\circ$ $^1G^\circ$	^1P ^1D ^1F ^1G ^1H	--------
$4d^2\ 5s(^4P)nx$	^5P	$^5S^\circ$ $^5P^\circ$ $^5D^\circ$	^5P ^5D ^5F	--------
	^3P	$^3S^\circ$ $^3P^\circ$ $^3D^\circ$	^3P ^3D ^3F	--------
$4d^3(^2G)nx$	^3G	$^3F^\circ$ $^3G^\circ$ $^3H^\circ$	^3D ^3F ^3G ^3H ^3I	--------
	^1G	$^1F^\circ$ $^1G^\circ$ $^1H^\circ$	^1D ^1F ^1G ^1H ^1I	--------
$4d^3(^4P)nx$	^5P	$^5S^\circ$ $^5P^\circ$ $^5D^\circ$	^5P ^5D ^5F	--------
	^3P	$^3S^\circ$ $^3P^\circ$ $^3D^\circ$	^3P ^3D ^3F	--------
$4d^3(^2H)nx$	^3H	$^3G^\circ$ $^3H^\circ$ $^3I^\circ$	^3F ^3G ^3H ^3I ^3K	--------
	^1H	$^1G^\circ$ $^1H^\circ$ $^1I^\circ$	^1F ^1G ^1H ^1I ^1K	--------
$4d^3(^2D)nx$	^3D	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$	^3S ^3P ^3D ^3F ^3G	--------
	^1D	$^1P^\circ$ $^1D^\circ$ $^1F^\circ$	^1S ^1P ^1D ^1F ^1G	--------
$4d^2\ 5s(^2G)nx$	^3G	$^3F^\circ$ $^3G^\circ$ $^3H^\circ$	^3D ^3F ^3G ^3H ^3I	--------
	^1G	$^1F^\circ$ $^1G^\circ$ $^1H^\circ$	^1D ^1F ^1G ^1H ^1I	--------
$4d\ 5s^2(^2D)nx$	^3D	$^3P^\circ$ $^3D^\circ$ $^3F^\circ$	^3S ^3P ^3D ^3F ^3G	--------
	^1D	$^1P^\circ$ $^1D^\circ$ $^1F^\circ$	^1S ^1P ^1D ^1F ^1G	--------
$4d^3(^2F)nx$	^3F	$^3D^\circ$ $^3F^\circ$ $^3G^\circ$	^3P ^3D ^3F ^3G ^3H	--------
	^1F	$^1D^\circ$ $^1F^\circ$ $^1G^\circ$	^1P ^1D ^1F ^1G ^1H	--------
$4d^3(^2P)nx$	^3P	$^3S^\circ$ $^3P^\circ$ $^3D^\circ$	^3P ^3D ^3F	--------
	^1P	$^1S^\circ$ $^1P^\circ$ $^1D^\circ$	^1P ^1D ^1F	--------
$4d^2\ 5s(^2S)nx$	^3S	$^3P^\circ$	^3D	--------
	^1S	$^1P^\circ$	^1D	--------

†Incomplete — only high multiplicity terms from $d^2\ ^3F$ listed.

TABLE 17. PREDICTED TERMS OF THE Nb I ISOELECTRONIC SEQUENCE

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Predicted Terms			
$4d^5$	^{6}S			
	^{4}P ^{4}D ^{4}F ^{4}G			
	^{2}S ^{2}D ^{2}F ^{2}G ^{2}I			
	^{2}P ^{2}D ^{2}F ^{2}G ^{2}H			
	^{2}D			
$4d^3\ 5s^2$	^{4}P ^{4}F			
	^{2}P ^{2}D ^{2}F ^{2}G ^{2}H			
	^{2}D			
	ns ($n \geq 5$)	*np* ($n \geq 5$)	*nd* ($n \geq 5$)	----
$4d^4(^5D)nx$	^{6}D	^{6}P° ^{6}D° ^{6}F°	^{6}S ^{6}P ^{6}D ^{6}F ^{6}G	----
	^{4}D	^{4}P° ^{4}D° ^{4}F°	^{4}S ^{4}P ^{4}D ^{4}F ^{4}G	----
$4d^3\ 5s(^5F)nx$	^{6}F	^{6}D° ^{6}F° ^{6}G°	^{6}P ^{6}D ^{6}F ^{6}G ^{6}H	----
	^{4}F	^{4}D° ^{4}F° ^{4}G°	^{4}P ^{4}D ^{4}F ^{4}G ^{4}H	----
$4d^4(^3P)nx$	^{4}P	^{4}S° ^{4}P° ^{4}D°	^{4}P ^{4}D ^{4}F	----
	^{2}P	^{2}S° ^{2}P° ^{2}D°	^{2}P ^{2}D ^{2}F	----
$4d^3\ 5s(^3F)nx$	^{4}F	^{4}D° ^{4}F° ^{4}G°	^{4}P ^{4}D ^{4}F ^{4}G ^{4}H	----
	^{2}F	^{2}D° ^{2}F° ^{2}G°	^{2}P ^{2}D ^{2}F ^{2}G ^{2}H	----
$4d^4(^3H)nx$	^{4}H	^{4}G° ^{4}H° ^{4}I°	^{4}F ^{4}G ^{4}H ^{4}I ^{4}K	----
	^{2}H	^{2}G° ^{2}H° ^{2}I°	^{2}F ^{2}G ^{2}H ^{2}I ^{2}K	----
$4d^4(^3G)nx$	^{4}G	^{4}F° ^{4}G° ^{4}H°	^{4}D ^{4}F ^{4}G ^{4}H ^{4}I	----
	^{2}G	^{2}F° ^{2}G° ^{2}H°	^{2}D ^{2}F ^{2}G ^{2}H ^{2}I	----

$4d^3 5s(^5P)nx$		^{6}P						^{6}S°	^{6}P°	^{6}D°							^{6}P	^{6}D	^{6}F						----
		^{4}P						^{4}S°	^{4}P°	^{4}D°							^{4}P	^{4}D	^{4}F						----
$4d^4(^1D)nx$			^{2}D						^{2}P°	^{2}D°	^{2}F°					^{2}S	^{2}P	^{2}D	^{2}F	^{2}G					----
$4d^4(^3F)nx$				^{4}F						^{4}D°	^{4}F°	^{4}G°					^{4}P	^{4}D	^{4}F	^{4}G	^{4}H				----
				^{2}F						^{2}D°	^{2}F°	^{2}G°					^{2}P	^{2}D	^{2}F	^{2}G	^{2}H				----
$4d^4(^3D)nx$			^{4}D						^{4}P°	^{4}D°	^{4}F°					^{4}S	^{4}P	^{4}D	^{4}F	^{4}G					----
			^{2}D						^{2}P°	^{2}D°	^{2}F°					^{2}S	^{2}P	^{2}D	^{2}F	^{2}G					----
$4d^3 5s(^3P)nx$		^{4}P						^{4}S°	^{4}P°	^{4}D°							^{4}P	^{4}D	^{4}F						----
		^{2}P						^{2}S°	^{2}P°	^{2}D°							^{2}P	^{2}D	^{2}F						----
$4d^4(^1G)nx$					^{2}G						^{2}F°	^{2}G°	^{2}H°					^{2}D	^{2}F	^{2}G	^{2}H	^{2}I			----
$4d^4(^1I)nx$							^{2}I						^{2}H°	^{2}I°	^{2}K°					^{2}G	^{2}H	^{2}I	^{2}K	^{2}L	----
$4d^3 5s(^3G)nx$					^{4}G						^{4}F°	^{4}G°	^{4}H°					^{4}D	^{4}F	^{4}G	^{4}H	^{4}I			----
					^{2}G						^{2}F°	^{2}G°	^{2}H°					^{2}D	^{2}F	^{2}G	^{2}H	^{2}I			----
$4d^3 5s(^1G)nx$					^{2}G						^{2}F°	^{2}G°	^{2}H°					^{2}D	^{2}F	^{2}G	^{2}H	^{2}I			----
$4d^4(^1S)nx$	^{2}S								^{2}P°									^{2}D							----
$4d^3 5s(^3H)nx$						^{4}H						^{4}G°	^{4}H°	^{4}I°					^{4}F	^{4}G	^{4}H	^{4}I	^{4}K		----
						^{2}H						^{2}G°	^{2}H°	^{2}I°					^{2}F	^{2}G	^{2}H	^{2}I	^{2}K		----
$4d^4(^1F)nx$				^{2}F						^{2}D°	^{2}F°	^{2}G°					^{2}P	^{2}D	^{2}F	^{2}G	^{2}H				----
$4d^3 5s(^3D)nx$			^{4}D						^{4}P°	^{4}D°	^{4}F°					^{4}S	^{4}P	^{4}D	^{4}F	^{4}G					----
			^{2}D						^{2}P°	^{2}D°	^{2}F°					^{2}S	^{2}P	^{2}D	^{2}F	^{2}G					----
$4d^3 5s(^1P)nx$		^{2}P						^{2}S°	^{2}P°	^{2}D°							^{2}P	^{2}D	^{2}F						----
$4d^3 5s(^1H)nx$						^{2}H						^{2}G°	^{2}H°	^{2}I°					^{2}F	^{2}G	^{2}H	^{2}I	^{2}K		----
$4d^3 5s(^1D)nx$			^{2}D						^{2}P°	^{2}D°	^{2}F°					^{2}S	^{2}P	^{2}D	^{2}F	^{2}G					----
$4d^3 5s(^1F)nx$				^{2}F						^{2}D°	^{2}F°	^{2}G°					^{2}P	^{2}D	^{2}F	^{2}G	^{2}H				

TABLE 18. THE CHEMICAL ELEMENTS—IONIZATION POTENTIALS

Z	Element	Spectrum I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
1	H	13. 595																		
2	He	24. 580	54. 403																	
3	Li	5. 390	75. 619	122. 419																
4	Be	9. 320	18. 206	153. 850	217. 657															
5	B	8. 296	25. 149	37. 920	259. 298	340. 127														
6	C	11. 264	24. 376	47. 864	64. 476	391. 986	489. 84													
7	N	14. 54	29. 605	47. 426	77. 450	97. 863	551. 925	666. 83												
8	O	13. 614	35. 146	54. 934	77. 394	113. 873	138. 080	739. 114	871. 12											
9	F	17. 418	34. 98	62. 646	87. 23	114. 214	157. 117	185. 139	953. 60											
10	Ne	21. 559	41. 07	64	97. 16	126. 4	157. 91													
11	Na	5. 138	47. 29	71. 65	98. 88	138. 60	172. 36	208. 444	264. 155	299. 78										
12	Mg	7. 644	15. 03	80. 12	109. 29	141. 23	186. 86	225. 31	265. 957	327. 90	367. 36	1761. 23								
13	Al	5. 984	18. 823	28. 44	119. 96	153. 77	190. 42	241. 93	285. 13	330. 1	398. 5	441. 9	2085. 46							
14	Si	8. 149	16. 34	33. 46	45. 13	166. 73	205. 11	246. 41	303. 87	351. 83	401. 3	476. 0	523. 2							
15	P	10. 55	19. 65	30. 156	51. 354	65. 007	220. 414	263. 31	309. 26	372. 62	425. 46	479. 4	560. 3	611. 4						
16	S	10. 357	23. 4	35. 0	47. 29	72. 5	88. 029	280. 99	328. 80	378. 95	448. 2									
17	Cl	13. 01	23. 80	39. 90	53. 5	67. 80	96. 7	114. 27	348. 3	400. 7	455. 3									
18	A	15. 755	27. 62	40. 90	59. 79	75. 0	91. 3	124. 0	143. 46	421										
19	K	4. 339	31. 81	46	60. 90	------	99. 7	118	155	175. 94	503. 8									
20	Ca	6. 111	11. 87	51. 21	67	84. 39	------	128	147	188	211. 29	591. 8	655							
21	Sc	6.56	12. 80	24. 75	73. 9	92	111. 1	------	159	180	226	250	687							
22	Ti	6. 83	13. 57	27. 47	43. 24	99. 8	120	140. 8	------	193	------	266	291. 5	788. 4						
23	V	6. 74	14. 65	29. 31	48	65. 2	128. 9	151	173. 7	------	------	------	309	336. 3	897. 1					
24	Cr	6. 763	16. 49	30. 95	49. 6	73	90. 6	161. 1	185	209. 6	------	------	------	355	384. 2	1013. 0				
25	Mn	7. 432	15. 64	33. 69	------	76	------	119. 24	196	222	248	------	------	------	404	435	1135. 9			
26	Fe	7. 90	16. 18	30. 64	------	------	------	------	151	235	262	290	------	355	390	457	489			
27	Co	7. 86	17. 05	33. 49	------	------	------	------	------	------	------	305	------	------	------	------	512	547	1403	
28	Ni	7. 633	18. 15	35. 16	------	------	------	------	------	------	------	------	350	------	------	455	------	------	607	
29	Cu	7. 724	20. 29	36. 83	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	671

30	Zn	9. 391	17. 96	39. 70															
31	Ga	6. 00	20. 51	30. 70	64. 2														
32	Ge	7. 88	15. 93	34. 21	45. 7	93. 4													
33	As	9. 81	20. 2	28. 3	50. 1	62. 6	127. 5												
34	Se	9. 75	21. 5	32. 0	42. 9	73. 1	81. 7	155											
35	Br	11. 84	21. 6	35. 9	--	--	--	--	193										
36	Kr	13. 996	24. 56	36. 9															
37	Rb	4. 176	27. 5	40	--	--	--	--	--	--	277								
38	Sr	5. 692	11. 027	--	57	--	--	--	--	--	--	324							
39	Y	6. 5	12. 4	20. 5	--	77	--	--	--	--	--	--	374						
40	Zr	6. 95	14. 03	24. 8	33. 97	--	99												
41	Nb	6. 77	14	28. 1	38. 3	50	103	125											

Table 19. Chemical Symbols

Symbol	Element	Z	Symbol	Element	Z	Symbol	Element	Z	Symbol	Element	Z
A	Argon	18	Dy	Dysprosium	66	Mn	Manganese	25	Ru	Ruthenium	44
Ac	Actinium	89	Er	Erbium	68	Mo	Molybdenum	42	S	Sulfur	16
Ag	Silver	47	Eu	Europium	63	N	Nitrogen	7	Sb	Antimony	51
Al	Aluminum	13	F	Fluorine	9	Na	Sodium	11	Sc	Scandium	21
Am	Americium	95	Fe	Iron	26	Nb	Niobium	41	Se	Selenium	34
As	Arsenic	33	Fr	Francium	87	Nd	Neodymium	60	Si	Silicon	14
At	Astatine	85	Ga	Gallium	31	Ne	Neon	10	Sm	Samarium	62
Au	Gold	79	Gd	Gadolinium	64	Ni	Nickel	28	Sn	Tin	50
B	Boron	5	Ge	Germanium	32	Np	Neptunium	93	Sr	Strontium	38
Ba	Barium	56	H	Hydrogen	1	O	Oxygen	8	Ta	Tantalum	73
Be	Beryllium	4	(D	Deuterium)		Os	Osmium	76	Tb	Terbium	65
Bi	Bismuth	83	(T	Tritium)		P	Phosphorus	15	Tc	Technetium	43
Bk	Berkelium	97	He	Helium	2	Pa	Protactinium	91	Te	Tellurium	52
Br	Bromine	35	Hf	Hafnium	72	Pb	Lead	82	Th	Thorium	90
C	Carbon	6	Hg	Mercury	80	Pd	Palladium	46	Ti	Titanium	22
Ca	Calcium	20	Ho	Holmium	67	Pm	Promethium	61	Tl	Thallium	81
Cd	Cadmium	48	I	Iodine	53	Po	Polonium	84	Tm	Thulium	69
Ce	Cerium	58	In	Indium	49	Pr	Praseodymium	59	U	Uranium	92
Cf	Californium	98	Ir	Iridium	77	Pt	Platinum	78	V	Vanadium	23
Cl	Chlorine	17	K	Potassium	19	Pu	Plutonium	94	W	Wolfram	74
Cm	Curium	96	Kr	Krypton	36	Ra	Radium	88	Xe	Xenon	54
Co	Cobalt	27	La	Lanthanum	57	Rb	Rubidium	37	Y	Yttrium	39
Cr	Chromium	24	Li	Lithium	3	Re	Rhenium	75	Yb	Ytterbium	70
Cs	Cesium	55	Lu	Lutetium	71	Rh	Rhodium	45	Zn	Zinc	30
Cu	Copper	29	Mg	Magnesium	12	Rn	Radon	86	Zr	Zirconium	40

TABLE 20. THE PERIODIC SYSTEM*

		s	s	p	p	p	p	p	p	d	d	d	d	d	d	d	d	d	d	f	f	f	f	f	f	f	f	f	f	f	f	f	f
1	1s	H 1	**He** 2																														
2	2s	Li 3	Be 4																														
	2p			B 5	C 6	N 7	O 8	F 9	**Ne** 10																								
3	3s	Na 11	Mg 12																														
	3p			Al 13	Si 14	P 15	S 16	Cl 17	**A** 18																								
4	{4s	K 19	Ca 20																														
	3d}									Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30														
	4p			Ga 31	Ge 32	As 33	Se 34	Br 35	**Kr** 36																								
5	{5s	Rb 37	Sr 38																														
	4d}									Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48														
	5p			In 49	Sn 50	Sb 51	Te 52	I 53	**Xe** 54																								
6	{6s	Cs 55	Ba 56																														
	4f																			La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70
	5d}									Lu 71	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80														
	6p			Tl 81	Pb 82	Bi 83	Po 84	At 85	**Rn** 86																								
7	{7s	Fr 87	Ra 88																														
	5f																			Ac 89	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	99	100	101	102
	6d}									103	104	105	106	107	108	109	110	111	112														

*This arrangement is by Catalán. See J. Cabrera, Fisica general Zaragoza, Spain (1950). The electrons indicated in column two that are connected by braces have approximately the same binding energy. Consequently, for some elements one type of electron is preferred over another in the normal configuration, as for example, Cr, Nb, Pd, La, Ac, Th.

Table 21. Index—Isoelectronic Sequences

[The tabular entries are page numbers]

Z	Element	Spectrum																		
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
24	Cr	1	**10**	14	**16**	18	**20**	21	**22**	22			**23**	24	**25**	25				
25	**Mn**	**27**	32	**37**	38	**40**	41	**42**	43	**44**	45			**46**	46	**47**	47			
26	Fe	49	**55**	60	**65**	66	**67**	69	**70**	70	**71**	72		73	**74**	74	**75**	76		
27	**Co**	**78**	83	**85**	88	**88**	89	**90**	92			**92**			93	**93**	94	**95**	96	
28	Ni	97	**101**	103		104	**104**	105	**106**	108			**108**	108		109	**110**		**110**	
29	**Cu**	**111**	115	**121**				**123**												123
30	Zn	124	**126**	128	**129**															
31	**Ga**	**130**	131	**133**	134															
32	Ge	135	**137**	139	**140**	141														
33	As	**142**	144	**146**	147	**148**	149													
34	Se	150	**152**	154	**156**	156	**157**	158												
35	**Br**	**159**	161	**163**	164	**165**	166	**167**	167	**168**										
36	Kr	169	**173**	176	**178**					179										
37	**Rb**	**180**	184	**185**						**186**	186	**187**	188	188	188					
38	Sr	189	**191**		**193**							194	**194**	195	**195**					
39	**Y**	**196**	199	**201**		**202**							203	**204**	204	**204**				
40	Zr	205	**209**	212	**213**		**214**								**215**					
41	**Nb**	**216**	221	**223**	224	**225**	226	**227**												

CHROMIUM

Cr I

24 electrons $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s\ {}^7S_3$

$a\ {}^7S_3$ **54565±1** cm^{-1} I. P. 6.763 volts

The arc spectrum of chromium has an interesting history. As early as 1907 Miller found pairs of lines having similar Zeeman patterns, which were shown by Richter in 1914 to be members of the two outstanding triplets in the blue and violet. This early work inspired a systematic search, started in 1918 at the National Bureau of Standards, for all groups of lines exhibiting recurring constant wave number differences, and additional triplets in the near infrared were reported by Kiess and Meggers in 1920.

This spectrum is unique in that the discovery of further regularities in Cr I was made independently and almost simultaneously at three places. In 1922 when Catalán announced his discovery of multiplets in the spectra of manganese, he also reported a few in Cr I. At nearly the same time Fr. Gieseler, from her study of the Zeeman effect, found similar groups of related lines in Cr I. Shortly afterwards C. C. Kiess and H. K. Kiess reported the arrangement of the strong triplets in two systems of series including both sharp and diffuse members.

The present term list has been furnished by C. C. Kiess in advance of publication, especially for inclusion here. He has revised and extended the earlier work by Catalán and others. Approximately 2800 lines are classified in the range between 1988 A and 11610 A, resulting from combinations among 155 terms. Four multiplicities, singlets, triplets, quintets, and septets, are known, the terms of each being connected by observed intersystem combinations. The limit is excellently determined from three series of ^{7}S, ^{5}S, and ^{7}P° terms, two of three members each, and one of four members, which are accurately represented by a Ritz formula.

In 1945 Kiess generously furnished the writer with his analysis for inclusion in her *"Revised Multiplet Table."* His later work has introduced changes in both the notation and the analysis she used. In order to avoid confusion these changes are recorded below, the first entry (R M T), denoting the data used in the *"Revised Multiplet Table"*, the second, (A E L), the present revision of that material:

Changes in Notation			
R M T	A E L	R M T	A E L
$f\ {}^5P$	$e\ {}^5P$	$s\ {}^3G^\circ$	$r\ {}^3G^\circ$
$z\ {}^1H^\circ$	$y\ {}^1H^\circ$	$q\ {}^3H^\circ$	$p\ {}^3H^\circ$
$z\ {}^1I^\circ$	$y\ {}^1I^\circ$	$w\ {}^3I^\circ_5$	$x\ {}^1H^\circ$
$y\ {}^1I^\circ$	$x\ {}^1I^\circ$	$u'\ {}^5F^\circ$	$t\ {}^5F^\circ$
$w\ {}^3F^\circ$	$v\ {}^3F^\circ$	$t\ {}^5F^\circ$	$s\ {}^5F^\circ$
$v\ {}^3F^\circ$	$u\ {}^3F^\circ$	$s\ {}^5F^\circ$	$r\ {}^5F^\circ$
$u\ {}^3F^\circ$	$s\ {}^3F^\circ$	$r\ {}^5F^\circ$	$q\ {}^5F^\circ$
$t\ {}^3F^\circ$	$r\ {}^3F^\circ$	1°_4	2°_4

Cr I—Continued

Changes in Analysis		
Desig.	R M T	A E L
$g\ ^7D_1$	47699. 18	47700. 18
$v\ ^3P^\circ_2$	Missing	56802. 50
$t\ ^3P^\circ_{2,1}$	--------	Rejected
$x\ ^3D^\circ_1$	48681. 53:	48839. 90
$u\ ^3H^\circ_4$	Missing	55915. 50
$w\ ^3I^\circ_5$	60005. 4	59806. 27
$w\ ^5D^\circ_0$	Missing	46081. 27
$t\ ^5D^\circ_0$	52000. 59	51999. 62
$s\ ^5D^\circ_2$	53540. 8	53558. 05

All three-place g-values in the table and those for the levels $a\ ^5P_3$, $z\ ^5S^\circ_2$, and $u\ ^5P^\circ_{2,1}$ have been calculated by Kiess from Zeeman patterns observed at the Massachusetts Institute of Technology. The rest are from the paper by Catalán and Sancho.

This detailed analysis will be published by the National Bureau of Standards in the near future. With this splendid piece of work Kiess has provided another highly complex spectrum which affords an excellent confirmation of Hund's general theory of atomic spectra.

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Cr I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5(a\,^6S)4s$	$a\,^7S$	3	0.00		2.007
$3d^5(a\,^6S)4s$	$a\,^5S$	2	7593.16		2.006
$3d^4\,4s^2$	$a\,^5D$	0	7750.78	60.04	0.000
		1	7810.82	116.65	1.501
		2	7927.47	167.74	1.496
		3	8095.21	212.36	1.501
		4	8307.57		1.497
$3d^5(a\,^4G)4s$	$a\,^5G$	2	20517.40	3.52	0.37
		3	20520.92	2.77	0.93
		4	20523.69	0.25	1.13
		5	20523.94	−4.34	1.25
		6	20519.60		1.33
$3d^5(a\,^4P)4s$	$a\,^5P$	3	21840.84	−7.04	1.60
		2	21847.88	−9.06	1.847
		1	21856.94		2.500
$3d^4\,4s^2$	$a\,^3P$	0	23163.27	348.73	
		1	23512.00	581.16	
		2	24093.16		
$3d^5(a\,^6S)4p$	$z\,^7P^\circ$	2	*23305.01*	81.34	2.334
		3	*23386.35*	112.49	1.92
		4	*23498.84*		1.752
$3d^4\,4s^2$	$a\,^3H$	4	23933.90	122.21	
		5	24056.11	144.12	
		6	24200.23		
$3d^5(b\,^4D)4s$	$b\,^5D$	0	24277.06	9.48	0.00
		1	24286.54	13.35	1.48
		2	24299.89	4.05	1.51
		3	24303.94	−21.60	1.55
		4	24282.34		1.51
$3d^5(a\,^4G)4s$	$a\,^3G$	3	24833.86	63.69	
		4	24897.55	141.06	
		5	25038.61		
$3d^4\,4s^2$	$a\,^3F$	2	24940.61	165.73	
		3	25106.34	71.05	
		4	25177.39		
$3d^4\,4s(a\,^6D)4p$	$z\,^7F^\circ$	0	*24971.21*	39.43	
		1	*25010.64*	78.56	1.52
		2	*25089.20*	116.82	1.50
		3	*25206.02*	153.60	1.49
		4	*25359.62*	189.02	1.51
		5	*25548.64*	222.76	1.51
		6	*25771.40*		1.53
$3d^5(a\,^6S)4p$	$z\,^5P^\circ$	3	*26787.50*	−8.78	1.670
		2	*26796.28*	−5.65	1.830
		1	*26801.93*		2.512
$3d^5(a\,^4P)4s$	$b\,^3P$	0	27163.20	13.02	
		1	27176.22	46.83	
		2	27223.05		
$3d^4\,4s(a\,^6D)4p$	$z\,^7D^\circ$	1	*27300.19*	81.99	3.01
		2	*27382.18*	118.19	1.99
		3	*27500.37*	149.34	1.76
		4	*27649.71*	175.74	1.66
		5	*27825.45*		1.61

Cr I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^4\,4s^2$	$b\,^3G$	3	27597.22	106.62	
		4	27703.84	113.04	
		5	27816.88		
$3d^4\,4s(a\,^6D)4p$	$y\,^7P^\circ$	2	*27728.87*	91.36	2.341
		3	*27820.23*	115.03	1.929
		4	*27935.26*		1.761
$3d^5(b\,^4D)4s$	$a\,^3D$	3	28637.00	−45.18	
		2	28682.18	2.75	
		1	28679.43		
$3d^4\,4s(a\,^6D)4p$	$y\,^5P^\circ$	1	*29420.90*	163.72	2.513
		2	*29584.62*	240.13	1.836
		3	*29824.75*		1.669
$3d^4\,4s(a\,^6D)4p$	$z\,^5F^\circ$	1	*30787.30*	71.52	0.002
		2	*30858.82*	106.64	0.997
		3	*30965.46*	140.91	1.245
		4	*31106.37*	173.98	1.345
		5	*31280.35*		1.396
$3d^5(a\,^2D)4s$	$b\,^3D$	3	31009.00	−19.33	
		2	31028.33	−20.52	
		1	31048.85		
$3d^5(a\,^2I)4s$	$a\,^3I$	7	31048.00	−1.33	
		6	31049.33	−6.02	
		5	31055.35		
$3d^5(b\,^4F)4s$	$a\,^5F$	1	31352.42	2.79	
		2	31355.21	9.12	
		3	31364.33	13.63	
		4	31377.96	15.44	
		5	31393.40		
$3d^4\,4s^2$	$a\,^1G$	4	31987.06		
$3d^4\,4s^2$	$a\,^1I$	6	32097.36		
$3d^5(a\,^2F)4s$	$b\,^3F$	2	33040.10	20.64	
		3	33060.74	52.53	
		4	33113.27		
$3d^4\,4s(a\,^6D)4p$	$z\,^5D^\circ$	0	*33338.20*	85.59	−0.003
		1	*33423.79*	118.32	1.499
		2	*33542.11*	129.44	1.497
		3	*33671.55*	144.51	1.497
		4	*33816.06*		1.499
$3d^4\,4s(a\,^4D)4p$	$z\,^3P^\circ$	0	*33762.56*	134.70	0.00
		1	*33897.26*	293.23	1.49
		2	*34190.49*		1.55
$3d^5(a\,^2I)4s$	$b\,^1I$	6	33762.74		
$3d^4\,4s^2$	$c\,^3D$	1	33906.65	29.00	
		2	33935.65	−0.77	
		3	33934.88		
$3d^6$	$c\,^5D$	4	35398.02	−103.24	
		3	35501.26	−71.68	
		2	35572.94	−45.57	
		1	35618.51	−22.18	
		0	35640.69		
$3d^5(b\,^4F)4s$	$c\,^3F$	2	35807.90	5.83	
		3	35813.73	49.09	
		4	35862.82		

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5(b\ ^2\mathrm{H})4s$	$b\ ^3\mathrm{H}$	4	35870. 53	13. 87	
		5	35884. 40	49. 62	
		6	35934. 02		
$3d^4\ 4s(a\ ^4\mathrm{D})4p$	$z\ ^3\mathrm{F}^\circ$	2	35897. 87	136. 35	
		3	36034. 22	177. 93	
		4	36212. 15		
$3d^5(b\ ^2\mathrm{F})4s$	$d\ ^3\mathrm{F}$	2	36558. 55	−6. 42	
		3	36552. 13	25. 60	
		4	36577. 73		
$3d^5(a\ ^6\mathrm{S})5s$	$e\ ^7\mathrm{S}$	3	36895. 73		
$3d^5(b\ ^2\mathrm{G})4s$	$c\ ^3\mathrm{G}$	3	37205. 88	38. 29	
		4	37244. 17	−10. 67	
		5	37233. 50		
$3d^5(a\ ^6\mathrm{S})5s$	$e\ ^5\mathrm{S}$	2	37883. 34		
$3d^5(b\ ^2\mathrm{H})4s$	$a\ ^1\mathrm{H}$	5	38537. 68		
$3d^4\ 4s(a\ ^4\mathrm{D})4p$	$z\ ^3\mathrm{D}^\circ$	1	38597. 06	133. 61	
		2	38730. 67	180. 66	
		3	38911. 33		
$3d^5(b\ ^2\mathrm{G})4s$	$b\ ^1\mathrm{G}$	4	39158. 63		
$3d^4\ 4s(a\ ^4\mathrm{D})4p$	$y\ ^5\mathrm{F}^\circ$	1	40906. 46	64. 83	0. 004
		2	40971. 29	114. 97	1. 28
		3	41086. 26	138. 52	1. 246
		4	41224. 78	168. 69	1. 360
		5	41393. 47		
$3d^4\ 4s(a\ ^4\mathrm{D})4p$	$x\ ^5\mathrm{P}^\circ$	1	40930. 31	52. 66	2. 455
		2	40982. 97	60. 38	1. 76
		3	41043. 35		1. 640
$3d^4\ 4s(a\ ^4\mathrm{D})4p$	$y\ ^5\mathrm{D}^\circ$	0	41224. 80	64. 37	−0. 001
		1	41289. 17	119. 86	1. 503
		2	41409. 03	166. 07	1. 504
		3	41575. 10	207. 09	1. 503
		4	41782. 19		1. 500
$3d^4\ 4s(a\ ^4\mathrm{H})4p$	$z\ ^5\mathrm{H}^\circ$	3	42025. 60	54. 21	
		4	42079. 81	73. 93	
		5	42153. 74	98. 43	
		6	42252. 17	135. 15	
		7	42387. 32		
$3d^4\ 4s(b\ ^4\mathrm{P})4p$	$x\ ^5\mathrm{D}^\circ$	0	42218. 37	74. 59	−0. 003
		1	42292. 96	145. 86	1. 501
		2	42438. 82	209. 44	1. 494
		3	42648. 26	260. 31	1. 498
		4	42908. 57		1. 497
$3d^5(a\ ^6\mathrm{S})5p$	$x\ ^7\mathrm{P}^\circ$	2	42238. 04	16. 07	
		3	42254. 11	21. 09	
		4	42275. 20		
$3d^5(a\ ^6\mathrm{S})4d$	$e\ ^7\mathrm{D}$	1	42253. 42	1. 10	
		2	42254. 52	1. 74	
		3	42256. 26	2. 11	
		4	42258. 37	2. 69	
		5	42261. 06		1. 55
$3d^5(a\ ^4\mathrm{G})4p$	$z\ ^5\mathrm{G}^\circ$	2	42515. 35	23. 46	0. 35
		3	42538. 81	26. 04	
		4	42564. 85	24. 40	
		5	42589. 25	16. 56	1. 23
		6	42605. 81		1. 32
$3d^4\ 4s(b\ ^4\mathrm{P})4p$	$z\ ^5\mathrm{S}^\circ$	2	43124. 88		1. 96
$3d^5(a\ ^6\mathrm{S})4d$	$e\ ^5\mathrm{D}$	4	44050. 87	−17. 85	
		3	44068. 72	−12. 18	
		2	44080. 90	−8. 02	
		1	44088. 92	−3. 88	
		0	44092. 80		
$3d^5(a\ ^4\mathrm{P})4p$	$w\ ^5\mathrm{P}^\circ$	1	44125. 90	61. 02	2. 74
		2	44186. 92	72. 44	1. 79
		3	44259. 36		1. 68
$3d^4\ 4s(a\ ^4\mathrm{H})4p$	$z\ ^5\mathrm{I}^\circ$	4	44246. 70	61. 26	
		5	44307. 96	85. 14	
		6	44393. 10	121. 34	
		7	44514. 44	152. 11	
		8	44666. 55		
$3d^4\ 4s(a\ ^4\mathrm{H})4p$	$y\ ^5\mathrm{G}^\circ$	2	44299. 98	73. 36	0. 35
		3	44373. 34	161. 12	0. 93
		4	44534. 46	57. 00	
		5	44591. 46	154. 80	1. 25
		6	44746. 26		1. 34
$3d^4\ 4s(b\ ^4\mathrm{P})4p$	$v\ ^5\mathrm{P}^\circ$	1	44666. 74	208. 45	2. 47
		2	44875. 19	238. 03	
		3	45113. 22		1. 65
$3d^4\ 4s(a\ ^4\mathrm{F})4p$	$x\ ^5\mathrm{F}^\circ$	1	45201. 84	23. 36	
		2	45225. 20	30. 31	
		3	45255. 51	30. 57	
		4	45286. 08	20. 37	
		5	45306. 45		1. 41
$3d^5(a\ ^4\mathrm{G})4p$	$z\ ^3\mathrm{H}^\circ$	6	45348. 73	−5. 45	
		5	45354. 18	−4. 45	
		4	45358. 63		
$3d^5(a\ ^4\mathrm{G})4p$	$y\ ^5\mathrm{H}^\circ$	3	45566. 02	48. 86	0. 52
		4	45614. 88	48. 40	
		5	45663. 28	44. 08	
		6	45707. 36	34. 13	
		7	45741. 49		1. 29
$3d^5(a\ ^6\mathrm{S})6s$	$f\ ^7\mathrm{S}$	3	45643. 38		2. 05
$3d^5(a\ ^4\mathrm{P})4p$	$y\ ^3\mathrm{P}^\circ$	0	45722. 59	−3. 39	
		1	45719. 20	15. 12	
		2	45734. 32		
$3d^5(a\ ^4\mathrm{G})4p$	$y\ ^3\mathrm{F}^\circ$	2	45966. 45	33. 91	
		3	46000. 36	57. 84	
		4	46058. 20		
$3d^5(a\ ^6\mathrm{S})6s$	$f\ ^5\mathrm{S}$	2	45967. 81		
$3d^5(a\ ^4\mathrm{P})4p$	$y\ ^3\mathrm{D}^\circ$	1	46077. 09	32. 17	
		2	46109. 26	65. 14	1. 24
		3	46174. 40		1. 33

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5(a\ ^4P)4p$	$w\ ^5D^\circ$	0	46081.27	217.05	
		1	46298.32	51.18	
		2	46349.50	18.85	
		3	46368.35	54.11	
		4	46422.46		
$3d^4\ 4s(a\ ^6D)5s$	$f\ ^7D$	1	46448.60	76.24	2.99
		2	46524.84	112.37	1.99
		3	46637.21	145.85	1.77
		4	46783.06	175.92	1.63
		5	46958.98		1.61
$3d^5(a\ ^4G)4p$	$w\ ^5F^\circ$	1	46678.35	−1.29	
		2	46677.06	11.18	
		3	46688.24	32.30	1.25
		4	46720.54	−15.56	
		5	46704.98		1.37
$3d^4\ 4s(a\ ^4H)4p$	$z\ ^3G^\circ$	3	46846.77	58.26	
		4	46905.03	80.84	
		5	46985.87		
$3d^4\ 4s(c\ ^4D)4p$	$u\ ^5P^\circ$	3	46878.61	−89.09	1.68
		2	46967.70	−54.05	1.83
		1	47021.75		2.43
$3d^4\ 4s(b\ ^4G)4p$	$x\ ^5G^\circ$	2	47047.47	78.23	0.45
		3	47125.70	64.17	0.96
		4	47189.87	38.93	
		5	47228.80	−6.53	1.27
		6	47222.27		1.44
$3d^5(a\ ^4G)4p$	$y\ ^3G^\circ$	3	47048.48	6.43	
		4	47054.91	0.40	
		5	47055.31		
$3d^4\ 4s(b\ ^4P)4p$	$z\ ^3S^\circ$	1	47088.40		
$3d^4\ 4s(a\ ^4H)4p$	$z\ ^3I^\circ$	5	47586.06	44.37	
		6	47630.43	62.20	
		7	47692.63		
$3d^4\ 4s(b\ ^4G)4p$	$x\ ^5H^\circ$	3	47621.31	67.20	
		4	47688.51	105.31	
		5	47793.82	148.47	
		6	47942.29	197.89	
		7	48140.18		
$3d^5(b\ ^4D)4p$	$v\ ^5F^\circ$	1	47629.66	1.85	
		2	47631.51	4.74	
		3	47636.25	3.59	
		4	47639.84	4.92	1.34
		5	47644.76		
$3d^5(a\ ^6S)6p$	$w\ ^7P^\circ$	2	47697.44	11.15	
		3	47708.59	10.49	
		4	47719.08		
$3d^5(a\ ^6S)5d$	$g\ ^7D$	1	47700.18	0.77	
		2	47700.95	1.35	
		3	47702.30	2.36	
		4	47704.66	5.14	
		5	47709.80		
$3d^5(b\ ^4D)4p$	$v\ ^5D^\circ$	0	47788.08	−15.78	0.00
		1	47772.30	13.80	1.37
		2	47786.10	28.30	1.39
		3	47814.40	52.08	1.53
		4	47866.48		1.50

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^4\ 4s(b\ ^4G)4p$	$u\ ^5F^\circ$	1	47877.55	40.38	0.00
		2	47917.93	56.60	1.04
		3	47974.53	39.87	1.36
		4	48014.40	−28.64	
		5	47985.76		1.38
$3d^4\ 4s(c\ ^4D)4p$	$t\ ^5F^\circ$	1	48210.04	7.79	
		2	48217.83	34.08	
		3	48251.91	−209.08	
		4	48042.83		
		5			
$3d^4\ 4s(b\ ^4P)4p$	$x\ ^3P^\circ$	0	48226.36	104.94	
		1	48331.30	127.37	
		2	48458.67		
$3d^4\ 4s(a\ ^4H)4p$	$y\ ^3H^\circ$	4	48288.37	22.02	
		5	48310.39	134.96	
		6	48445.35		
$3d^4\ 4s(a\ ^6D)5s$	$f\ ^5D$	0	48488.23	19.33	
		1	48507.56	51.01	
		2	48558.57	103.02	
		3	48661.59	162.91	1.46
		4	48824.50		1.46
$3d^4\ 4s(a\ ^4F)4p$	$x\ ^3G^\circ$	3	48515.08	47.08	
		4	48562.16	224.23	
		5	48786.39		
	1°	3	48636.14		
$3d^4\ 4s(b\ ^4P)4p$	$x\ ^3D^\circ$	1	48839.90	187.68	
		2	49027.58	283.28	
		3	49310.86		
$3d^5(a\ ^6S)7s$	$g\ ^7S$	3	49177.83		
$3d^4\ 4s(b\ ^4G)4p$	$w\ ^3G^\circ$	3	49370.70	83.24	
		4	49453.94	84.12	
		5	49538.06		
$3d^4\ 4s(a\ ^4F)4p$	$w\ ^5G^\circ$	2	49466.77	52.95	
		3	49519.72	53.31	1.04
		4	49573.03	44.58	
		5	49617.61	17.55	
		6	49635.16		1.35
$3d^5(a\ ^4P)4p$	$y\ ^3S^\circ$	1	49477.04		
	$e\ ^3F$	2	49586.38	131.50	
		3	49717.88	145.62	
		4	49863.50		
$3d^5(b\ ^4D)4p$	$t\ ^5P^\circ$	1	49588.97	9.11	2.48
		2	49598.08	214.38	1.88
		3	49812.46		1.77
$3d^5(b\ ^4D)4p$	$x\ ^3F^\circ$	4	49620.69	−29.53	
		3	49650.22	−2.54	
		2	49652.76		
$3d^5(a\ ^4P)4p$	$y\ ^5S^\circ$	2	49822.59		2.00
$3d^4\ 4s(a\ ^6D)5p$	$s\ ^5F^\circ$	1	50018.80	38.81	
		2	50057.61	44.43	
		3	50102.04	108.83	1.27
		4	50210.87	42.40	1.25
		5	50253.27		1.39

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5(b\,^4D)4p$	$w\,^3D^\circ$	1	50105.54	78.56	
		2	50184.10	80.38	
		3	50264.48		
$3d^4\,4s(c\,^4D)4p$	$u\,^5D^\circ$	4	50557.56	−70.55	1.54
		3	50628.11	−26.65	1.54
		2	50654.76	−8.01	1.51
		1	50662.77	1.57	1.46
		0	50661.20		0.00
$3d^4\,4s(a\,^4F)4p$	$w\,^3F^\circ$	2	50890.15	60.27	
		3	50950.42	109.37	
		4	51059.79		
$3d^5(b\,^4D)4p$	$w\,^3P^\circ$	0	51176.88	69.99	
		1	51246.87	39.65	
		2	51286.52		
$3d^5(a\,^2I)4p$	$z\,^1H^\circ$	5	51401.24		
$3d^4\,4s(a\,^4F)4p$	$t\,^5D^\circ$	0	51999.62	3.44	
		1	52003.06	9.38	
		2	52012.44	19.28	
		3	52031.72	32.55	
		4	52064.27		
$3d^5(a\,^2I)4p$	$y\,^3I^\circ$	5	52591.94	68.67	
		6	52660.61	17.27	
		7	52677.88		
	2°	4	52720.07		
$3d^4\,4s(b\,^4G)4p$	$x\,^3H^\circ$	6	52914.94	29.55	
		5	52885.39	−78.05	
		4	52963.44		
$3d^5(b\,^4F)4p$	$r\,^5F^\circ$	1	53011.65	25.87	
		2	53037.52	36.38	
		3	53073.90	43.64	
		4	53117.54	54.79	
		5	53172.33		1.42
$3d^4\,4s(a\,^6D)4d$	$e\,^7G$	1	53148.35	29.52	
		2	53177.87	50.62	
		3	53228.49	70.41	
		4	53298.90	94.60	
		5	53393.50	124.35	
		6	53517.85	144.79	
		7	53662.64		
$3d^4\,4s(a\,^6D)4d$	$e\,^7F$	0	53376.7	37.4	
		1	53414.1	53.3	
		2	53467.4	95.6	
		3	53563.0	140.9	
		4	53703.9	144.2	
		5	53848.1	192.1	
		6	54040.2		
$3d^4\,4s(a\,^6D)5p$	$s\,^5D^\circ$	0			
		1			
		2	53558.05	82.69	
		3	53640.74	142.03	
		4	53782.77		
$3d^4\,4s(a\,^2G)4p$	$v\,^3G^\circ$	3	53804.84	122.75	
		4	53927.59	150.54	
		5	54078.13		

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^4\,4s(a\,^4D)5p$	$q\,^5F^\circ$	1	54198.23	53.96	
		2	54252.19	76.76	
		3	54328.95	96.34	
		4	54425.29	111.24	
		5	54536.53		
	$e\,^5F$	1	54296.76	86.60	
		2	54383.36	92.93	
		3	54476.29	96.55	
		4	54572.84	87.47	
		5	54660.31		
$3d^5(a\,^2I)4p$	$z\,^3K^\circ$	6	54316.83	88.11	
		7	54404.94	93.33	
		8	54498.27		
Cr II $(^6S_{2\frac{1}{2}})$	***Limit***	------	**54565**		
$3d^4\,4s(a\,^4D)5s$	$g\,^5D$	0			
		1	54671.90	146.65	
		2	54818.55	168.27	
		3	54986.82	222.19	
		4	55209.01		
$3d^4\,4s(a\,^2H)4p$	$w\,^3H^\circ$	4	54736.55	62.63	
		5	54799.18	87.64	
		6	54886.82		
$3d^4\,4s(a\,^2H)4p$	$z\,^1I^\circ$	6	54800.26		
$3d^4\,4s(a\,^4D)5s$	$e\,^3D$	1	54804.69	169.95	
		2	54974.64	230.15	
		3	55204.79		
$3d^5(a\,^2I)4p$	$v\,^3H^\circ$	4	54810.94	118.78	
		5	54929.72	−63.15	
		6	54866.57		
$3d^5(a\,^2D)4p$	$v\,^3D^\circ$	1	54956.59	196.04	
		2	55152.63	299.01	
		3	55451.64		
$3d^5(a\,^2I)4p$	$z\,^1K^\circ$	7	54970.23		
$3d^4\,4s(c\,^2F)4p$	$v\,^3F^\circ$	2	54992.93	108.94	
		3	55101.87	105.53	
		4	55207.40		
$3d^5(a\,^2F)4p$	$u\,^3F^\circ$	4	55120.77	−231.95	
		3	55352.72	−120.95	
		2	55473.67		
$3d^5(a\,^2I)4p$	$y\,^1I^\circ$	6	55516.69		
$3d^4\,4s(a\,^2H)4p$	$x\,^3I^\circ$	5	55686.46	54.65	
		6	55741.11	57.99	
		7	55799.10		
$3d^5(b\,^2H)4p$	$u\,^3H^\circ$	6	55908.12	33.14	
		5	55874.98	−40.52	
		4	55915.50		
$3d^4\,4s(a\,^2H)4p$	$y\,^1H^\circ$	5	55945.08		
$3d^5(b\,^4F)4p$	$v\,^5G^\circ$	2	56155.12	54.69	
		3	56209.81	69.75	
		4	56279.56	82.30	
		5	56361.86	87.24	
		6	56449.10		

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5(a\,^2D)4p$	$v\,^3P^\circ$	2	56591.88	−130.72	
		1	56722.60	−79.90	
		0	56802.50		
$3d^5(b\,^2H)4p$	$u\,^3G^\circ$	3	56985.67	47.93	
		4	57033.60	54.65	
		5	57088.25		
$3d^4\,4s(a\,^2P)4p$	$u\,^3P^\circ$	2	57087.70	−44.89	
		1	57132.59	−22.00	
		0	57154.59		
$3d^4\,4s(a\,^6D)6p$	$p\,^5F^\circ$	1	57096.62	4.04	
		2	57100.66	85.94	
		3	57186.60	50.90	
		4	57237.50	90.16	
		5	57327.66		
$3d^5(b\,^2F)4p$	$t\,^3F^\circ$	2	57220.67	55.75	
		3	57276.42	59.05	
		4	57335.47		
$3d^5(a\,^4G)5s$	$e\,^5G$	2	57350.65	10.59	
		3	57361.24	11.54	
		4	57372.78	10.15	
		5	57382.93	6.39	
		6	57389.32		
$3d^4\,4s(c\,^2G)4p$	$t\,^3G^\circ$	3	57557.03	30.33	
		4	57587.36	115.00	
		5	57702.36		
$3d^4\,4s(a\,^4D)5p$	$r\,^5D^\circ$	0	57958.42	36.62	
		1	57995.04	68.76	
		2	58063.80	83.96	
		3	58147.76	144.86	
		4	58292.62		
	$e\,^3G$	3	57984.94	7.21	
		4	57992.15	−1.92	
		5	57990.23		
$3d^5(a\,^2D)4p$	$s\,^3F^\circ$	2	58162.84	39.81	
		3	58202.65	−34.76	
		4	58167.89		
$3d^4\,4s(a\,^2P)4p$	$u\,^3D^\circ$	1	58725.28	134.95	
		2	58860.23	261.92	
		3	59122.15		
$3d^4\,4s(a\,^2G)4p$	$t\,^3H^\circ$	4	58728.29	26.29	
		5	58754.58	20.78	
		6	58775.36		
$3d^5(a\,^2F)4p$	$t\,^3D^\circ$	1	58870.20	−98.17	
		2	58772.03	152.09	
		3	58924.12		
$3d^4\,4s(a\,^2G)4p$	$r\,^3F^\circ$	2	59357.90	59.11	
		3	59417.01	70.70	
		4	59487.71		
$3d^5(b\,^2H)4p$	$w\,^3I^\circ$	5	59806.27	78.00	
		6	59884.27	73.19	
		7	59957.46		
$3d^5(b\,^2H)4p$	$x\,^1H^\circ$	5	60005.60		
$3d^4\,4s(a\,^2P)4p$	$x\,^3S^\circ$	1	60084.09		

Cr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5(b\,^4F)4p$	$q\,^3F^\circ$	2	60253.00	73.04	
		3	60326.04	41.34	
		4	60367.38		
$3d^4\,4s(b\,^2I)4p$	$v\,^3I^\circ$	5	60427.63	99.92	
		6	60527.55	129.42	
		7	60656.97		
$3d^5(b\,^2H)4p$	$x\,^1I^\circ$	6	60441.42		
	$s\,^3G^\circ$	5	60467.85	−36.09	
		4	60503.94	−14.22	
		3	60518.16		
$3d^5(b\,^2F)4p$	$s\,^3D^\circ$	3	60615.84	−14.03	
		2	60629.87	−48.25	
		1	60678.12		
$3d^4\,4s(c\,^2G)4p$	$p\,^3F^\circ$	2			
		3	60819.50	141.08	
		4	60960.58		
$3d^4\,4s(c\,^2G)4p$	$s\,^3H^\circ$	4	60870.63	137.44	
		5	61008.07	183.57	
		6	61191.64		
$3d^5(b\,^2G)4p$	$r\,^3G^\circ$	3	61078.28	44.92	
		4	61123.20	38.15	
		5	61161.35		
$3d^4\,4s(b\,^4P)5s$	$e\,^5P$	1	61558.17	129.39	
		2	61687.56	162.61	
		3	61850.17		
	$^3{}^\circ$	2	61675.72		
	$q\,^3G^\circ$	3	61930.05	46.45	
		4	61976.50	61.10	
		5	62037.60		
$3d^5(a\,^4G)4d$	$f\,^5G$	2	62646.60	15.36	
		3	62661.96	9.04	
		4	62671.00	19.96	
		5	62690.96	−17.04	
		6	62673.92		
$3d^4\,4s(b\,^2I)4p$	$r\,^3H^\circ$	4	62762.06	68.20	
		5	62830.26	72.77	
		6	62903.03		
$3d^5(b\,^2G)4p$	$q\,^3H^\circ$	4	63116.80	27.56	
		5	63144.36	38.58	
		6	63182.94		
$3d^5(d\,^2G)4p$	$p\,^3H^\circ$	4	63841.81	85.46	
		5	63927.27	70.59	
		6	63997.86		
$3d^4\,4s(a\,^4H)5s$	$e\,^5H$	3	64712.04	39.38	
		4	64751.42	50.66	
		5	64802.08	34.22	
		6	64836.30	103.98	
		7	64940.28		
$3d^5(d\,^2G)4p?$	$p\,^3G^\circ$	3	66008.95	85.11	
		4	66094.06	86.28	
		5	66180.34		

February 1950.

Cr I Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms														
$3d^4\ 4s^2$		a ^{3}P	a ^{5}D c ^{3}D	a ^{3}F	b ^{3}G a ^{1}G	a ^{3}H	a ^{1}I								
$3d^6$			c ^{5}D												
	ns ($n \geq 4$)							*np* ($n \geq 4$)							
$3d^5(a\ ^6S)nx$	a, e, f, g ^{7}S a, e, f ^{5}S								z, x, w ^{7}P° z ^{5}P°						
$3d^4\ 4s(a\ ^6D)nx$			f ^{7}D f ^{5}D						y ^{7}P° y ^{5}P°	z ^{7}D° z, s ^{5}D°	z ^{7}F° z, s, p ^{5}F°				
$3d^4\ 4s(a\ ^4D)nx$			g ^{5}D e ^{3}D						x ^{5}P° z ^{3}P°	y, r ^{5}D° z ^{3}D°	y, q ^{5}F° z ^{3}F°				
$3d^5(a\ ^4G)nx$					a, e ^{5}G a ^{3}G						w ^{5}F° y ^{3}F°	z ^{5}G° y ^{3}G°	y ^{5}H° z ^{3}H°		
$3d^5(a\ ^4P)nx$		a ^{5}P b ^{3}P						y ^{5}S° y ^{3}S°	w ^{5}P° y ^{3}P°	w ^{5}D° y ^{3}D°					
$3d^5(b\ ^4D)nx$			b ^{5}D a ^{3}D						t ^{5}P° w ^{3}P°	v ^{5}D° w ^{3}D°	v ^{5}F° x ^{3}F°				
$3d^4\ 4s(b\ ^4P)nx$		e ^{5}P						z ^{5}S° z ^{3}S°	v ^{5}P° x ^{3}P°	x ^{5}D° x ^{3}D°					
$3d^5(a\ ^2I)nx$							a ^{3}I b ^{1}I						v ^{3}H° z ^{1}H°	y ^{3}I° y ^{1}I°	z ^{3}K° z ^{1}K°
$3d^4\ 4s(a\ ^4H)nx$						e ^{5}H						y ^{5}G° z ^{3}G°	z ^{5}H° y ^{3}H°	z ^{5}I° z ^{3}I°	
$3d^4\ 4s(a\ ^4F)nx$										t ^{5}D°	x ^{5}F° w ^{3}F°	w ^{5}G° x ^{3}G°			
$3d^5(a\ ^2D)nx$			b ^{3}D						v ^{3}P°	v ^{3}D°	s ^{3}F°				

$3d^5(a\ ^2F)nx$		$b\ ^3F$					$t\ ^3D^\circ$	$u\ ^3F^\circ$			
$3d^5(b\ ^4F)nx$		$a\ ^5F$ $c\ ^3F$						$r\ ^5F^\circ$ $q\ ^3F^\circ$	$v\ ^5G^\circ$		
$3d^4\ 4s(b\ ^4G)nx$								$u\ ^5F^\circ$	$x\ ^5G^\circ$ $w\ ^3G^\circ$	$x\ ^5H^\circ$ $x\ ^3H^\circ$	
$3d^4\ 4s(a\ ^2H)nx$										$w\ ^3H^\circ$ $y\ ^1H^\circ$	$x\ ^3I^\circ$ $z\ ^1I^\circ$
$3d^4\ 4s(a\ ^2P)nx$					$x\ ^3S^\circ$	$u\ ^3P^\circ$	$u\ ^3D^\circ$				
$3d^5(b\ ^2F)nx$		$d\ ^3F$					$s\ ^3D^\circ$	$t\ ^3F^\circ$			
$3d^5(b\ ^2H)nx$				$b\ ^3H$ $a\ ^1H$					$u\ ^3G^\circ$	$u\ ^3H^\circ$ $x\ ^1H^\circ$	$w\ ^3I^\circ$ $x\ ^1I^\circ$
$3d^4\ 4s(a\ ^2G)nx$								$r\ ^3F^\circ$	$v\ ^3G^\circ$	$t\ ^3H^\circ$	
$3d^4\ 4s(c\ ^4D)nx$						$u\ ^5P^\circ$	$u\ ^5D^\circ$	$t\ ^5F^\circ$			
$3d^5(b\ ^2G)nx$			$c\ ^3G$ $b\ ^1G$						$r\ ^3G^\circ$	$q\ ^3H^\circ$	
$3d^4\ 4s(c\ ^2G)nx$								$p\ ^3F^\circ$	$t\ ^3G^\circ$	$s\ ^3H^\circ$	
$3d^4\ 4s(c\ ^2F)nx$								$v\ ^3F^\circ$			
$3d^4\ 4s(b\ ^2I)nx$										$r\ ^3H^\circ$	$v\ ^3I^\circ$
$3d^5(d\ ^2G)nx$									$p\ ^3G^\circ?$	$p\ ^3H^\circ$	
	$nd\ (n \geq 4)$										
$3d^5(a\ ^6S)nx$	$e, g\ ^7D$ $e\ ^5D$										
$3d^4\ 4s(a\ ^6D)nx$		$e\ ^7F$	$e\ ^7G$								
$3d^5(a\ ^4G)nx$			$f\ ^5G$								

*For predicted terms in the spectra of the Cr I isoelectronic sequence, see Vol. II, Introduction.

Cr II

(V I sequence; 23 electrons) $Z=24$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\ ^6S_{2\frac{1}{2}}$

$a\ ^6S_{2\frac{1}{2}}$ **133060** cm^{-1} I. P. 16.49 volts

The present term list is the result of an extensive and detailed analysis of this complex spectrum recently completed by C. C. Kiess especially for inclusion here. His wavelength list extends from 1700 A to 7300 A, based on spectrograms secured at the National Bureau of Standards and at the Mt. Wilson Observatory; also at Princeton for the region shorter than 2000 A. Approximately 1950 classified lines and about 500 multiplets are now known.

Three series of two members each, ^6D, ^4D, and ^4G, give a limit that is known to be high. The correction derived from longer known series in related spectra has been estimated by H. N. Russell as about −0.37 ev, or roughly −2940 cm^{-1}. This adjustment has been made in the limit quoted here.

Intersystem combinations connect the terms of all multiplicities.

The low singlet terms from $3d^4$ in Cr III have not yet been found, although terms from these limits are known in Cr II. In the array of observed terms these limit terms have been inserted in the numerical order in which they appear in the table. The prefixes "a" have been assumed for them.

REFERENCES

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C. C. Kiess, J. Research Nat. Bur. Std. **47,** 385, RP2266 (1951). (I P) (T) (C L) (Z E)
H. N. Russell, J. Opt. Soc. Am. **40,** 619 (1950). (I P)

Cr II

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5$	$a\ ^6S$	2½	0.00		
$3d^4(a\ ^5D)4s$	$a\ ^6D$	0½	11962.00	70.72	3.323
		1½	12032.72	115.28	1.867
		2½	12148.00	155.98	1.669
		3½	12303.98	192.81	1.578
		4½	12496.79		1.554
$3d^4(a\ ^5D)4s$	$a\ ^4D$	0½	19528.38	102.90	0.000
		1½	19631.28	166.73	1.192
		2½	19798.01	226.17	1.370
		3½	20024.18		1.427
$3d^5$	$a\ ^4G$	2½	20512.62	5.71	0.599
		3½	20518.33	1.52	0.994
		4½	20519.85	−7.10	1.161
		5½	20512.75		1.278
$3d^5$	$a\ ^4P$	2½	21822.86	−1.96	1.590
		1½	21824.82	0.57	1.717
		0½	21824.25		2.693
$3d^5$	$b\ ^4D$	3½	25033.95	−13.09	1.432
		2½	25047.04	3.94	1.381
		1½	25043.10	7.46	1.207
		0½	25035.64		−0.045
$3d^4(a\ ^3P)4s$	$b\ ^4P$	0½	29952.08	355.52	2.685
		1½	30307.60	557.01	1.756
		2½	30864.61		1.572
$3d^5$	$a\ ^2I$	5½	30143.72	6.44	
		6½	30150.16		

Cr II

Config.	Desig.	J	Level	Interval	Obs. g
$3d^4(a\ ^3H)4s$	$a\ ^4H$	3½	30156.94	62.10	0.667
		4½	30219.04	79.73	0.978
		5½	30298.77	93.17	1.162
		6½	30391.94		1.234
$3d^4(a\ ^3F)4s$	$a\ ^4F$	1½	31083.11	34.48	0.418
		2½	31117.59	51.19	1.032
		3½	31168.78	50.71	1.246
		4½	31219.49		1.340
$3d^5$	$a\ ^2D$	2½	31351.15	−180.47	
		1½	31531.62		
$3d^5$	$a\ ^2F$	3½	32355.94	−247.79	
		2½	32603.73		
$3d^5$	$b\ ^4F$	1½	32844.92	10.17	
		2½	32855.09	−18.25	
		3½	32836.84	17.62	
		4½	32854.46		
$3d^4(a\ ^3G)4s$	$b\ ^4G$	2½	33418.11	103.12	0.588
		3½	33521.23	97.90	1.024
		4½	33619.13	75.34	1.185
		5½	33694.47		1.276
$3d^4(a\ ^3H)4s$	$a\ ^2H$	4½	34631.14	181.92	
		5½	34813.06		
$3d^4(a\ ^3P)4s$	$a\ ^2P$	0½	34659.48	696.58	0.670
		1½	35356.06		1.331
$3d^4(a\ ^3F)4s$	$b\ ^2F$	2½	35569.02	38.58	0.867
		3½	35607.60		1.144

Cr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5$	$b\,^2H$	4½	35610. 50	97. 16	
		5½	35707. 66		
$3d^5$	$a\,^2G$	3½	36101. 82	170. 84	
		4½	36272. 66		
$3d^4(a\,^3D)4s$	$c\,^4D$	3½	38269. 67	−45. 33	
		2½	38315. 00	−47. 56	
		1½	38362. 56	−33. 80	
		0½	38396. 36		
$3d^4(a\,^1G)4s$	$b\,^2G$	3½	38509. 07	54. 08	0. 910
		4½	38563. 15		1. 100
$3d^4(a\,^3G)4s$	$c\,^2G$	3½	39684. 00	140. 52	
		4½	39824. 52		
$3d^5$	$c\,^2F$	2½	39742. 36	134. 92	
		3½	39877. 28		
$3d^4(a\,^1I)4s$	$b\,^2I$	6½	40202. 14	−26. 30	
		5½	40228. 44		
$3d^4(a\,^1S)4s$	$a\,^2S$	0½	40415. 34		
$3d^4(a\,^3D)4s$	$b\,^2D$	2½	42898. 12	−88. 61	
		1½	42986. 73		
$3d^5$	$b\,^2S$	0½	44307. 44		
$3d^4(a\,^1D)4s$	$c\,^2D$	1½	45669. 54	61. 20	
		2½	45730. 74		
$3d^4(a\,^5D)4p$	$z\,^6F^\circ$	0½	*46823. 64*	81. 88	−0. 689
		1½	*46905. 52*	135. 02	1. 124
		2½	*47040. 54*	186. 96	1. 314
		3½	*47227. 50*	237. 44	1. 378
		4½	*47464. 94*	287. 04	1. 416
		5½	*47751. 98*		
$3d^5$	$d\,^2D$	2½	47354. 63	−18. 12	
		1½	47372. 75		
$3d^4(a\,^5D)4p$	$z\,^6P^\circ$	1½	*48399. 19*	92. 20	2. 382
		2½	*48491. 39*	140. 97	1. 875
		3½	*48632. 36*		1. 710
$3d^4(a\,^5D)4p$	$z\,^4P^\circ$	0½	*48749. 57*	256. 58	2. 844
		1½	*49006. 15*	345. 81	1. 802
		2½	*49351. 96*		1. 628
$3d^4(a\,^5D)4p$	$z\,^6D^\circ$	0½	*49493. 00*	71. 80	3. 155
		1½	*49564. 80*	141. 67	1. 824
		2½	*49706. 47*	−60. 22	1. 624
		3½	*49646. 25*	192. 18	1. 577
		4½	*49838. 43*		1. 570
$3d^4(a\,^1F)4s$	$d\,^2F$	3½	50667. 33	−20. 30	
		2½	50687. 63		
$3d^4(a\,^5D)4p$	$z\,^4F^\circ$	1½	*51584. 44*	85. 31	0. 406
		2½	*51669. 75*	119. 46	1. 025
		3½	*51789. 21*	153. 83	1. 248
		4½	*51943. 04*		1. 338
$3d^5$	$d\,^2G$	3½	52298. 12	23. 18	
		4½	52321. 30		
$3d^3\,4s^2$	$c\,^4F$	1½	53051. 55	219. 52	
		2½	53271. 07	295. 15	
		3½	53566. 22	357. 35	
		4½	53923. 57		
$3d^4(a\,^5D)4p$	$z\,^4D^\circ$	0½	*54418. 08*	81. 62	0. 007
		1½	*54499. 70*	126. 06	1. 178
		2½	*54625. 76*	158. 91	1. 376
		3½	*54784. 67*		1. 430

Cr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^3\,4s^2$	$e\,^2G$	3½	54444. 19	234. 76	
		4½	54678. 95		
$3d^3\,4s^2$	$c\,^4P$	2½	55023. 30	−58. 4	
		1½	55081. 7?		
		0½			
$3d^3\,4s^2$	$b\,^2P$	0½			
		1½	59130. 51		
$3d^3\,4s^2$	$e\,^2D$	1½	59527. 05	43. 18	
		2½	59570. 23		
$3d^4(a\,^3H)4p$	$z\,^4H^\circ$	3½	*63601. 20*	105. 42	0. 680
		4½	*63706. 62*	142. 49	1. 030
		5½	*63849. 11*	181. 74	1. 138
		6½	*64030. 85*		1. 234
$3d^4(a\,^3P)4p$	$y\,^4D^\circ$	0½	*63802. 41*	259. 41	0. 000
		1½	*64061. 82*	387. 02	1. 199
		2½	*64448. 84*	475. 46	1. 380
		3½	*64924. 30*		1. 411
$3d^4(a\,^3P)4p$	$z\,^2S^\circ$	0½	*65029. 67*		
$3d^4(a\,^3H)4p$	$z\,^4G^\circ$	2½	*65156. 84*	100. 19	0. 593
		3½	*65257. 03*	127. 01	0. 920
		4½	*65384. 04*	325. 49	1. 120
		5½	*65709. 53*		1. 265
$3d^4(a\,^3H)4p$	$z\,^4I^\circ$	4½	*65217. 61*	202. 34	
		5½	*65419. 95*	198. 46	
		6½	*65618. 41*	194. 22	
		7½	*65812. 63*		
$3d^4(a\,^3H)4p$	$z\,^2G^\circ$	3½	*65543. 06*	137. 09	
		4½	*65680. 15*		
$3d^4(a\,^3P)4p$	$y\,^4P^\circ$	0½	*66256. 77*	98. 36	2. 545
		1½	*66355. 13*	372. 03	1. 671
		2½	*66727. 16*		1. 502
$3d^4(a\,^3P)4p$	$z\,^2D^\circ$	1½	*66649. 71*	362. 57	
		2½	*67012. 28*		
$3d^4(a\,^3P)4p$	$z\,^2P^\circ$	0½	*66872. 12*	198. 36	
		1½	*67070. 48*		
$3d^4(a\,^3F)4p$	$y\,^4G^\circ$	2½	*67344. 42*	−10. 22	
		3½	*67334. 20*	19. 40	
		4½	*67353. 60*	15. 73	
		5½	*67369. 33*		
$3d^4(a\,^3F)4p$	$y\,^4F^\circ$	1½	*67379. 92*	7. 38	
		2½	*67387. 30*	6. 50	
		3½	*67393. 80*	55. 02	
		4½	*67448. 82*		
$3d^4(a\,^3H)4p$	$z\,^2I^\circ$	5½	*67506. 34*	82. 72	
		6½	*67589. 06*		
$3d^4(a\,^3F)4p$	$x\,^4D^\circ$	0½	*67859. 91*	10. 59	
		1½	*67870. 50*	−2. 45	
		2½	*67868. 05*	7. 63	
		3½	*67875. 68*		
$3d^4(a\,^3P)4p$	$z\,^4S^\circ$	1½	*68305. 73*		1. 978
$3d^4(a\,^3H)4p$	$z\,^2H^\circ$	4½	*68477. 11*	260. 88	
		5½	*68737. 99*		
$3d^4(a\,^3F)4p$	$z\,^2F^\circ$	2½	*68583. 44*	176. 56	
		3½	*68760. 00*		
$3d^4(a\,^3G)4p$	$y\,^4H^\circ$	3½	*68843. 51*	149. 04	
		4½	*68992. 55*	178. 05	
		5½	*69170. 60*	217. 80	
		6½	*69388. 40*		

Cr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^4(a\,^3G)4p$	$x\,^4F^\circ$	1½	69348.36		
		2½	69478.06	129.70	
		3½	69506.16	28.10	
		4½	69498.27	−7.89	
$3d^4(a\,^3F)4p$	$y\,^2D^\circ$	1½	69638.77		
		2½	69954.20	315.43	
$3d^4(a\,^3F)4p$	$y\,^2G^\circ$	3½	69903.46		
		4½	70107.83	204.37	
$3d^4(a\,^3G)4p$	$x\,^4G^\circ$	2½	70317.04		
		3½	70427.22	110.18	
		4½	70679.22	252.00	
		5½	70879.95	200.73	
$3d^4(a\,^3G)4p$	$y\,^2H^\circ$	4½	70394.46		
		5½	70399.04	4.58	
$3d^4(a\,^3G)4p$	$y\,^2F^\circ$	2½	70584.64		
		3½	70852.24	267.60	
$3d^4(a\,^3G)4p$	$x\,^2G^\circ$	3½	72648.79		
		4½	72716.91	68.12	
$3d^4(a\,^3D)4p$	$w\,^4D^\circ$	0½	73406.68		
		1½	73411.94	5.26	
		2½	73436.27	24.33	
		3½	73485.60	49.33	
$3d^4(a\,^3D)4p$	$x\,^2F^\circ$	3½	74114.48		
		2½	74436.14	−321.66	
$3d^4(a\,^3D)4p$	$w\,^4F^\circ$	1½	74273.48		
		2½	74318.86	45.38	
		3½	74423.84	104.98	
		4½	74504.51	80.67	
$3d^4(a\,^1I)4p$	$y\,^2I^\circ$	5½	74421.76		
		6½	74424.35	2.59	
$3d^4(a\,^1I)4p$	$x\,^2H^\circ$	4½	74455.90		
		5½	74707.42	251.52	
$3d^4(a\,^3D)4p$	$x\,^4P^\circ$	2½	74484.25		
		1½	74718.05	−233.80	
		0½	74920.80	−202.75	
$3d^4(a\,^1I)4p$	$z\,^2K^\circ$	6½	74743.33		
		7½	74958.80	215.47	
$3d^4(a\,^3D)4p$	$y\,^2P^\circ$	0½	74854.08		
		1½	74984.93	130.85	
$3d^4(a\,^1G)4p$	$w\,^2G^\circ$	3½	75716.74		
		4½	75810.10	93.36	
$3d^4(a\,^1G)4p$	$w\,^2F^\circ$	3½	76879.03		
		2½	76987.78	−108.75	
$3d^4(a\,^1G)4p$	$w\,^2H^\circ$	5½	77078.96		
		4½	77270.40	−191.44	
$3d^4(a\,^1S)4p$	$x\,^2P^\circ$	1½	77713.66		
		0½	77777.58	−63.92	
$3d^4(a\,^3D)4p$	$x\,^2D^\circ$	2½	77935.24		
		1½	78109.64	−174.40	
$3d^4(a\,^1D)4p$	$w\,^2D^\circ$	1½	80288.25		
		2½	80420.43	132.18	
$3d^4(a\,^1D)4p$	$v\,^2F^\circ$	2½	81232.91		
		3½	81432.36	199.45	
$3d^4(a\,^5D)5s$	$e\,^6D$	0½	82692.26		
		1½	82763.45	71.19	
		2½	82881.30	117.85	
		3½	83041.20	159.90	
		4½	83240.20	199.00	

Cr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^4(a\,^1D)4p$	$w\,^2P^\circ$	0½	82854.00		
		1½	82920.03	66.03	
$3d^4(a\,^5D)5s$	$e\,^4D$	0½	84208.28		
		1½	84318.54	110.26	
		2½	84494.20	175.66	
		3½	84725.96	231.76	
$3d^4(a\,^1F)4p$	$u\,^2F^\circ$	2½	84604.99		
		3½	84677.39	72.40	
$3d^4(a\,^1F)4p$	$v\,^2G^\circ$	3½	85573.42		
		4½	85939.50	366.08	
$3d^4(a\,^1F)4p$	$v\,^2D^\circ$	2½	86507.38		
		1½	86511.08	−3.70	
$3d^4(a\,^5D)4d$	$e\,^6G$	1½	86594.82		
		2½	86654.43	59.61	
		3½	86738.36	83.93	
		4½	86847.30	108.94	
		5½	86980.42	133.12	
		6½	87137.34	156.92	
$3d^4(a\,^5D)4d$	$e\,^6P$	1½	86667.95		
		2½	86691.77	23.82	
		3½	86782.07	90.30	
$3d^4(a\,^5D)4d$	$f\,^6D$	0½	87314.0		
		1½	87354.62	40.1	
		2½	87413.27	58.65	
		3½	87515.10	101.83	
		4½	87687.66	172.56	
$3d^4(a\,^5D)4d$	$e\,^6F$	0½	87542.12		
		1½	87594.60	52.48	
		2½	87666.00	71.40	
		3½	87758.88	92.88	
		4½	87948.70	189.82	
		5½	88001.32	52.62	
$3d^4(a\,^5D)4d$	$e\,^4G$	2½	89056.10		
		3½	89174.10	118.00	
		4½	89325.60	151.50	
		5½	89508.63	183.03	
$3d^4(a\,^5D)4d$	$e\,^4P$	0½	88426.2		
		1½	88636.7	210.5	
		2½	88923.2	286.5	
$3d^4(a\,^5D)4d$	$f\,^4D$	0½	89269.88		
		1½	89337.70	67.82	
		2½	89475.08	137.38	
		3½	89621.25	146.17	
$3d^4(a\,^5D)4d$	$e\,^4F$	1½	90512.50		
		2½	90591.10	78.60	
		3½	90725.50	134.40	
		4½	90851.00	125.50	
$3d^4(b\,^3F)4p$	$u\,^2G^\circ$	3½	90986.31		
		4½	91103.36	117.05	
$3d^4(b\,^3F)4p$	$u\,^2D^\circ$	2½	91426.31		
		1½	91556.54	−130.23	
$3d^4(a\,^5D)4d$	$e\,^6S$	2½	91954.78		
$3d^4(a\,^3G)5s$	$f\,^4G$	2½			
		3½			
		4½	105365.2		
		5½	105421.9	56.7	
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Cr III ($a\,^5D_0$)	**Limit**	----	**133060**		

February 1951.

Cr II Observed Terms*

Config. $1s^2 2s^2 2p^6 3s^2 3p^6+$	Observed Terms	
$3d^5$	$b\,^6S$ $a\,^4P$ $b\,^4D$ $b\,^4F$ $a\,^4G$ $b\,^2S$ $a\,^2D$ $a\,^2F$ $a\,^2G$ $a\,^2I$ $c\,^2D$ $c\,^2F$ $d\,^2G$ $b\,^2H$	
$3d^3\,4s$	$c\,^4P$ $c\,^4F$ $b\,^2P$ $e\,^2D$ $e\,^2G$	
	ns $(n\geq4)$	*np* $(n\geq4)$
$3d^4(a\,^5D)nx$	$a,e\,^6D$ $a,e\,^4D$	$z\,^6P^\circ$ $z\,^6D^\circ$ $z\,^6F^\circ$ $z\,^4P^\circ$ $z\,^4D^\circ$ $z\,^4F^\circ$
$3d^4(a\,^3P)nx$	$b\,^4P$ $a\,^2P$	$z\,^4S^\circ$ $y\,^4P^\circ$ $y\,^4D^\circ$ $z\,^2S^\circ$ $z\,^2P^\circ$ $z\,^2D^\circ$
$3d^4(a\,^3H)nx$	$a\,^4H$ $a\,^2H$	$z\,^4G^\circ$ $z\,^4H^\circ$ $z\,^4I^\circ$ $z\,^2G^\circ$ $z\,^2H^\circ$ $z\,^2I^\circ$
$3d^4(a\,^3F)nx$	$a\,^4F$ $b\,^2F$	$x\,^4D^\circ$ $y\,^4F^\circ$ $y\,^4G^\circ$ $y\,^2D^\circ$ $z\,^2F^\circ$ $y\,^2G^\circ$
$3d^4(a\,^3G)nx$	$b,f\,^4G$ $c\,^2G$	$x\,^4F^\circ$ $x\,^4G^\circ$ $y\,^4H^\circ$ $y\,^2F^\circ$ $x\,^2G^\circ$ $y\,^2H^\circ$
$3d^4(a\,^3D)nx$	$c\,^4D$ $b\,^2D$	$x\,^4P^\circ$ $w\,^4D^\circ$ $w\,^4F^\circ$ $y\,^2P^\circ$ $x\,^2D^\circ$ $x\,^2F^\circ$
$3d^4(a\,^1G)nx$	$b\,^2G$	$w\,^2F^\circ$ $w\,^2G^\circ$ $w\,^2H^\circ$
$3d^4(a\,^1I)nx$	$b\,^2I$	$x\,^2H^\circ$ $y\,^2I^\circ$ $z\,^2K^\circ$
$3d^4(a\,^1S)nx$	$a\,^2S$	$x\,^2P^\circ$
$3d^4(a\,^1D)nx$	$c\,^2D$	$w\,^2P^\circ$ $w\,^2D^\circ$ $v\,^2F^\circ$
$3d^4(a\,^1F)nx$	$d\,^2F$	$v\,^2D^\circ$ $u\,^2F^\circ$ $v\,^2G^\circ$
$3d^4(b\,^3F)nx$		$u\,^2D^\circ$ $u\,^2G^\circ$
	nd $(n\geq4)$	
$3d^4(a\,^5D)nx$	$e\,^6S$ $e\,^6P$ $f\,^6D$ $e\,^6F$ $e\,^6G$ $e\,^4P$ $f\,^4D$ $e\,^4F$ $e\,^4G$	

*For predicted terms of the V I isoelectronic sequence, see Volume I, pp. XXXVIII and XXXIX.

Cr III

(Ti I sequence; 22 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ {}^5\mathrm{D}_0$

$a\ {}^5\mathrm{D}_0$ **249700** cm^{-1} I. P. 30.95 volts

The early work on Cr III by White and by Bowen resulted in the classification of 112 lines from 16 triplet and quintet terms. Bowen found strong intersystem combinations connecting the two systems of terms.

Recently, F. L. Moore, Jr., has extended the observations and analysis, utilizing also unpublished wavelengths by Kiess and Lang. He has observed more than 2300 lines between 712 A and 3924 A, of which approximately 750 Cr III lines are classified. About 60 terms are known, including eight singlets, also connected with the rest by observed intersystem combinations. The limit quoted here has been estimated by Catalán from a study of isoelectronic data. From the $ns\ {}^{5,3}\mathrm{F}$ series ($n=4$, 5) Moore derives the value 253064. White estimated the value of the limit as about 222000 cm^{-1}.

This spectrum is of considerable astrophysical interest. For this reason Moore has made the present investigation and furnished his results especially for inclusion here. All of the terms in the table have been taken from his manuscript.

REFERENCES

H. E. White, Phys. Rev. **33,** 914 (1929). (T) (C L)

I. S. Bowen, Phys. Rev. **52,** 1153 (1937). (T) (C L)

F. L. Moore, Jr., unpublished material (May 1951). (I P) (T) (C L)

M. A. Catalán, unpublished material (April 1951). (I P)

Cr III

Config.	Desig.	*J*	Level	Interval
$3d^4$	$a\ {}^5\mathrm{D}$	0	0. 0	59. 9
		1	59. 9	122. 0
		2	181. 9	173. 9
		3	355. 8	219. 2
		4	575. 0	
$3d^4$	$a\ {}^3\mathrm{P}$	0	16770. 9	396. 5
		1	17167. 4	682. 6
		2	17850. 0	
$3d^4$	$a\ {}^3\mathrm{H}$	4	17272. 8	122. 7
		5	17395. 5	133. 3
		6	17528. 8	
$3d^4$	$a\ {}^3\mathrm{F}$	2	18451. 0	59. 0
		3	18510. 0	71. 6
		4	18581. 6	
$3d^4$	$a\ {}^3\mathrm{G}$	3	20702. 0	149. 3
		4	20851. 3	143. 3
		5	20994. 6	
$3d^4$	$a\ {}^3\mathrm{D}$	3	25725. 8	−55. 2
		2	25781. 0	−67. 2
		1	25848. 2	
$3d^4$	$a\ {}^1\mathrm{F}$	3	41052. 8	
$3d^4$	$b\ {}^3\mathrm{F}$	4	43286. 4	−35. 3
		3	43321. 7	17. 6
		2	43304. 1	
$3d^4$	$b\ {}^3\mathrm{P}$	0	48759. 7	163. 6
		1	48923. 3	544. 2
		2	49467. 5	
$3d^3(a\ {}^4\mathrm{F})4s$	$a\ {}^5\mathrm{F}$	1	49491. 0	135. 8
		2	49626. 8	200. 9
		3	49827. 7	261. 5
		4	50089. 2	319. 0
		5	50408. 2	
$3d^4$	$b\ {}^1\mathrm{G}$	4	51093. 1	

Cr III

Config.	Desig.	*J*	Level	Interval
$3d^3(a\ {}^4\mathrm{F})4s$	$c\ {}^3\mathrm{F}$	2	56650. 5	341. 7
		3	56992. 2	429. 9
		4	57422. 1	
$3d^3(a\ {}^4\mathrm{P})4s$	$a\ {}^5\mathrm{P}$	1	63038. 6	133. 6
		2	63172. 2	248. 1
		3	63420. 3	
$3d^3(a\ {}^2\mathrm{G})4s$	$b\ {}^3\mathrm{G}$	3	65890. 9	136. 9
		4	66027. 8	194. 9
		5	66222. 7	
$3d^3(a\ {}^4\mathrm{P})4s$	$c\ {}^3\mathrm{P}$	0		
		1	66602. 2	579. 5
		2	67181. 7	
$3d^3(a\ {}^2\mathrm{G})4s$	$c\ {}^1\mathrm{G}$	4	68575. 4	
$3d^3(a\ {}^2\mathrm{P})4s$	$d\ {}^3\mathrm{P}$	0	69510. 6	270. 3
		1	69780. 9	510. 9
		2	70291. 8	
$3d^3(a\ {}^2\mathrm{D})4s$	$b\ {}^3\mathrm{D}$	1	70980. 2	185. 9
		2	71166. 1	155. 7
		3	71321. 8	
$3d^3(a\ {}^2\mathrm{H})4s$	$a\ {}^1\mathrm{H}$	5	71408. 2	
$3d^3(a\ {}^2\mathrm{H})4s$	$b\ {}^3\mathrm{H}$	4	71676. 2	59. 8
		5	71736. 0	132. 5
		6	71868. 5	
$3d^3(a\ {}^2\mathrm{F})4s$	$d\ {}^3\mathrm{F}$	2		
		3	81664. 5	591. 4
		4	82255. 9	
$3d^3(a\ {}^4\mathrm{F})4p$	$z\ {}^5\mathrm{G}^\circ$	2	*93765. 6*	263. 6
		3	*94029. 2*	345. 5
		4	*94374. 7*	424. 9
		5	*94799. 6*	504. 5
		6	*95304. 1*	

Cr III—Continued

Config.	Desig.	J	Level	Interval
$3d^3(a\,^4F)4p$	$z\,^5D^{\circ}$	0	95778.6	369.9
		1	96148.5	237.4
		2	96385.9	327.2
		3	96713.1	384.0
		4	97097.1	
$3d^3(a\,^4F)4p$	$z\,^5F^{\circ}$	1	96773.5	147.9
		2	96921.4	198.9
		3	97120.3	238.4
		4	97358.7	259.6
		5	97618.3	
$3d^3(a\,^4F)4p$	$z\,^3D^{\circ}$	1	97076.9	229.2
		2	97306.1	376.9
		3	97683.0	
$3d^3(a\,^4F)4p$	$z\,^3G^{\circ}$	3	99840.7	258.8
		4	100099.5	321.9
		5	100421.4	
$3d^3(a\,^4F)4p$	$z\,^3F^{\circ}$	2	101443.7	301.6
		3	101745.3	354.3
		4	102099.6	
$3d^3(a\,^4P)4p$	$z\,^5P^{\circ}$	1	108248.3	210.9
		2	108459.2	334.1
		3	108793.3	
$3d^3(a\,^4P)4p$	$y\,^5D^{\circ}$	0	109145.9	91.5
		1	109237.4	196.8
		2	109434.2	287.2
		3	109721.4	432.6
		4	110154.0	
$3d^3(a\,^2G)4p$	$z\,^3H^{\circ}$	4	109533.5	410.4
		5	109943.9	561.1
		6	110505.0	
$3d^3(a\,^4P?)4p$	$z\,^3P^{\circ}$	0		
		1		
		2	109569.7	
$3d^3(a\,^2G)4p$	$y\,^3G^{\circ}$	3	111375.0	268.3
		4	111643.3	210.7
		5	111854.0	
$3d^3(a\,^2G)4p$	$y\,^3F^{\circ}$	4	112371.2	−95.0
		3	112466.2	67.7
		2	112398.5	
$3d^3(a\,^4P)4p$	$z\,^5S^{\circ}$	2	113355.7	
$3d^3(a\,^2G)4p$	$z\,^1G^{\circ}$	4	114354.9	
$3d^3(a\,^4P)4p$	$y\,^3D^{\circ}$	1	114715.9	465.9
		2	115181.8	370.9
		3	115552.7	
$3d^3(a\,^2H)4p$	$y\,^3H^{\circ}$	4	115570.2	98.7
		5	115668.9	174.6
		6	115843.5	
$3d^3(a\,^2D)4p$	$x\,^3F^{\circ}$	2	116391.6	140.5
		3	116532.1	434.9
		4	116967.0	
$3d^3(a\,^2H)4p$	$y\,^1G^{\circ}$	4	117099.3	
$3d^3(a\,^2H)4p$	$z\,^3I^{\circ}$	5	117145.2	342.3
		6	117487.5	434.8
		7	117922.3	
$3d^3(a\,^2G)4p$	$z\,^1H^{\circ}$	5	117186.9	
$3d^3(a\,^2D)4p$	$w\,^3D^{\circ}$	1	118055.2	368.1
		2	118423.3	174.9
		3	118598.2	
$3d^3(a\,^2H)4p$	$y\,^1H^{\circ}$	5	119039.9	
$3d^3(a\,^2H)4p$	$x\,^3G^{\circ}$	5	120699.7	−48.1
		4	120747.8	−17.5
		3	120765.3	
$3d^3(a\,^2F)4p$	$w\,^3F^{\circ}$	2	128753.9	28.3
		3	128782.2	67.2
		4	128849.4	
$3d^3(a\,^2F)4p$	$w\,^3G^{\circ}$	3	131118.1	149.2
		4	131267.3	181.5
		5	131448.8	
$3d^3(a\,^2F)4p$	$v\,^3D^{\circ}$	1		
		2	138362.4?	613.1
		3	138975.5	
$3d^3(b?\,^2D)4p$	$v\,^3F^{\circ}$	2		
		3	150972.5	
		4		
$3d^3(a\,^4F)4d$	$e\,^5H$	3	152927.3	171.8
		4	153099.1	215.5
		5	153314.6	257.1
		6	153571.7	300.0
		7	153871.7	
$3d^3(a\,^4F)4d$	$e\,^5F$	1	153729.8	163.7
		2	153893.5	192.2
		3	154085.7	371.4
		4	154457.1	392.5
		5	154849.6	
$3d^3(a\,^4F)4d$	$e\,^5G$	2		
		3		
		4		
		5		
		6	154854.6	
$3d^3(a\,^4F)4d$	$e\,^5D$	0		
		1		
		2		
		3		
		4	155064.0	
$3d^3(a\,^4F)5s$	$f\,^5F$	1	157303.2	131.9
		2	157435.1	202.2
		3	157637.3	270.7
		4	157908.0	333.8
		5	158241.8	
$3d^3(a\,^4F)4d$	$e\,^3H$	4		
		5		
		6	157668.9	
$3d^3(a\,^4F)4d$	$e\,^3G$	3	158066.7	376.2
		4	158442.9	
		5		
$3d^3(a\,^4F)5s$	$f\,^3F$	2	159031.8	343.8
		3	159375.6	427.7
		4	159803.3	
$3d^3(a\,^4F)4d$	$e\,^3F$	2	158328.3	135.3
		3	158463.6	160.1
		4	158623.7	
$3d^3(a\,^2G)4d$	$f\,^3H$	4		
		5		
		6	168582.3	
$3d^3(a\,^2H)4d$	$g\,^3H$	4		
		5	173565.9	360.7
		6	173926.6	
$3d^3(a\,^2H)4d$	$f\,^3I$	5	173200.5	462.3
		6	173662.8	213.5
		7	173876.3	
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Cr IV $(a\,^4F_{1\frac{1}{2}})$	*Limit*	-----	249700	

May 1951.

Cr III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms		
$3d^4$	$a\,{}^5D$ $a\,{}^3P$ $a\,{}^3D$ $a\,{}^3F$ $a\,{}^3G$ $a\,{}^3H$ $b\,{}^3P$ $b\,{}^3F$ $a\,{}^1F$ $b\,{}^1G$		
	$ns\ (n\geq 4)$	$np\ (n\geq 4)$	$nd\ (n\geq 4)$
$3d^3(a\,{}^4F)nx$	$a, f\,{}^5F$ $c, f\,{}^3F$	$z\,{}^5D^\circ$ $z\,{}^5F^\circ$ $z\,{}^5G^\circ$ $z\,{}^3D^\circ$ $z\,{}^3F^\circ$ $z\,{}^3G^\circ$	$e\,{}^5D$ $e\,{}^5F$ $e\,{}^5G$ $e\,{}^5H$ $e\,{}^3F$ $e\,{}^3G$ $e\,{}^3H$
$3d^3(a\,{}^4P)nx$	$a\,{}^5P$ $c\,{}^3P$	$z\,{}^5S^\circ$ $z\,{}^5P^\circ$ $y\,{}^5D^\circ$ $z\,{}^3P^\circ$ $y\,{}^3D^\circ$	
$3d^3(a\,{}^2P)nx$	$d\,{}^3P$		
$3d^3(a\,{}^2G)nx$	$b\,{}^3G$ $c\,{}^1G$	$y\,{}^3F^\circ$ $y\,{}^3G^\circ$ $z\,{}^3H^\circ$ $z\,{}^1G^\circ$ $z\,{}^1H^\circ$	$f\,{}^3H$
$3d^3(a\,{}^2D)nx$	$b\,{}^3D$	$w\,{}^3D^\circ$ $x\,{}^3F^\circ$	
$3d^3(a\,{}^2H)nx$	$b\,{}^3H$ $a\,{}^1H$	$x\,{}^3G^\circ$ $y\,{}^3H^\circ$ $z\,{}^3I^\circ$ $y\,{}^1G^\circ$ $y\,{}^1H^\circ$	$g\,{}^3H$ $f\,{}^3I$
$3d^3(a\,{}^2F)nx$	$d\,{}^3F$	$v\,{}^3D^\circ$ $w\,{}^3F^\circ$ $w\,{}^3G^\circ$	
$3d^3(b?\,{}^2D)nx$		$v\,{}^3F^\circ$	

*For predicted terms in the spectra of the Ti I isoelectronic sequence, see Volume I, p. xxxvii.

Cr IV

(Sc I sequence; 21 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ {}^4F_{1\frac{1}{2}}$

$a\,{}^4F_{1\frac{1}{2}}$ **400000?** cm^{-1} I. P. 49.6 volts

The analysis was begun by White in 1929 and carried further by Bowen in 1937. It has recently been revised and extended by F. L. Moore, Jr., especially for inclusion here. The new observations extend from 500 A to 2050 A. At present Moore has more than 200 classified lines. The doublet and quartet terms are connected by observed intersystem combinations.

Moore's provisional value of the limit, derived from the $ns\,{}^{4,2}F$ series ($n=4,5$), is quoted above.

The prefix "*a*" has here been ascribed by the writer to the limit terms ^1G and ^1S, although these terms have not yet been observed in Cr V.

REFERENCES

H. E. White, Phys. Rev. **33**, 672 (1929). (I P) (T) (C L)
I. S. Bowen, Phys. Rev. **52**, 1153 (1937). (T) (C L)
F. L. Moore, Jr., unpublished material (May 1951). (I P) (T) (C L)

Cr IV

Config.	Desig.	J	Level	Interval
$3d^3$	$a\ ^4F$	1½	0	244
		2½	244	317
		3½	561	395
		4½	956	
$3d^3$	$a\ ^4P$	0½	14072	143
		1½	14215	266
		2½	14481	
$3d^3$	$a\ ^2P$	1½	14185	−132
		0½	14317	
$3d^3$	$a\ ^2G$	3½	15064	350
		4½	15414	
$3d^3$	$a\ ^2D$	1½	20218	449
		2½	20667	
$3d^3$	$a\ ^2H$	4½	21078	250
		5½	21328	
$3d^3$	$a\ ^2F$	3½	36490	−572
		2½	37062	
$3d^2(a\ ^3F)4s$	$b\ ^4F$	1½	104003	262
		2½	104265	372
		3½	104637	476
		4½	105113	
$3d^2(a\ ^3F)4s$	$b\ ^2F$	2½	109950	750
		3½	110700	
$3d^2(a\ ^1G)4s$	$b\ ^2G$	4½	127202	−16
		3½	127218	
$3d^2(a\ ^3F)4p$	$z\ ^4G°$	2½	*157369*	573
		3½	*157942*	696
		4½	*158638*	820
		5½	*159458*	
$3d^2(a\ ^3F)4p$	$z\ ^4F°$	1½	*158536*	365
		2½	*158901*	459
		3½	*159360*	512
		4½	*159872*	
$3d^2(a\ ^3F)4p$	$z\ ^2F°$	2½	*160313*	633
		3½	*160946*	
$3d^2(a\ ^3F)4p$	$z\ ^4D°$	0½	*160512*	487
		1½	*160999*	507
		2½	*161506*	566
		3½	*162072*	
$3d^2(a\ ^3F)4p$	$z\ ^2D°$	1½	*161765*	545
		2½	*162310*	
$3d^2(a\ ^3F)4p$	$z\ ^2G°$	3½	*164920*	520
		4½	*165440*	
$3d^2(a\ ^1D)4p$	$y\ ^2D°$	2½	*169260*	−589
		1½	*169849*	
$3d^2(a\ ^3P)4p$	$x\ ^2D°$	1½		
		2½	*174978*	

Cr IV

Config.	Desig.	J	Level	Interval
$3d^2(a\ ^3P)4p$	$y\ ^4D°$	0½		
		1½	*173674*	429
		2½	*174103*	751
		3½	*174854*	
$3d^2(a\ ^1D)4p$	$y\ ^2F°$	2½		
		3½	*175166*	
$3d^2(a\ ^1G)4p$	$y\ ^2G°$	3½	*177926*	110
		4½	*178036*	
$3d^2(a\ ^1S)4p$	$x\ ^2P°$	0½	*182029*	85
		1½	*182114*	
$3d^2(a\ ^1G)4p$	$z\ ^2H°$	4½	*182391*	62
		5½	*183453*	
$3d^2(a\ ^1G)4p$	$x\ ^2F°$	2½		
		3½	*184868*	
$3d^2(a\ ^3F)4d$	$e\ ^4G$	2½	232573	332
		3½	232905	339
		4½	233244	411
		5½	233655	
$3d^2(a\ ^3F)4d$	$e\ ^2G$	3½	232889	632
		4½	233521	
$3d^2(a\ ^3F)4d$	$e\ ^4H$	3½	233365	353
		4½	233718	390
		5½	234108	400
		6½	234508	
$3d^2(a\ ^3F)4d$	$e\ ^2F$	2½	233446	201
		3½	233647	
$3d^2(a\ ^3F)4d$	$e\ ^4F$	1½		
		2½		
		3½		
		4½	234094	
$3d^2(a\ ^3F)5s$	$f\ ^4F$?	1½	252073	239
		2½	252312	371
		3½	252683	
		4½		
$3d^2(a\ ^3F)5s$	$f\ ^2F$?	2½	253426	553
		3½	253979	
$3d^2(a\ ^1G)4d$	$e\ ^2H$	4½	258397	1409
		5½	259806	
$3d^2(a\ ^1G)4d$	$f\ ^2G$	3½		
		4½	259504	
$3d^2(a\ ^3F)4f$	$y\ ^4G°$	5½	*300340*	
		3½		
		3½	*300366*	
		2½		
Cr V ($^3F_2$)	***Limit***	---------	**400000?**	

May 1951.

Cr IV OBSERVED TERMS*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms			
$3d^3$	$a\,^4P$ $a\,^4F$ $a\,^2P$ $a\,^2D$ $a\,^2F$ $a\,^2G$ $a\,^2H$			
	ns $(n\geq4)$	np $(n\geq4)$	nd $(n\geq4)$	nf $(n\geq4)$
$3d^2(a\,^3F)nx$	$b, f\,^4F$ $b, f\,^2F$	$z\,^4D^\circ$ $z\,^4F^\circ$ $z\,^4G^\circ$ $z\,^2D^\circ$ $z\,^2F^\circ$ $z\,^2G^\circ$	$e\,^4F$ $e\,^4G$ $e\,^4H$ $e\,^2F$ $e\,^2G$	$y\,^4G^\circ$?
$3d^2(a\,^1D)nx$		$y\,^2D^\circ$ $y\,^2F^\circ$		
$3d^2(a\,^3P)nx$		$y\,^4D^\circ$ $x\,^2D^\circ$		
$3d^2(a\,^1G)nx$	$b\,^2G$	$x\,^2F^\circ$ $y\,^2G^\circ$ $z\,^2H^\circ$	$f\,^2G$ $e\,^2H$	
$3d^2(a\,^1S)nx$		$x\,^2P^\circ$		

*For predicted terms in the spectra of the Sc I isoelectronic sequence, see Volume I, p. xxxvi.

Cr V

(Ca I sequence; 20 electrons) $Z=24$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^2\ ^3F_2$

$a\ ^3F_2$ **589700** cm^{-1} I. P. 73 volts

This spectrum is incompletely analyzed. In 1929 White published 55 classified lines in the region between 433 A and 1820 A. Cady has also made some observations and revised White's intersystem combinations and singlet terms. Edlén, who obtained Cady's unpublished material from Bowen, has furnished this material, together with additional revisions. One term ($^1S_0$) has been rejected, and three ($a\ ^1G$, $b\ ^1D$, and $z\ ^1F^\circ$) are not connected with the rest, as indicated by x in the table. Edlén's estimated value of $a\ ^1G$ is entered in brackets.

The observed tabular values are from Cady's list for terms having configurations $3d^2$ and $3d(^2D)\,4p$. The remaining term values have been adjusted to these by means of the combinations observed by White. The small numerical differences in the two lists of triplet terms are due only to discrepancies in the measured wavelengths used for each, and not to differences in interpretation.

White's estimated ionization potential, based on extrapolation of isoelectronic sequence data, has been used to derive the limit entered in brackets in the table.

REFERENCES

H. E. White, Phys. Rev. **33,** 538 (1929). (I P) (T) (C L)
W. M. Cady, unpublished material (1939?). (T) (C L)
B. Edlén, unpublished material (1949). (T)

Cr V

Config.	Desig.	J	Level	Interval
$3d^2$	$a\,^3F$	2	0	
		3	513	513
		4	1146	633
$3d^2$	$a\,^1D$	2	13200	
$3d^2$	$a\,^3P$	0	15500	
		1	15684	184
		2	16052	368
$3d^2$	$a\,^1G$	4	[22060]+x	
$3d(^2D)4s$	$a\,^3D$	1	167184	
		2	167497	313
		3	168099	602
$3d(^2D)4s$	$b\,^1D$	2	171736+x	
$3d(^2D)4p$	$z\,^1D^\circ$	2	*226130*	
$3d(^2D)4p$	$z\,^3D^\circ$	1	*228006*	
		2	*228497*	491
		3	*229127*	630
$3d(^2D)4p$	$z\,^3F^\circ$	2	*229556*	
		3	*230328*	772
		4	*231408*	1080
$3d(^2D)4p$	$z\,^3P^\circ$	0	*234680*	
		1	*234625*	−55
		2	*234857*	232
$3d(^2D)4p$	$z\,^1F^\circ$	3	*237568+x*	
$3d(^2D)4p$	$z\,^1P^\circ$	1	*239939*	
$3d(^2D)4d$	$e\,^3G$	3	319451	
		4	319811	360
		5	320406	595
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Cr VI ($^2D_{1\frac{1}{2}}$)	*Limit*	-----	[589700]	

March 1949.

Cr V Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms		
$3d^2$	{ $a\,^3P$, $a\,^1D$, $a\,^3F$, $a\,^1G$		
	ns ($n\geq 4$)	*np* ($n\geq 4$)	*nd* ($n\geq 4$)
$3d(^2D)nx$	{ $a\,^3D$, $b\,^1D$	$z\,^3P^\circ$ $z\,^3D^\circ$ $z\,^3F^\circ$ $z\,^1P^\circ$ $z\,^1D^\circ$ $z\,^1F^\circ$	$e\,^3G$

*An array of predicted terms in the spectra of the Ca I isoelectronic sequence is given in Vol. I, p. xxxv. Owing to the change in binding energies of the 3*d* and 4*s* electrons along this sequence the arrangement of the arrays of observed and predicted terms is not identical. In Cr V the prefixes *a*, *b* . . . *e*, *z* replace those indicating the running electron.

Cr VI

(K I sequence; 19 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d\ ^2D_{1\frac{1}{2}}$

$3d\ ^2D_{1\frac{1}{2}}$ **730900** cm^{-1} I. P. 90.6 volts

The analysis is very incomplete. Six lines have been classified, in the range between 209A and 1455 A. The terms have been calculated chiefly from the data by Gibbs and White. The limit is from an estimate by Kruger and Weissberg, based on isoelectronic sequence data.

REFERENCES

R. C. Gibbs and H. E. White, Proc. Nat. Acad. Sci. **12,** 676 (1926). (C L)
R. C. Gibbs and H. E. White, Phys. Rev. **33,** 162 (1929). (C L)
P. G. Kruger and S. G. Weissberg, Phys. Rev. **52,** 316 (1937). (I P) (C L)

Cr VI

Config.	Desig.	J	Level	Interval
$3p^6(^1S)3d$	$3d\ ^2D$	1½	0	957
		2½	957	
$3p^6(^1S)4s$	$4s\ ^2S$	0½	227775	
$3p^6(^1S)4p$	$4p\ ^2P^\circ$	0½	*296489*	1822
		1½	*298311*	
$3p^6(^1S)4f$	$4f\ ^2F^\circ$	{2½, 3½}	*476255*	
-----------	--------	-----	--------	
Cr VII ($^1S_0$)	*Limit*	-----	[730900]	

May 1948.

Cr VII

(A I sequence; 18 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ {}^1S_0$

$3p^6\ {}^1S_0$ **1299700** cm^{-1} I. P. 161.1 volts

Four lines are classified in the region between 104 A and 148 A, as combinations with the ground term. The values listed in the table have been rounded off in the last places.

For convenience, the Paschen notation has been added by the writer in column one under the heading "A I". As for A I, the *jl*-coupling notation in the general form suggested by Racah is here introduced, although *LS*-designations as indicated in column two under the heading "Authors" are perhaps preferable for the terms thus far identified.

REFERENCES

P. G. Kruger and S. G. Weissberg, Phys. Rev. **48**, 659 (1935). (I P) (T) (C L)
P. G. Kruger, S. G. Weissberg and L. W. Phillips, Phys. Rev. **51**, 1090, (1937). (I P) (T)
G. Racah, Phys. Rev. **61**, 537 (L) (1942).

Cr VII

A I	Authors	Config.	Desig.	*J*	Level
$1p_0$	$3p^6\ {}^1S$	$3p^6$	$3p^6\ {}^1S$	0	0
$1s_4$	$3p^5\ 4s\ {}^3P°$	$3p^5(^2P°_{1\frac{1}{2}})4s$	$4s\ [1\frac{1}{2}]°$	2 1	*672330*
$1s_2$	$3p^5\ 4s\ {}^1P°$	$3p^5(^2P°_{\frac{1}{2}})4s$	$4s'\ [0\frac{1}{2}]°$	0 1	*682440*
$2s_4$	$3p^5\ 5s\ {}^3P°$	$3p^5(^2P°_{1\frac{1}{2}})5s$	$5s\ [1\frac{1}{2}]°$	2 1	*951110*
$2s_2$	$3p^5\ 5s\ {}^1P°$	$3p^5(^2P°_{\frac{1}{2}})5s$	$5s'\ [0\frac{1}{2}]°$	0 1	*960340*
		Cr VIII ($^2P°_{1\frac{1}{2}}$)	***Limit***	---	**1299700**
		Cr VIII ($^2P°_{\frac{1}{2}}$)	*Limit*	---	1309640

May 1948.

Cr VIII

(Cl I sequence; 17 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ {}^2P^\circ_{1\frac{1}{2}}$

$3p^5\ {}^2P^\circ_{1\frac{1}{2}}$ ***1491000*** cm^{-1} I. P. 185 volts

All of the terms except $3p^6\ {}^2S$ are from the paper by Edlén. Twelve lines in the region between 124 A and 430 A have been classified as combinations from the ground term. Edlén has estimated the value of the limit by extrapolation along the isoelectronic sequence, as indicated by brackets in the table.

His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

S. G. Weissberg and P. G. Kruger, Phys. Rev. **49**, 872 (A) (1936). (C L)
B. Edlén, Zeit Phys. **104**, 407 (1937). (I P) (T) (C L)

Cr VIII

Config.	Desig.	J	Level	Interval
$3s^2\ 3p^5$	$3p^5\ {}^2P^\circ$	1½ 0½	*0* *9900*	−9900
$3s\ 3p^6$	$3p^6\ {}^2S$	0½	242131	
$3s^2\ 3p^4(^3P)4s$	$4s\ {}^4P$	2½ 1½ 0½	735880 741060	−5180
$3s^2\ 3p^4(^3P)4s$	$4s\ {}^2P$	1½ 0½	749650 755740	−6090
$3s^2\ 3p^4(^1D)4s$	$4s'\ {}^2D$	2½ 1½	769240 769560	−320
$3s^2\ 3p^4(^1S)4s$	$4s''\ {}^2S$	0½	805260	
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Cr IX ($^3P_2$)	*Limit*	-----	[*1491000*]	

January 1948.

Cr IX

(S I sequence; 16 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ {}^3P_2$

$3p^4\ {}^3P_2$ **1691000** cm^{-1} I. P. 209.6 volts

Edlén has classified 11 lines in the interval between 117 A and 123 A, and extrapolated the value of the limit from isoelectronic sequence data.

The singlet and triplet terms are not connected by observed intersystem combinations. By analogy with Fe XI, Edlén has revised the interpolated values of the singlet terms for inclusion here, and the uncertainty, x, is probably not large.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **104**, 188 (1937). (I P) (T) (C L)
B. Edlén, letter (January 1950). (T)

Cr IX

Config.	Desig.	J	Level	Interval
$3s^2\,3p^4$	$3p^4\ ^3P$	2 1 0	0 7860 9600	−7860 −1740
$3s^2\,3p^4$	$3p^4\ ^1D$	2	30270+x	
$3s^2\,3p^4$	$3p^4\ ^1S$	0	66940+x	
$3s^2\,3p^3\,(^4S°)4s$	$4s\ ^3S°$	1	*821150*	
$3s^2\,3p^3\,(^2D°)4s$	$4s'\ ^3D°$	1 2 3	*845930* *846280* *847870*	350 1590
$3s^2\,3p^3\,(^2D°)4s$	$4s'\ ^1D°$	2	*854720*+x	
$3s^2\,3p^3\,(^2P°)4s$	$4s''\ ^1P°$	1	*881800*+x	
-----------	--------	-----	--------	
Cr X ($^4S°_{1\frac{1}{2}}$)	***Limit***	-----	**[1691000]**	

January 1950.

Cr XII

(Al I sequence; 13 electrons) Z=24

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p\ ^2P°_{0\frac{1}{2}}$

$3p\ ^2P°_{0\frac{1}{2}}$ cm⁻¹ I. P. volts

This spectrum has not been analyzed, but Edlén has classified 2 lines as follows:

I. A.	Int.	Wave No.	Desig.
75. 815 76. 488	2 3	1319000 1307400	} $3p\ ^2P°-4d\ ^2D$

His unit, 10^3 cm^{-1}, is here changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103,** 540 (1936). (C L)

December 1947.

Cr XIII

(Mg I sequence; 12 electrons) $Z=24$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ ^1S_0$

$3s^2\ ^1S_0$ **2862000** cm^{-1} I. P. 355 volts

Edlén has classified 14 lines in the region between 53 A and 91 A. No intersystem combinations have been observed and the triplet terms are not all connected by observed combinations. He has determined the relative positions of the various groups of terms and also the ionization potential by extrapolation along the isoelectronic sequence. His estimated value of the limit is entered in brackets in the table. His unit, $10^3\ cm^{-1}$, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103**, 536 (1936). (I P) (T) (C L)

Cr XIII

Config.	Desig.	J	Level	Interval
$3s^2$	$3s^2\ ^1S$	0	0	
$3s(^2S)3p$	$3p\ ^3P^\circ$	0	*203030+x*	
		1	*206960+x*	3930
		2	*216150+x*	9190
$3s(^2S)3d$	$3d\ ^3D$	1		
		2		
		3	594270+x	
$3s(^2S)4s$	$4s\ ^3S$	1	1384840+x	
$3s(^2S)4p$	$4p\ ^1P^\circ$	1	*1492920*	
$3s(^2S)4d$	$4d\ ^3D$	1	1615620+x	
		2	1616020+x	400
		3	1616750+x	730
$3s(^2S)4f$	$4f\ ^3F^\circ$	2		
		3		
		4	*1682940+x*	
$3s(^2S)5d$	$5d\ ^3D$	1		
		2		
		3	2076100+x	
$3s(^2S)5f$	$5f\ ^3F^\circ$	2		
		3		
		4	*2110160+x*	
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Cr XIV ($^2S_{1/2}$)	*Limit*	-----	[2862000]	

August 1947.

Cr XIV

(Na I sequence; 11 electrons) $Z=24$

Ground state $1s^2\,2s^2\,2p^6\,3s\ ^2S_{1/2}$

$3s\ ^2S_{1/2}$ **3099630** cm^{-1} I. P. 384.20 volts

Edlén classified 16 lines in the interval 46 A to 86 A and extrapolated the absolute value of the ground term from isoelectronic sequence data. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **100,** 621 (1936). (I P) (T) (C L)

Cr XIV

Config.	Desig.	J	Level	Interval
3s	$3s\ ^2S$	0½	0	
3p	$3p\ ^2P^\circ$	0½ 1½	*242400* *256320*	13920
3d	$3d\ ^2D$	1½ 2½	588910 590620	1710
4s	$4s\ ^2S$	0½	1478250	
4p	$4p\ ^2P^\circ$	0½ 1½	*1574180* *1579550*	5370
4d	$4d\ ^2D$	1½ 2½	1700870 1701760	890
4f	$4f\ ^2F^\circ$	2½ 3½	*1750930* *1751220*	290
5p	$5p\ ^2P^\circ$	0½ 1½	*2149290* *2152020*	2730
5d	$5d\ ^2D$	1½ 2½	2210440 2210900	460
5f	$5f\ ^2F^\circ$	2½ 3½	*2236380* *2236550*	170
6f	$6f\ ^2F^\circ$	2½ 3½	*2500370*	
Cr XV ($^1S_0$)	*Limit*	-----	**[3099630]**	

June 1947.

Cr XV

(Ne I sequence; 10 electrons) $Z=24$

Ground state $1s^2\,2s^2\,2p^6\ ^1S_0$

$2p^6\ ^1S_0$ **8172300** cm^{-1} I. P. 1013.0 volts

Nine lines have been classified by Tyrén in the interval between 15 A and 21 A, as combinations with the ground term. His absolute term values have been derived by extrapolation along the Ne I isoelectronic sequence.

By analogy with Ne I the *jl*-coupling notation in the general form suggested by Racah is introduced.

The unit adopted by Tyrén, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

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G. Racah, Phys. Rev. **61,** 537 (L) (1942).

Cr XV

Author	Config.	Desig.	J	Level
$2p\ ^1S$	$2p^6$	$2p^6\ ^1S$	0	0
	$2p^5(^2P^\circ_{1\frac{1}{2}})3s$	$3s\ [1\frac{1}{2}]^\circ$	2	
$3s\ ^3P_1$			1	*4727500*
	$2p^5(^2P^\circ_{0\frac{1}{2}})3s$	$3s'\ [0\frac{1}{2}]^\circ$	0	
$3s\ ^1P_1$			1	*4793200*
	$2p^5(^2P^\circ_{1\frac{1}{2}})3d$	$3d\ [0\frac{1}{2}]^\circ$	0	
$3d\ ^3P_1$			1	*5259000*
$3d\ ^1P_1$	"	$3d\ [1\frac{1}{2}]^\circ$	1	*5324200*
$3d\ ^3D_1$	$2p^5(^2P^\circ_{0\frac{1}{2}})3d$	$3d'\ [1\frac{1}{2}]^\circ$	1	*5406300*

Cr XV

Author	Config.	Desig.	J	Level
$3p'\ ^3P_1$	$2p^6(^2S)3p$	$3p\ \ ^3P^\circ$	2 1 0	*5894500*
$3p'\ ^1P_1$	$2p^6(^2S)3p$	$3p\ \ ^1P^\circ$	1	*5921000*
$4d\ ^1P_1$	$2p^5(^2P^\circ_{1\frac{1}{2}})4d$	$4d\ [1\frac{1}{2}]^\circ$	1	*6576000*
$4d\ ^3D_1$	$2p^5(^2P^\circ_{0\frac{1}{2}})4d$	$4d'\ [1\frac{1}{2}]^\circ$	1	*6641000*
	--------------	--------	---	-------
	Cr XVI $(^2P^\circ_{1\frac{1}{2}})$	***Limit***	---	[8172300]
	Cr XVI $(^2P^\circ_{0\frac{1}{2}})$	*Limit*	---	8242400

April 1947.

Cr XV Observed Levels*

Config. $1s^2+$	Observed Terms		
$2s^2\ 2p^6$	$2p^6\ ^1S$		
	$ns\ (n\geq 3)$	$np\ (n\geq 3)$	$nd\ (n\geq 3)$
$2s^2\ 2p^5(^2P^\circ)nx$	$3s\ \ ^3P^\circ$ $3s\ \ ^1P^\circ$		$3d\ ^3P^\circ$ 3, $4d\ ^3D^\circ$ 3, $4d\ ^1P^\circ$
$2s\ 2p^6(^2S)nx$		$3p\ ^3P^\circ$ $3p\ ^1P^\circ$	

jl—Coupling Notation

Config. $1s^2+$	Observed Pairs		
	$ns\ (n\geq 3)$		$nd\ (n\geq 3)$
$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})nx$	$3s\ [1\frac{1}{2}]^\circ$		$3d\ [0\frac{1}{2}]^\circ$ 3, $4d\ [1\frac{1}{2}]^\circ$
$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})nx'$	$3s'[0\frac{1}{2}]^\circ$		3, $4d'[1\frac{1}{2}]^\circ$

*For predicted levels in the spectra of the Ne I isoelectronic sequence, see Vol. I, p. XXXI.

MANGANESE

Mn I

25 electrons $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2\ {}^6S_{2\frac{1}{2}}$

$a\ {}^6S_{2\frac{1}{2}}$ **59960** cm^{-1} I. P. 7.432 volts

Manganese occupies one of the most important places in the development of spectrum analysis. It was in the spectra of this element that M. A. Catalán first discovered multiplets. This led directly to further analysis of complex spectra, and culminated in the development of the Hund theory, which is beautifully confirmed in detail by observation.

During his recent visit to the United States, Catalán extended his early work on Mn I as well as that of Back, Meggers, Russell, Dunham, and others, to include more than 1500 classified lines and over 400 multiplets. The observations of the spectrum now cover the region from 600 A to 17607 A. The present term list has been furnished by him in advance of publication especially for inclusion here. Some terms and configurations have been contributed by Olga García-Riquelme in connection with her doctoral thesis prepared under the direction of Catalán.

The terms of all four multiplicities are connected by observed intersystem combinations.

A detailed discussion of asymmetrical Zeeman patterns of Mn I is given in the references. For example, Catalán lists two g values, 1.068 and 1.003, for the level $z\,{}^6F^\circ_{1\frac{1}{2}}$, and two (1.068 and 0.906) for $y\,{}^6F^\circ_{1\frac{1}{2}}$, one for each of the magnetic levels. Only one entry for each of these levels is included in the table.

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Mn I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5\ 4s^2$	$a\ {}^6S$	2½	0.00		1.999
$3d^6(a\ {}^5D)4s$	$a\ {}^6D$	4½	17052.29	−229.71	1.559
		3½	17282.00	−169.52	1.584
		2½	17451.52	−116.96	1.657
		1½	17568.48	−68.67	1.866
		0½	17637.15		3.327
$3d^5\ 4s(a\ {}^7S)4p$	$z\ {}^8P^\circ$	2½	*18402.46*	129.18	2.284
		3½	*18531.64*	173.73	1.938
		4½	*18705.37*		1.779
$3d^6(a\ {}^5D)4s$	$a\ {}^4D$	3½	23296.67	−252.53	1.427
		2½	23549.20	−170.32	1.368
		1½	23719.52	−99.35	1.198
		0½	23818.87		0.000
$3d^5\ 4s(a\ {}^7S)4p$	$z\ {}^6P^\circ$	1½	*24779.32*	8.73	2.364
		2½	*24788.05*	14.20	
		3½	*24802.25*		1.714
$3d^5\ 4s^2$	$a\ {}^4G$	5½	25265.74	−19.69	1.270
		4½	25285.43	−2.31	
		3½	25287.74	6.70	
		2½	25281.04		

Mn I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5\ 4s^2$	$a\ {}^4P$	2½	27201.54	−46.46	1.597
		1½	27248.00	−33.85	1.730
		0½	27281.85		2.666
$3d^5\ 4s^2$	$b\ {}^4D$	3½	30354.21	−65.40	1.423
		2½	30419.61	−6.10	
		1½	30425.71	13.97	
		0½	30411.74		
$3d^5\ 4s(a\ {}^5S)4p$	$z\ {}^4P^\circ$	2½	*31001.15*	−75.27	1.600
		1½	*31076.42*	−48.53	1.732
		0½	*31124.95*		
$3d^6(a\ {}^3P)4s$	$b\ {}^4P$	2½	33825.49	−637.88	1.604
		1½	34463.37	−381.89	
		0½	34845.26		
$3d^6(a\ {}^3H)4s$	$a\ {}^4H$	6½	34138.88	−111.64	1.231
		5½	34250.52	−93.38	1.135
		4½	34343.90	−79.37	0.971
		3½	34423.27		0.665
$3d^6(a\ {}^3F)4s$	$a\ {}^4F$	4½	34938.70	−102.67	1.328
		3½	35041.37	−73.61	1.238
		2½	35114.98	−50.07	
		1½	35165.05		

Mn I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5\,4s(a\,^5S)4p$	$y\,^6P^\circ$	1½	*35689.98*	35.87	2.400
		2½	*35725.85*	44.12	1.886
		3½	*35769.97*		1.712
$3d^6(a\,^3G)4s$	$b\,^4G$	5½	37420.24	−210.58	1.263
		4½	37630.82	−106.40	1.163
		3½	37737.22	−52.71	0.989
		2½	37789.93		
$3d^6(a\,^3H)4s$	$a\,^2H$	5½	38008.70	−111.48	
		4½	38120.18		
$3d^6(a\,^3F)4s$	$a\,^2F$	3½	38669.60		
		2½			
$3d^5\,4s(a\,^7S)5s$	$e\,^8S$	3½	39431.31		2.000
$3d^5\,4s(a\,^7S)5s$	$e\,^6S$	2½	41403.93		
$3d^6(a\,^5D)4p$	$z\,^6D^\circ$	4½	*41789.48*	−143.16	1.556
		3½	*41932.64*	−121.09	1.587
		2½	*42053.73*	−89.84	1.653
		1½	*42143.57*	−54.99	1.867
		0½	*42198.56*		3.317
$3d^6(a\,^5D)4p$	$z\,^6F^\circ$	5½	*43314.23*	−114.35	1.464
		4½	*43428.58*	−95.50	1.431
		3½	*43524.08*	−71.42	1.395
		2½	*43595.50*	−48.95	1.310
		1½	*43644.45*	−28.51	1.068
		0½	*43672.96*		−0.602
$3d^6(a\,^5D)4p$	$z\,^4F^\circ$	4½	*44288.76*	−234.69	1.317
		3½	*44523.45*	−172.84	1.240
		2½	*44696.29*	−118.44	1.030
		1½	*44814.73*		0.400
$3d^7$	$c\,^4F$	1½	44978.98	34.57	
		2½	45013.55	47.26	
		3½	45060.81	69.35	
		4½	45130.16		
$3d^6(a\,^5D)4p$	$x\,^6P^\circ$	3½	*44993.92*	−162.19	1.717
		2½	*45156.11*	−103.06	1.885
		1½	*45259.17*		2.399
$3d^6(a\,^5D)4p$	$z\,^4D^\circ$	3½	*45754.27*	−186.66	1.427
		2½	*45940.93*	−142.96	1.372
		1½	*46083.89*	−86.04	1.200
		0½	*46169.93*		0.000
$3d^5\,4s(a\,^7S)5p$	$y\,^8P^\circ$	2½	*45981.40*	20.52	
		3½	*46001.92*	26.95	
		4½	*46028.87*		
$3d^5\,4s(a\,^7S)4d$	$e\,^8D$	1½	46706.09	0.94	
		2½	46707.03	1.30	
		3½	46708.33	1.82	
		4½	46710.15	2.43	
		5½	46712.58		
$3d^6(a\,^5D)4p$	$y\,^4P^\circ$	2½	*46901.13*	−253.38	1.595
		1½	*47154.51*	−144.78	1.732
		0½	*47299.29*		2.666
$3d^5\,4s(a\,^7S)4d$	$e\,^6D$	4½	47207.28	−4.78	
		3½	47212.06	−3.55	
		2½	47215.61	−2.54	
		1½	47218.15	−1.49	
		0½	47219.64		
$3d^5\,4s(a\,^7S)5p$	$w\,^6P^\circ$	3½	*47387.62*	−271.90	1.713
		2½	*47659.52*	−122.91	1.952
		1½	*47782.43*		2.336
$3d^5\,4s(a\,^5P)4p$	$y\,^6D^\circ$	0½	*47452.16*	14.50	3.174
		1½	*47466.66*	287.33	
		2½	*47753.99*	20.53	1.820
		3½	*47774.52*	129.28	1.594
		4½	*47903.80*		1.540

Mn I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^5\,4s(a\,^5G)4p$	$y\,^6F^\circ$	5½	*48021.43*	−146.58	1.460
		4½	*48168.01*	−57.98	1.432
		3½	*48225.99*	−44.92	1.403
		2½	*48270.91*	−30.07	1.319
		1½	*48300.98*	−17.14	1.068
		0½	*48318.12*		−0.496
$3d^5\,4s(a\,^5S)5s$	$f\,^6S$	2½	49415.35		
$3d^5\,4s(a\,^5S)5s$	$e\,^4S$	1½	49591.51		
$3d^5\,4s(a\,^5P)4p$	$v\,^6P^\circ$	3½	*49888.08*	−124.45	1.711
		2½	*50012.53*	−86.63	1.888
		1½	*50099.16*		2.398
$3d^5\,4s(a\,^5G)4p$	$z\,^4H^\circ$	3½	*50065.46*	7.13	
		4½	*50072.59*	8.72	
		5½	*50081.31*	13.29	
		6½	*50094.60*		
$3d^5\,4s(a\,^7S)6s$	$f\,^8S$	3½	50157.63		1.995
$3d^5\,4s(a\,^5G)4p$	$y\,^4F^\circ$	4½	*50341.30*	−17.98	
		3½	*50359.28*	−13.95	
		2½	*50373.23*	−10.04	
		1½	*50383.27*		
$3d^5\,4s(b\,^5D)4p$	$x\,^6F^\circ$	0½	*50818.64*	44.41	
		1½	*50863.05*	68.37	
		2½	*50931.42*	83.53	
		3½	*51014.95*	85.54	
		4½	*51100.49*	68.69	
		5½	*51169.18*		
$3d^5\,4s(a\,^7S)6s$	$g\,^6S$	2½	50904.68		
$3d^5\,4s(a\,^5P)4p$	$x\,^4P^\circ$	2½	*51305.41*	−140.24	1.591
		1½	*51445.65*	−107.13	1.728
		0½	*51552.78*		2.664
$3d^5\,4s(a\,^5G)4p$	$z\,^4G^\circ$	2½	*51515.63*	14.98	
		3½	*51530.61*	15.66	
		4½	*51546.27*	14.66	
		5½	*51560.93*		1.273
$3d^7$	$c\,^4P$	2½	51638.17	−80.05	
		1½	51718.22	−69.70	
		0½	51787.92		
$3d^5\,4s(b\,^5D)4p$	$u\,^6P^\circ$	1½	*52015.00*	113.65	
		2½	*52128.65*	124.59	
		3½	*52253.24*		
$3d^5\,4s(a\,^7S)5d$	$f\,^8D$	1½, 2½, 3½	} 52702	1	
		4½	52703	2	
		5½	52705		
$3d^5\,4s(a\,^7S)5d$	$f\,^6D$	4½	52726.39	−4.02	
		3½	52730.41	−2.81	
		2½	52733.22	−1.79	
		1½	52735.01	−0.82	
		0½	52735.83		
$3d^5\,4s(b\,^5D)4p$	$x\,^6D^\circ$	4½	*52758.11*	−111.99	1.552
		3½	*52870.10*	−13.77	
		2½	*52883.87*	0.00	
		1½	*52883.87*	0.77	
		0½	*52883.10*		
$3d^5\,4s(a\,^7S)4f$	$z\,^8F^\circ$	0½ to 6½	} *52977.96*		
$3d^5\,4s(a\,^5P)4p$	$y\,^4D^\circ$	0½	*53101.32*	1.87	
		1½	*53103.19*	6.02	
		2½	*53109.21*	14.88	
		3½	*53124.09*		1.423

Mn I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})6p$	$t\ ^{6}\mathrm{P}^{\circ}$	3½	*53261. 42*	−30. 16	
		2½	*53291. 58*	−19. 79	
		1½	*53311. 37*		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})7s$	$g\ ^{8}\mathrm{S}$	3½	54180		
$3d^{5}\ 4s(a\ ^{5}\mathrm{P})4p$	$z\ ^{4}\mathrm{S}^{\circ}$	1½	*54218. 71*		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})7s$	$h\ ^{6}\mathrm{S}$	2½	54460. 30		
$3d^{5}\ 4s(a\ ^{5}\mathrm{S})4d$	$g\ ^{6}\mathrm{D}$	4½	54938. 71	−6. 57	
		3½	54945. 28	−5. 38	
		2½	54950. 66	−2. 36	
		1½	54953. 02	3. 12	
		0½	54949. 90		
	$x\ ^{4}\mathrm{D}^{\circ}$	3½	*55107. 52*	−78. 65	1. 407
		2½	*55186. 17*	−93. 74	1. 365
		1½	*55279. 91*		0. 826
		0½			
$3d^{5}\ 4s(b\ ^{5}\mathrm{D})4p$	$w\ ^{4}\mathrm{P}^{\circ}$	2½	*55405. 14*	36. 48	
		1½	*55368. 66*	−88. 54	
		0½	*55457. 20*		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})6d$	$g\ ^{8}\mathrm{D}$	1½			
		2½			
		3½	55374	1	
		4½	55375	1	
		5½	55376		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})5f$	$y\ ^{8}\mathrm{F}^{\circ}$	0½ to 6½	*55499. 08*		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})6d$	$h\ ^{6}\mathrm{D}$	4½	55681. 9	−6. 2	
		3½	55688. 1	−2. 7	
		2½	55690. 8	−1. 1	
		1½	55691. 9	−0. 5	
		0½	55692. 4		
	1°	2½	*55923. 81*		
$3d^{5}\ 4s(a\ ^{5}\mathrm{S})5p$	$s\ ^{6}\mathrm{P}^{\circ}$	1½	*55996. 62*	11. 29	
		2½	*56007. 91*	4. 51	
		3½	*56012. 42*		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})8s$	$h\ ^{8}\mathrm{S}$	3½	56144. 16		
$3d^{6}(a\ ^{5}\mathrm{D})5s$	$i\ ^{6}\mathrm{D}$	4½	56189. 45	−166. 76	
		3½	56356. 21	−134. 58	
		2½	56490. 79	−77. 14	
		1½	56567. 93	−98. 13	
		0½	56666. 06		
	$e\ ^{4}\mathrm{D}$	3½	56462. 08	−99. 87	
		2½	56561. 95	−39. 68	
		1½	56601. 63	−45. 3	
		0½	56646. 9 ?		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})7d$	$h\ ^{8}\mathrm{D}$	1½ to 5½	56801. 4		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})6f$	$x\ ^{8}\mathrm{F}^{\circ}$	0½ to 6½	*56863*		
$3d^{5}\ 4p^{2}$	$e\ ^{8}\mathrm{P}$	2½	57086. 33	131. 82	
		3½	57218. 15	170. 75	
		4½	57388. 90		
$3d^{5}\ 4s(b\ ^{3}\mathrm{P})4p$	$u\ ^{4}\mathrm{P}^{\circ}$	0½	*57228. 30*	132. 48	
		1½	*57360. 78*	126. 30	1. 736
		2½	*57487. 08*		
$3d^{6}(a\ ^{5}\mathrm{D})5s$	$f\ ^{4}\mathrm{D}$	3½	57305. 62	−180. 35	
		2½	57485. 97	−135. 93	
		1½	57621. 90	−83. 93	
		0½	57705. 83		

Mn I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^{5}\ 4s(b\ ^{3}\mathrm{P})4p$	$y\ ^{4}\mathrm{S}^{\circ}$	1½	*57512. 16*		2. 000
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})8d$	$i\ ^{8}\mathrm{D}$	1½ to 5½	57651. 93		
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})7f$	$w\ ^{8}\mathrm{F}^{\circ}$	0½ to 6½	*57695. 3*		
$3d^{6}(a\ ^{3}\mathrm{H})4p$	$y\ ^{4}\mathrm{G}^{\circ}$	5½	*58075. 06*	−35. 18	1. 269
		4½	*58110. 24*	−26. 45	1. 168
		3½	*58136. 69*	−23. 04	0. 980
		2½	*58159. 73*		0. 578
$3d^{5}\ 4s(a\ ^{7}\mathrm{S})9d$	$j\ ^{8}\mathrm{D}$	1½ to 5½	58199. 7		
$3d^{6}(a\ ^{3}\mathrm{H})4p$	$y\ ^{4}\mathrm{H}^{\circ}$	6½	*58338. 67*	−88. 63	1. 228
		5½	*58427. 30*	−58. 22	1. 133
		4½	*58485. 52*	−34. 38	0. 968
		3½	*58519. 90*		0. 665
$3d^{6}(a\ ^{3}\mathrm{H})4p$	$z\ ^{4}\mathrm{I}^{\circ}$	7½	*58852. 60*	9. 21	
		6½	*58843. 39*	−8. 10	
		5½	*58851. 49*	−15. 17	
		4½	*58866. 66*		
$3d^{6}(a\ ^{3}\mathrm{P})4p$	$t\ ^{4}\mathrm{P}^{\circ}$	2½	*59116. 60*	−267. 85	
		1½	*59384. 45*	−183. 84	
		0½	*59568. 29*		
$3d^{6}(a\ ^{3}\mathrm{F})4p$	$w\ ^{4}\mathrm{F}^{\circ}$	4½	*59257. 44*	−32. 79	1. 327
		3½	*59290. 23*	−70. 49	
		2½	*59360. 72*	−55. 43	
		1½	*59416. 15*		
$3d^{6}(a\ ^{3}\mathrm{P})4p$	$v\ ^{4}\mathrm{D}^{\circ}$	3½	*59339. 49*	−260. 86	
		2½	*59600. 35*	−389. 42	
		1½	*59989. 77*	−152. 21	
		0½	*60141. 98*		
$3d^{6}(a\ ^{3}\mathrm{F})4p$	$u\ ^{4}\mathrm{D}^{\circ}$	3½	*59470. 14*	−10. 66	
		2½	*59480. 80*	−47. 09	
		1½	*59527. 89*	0. 53	
		0½	*59527. 36*		
$3d^{6}(a\ ^{3}\mathrm{H})4p$	$z\ ^{2}\mathrm{I}^{\circ}$	6½	*59617. 12*	−210. 76	
		5½	*59827. 88*		
$3d^{6}(a\ ^{3}\mathrm{F})4p$	$x\ ^{4}\mathrm{G}^{\circ}$	5½	*59652. 90*	−79. 04	
		4½	*59731. 94*	−52. 37	
		3½	*59784. 31*	−33. 39	
		2½	*59817. 70*		
Mn II ($^{7}\mathrm{S}_{3}$)	***Limit***	-------	**59960**		
$3d^{6}(a\ ^{3}\mathrm{P})4p$	$x\ ^{4}\mathrm{S}^{\circ}$	1½	*60126. 81*		
$3d^{6}(a\ ^{3}\mathrm{F})4p$	$z\ ^{2}\mathrm{G}^{\circ}$	4½	*60668. 49*	−70. 93	
		3½	*60739. 42*		
$3d^{5}\ 4s(^{3}\mathrm{I})4p$	$x\ ^{4}\mathrm{H}^{\circ}$	6½	*60891. 48*	−42. 25	1. 228
		5½	*60933. 73*	−22. 15	1. 134
		4½	*60955. 88*	−1. 33	
		3½	*60957. 21*		
	$y\ ^{2}\mathrm{G}^{\circ}$	3½	*60902. 80*	36. 17	
		4½	*60938. 97*		
$3d^{5}\ 4s(^{3}\mathrm{I})4p$	$y\ ^{4}\mathrm{I}^{\circ}$	7½	*61204. 54*	−21. 01	
		6½	*61225. 55*	−0. 22	
		5½	*61225. 77*	14. 34	
		4½	*61211. 43*		
	$w\ ^{4}\mathrm{G}^{\circ}$	5½	*61469. 21*	−16. 13	
		4½	*61485. 34*	4. 74	
		3½	*61480. 60*	9. 37	
		2½	*61471. 23*		

Mn I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6(a\ ^5D)4d$	$e\ ^6F$	5½	61713.62	−316.56	
		4½	62030.18	−264.48	
		3½	62294.66		
		2½			
		1½			
		0½			
	2°	3½	61710.98		
	3°	4½	61714.52		
	4°	5½	61744.04		
	5°	3½	61785.94		
$3d^6(a\ ^5D)4d$	$e\ ^6G$	6½	62001.09	−133.36	
		5½	62134.45	−166.18	
		4½	62300.63	−125.85	
		3½	62426.48	−88.11	
		2½	62514.59	−58.52	
		1½	62573.11		
	$z\ ^2F^\circ$	3½	62034.04	−40.98	
		2½	62075.02		
	6°	4½	62345.73		
$3d^6(a\ ^3G)4p$	$v\ ^4F^\circ$	1½	62390.20	97.16	
		2½	62487.36	17.93	
		3½	62505.29	−112.47	
		4½	62392.82		1.329
$3d^5\ 4s(a\ ^5F)4p$	$w\ ^6D^\circ$	4½	62670.81	−180.66	
		3½	62851.47	90.14	
		2½	62761.33	−26.30	
		1½	62787.63	19.47	
		0½	62768.16		
	7°	2½	63139.70		
	$z\ ^2H^\circ$	5½	63288.78	85.75	
		4½	63374.53		
	8°	3½	63288.78		
	9°	4½	63347.91		
	$w\ ^4H^\circ$	6½	63363.54	−94.31	1.231
		5½	63457.85	13.24	
		4½	63444.61	49.16	
		3½	63395.45		
	$y\ ^2H^\circ$	5½	63449.13	−99.36	
		4½	63548.49		
	10°	2½	63523.82		
	11°	3½	63546.30		
	12°	1½, 2½	63583.84		
	$z\ ^2D^\circ$	2½	63764.90	−80.42	
		1½	63845.32		
	$x\ ^2H^\circ$	5½	64051.91	−3.46	
		4½	64055.37		
	13°	3½	64409.69		
	$x\ ^2G^\circ$	4½	64585.44	−63.76	
		3½	64649.20		
	14°	0½	64638.68		
	$y\ ^2D^\circ$	1½	64683.95	28.99	
		2½	64712.94		
	$v\ ^4H^\circ$	6½	64731.88	−87.65	1.236
		5½	64819.53	−68.47	1.137
		4½	64888.00	−32.33	0.974
		3½	64920.33		

Mn I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
	15°	2½	64823.21		
	16°	3½	64988.22		
	$w\ ^2G^\circ$	4½	65262.28	−49.70	
		3½			
	17°	3½	65617.37		
	18°	4½	65768.81		
	$v\ ^4G^\circ$	2½	65873.40	2.94	
		3½	65876.34	32.58	
		4½	65908.92	−21.61	1.160
		5½	65887.31		1.259
	$x\ ^2D^\circ$	2½	65946.87	−15.03	
		1½	65961.90		
	$y\ ^2F^\circ$	2½	66020.63	128.47	
		3½	66149.10		
	$u\ ^4H^\circ$	3½	66334.47	21.93	
		4½	66356.40	62.15	
		5½	66418.55	150.03	
		6½	66568.58		
	$u\ ^4G^\circ$	2½	66395.19	59.08	
		3½	66454.27	68.35	
		4½	66522.62	50.98	
		5½	66573.60		
	19°	1½	66504.21		
	20°	3½	66600.17		
	21°	4½	66630.92		
	22°	2½	66654.65		
	23°	2½, 3½	66737.82		
	24°	2½, 3½	66783.05		
	25°	2½	66837.64		
	26°	1½	66843.79		
	27°	4½	66855.00		
	28°	2½	66910.02		
	29°	3½	66981.30		
	30°	4½	67024.41		
	31°	5½, 6½	67206.00		
	$w\ ^2H^\circ$	5½	67504.90	−71.94	
		4½	67576.84		
	32°	5½	67664.49		
	$t\ ^4G^\circ$	5½	67752.84	−66.33	1.266
		4½	67819.17	−72.19	
		3½	67891.36	−73.68	
		2½	67965.04		
	$v\ ^2G^\circ$	4½	68286.44	−52.15	
		3½	68338.59		
$3d^5\ 4s(a\ ^5G)5s$	$e\ ^4G$	5½	68692.02	−24.20	
		4½	68716.22	−30.45	
		3½	68746.67	−16.1	
		2½	68762.8		
	33°	5½	69722.96		

November 1951.

Mn I Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms						
$3d^5\,4s^2$	$a\,^6\mathrm{S}$	$a\,^4\mathrm{P}$		$b\,^4\mathrm{D}$		$a\,^4\mathrm{G}$	
$3d^7$		$c\,^4\mathrm{P}$			$c\,^4\mathrm{F}$		
$3d^5\,4p^2$		$e\,^8\mathrm{P}$					

Config.	$ns\ (n\geq 4)$	$np\ (n\geq 4)$	$nd\ (n\geq 4)$	$nf\ (n\geq 4)$
$3d^5\,4s(a\,^7\mathrm{S})nx$	$e, f, g, h\,^8\mathrm{S}$ $e, g, h\,^6\mathrm{S}$	$z, y\,^8\mathrm{P}^\circ$ $z, w, t\,^6\mathrm{P}^\circ$	$e, f, g, h, i, j\,^8\mathrm{D}$ $e, j, h\,^6\mathrm{D}$	$z, y, x, w\,^8\mathrm{F}^\circ$
$3d^5\,4s(a\,^5\mathrm{S})nx$	$f\,^6\mathrm{S}$ $e\,^4\mathrm{S}$	$y, s\,^6\mathrm{P}^\circ$ $z\,^4\mathrm{P}^\circ$	$g\,^6\mathrm{D}$	
$3d^6(a\,^5\mathrm{D})nx$	$a, i\,^6\mathrm{D}$ $a, f\,^4\mathrm{D}$	$x\,^6\mathrm{P}^\circ$ $z\,^6\mathrm{D}^\circ$ $z\,^6\mathrm{F}^\circ$ $y\,^4\mathrm{P}^\circ$ $z\,^4\mathrm{D}^\circ$ $z\,^4\mathrm{F}^\circ$	$e\,^6\mathrm{F}$ $e\,^6\mathrm{G}$	
$3d^5\,4s(a\,^5\mathrm{G})nx$	$c\,^4\mathrm{G}$	$y\,^6\mathrm{F}^\circ$ $y\,^4\mathrm{F}^\circ$ $z\,^4\mathrm{G}^\circ$ $z\,^4\mathrm{H}^\circ$		
$3d^6(a\,^3\mathrm{P})nx$	$b\,^4\mathrm{P}$	$x\,^4\mathrm{S}^\circ$ $t\,^4\mathrm{P}^\circ$ $v\,^4\mathrm{D}^\circ$		
$3d^5\,4s(a\,^5\mathrm{P})nx$		$v\,^6\mathrm{P}^\circ$ $y\,^6\mathrm{D}^\circ$ $z\,^4\mathrm{S}^\circ$ $x\,^4\mathrm{P}^\circ$ $y\,^4\mathrm{D}^\circ$		
$3d^6(a\,^3\mathrm{H})nx$	$a\,^4\mathrm{H}$ $a\,^2\mathrm{H}$	$y\,^4\mathrm{G}^\circ$ $y\,^4\mathrm{H}^\circ$ $z\,^4\mathrm{I}^\circ$ $z\,^2\mathrm{I}^\circ$		
$3d^6(a\,^3\mathrm{F})nx$	$a\,^4\mathrm{F}$ $a\,^2\mathrm{F}$	$u\,^4\mathrm{D}^\circ$ $w\,^4\mathrm{F}^\circ$ $x\,^4\mathrm{G}^\circ$		
$3d^5\,4s(b\,^5\mathrm{D})nx$		$u\,^6\mathrm{P}^\circ$ $x\,^6\mathrm{D}^\circ$ $x\,^6\mathrm{F}^\circ$ $w\,^4\mathrm{P}^\circ$		
$3d^6(a\,^3\mathrm{G})nx$	$b\,^4\mathrm{G}$	$v\,^4\mathrm{F}^\circ$		
$3d^5\,4s(b\,^3\mathrm{P})nx$		$y\,^4\mathrm{S}^\circ$ $u\,^4\mathrm{P}^\circ$		
$3d^5\,4s(a\,^5\mathrm{F})nx$		$w\,^6\mathrm{D}^\circ$		
$3d^5\,4s(\,^3\mathrm{I})nx$		$x\,^4\mathrm{H}^\circ$ $y\,^4\mathrm{I}^\circ$		

*For predicted terms in the spectra of the Mn I isoelectronic sequence, see Vol. II, Introduction.

Mn II

(Cr I sequence; 24 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s\ {}^7S_3$

$4s\ {}^7S_3$ **126147** cm^{-1} I. P. 15.64 volts

When Catalán announced his important discovery of multiplets in the spectrum of Mn I he listed, also, 24 lines of Mn II as members of four multiplets. Subsequently, Russell and, independently, Duffendack and Black, confirmed the regularities suggested by Catalán, and extended the list to include 33 lines classified as combinations among seven terms.

The leading investigation of this spectrum has, however, been carried on by Curtis, who has extended his earlier work and furnished the present analysis in advance of publication, for inclusion here. His line list now includes nearly 1100 classified lines in the interval from 900 A to 6500 A. The terms of all three multiplicities are connected by observed intersystem combinations. Curtis has calculated the limit from four members of the $3d^5(^6S)nf\ {}^7F^\circ$ series, well represented by a Ritz formula.

The writer has changed the author's notation to that adopted for complex spectra and described in detail in the text of Volume I, p. XII, namely that with the prefixes *a*, *b*, *c*, . . . *z*, *y*, *x*, etc., throughout. For convenience in cross reference, Curtis' notation is entered in column 1.

This spectrum is important astrophysically. The present investigation will be extremely useful in the interpretation of stellar spectra.

The observed *g*-values have been derived by Catalán from observations of the Zeeman Effect made with the Bitter magnet and large grating spectrographs at the Massachusetts Institute of Technology, with the generous cooperation of Harrison.

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Mn II

Curtis	Config.	Desig.	J	Level	Interval	Obs. g
$4s\ ^7S_3$	$3d^5(a\ ^6S)4s$	$a\ ^7S$	3	0.00		2.00
$4s\ ^5S_2$	$3d^5(a\ ^6S)4s$	$a\ ^5S$	2	9472.86		2.00
$3d\ ^5D_4$	$3d^6$	$a\ ^5D$	4	14325.64	−267.98	1.49
$3d\ ^5D_3$			3	14593.62	−187.41	1.49
$3d\ ^5D_2$			2	14781.03	−120.03	1.49
$3d\ ^5D_1$			1	14901.06	−58.62	1.49
$3d\ ^5D_0$			0	14959.68		0.00
$a\ ^5G_6$	$3d^5(a\ ^4G)4s$	$a\ ^5G$	6	27546.90	−24.05	1.33
$a\ ^5G_5$			5	27570.95	−12.35	1.26
$a\ ^5G_4$			4	27583.30	−4.93	
$a\ ^5G_3$			3	27588.23	−0.80	
$a\ ^5G_2$			2	27589.03		
$3d\ ^3P_2$	$3d^6$	$a\ ^3P$	2	29869.11	−815.70	
$3d\ ^3P_1$			1	30684.81		
$3d\ ^3P_0$			0			
$a\ ^5P_3$	$3d^5(a\ ^4P)4s$	$a\ ^5P$	3	29889.31	−29.91	1.66
$a\ ^5P_2$			2	29919.22	−31.90	1.84
$a\ ^5P_1$			1	29951.12		2.42?
$3d\ ^3H_6$	$3d^6$	$a\ ^3H$	6	30523.45	−155.79	1.15
$3d\ ^3H_5$			5	30679.24	−116.51	1.04
$3d\ ^3H_4$			4	30795.75		0.81
$3d\ ^3F_4$	$3d^6$	$a\ ^3F$	4	31514.35	−147.37	1.25
$3d\ ^3F_3$			3	31661.72	−99.21	1.07
$3d\ ^3F_2$			2	31760.93		0.66
$a\ ^5D_4$	$3d^5(a\ ^4D)4s$	$b\ ^5D$	4	32787.60	−69.35	
$a\ ^5D_3$			3	32856.95	−1.89	
$a\ ^5D_2$			2	32858.84	22.44	
$a\ ^5D_1$			1	32836.40	18.30	
$a\ ^5D_0$			0	32818.10		
$a\ ^3G_5$	$3d^6$	$a\ ^3G$	5	33147.39	−100.93	1.20
$a\ ^3G_4$			4	33248.32	−30.07	1.04
$a\ ^3G_3$			3	33278.39		0.75
$3d\ ^3G_5$	$3d^5(a\ ^4G)4s$	$b\ ^3G$	5	34761.81	−148.62	1.21
$3d\ ^3G_4$			4	34910.43	−94.00	1.05
$3d\ ^3G_3$			3	35004.43		0.75
$a\ ^3P_2$	$3d^5(a\ ^4P)4s$	$b\ ^3P$	2	36274.29	−90.01	1.48
$a\ ^3P_1$			1	36364.30	−63.59	1.48
$a\ ^3P_0$			0	36427.89		0.00
$3d\ ^3D_1$	$3d^6$	$a\ ^3D$	1	37811.57	36.33	0.52
$3d\ ^3D_2$			2	37847.90	3.25	1.17
$3d\ ^3D_3$			3	37851.15		1.35
$4p\ ^7P_2$	$3d^5(a\ ^6S)4p$	$z\ ^7P^\circ$	2	*38366.07*	176.89	2.32
$4p\ ^7P_3$			3	*38542.96*	263.57	1.94?
$4p\ ^7P_4$			4	*38806.53*		1.76
$a\ ^3D_3$	$3d^5(a\ ^4D)4s$	$b\ ^3D$	3	39808.14	−5.24	1.34
$a\ ^3D_2$			2	39813.38	−13.19	1.15
$a\ ^3D_1$			1	39826.57		0.50
$a\ ^5F_1$	$3d^5(a\ ^4F)4s$	$a\ ^5F$	1	43311.0	28.1	
$a\ ^5F_2$			2	43339.1	55.9	
$a\ ^5F_3$			3	43395.0	141.9	
$a\ ^5F_4$			4	43536.9	−8.6	
$a\ ^5F_5$			5	43528.3		

Mn II

Curtis	Config.	Desig.	J	Level	Interval	Obs. g
$4p\ ^5P_3$	$3d^5(a\ ^6S)4p$	$z\ ^5P^\circ$	3	*43370.37*	−114.13	1.67
$4p\ ^5P_2$			2	*43484.50*	−72.53	1.83
$4p\ ^5P_1$			1	*43557.03*		2.49
$b\ ^5D_0$	$3d^4\ 4s^2$	$c\ ^5D$	0	54846.0	92.1	
$b\ ^5D_1$			1	54938.1	177.7	
$b\ ^5D_2$			2	55115.8	255.5	
$b\ ^5D_3$			3	55371.3	325.2	
$b\ ^5D_4$			4	55696.5		
$z\ ^5G_2$	$3d^5(a\ ^4G)4p$	$z\ ^5G^\circ$	2	*64456.33*	16.80	1.31
$z\ ^5G_3$			3	*64473.13*	20.70	1.26
$z\ ^5G_4$			4	*64493.83*	24.74	
$z\ ^5G_5$			5	*64518.57*	31.15	
$z\ ^5G_6$			6	*64549.72*		
$z\ ^5H_3$	$3d^5(a\ ^4G)4p$	$z\ ^5H^\circ$	3	*65482.66*	83.02	1.30
$z\ ^5H_4$			4	*65565.68*	92.62	1.21
$z\ ^5H_5$			5	*65658.30*	96.20	
$z\ ^5H_6$			6	*65754.50*	92.11	
$z\ ^5H_7$			7	*65846.61*		
$z\ ^5F_5$	$3d^5(a\ ^4G)4p$	$z\ ^5F^\circ$	5	*66542.26*	−100.75	1.40
$z\ ^5F_4$			4	*66643.01*	−43.44	
$z\ ^5F_3$			3	*66686.45*	9.89	
$z\ ^5F_2$			2	*66676.56*	31.78	
$z\ ^5F_1$			1	*66644.78*		
	$3d^5(a\ ^4P)4p$	$z\ ^5D^\circ$	0			
$z\ ^5D_1$			1	*66893.79*	7.35	
$z\ ^5D_2$			2	*66901.14*	107.79	
$z\ ^5D_3$			3	*67008.93*	286.23	1.45
$z\ ^5D_4$			4	*67295.16*		1.49
$z\ ^5S_2$?	$3d^5(a\ ^4P)4p$	$z\ ^5S^\circ$	2	*66929.22*		
$z\ ^3H_6$	$3d^5(a\ ^4G)4p$	$z\ ^3H^\circ$	6	*67744.08*	−101.85	1.16
$z\ ^3H_5$			5	*67845.93*	−64.33	1.03
$z\ ^3H_4$			4	*67910.26*		0.78
$z\ ^3F_2$	$3d^5(a\ ^4G)4p$	$z\ ^3F^\circ$	2	*67766.51*	45.24	0.66
$z\ ^3F_3$			3	*67811.75*	53.88	1.08
$z\ ^3F_4$			4	*67865.63*		1.25
$z\ ^5P_3$	$3d^5(a\ ^4P)4p$	$y\ ^5P^\circ$	3	*68284.38*	−132.96	1.65
$z\ ^5P_2$			2	*68417.34*	−79.03	
$z\ ^5P_1$			1	*68496.37*		
$z\ ^3P_2$	$3d^5(a\ ^4P)4p$	$z\ ^3P^\circ$	2	*69044.61*	−171.12	1.49
$z\ ^3P_1$			1	*69215.73*	−103.28	1.49
$z\ ^3P_0$			0	*69319.01*		0.00
$y\ ^5F_1$	$3d^5(a\ ^4D)4p$	$y\ ^5F^\circ$	1	*70150.39*	80.68	
$y\ ^5F_2$			2	*70231.07*	111.51	
$y\ ^5F_3$			3	*70342.58*	154.86	
$y\ ^5F_4$			4	*70497.44*	159.74	1.39?
$y\ ^5F_5$			5	*70657.18*		1.40
$z\ ^3G_3$	$3d^5(a\ ^4G)4p$	$z\ ^3G^\circ$	3	*70517.72*	28.30	0.75
$z\ ^3G_4$			4	*70546.02*	−18.70	1.15?
$z\ ^3G_5$			5	*70527.32*		1.20
$z\ ^3D_3$	$3d^5(a\ ^4P)4p$	$z\ ^3D^\circ$	3	*70745.08*	−195.16	1.33
$z\ ^3D_2$			2	*70940.24*	−137.94	1.16
$z\ ^3D_1$			1	*71078.18*		0.50
$y\ ^5P_1$	$3d^5(a\ ^4D)4p$	$x\ ^5P^\circ$	1	*71263.92*	59.23	
$y\ ^5P_2$			2	*71323.15*	66.99	
$y\ ^5P_3$			3	*71390.14*		

Mn II—Continued

Curtis	Config.	Desig.	J	Level	Interval	Obs. g
$y\ ^5D_4$	$3d^5(a\ ^4D)4p$	$y\ ^5D^\circ$	4	72010.75	−236.63	1.48
$y\ ^5D_3$			3	72247.38	−59.43	
$y\ ^5D_2$			2	72306.81	−13.81	
$y\ ^5D_1$			1	72320.62	−1.45	
$y\ ^5D_0$			0	72322.07		
$y\ ^3D_1$	$3d^5(a\ ^4D)4p$	$y\ ^3D^\circ$	1	73385.15	10.82	
$y\ ^3D_2$			2	73395.97	−0.85	
$y\ ^3D_3$			3	73395.12		
$y\ ^3F_4$	$3d^5(a\ ^4D)4p$	$y\ ^3F^\circ$	4	73683.11	−97.70	1.24
$y\ ^3F_3$			3	73780.81	−4.44	1.09
$y\ ^3F_2$			2	73785.25		0.75
$z\ ^3S_1$	$3d^5(a\ ^4P)4p$	$z\ ^3S^\circ$	1	73911.31		
$5s\ ^7S_3$	$3d^5(a\ ^6S)5s$	$e\ ^7S$	3	74559.97		2.00
	$3d^5(a\ ^4D)4p$	$y\ ^3P^\circ$	0			
$y\ ^3P_1$			1	75719.59	199.14	
$y\ ^3P_2$			2	75918.73		
$5s\ ^5S_2$	$3d^5(a\ ^6S)5s$	$e\ ^5S$	2	76374.56		2.00
$4d\ ^7D_1$	$3d^5(a\ ^6S)4d$	$e\ ^7D$	1	79540.76	3.75	
$4d\ ^7D_2$			2	79544.51	5.77	
$4d\ ^7D_3$			3	79550.28	8.10	
$4d\ ^7D_4$			4	79558.38	10.72	
$4d\ ^7D_5$			5	79569.10		
$4d\ ^5D_4$	$3d^5(a\ ^6S)4d$	$e\ ^5D$	4	82136.20	−8.14	
$4d\ ^5D_3$			3	82144.34	−6.73	
$4d\ ^5D_2$			2	82151.07	−4.65	
$4d\ ^5D_1$			1	82155.72	−2.44	
$4d\ ^5D_0$			0	82158.16		
$z\ ^7P_2$	$3d^4\ 4s(a\ ^6D)4p$?	$y\ ^7P^\circ$	2	83255.8	119.8	
$z\ ^7P_3$			3	83375.6	153.8	
$z\ ^7P_4$			4	83529.4		
$5p\ ^7P_2$	$3d^5(a\ ^6S)5p$?	$x\ ^7P^\circ$	2	85895.27	65.14	
$5p\ ^7P_3$			3	85960.41	96.99	
$5p\ ^7P_4$			4	86057.40		
$5p\ ^5P_3$	$3d^5(a\ ^6S)5p$	$w\ ^5P^\circ$	3	86897.7	−39.1	
$5p\ ^5P_2$			2	86936.8	−24.2	
$5p\ ^5P_1$			1	86961.0		
$x\ ^5P_1$	$3d^4\ 4s(a\ ^6D)4p$?	$v\ ^5P^\circ$	1	88839.6	239.3	
$x\ ^5P_2$			2	89078.9	349.9	
$x\ ^5P_3$			3	89428.8		
$6s\ ^7S_3$	$3d^5(a\ ^6S)6s$	$f\ ^7S$	3	97728.0		
$6s\ ^5S_2$	$3d^5(a\ ^6S)6s$	$f\ ^5S$	2	98410.1		
$4f\ ^7F_6$	$3d^5(a\ ^6S)4f$	$z\ ^7F^\circ$	6	98423.5	−0.2	
$4f\ ^7F_5$			5	98423.7	−0.1	
$4f\ ^7F_4$			4	98423.8	−0.2	
$4f\ ^7F_3$			3	98424.0	−0.1	
$4f\ ^7F_2$			2	98424.1		
			1			
			0			
$4f\ ^5F_1$	$3d^5(a\ ^6S)4f$	$x\ ^5F^\circ$	1	98461.76	0.58	
$4f\ ^5F_2$			2	98462.34	0.82	
$4f\ ^5F_3$			3	98463.16	1.00	
$4f\ ^5F_4$			4	98464.16	0.99	
$4f\ ^5F_5$			5	98465.15		
	$3d^5(a\ ^6S)5d$	$f\ ^7D$	1			
$5d\ ^7D_2$			2	99892.5	2.3	
$5d\ ^7D_3$			3	99894.8	3.8	
$5d\ ^7D_4$			4	99898.6	4.5	
$5d\ ^7D_5$			5	99903.1		
$5d\ ^5D_4$	$3d^5(a\ ^6S)5d$	$f\ ^5D$	4	100682.3	−5.8	
$5d\ ^5D_3$			3	100688.1	−4.5	
$5d\ ^5D_2$			2	100692.6	−2.7	
$5d\ ^5D_1$			1	100695.3		
			0			
$e\ ^5G_6$	$3d^5(a\ ^4G)5s$	$e\ ^5G$	6	101467.58	−21.73	
$e\ ^5G_5$			5	101489.31	−9.72	
$e\ ^5G_4$			4	101499.03	−2.27	
$e\ ^5G_3$			3	101501.30	1.46	
$e\ ^5G_2$			2	101499.84		
$e\ ^3G_5$	$3d^5(a\ ^4G)5s$	$e\ ^3G$	5	102680.09	−23.25	
$e\ ^3G_4$			4	102703.34	−2.03	
$e\ ^3G_3$			3	102705.37		
$e\ ^5P_3$	$3d^5(a\ ^4P)5s$	$e\ ^5P$	3	103803.44	−32.73	
$e\ ^5P_2$			2	103836.17	−31.97	
$e\ ^5P_1$			1	103868.14		
$e\ ^3P_0$	$3d^5(a\ ^4P)5s$	$e\ ^3P$	0	104914.18?	106.49	
$e\ ^3P_1$			1	105020.67	34.76	
$e\ ^3P_2$			2	105055.43		
$e\ ^5H_3$	$3d^5(a\ ^4G)4d$	$e\ ^5H$	3	106157.4	6.8	
$e\ ^5H_4$			4	106164.2	4.7	
$e\ ^5H_5$			5	106168.9	1.0	
$e\ ^5H_6$			6	106169.9	−2.2	
$e\ ^5H_7$			7	106167.7		
$w\ ^5F_1$	$3d^4\ 4s(b\ ^4D)4p$	$w\ ^5F^\circ$	1	106265.3	108.4	
$w\ ^5F_2$			2	106373.7	152.1	
$w\ ^5F_3$			3	106525.8	181.5	
$w\ ^5F_4$			4	106707.3	186.5	
$w\ ^5F_5$			5	106893.8		
$w\ ^5P_1$	$3d^4\ 4s(b\ ^4D)4p$	$u\ ^5P^\circ$	1	106479.2	270.8	
$w\ ^5P_2$			2	106750.0	422.8	
$w\ ^5P_3$			3	107172.8		
$e\ ^5I_4$	$3d^5(a\ ^4G)4d$	$e\ ^5I$	4	106512.1	7.0	
$e\ ^5I_5$			5	106519.1	3.4	
$e\ ^5I_6$			6	106522.5	−2.7	
$e\ ^5I_7$			7	106519.8	−11.7	
$e\ ^5I_8$			8	106508.1		
$e\ ^5D_4$	$3d^5(a\ ^4D)5s$	$g\ ^5D$	4	106885.90	−64.34	
$e\ ^5D_3$			3	106950.24	−16.70	
$e\ ^5D_2$			2	106966.94	4.38	
$e\ ^5D_1$			1	106962.56	6.14	
$e\ ^5D_0$			0	106956.42		
$e\ ^3D_3$	$3d^5(a\ ^4D)5s$	$e\ ^3D$	3	108102.25	−68.20	
$e\ ^3D_2$			2	108170.45	−2.09	
$e\ ^2D_1$			1	108172.54?		
$7s\ ^7S_3$	$3d^5(a\ ^6S)7s$	$g\ ^7S$	3	108126.2		
$5f\ ^7F_{6,\ 5}$	$3d^5(a\ ^6S)5f$	$y\ ^7F^\circ$	{6, 5}	108409.8	−0.3	
$5f\ ^7F_4$			4	108410.1	−0.1	
$5f\ ^7F_3$			3	108410.2	−0.1	
$5f\ ^7F_2$			2	108410.3		
			1			
			0			

Mn II—Continued

Curtis	Config.	Desig.	J	Level	Interval	Obs. g
$5f\,^5F_1$	$3d^5(a\,^6S)5f$	$v\,^5F^\circ$	1	*108435.6*	1.6	
$5f\,^5F_2$			2	*108437.2*	1.8	
$5f\,^5F_3$			3	*108439.0*	2.4	
$5f\,^5F_4$			4	*108441.4*	1.6	
$5f\,^5F_5$			5	*108443.0*		
$7s\,^5S_2$	$3d^5(a\,^6S)7s$	$g\,^5S$	2	108447.6		
$v\,^5G_2$		$y\,^5G^\circ$	2	*108485.4*	17.6	
$v\,^5G_3$			3	*108503.0*	21.7	
$v\,^5G_4$			4	*108524.7*	26.0	
$v\,^5G_5$			5	*108550.7*	37.2	
$v\,^5G_6$			6	*108587.9*		
$v\,^5P_1$		$t\,^5P^\circ$	1	*108726.4*	148.3	
$v\,^5P_2$			2	*108974.7*	404.2	
$v\,^5P_3$			3	*109378.9*		
$v\,^5F_1$		$u\,^5F^\circ$	1	*108994.0*	51.7	
$v\,^5F_2$			2	*109045.7*	76.7	
$v\,^5F_3$			3	*109122.4*	98.7	
$v\,^5F_4$			4	*109221.1*	106.0	
$v\,^5F_5$			5	*109327.1*		
$w\,^5D_0$		$x\,^5D^\circ$	0	*109167.7*	67.6	
$w\,^5D_1$			1	*109235.3*	108.4	
$w\,^5D_2$			2	*109343.7*	132.6	
$w\,^5D_3$			3	*109476.3*	131.5	
$w\,^5D_4$			4	*109607.8*		
$6d\,^7D_1$	$3d^5(a\,^6S)6d$	$g\,^7D$	1	109241.31	1.05	
$6d\,^7D_2$			2	109242.36	1.59	
$6d\,^7D_3$			3	109243.95	2.20	
$6d\,^7D_4$			4	109246.15	2.85	
$6d\,^7D_5$			5	109249.00		
$v\,^5D_0$	$3d^4\,4s(b\,^4D)4p$	$w\,^5D^\circ$	0	*109958.0*	36.3	
$v\,^5D_1$			1	*109994.3*	74.2	
$v\,^5D_2$			2	*110068.5*	136.4	
$v\,^5D_3$			3	*110204.9*	223.8	
$v\,^5D_4$			4	*110428.7*		
$v\,^5H_3$		$y\,^5H^\circ$	3	*110547.5*	54.5	
$v\,^5H_4$			4	*110602.0*	90.2	
$v\,^5H_5$			5	*110692.2*	102.8	
$v\,^5H_6$			6	*110795.0*	131.0	
$v\,^5H_7$			7	*110926.0*		
$u\,^5F_1$		$t\,^5F^\circ$	1	*111017.5*	43.0	
$u\,^5F_2$			2	*111060.5*	54.9	
$u\,^5F_3$			3	*111115.4*	43.8	
$u\,^5F_4$			4	*111159.2*	1.3	
$u\,^5F_5$			5	*111160.5*		
$u\,^5P_1$		$s\,^5P^\circ$	1	*111162.3*	16.5	
$u\,^5P_2$			2	*111178.8*	34.0	
$u\,^5P_3$			3	*111212.8*		
$u\,^5G_2$		$x\,^5G^\circ$	2	*113093.0*	17.3	
$u\,^5G_3$			3	*113110.3*	71.4	
$u\,^5G_4$			4	*113181.7*	69.1	
$u\,^5G_5$			5	*113250.8*	72.2	
$u\,^5G_6$			6	*113323.0*		
$t\,^5F_1$		$s\,^5F^\circ$	1	*113645.5*	−0.5	
$t\,^5F_2$			2	*113645.0*	−3.6	
$t\,^5F_3$			3	*113641.4*	5.3	
$t\,^5F_4$			4	*113646.7*	11.3	
$t\,^5F_5$			5	*113658.0*		
$8s\,^7S_3$	$3d^5(a\,^6S)8s$	$h\,^7S$	3	113697.6		

Mn II—Continued

Curtis	Config.	Desig.	J	Level	Interval	Obs. g
$6f\,^7F_6$	$3d^5(a\,^6S)6f$	$x\,^7F^\circ$	6	*113840.0*	−0.1	
$6f\,^7F_5$			5	*113840.1*	−0.1	
$6f\,^7F_4$			4	*113840.2*	−0.1	
			3	*113840.3*		
			2			
			1			
			0			
$8s\,^5S_2$	$3d^5(a\,^6S)8s$	$h\,^5S$	2	113895.2		
$6g\,^5G_6$	$3d^5(a\,^6S)6g$	$f\,^5G$	{6, 5, 4, 3, 2}	113932.0		
$6g\,^5G_5$						
$6g\,^5G_4$						
$6g\,^5G_3$						
$6g\,^5G_2$						
$6g\,^7G$	$3d^5(a\,^6S)6g$	$e\,^7G$	{7 to 1}	113932		
$6f\,^5F_1$	$3d^5(a\,^5S)6f$	$r\,^5F^\circ$	1	*114023.5*	1.3	
$6f\,^5F_2$			2	*114024.8*	1.5	
$6f\,^5F_3$			3	*114026.3*	1.5	
$6f\,^5F_4$			4	*114027.8*	−1.0	
$6f\,^5F_5$			5	*114026.8*		
$7d\,^7D_1$	$3d^5(a\,^6S)7d$	$h\,^7D$	1	114344.18	0.66	
$7d\,^7D_2$			2	114344.84	1.03	
$7d\,^7D_3$			3	114345.87	1.38	
$7d\,^7D_4$			4	114347.25	1.81	
$7d\,^7D_5$			5	114349.06		
$7d\,^5D_4$	$3d^5(a\,^6S)7d$	$h\,^5D$	4	114932.2	−11.7	
$7d\,^5D_3$			3	114943.9	−8.0	
$7d\,^5D_2$			2	114951.9	−4.6	
$7d\,^5D_1$			1	114956.5	−1.6	
$7d\,^5D_0$			0	114958.1		
$9s\,^7S_3$	$3d^5(a\,^6S)9s$	$i\,^7S$	3	117031.1		
$7f\,^7F_6$	$3d^5(a\,^6S)7f$	$w\,^7F^\circ$	6	*117112.9*	−0.1	
$7f\,^7F_5$			5	*117113.0*	−0.1	
$7f\,^7F_{4,3}$			{4, 3}	*117113.1*		
			2			
			1			
			0			
	$3d^5(a\,^6S)7f$	$q\,^5F^\circ$	1			
			2			
			3			
$7f\,^5F_4$			4	*117137.8*	10.5	
$7f\,^5F_5$			5	*117148.3*		
$s\,^5F_1$		$p\,^5F^\circ$	1	*117164.7*	67.0	
$s\,^5F_2$			2	*117231.7*	82.9	
$s\,^5F_3$			3	*117314.6*	84.7	
$s\,^5F_4$			4	*117399.3*	83.9	
$s\,^5F_5$			5	*117483.2*		
$10s\,^7S_3$	$3d^5(a\,^6S)10s$	$j\,^7S$	3	119185.6		
$8f\,^5F$	$3d^5(a\,^6S)8f$	$o\,^5F^\circ$	{1 to 5}	*119253*		
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	Mn III ($a\,^6S_{2\frac{1}{2}}$)	*Limit*	---	126147		

November 1951.

Mn II Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms		
$3d^6$	a ^{5}D a ^{3}P a ^{3}D a ^{3}F a ^{3}G a ^{3}H		
$3d^4\,4s^2$	c ^{5}D		
	ns ($n\geq 4$)	np ($n\geq 4$)	nd ($n\geq 4$)
$3d^5(a\,^6S)nx$	a, e, f, g, h, i, j ^{7}S a, e, f, g, h ^{5}S	z, x ^{7}P° z, w ^{5}P°	e, f, g, h ^{7}D e, f, h ^{5}D
$3d^5(a\,^4G)nx$	a, e ^{5}G b, e ^{3}G	z ^{5}F° z ^{5}G° z ^{5}H° z ^{3}F° z ^{3}G° z ^{3}H°	e ^{5}H e ^{5}I
$3d^5(a\,^4P)nx$	a, e ^{5}P b, e ^{3}P	z ^{5}S° y ^{5}P° z ^{5}D° z ^{3}S° z ^{3}P° z ^{3}D°	
$3d^5(a\,^4D)nx$	b, g ^{5}D b, e ^{3}D	x ^{5}P° y ^{5}D° y ^{5}F° y ^{3}P° y ^{3}D° y ^{3}F°	
$3d^5(a\,^4F)nx$	a ^{5}F		
$3d^4\,4s(a\,^6D)nx$		y ^{7}P° v ^{5}P°	
$3d^4\,4s(b\,^4D)nx$		u ^{5}P° w ^{5}D° w ^{5}F°	
	nf ($n\geq 4$)	ng ($n\geq 5$)	
$3d^5(a\,^6S)nx$	z, y, x, w ^{7}F° x, v, r, q, o ^{5}F°	e ^{7}G f ^{5}G	

*For predicted terms in the spectra of the Cr I isoelectronic sequence, see Vol. II, Introduction.

Mn III

(V I sequence; 23 electrons) $Z=25$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\ ^6S_{2\frac{1}{2}}$

$a\ ^6S_{2\frac{1}{2}}$ **271800** cm^{-1} I. P. 33.69 volts

The early analysis by Gibbs and White has been extended by Catalán and Miss García-Riquelme especially for inclusion here. The present observations extend from 594 A to 3997 A. The resonance lines reported by Kruger and Miss Gilroy have been confirmed. Fifteen new terms are listed in the current manuscript.

Catalán has derived the limit from the $ns\ ^6D$ series ($n=4,5$) by means of a Ritz formula, with the assumed value of α equal to 3.3×10^{-6}. The total number of classified lines is 173. Observed intersystem combinations connect the systems of terms of different multiplicity.

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Mn III

Config.	Desig.	J	Level	Interval
$3d^5$	$a\ ^6S$	2½	0.0	
$3d^5$	$a\ ^4G$	5½	26824.5	
		4½	26852.4	−27.9
		3½	26860.3	−7.9
		2½	26856.9	3.4
$3d^5$	$a\ ^4P$	2½	29168.9	
		1½	29243.0	−74.1
		0½		
$3d^5$	$a\ ^4D$	3½	32308.9	
		2½	32385.7	−76.8
		1½		
		0½		
$3d^5$	$a\ ^4F$	4½	43574.2	
		3½	43604.2	−30.0
		2½	43670.5	−66.3
		1½	43675.6	−5.1
$3d^4(^5D)4s$	$a\ ^6D$	0½	62456.7	
		1½	62567.9	111.2
		2½	62747.3	179.4
		3½	62988.9	241.6
		4½	63285.2	296.3
$3d^4(^5D)4s$	$b\ ^4D$	0½	71396.5	
		1½	71565.5	169.0
		2½	71833.4	267.9
		3½	72184.8	351.4
$3d^4(^5D)4p$	$z\ ^6F°$	0½	*110036.8*	
		1½	*110173.9*	137.1
		2½	*110399.6*	225.7
		3½	*110712.8*	313.2
		4½	*111112.8*	400.0
		5½	*111603.0*	490.2
$3d^4(^5D)4p$	$z\ ^6P°$	1½	*111778.0*	
		2½	*111885.4*	107.4
		3½	*112059.7*	174.3
$3d^4(^5D)4p$	$z\ ^4P°$	0½	*112815.8*	
		1½	*113080.2*	264.4
		2½	*113678.4*	598.2
$3d^4(^5D)4p$	$z\ ^6D°$	0½	*113993.3*	
		1½	*114096.7*	103.4
		2½	*114289.8*	193.1
		3½	*114210.9*	−78.9
		4½	*114503.0*	292.1

Mn III

Config.	Desig.	J	Level	Interval
$3d^4(^5D)4p$	$z\ ^4F°$	1½	*116581.6*	
		2½	*116693.5*	111.9
		3½	*116853.0*	159.5
		4½	*117064.4*	211.4
$3d^4(^5D)4p$	$z\ ^4D°$	0½	*120977.2*	
		1½	*121094.2*	117.0
		2½	*121270.5*	176.3
		3½	*121483.7*	213.2
$3d^4(^5D)4d$	$e\ ^6G$	1½	172444.6	
		2½	172548.0	103.4
		3½	172683.6	135.6
		4½	172856.2	172.6
		5½	173064.4	208.2
		6½	173307.6	243.2
$3d^4(^5D)4d$	$e\ ^6P$	1½	172571.7	
		2½	172616.2	44.5
		3½	172758.5	142.3
$3d^4(^5D)4d$	$e\ ^6D$	0½		
		1½		
		2½		
		3½	174175.7	
		4½	174419.1	243.4
$3d^4(^5D)4d$	$e\ ^6F$	0½		
		1½		
		2½		
		3½	174576.8	
		4½	174875.6	298.8
		5½	174976.3	100.7
$3d^4(^5D)5s$	$f\ ^6D$	0½	176100.0	
		1½	176206.0	106.0
		2½	176392.0	186.0
		3½	176642.0	250.0
		4½	176946.4	304.4
$3d^4(^5D)4d$	$e\ ^6S$	2½	181951.3	
Mn IV ($^5D_0$)	*Limit*	---------	**271800**	

May 1951.

Mn III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms	
$3d^5$	$a\ ^6S$ $a\ ^4P$ $a\ ^4D$ $a\ ^4F$ $a\ ^4G$	
	ns ($n \geq 4$)	np ($n \geq 4$)
$3d^4(^5D)nx$	$a, f\ ^6D$ $b\ ^4D$	$z\ ^6P^\circ$ $z\ ^6D^\circ$ $z\ ^6F^\circ$ $z\ ^4P^\circ$ $z\ ^4D^\circ$ $z\ ^4F^\circ$
	nd ($n \geq 4$)	
$3d^4(^5D)nx$	$e\ ^6S$ $e\ ^6P$ $e\ ^6D$ $e\ ^6F$ $e\ ^6G$	

*For predicted terms in the spectra of the V I isoelectronic sequence, see Vol. I, p. XXXVII.

Mn IV

(Ti I sequence; 22 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ ^5D_0$

$a\ ^5D_0$ cm^{-1} I. P. volts

The analysis is from Bowen, who has extended White's early work and published 156 classified lines, 100 in the range 540 A to 675 A, and 56 in the range 1442 A to 1973 A. The triplet and quintet systems of terms are connected by observed intersystem combinations.

F. L. Moore, Jr., has recently observed this spectrum in more detail and with higher accuracy. He confirms the multiplet by White ($3d^3\ 4s\ ^5F - 3d^3\ 4p\ ^5G^\circ$) without doubt, and expects to carry the analysis much further in the near future.

No series have been found.

REFERENCES

I. S. Bowen, Phys. Rev. **52**, 1153 (1937). (T) (C L)
F. L. Moore, Jr., private communication (May 1951).

Mn IV

Config.	Desig.	J	Level	Interval
$3d^4$	$a\,^5D$	0	0	92
		1	92	188
		2	280	267
		3	547	333
		4	880	
$3d^4$	$a\,^3P$	0	20646	628
		1	21274	1047
		2	22321	
$3d^4$	$a\,^3H$	4	21273	196
		5	21469	207
		6	21676	
$3d^4$	$a\,^3F$	2	22786	73
		3	22859	98
		4	22957	
$3d^4$	$a\,^3G$	3	25434	232
		4	25666	209
		5	25875	
$3d^3(a\,^4F)4s$	$a\,^5F$	1	111502	204
		2	111706	300
		3	112006	398
		4	112402	475
		5	112877	
$3d^3(a\,^4F)4s$	$b\,^3F$	2	119431	524
		3	119955	644
		4	120599	
$3d^3(a\,^4F)4p$	$z\,^5G^\circ$	2	*167885*	410
		3	*168295*	535
		4	*168830*	662
		5	*169492*	786
		6	*170278*	

Mn IV

Config.	Desig.	J	Level	Interval
$3d^3(a\,^4F)4p$	$z\,^5D^\circ$	0		
		1		
		2	*170861*	411
		3	*171272*	488
		4	*171760*	
$3d^3(a\,^4F)4p$	$z\,^5F^\circ$	1	*171381*	313
		2	*171694*	382
		3	*172076*	395
		4	*172471*	392
		5	*172863*	
$3d^3(a\,^4F)4p$	$z\,^3D^\circ$	1	*172081*	310
		2	*172391*	557
		3	*172948*	
$3d^3(a\,^4F)4p$	$z\,^3G^\circ$	3	*175422*	382
		4	*175804*	479
		5	*176283*	
$3d^3(a\,^4F)4p$	$z\,^3F^\circ$	2	*177624*	446
		3	*178070*	503
		4	*178573*	
$3d^3(a\,^4P)4p$	$z\,^5P^\circ$	1	*184560*	336
		2	*184896*	534
		3	*185430*	
$3d^3(a\,^2G)4p$	$y\,^3G^\circ$	3	*188753*	454
		4	*189207*	346
		5	*189553*	
$3d^3(a\,^2H)4p$	$x\,^3G^\circ$	5	*200186*	−98
		4	*200284*	−40
		3	*200324*	

May 1951.

Mn IV Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms	
$3d^4$	$a\,^5D$; $a\,^3P$ $a\,^3F$ $a\,^3G$ $a\,^3H$	
	ns $(n\geq 4)$	np $(n\geq 4)$
$3d^3(a\,^4F)nx$	$a\,^5F$ $b\,^3F$	$z\,^5D^\circ$ $z\,^5F^\circ$ $z\,^5G^\circ$ $z\,^3D^\circ$ $z\,^3F^\circ$ $z\,^3G^\circ$
$3d^3(a\,^4P)nx$		$z\,^5P^\circ$
$3d^3(a\,^2G)nx$		$y\,^3G^\circ$
$3d^3(a\,^2H)nx$		$x\,^3G^\circ$

*For predicted terms in the spectra of the Ti I isoelectronic sequence, see Vol. I, p. XXXVII.

Mn V

(Sc I sequence; 21 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ {}^4F_{1\frac{1}{2}}$

$a\ {}^4F_{1\frac{1}{2}}$ **613200±** cm^{-1} I. P. 76 volts

The analysis is incomplete. The first work was by White who found twelve multiplets giving three of the leading low terms from the $3d^3$ configuration, two terms from $3d^2\,4s$ and five from $3d^2\,4p$. Later Bowen extended the analysis and observed intersystem combinations connecting the doublet and quartet terms. About one hundred lines are now classified, in the region from 382 A to 1620 A.

The terms are mostly from Bowen's 1935 paper. Two of his terms have been added from the 1940 reference below. The two terms $b\ {}^4F$ and $b\ {}^2F$ are from White with values slightly adjusted by the writer to fit Bowen's term array, since the two sets of measures of the extreme ultraviolet lines are not completely accordant.

White's ${}^2F$ term is here called $b\ {}^2F$ on the assumption that the ${}^2F$ term having the configuration $3d^3$, which is not yet known, will probably be lower and should, therefore, be designated $a\ {}^2F$.

The limit (entered in brackets in the table) has been calculated from White's estimated ionization potential, which in turn is based on his extrapolation of isoelectronic sequence data.

REFERENCES

H. E. White, Phys. Rev. **33**, 672 (1929). (I P) (T) (C L)
I. S. Bowen, Phys. Rev. **47**, 924 (1935). (T) (C L)
S. Pasternack, Astroph. J. **92**, 140 (1940). (T)

Mn V

Config.	Desig.	J	Level	Interval
$3d^3$	$a\ {}^4F$	1½	0	349
		2½	349	478
		3½	827	579
		4½	1406	
$3d^3$	$a\ {}^4P$	0½	16420	160
		1½	16580	456
		2½	17036	
$3d^3$	$a\ {}^2G$	3½	17878	504
		4½	18382	
$3d^3$	$a\ {}^2P$	1½	22902	−176
		0½	23078	
$3d^3$	$a\ {}^2D$	2½	24610	−41
		1½	24651	
$3d^3$	$a\ {}^2H$	4½	24953	362
		5½	25315	
$3d^2(a\ {}^3F)4s$	$b\ {}^4F$	1½	176937	377
		2½	177314	548
		3½	177862	698
		4½	178560	
$3d^2(a\ {}^3F)4s$	$b\ {}^2F$	2½	183528	1105
		3½	184633	
$3d^2(a\ {}^3F)4p$	$z\ {}^4G°$	2½	*241906*	847
		3½	*242753*	1037
		4½	*243790*	1246
		5½	*245036*	
$3d^2(a\ {}^3F)4p$	$z\ {}^4F°$	1½	*243115*	552
		2½	*243667*	703
		3½	*244370*	755
		4½	*245125*	

Mn V

Config.	Desig.	J	Level	Interval
$3d^2(a\ {}^3F)4p$	$z\ {}^2F°$	2½	*245486*	821
		3½	*246307*	
$3d^2(a\ {}^3F)4p$	$z\ {}^4D°$	0½	*246530*	−387
		1½	*246143*	737
		2½	*246880*	806
		3½	*247686*	
$3d^2(a\ {}^3F)4p$	$z\ {}^2D°$	1½		
		2½	*248074*	
$3d^2(a\ {}^3F)4p$	$z\ {}^2G°$	3½	*250949*	751
		4½	*251700*	
$3d^2(a\ {}^3P)4p$	$z\ {}^4S°$	1½	*257424*	
$3d^2(a\ {}^3P)4p$	$y\ {}^4D°$	0½		
		1½	*260808*	652
		2½	*261460*	1106
		3½	*262566*	
$3d^2(a\ {}^3P)4p$	$z\ {}^4P°$	0½	*264382*	330
		1½	*264712*	756
		2½	*265468*	
$3d^2(a\ {}^1G)4p$	$y\ {}^2G°$	3½	*265555*	160
		4½	*265715*	
$3d^2(a\ {}^1G)4p$	$z\ {}^2H°$	4½	*271475*	1149
		5½	*272624*	
----------	------	-----	----------	
Mn VI (${}^3F_2$)	*Limit*	-----	[613200]	

December 1948.

Mn v Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms	
$3d^3$	$\{a\ ^4P$ $a\ ^4F$ $\{a\ ^2P$ $a\ ^2D$ $a\ ^2G$ $a\ ^2H$	
	ns ($n\geq4$)	*np* ($n\geq4$)
$3d^2(a\ ^3F)nx$	$\{b\ ^4F$ $\{b\ ^2F$	$z\ ^4D^\circ$ $z\ ^4F^\circ$ $z\ ^4G^\circ$ $z\ ^2D^\circ$ $z\ ^2F^\circ$ $z\ ^2G^\circ$
$3d^2(a\ ^3P)nx$		$z\ ^4S^\circ$ $z\ ^4P^\circ$ $y\ ^4D^\circ$
$3d^2(a\ ^1G)nx$		$y\ ^2G^\circ$ $z\ ^2H^\circ$

*For predicted terms in the spectra of the Sc I isoelectronic sequence see Vol. I, p. xxxvi.

Mn VI

(Ca I sequence; 20 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ ^3F_2$

$a\ ^3F_2$ cm^{-1} I. P. volts

The analysis is incomplete. Thirty lines were classified by Cady in the range between 307 A and 329 A. The present term list is from an unpublished manuscript by Edlén, who has revised Cady's analysis, by using unpublished wavelengths by Bowen.

REFERENCES

W. M. Cady, Phys. Rev. **43,** 324 (1933). (T) (C L)
B. Edlén, unpublished material (Feb. 1949). (T)

Mn VI

Config.	Desig.	*J*	Level	Interval
$3d^2$	$a\ ^3F$	2	0	746
		3	746	923
		4	1669	
$3d^2$	$a\ ^1D$	2	15336	
$3d^2$	$a\ ^3P$	0	17782	275
		1	18057	571
		2	18628	
$3d^2$	$a\ ^1G$	4	25511	
$3d(^2D)4p$	$z\ ^1D^\circ$	2	*319811*	
$3d(^2D)4p$	$z\ ^3D^\circ$	1	*321695*	714
		2	*322409*	874
		3	*323283*	

Mn VI

Config.	Desig.	*J*	Level	Interval
$3d(^2D)4p$	$z\ ^3F^\circ$	2	*323795*	1053
		3	*324848*	1521
		4	*326369*	
$3d(^2D)4p$	$z\ ^3P^\circ$	0	*329732*	−97
		1	*329635*	360
		2	*329995*	
$3d(^2D)4p$	$z\ ^1F^\circ$	3	*333063*	
$3d(^2D)4p$	$z\ ^1P^\circ$	1	*336126*	

March 1949.

Mn VI OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms
$3d^2$	{ $a\ ^3P$ $a\ ^1D$ $a\ ^3F$ $a\ ^1G$
	np $(n \geq 4)$
$3d(^2D)nx$	{ $z\ ^3P°$ $z\ ^3D°$ $z\ ^3F°$ / $z\ ^1P°$ $z\ ^1D°$ $z\ ^1F°$

*For predicted terms in the spectra of the Ca I isoelectronic sequence, see Vol. I, p. xxxv.

Mn VII

(K I sequence; 19 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d\ ^2D_{1\frac{1}{2}}$

$3d\ ^2D_{1\frac{1}{2}}$ **962001** cm^{-1} I. P. 119.24 volts

Twenty-two lines have been classified in the range from 111 A to 1267 A. The terms are from the paper by Kruger and Weissberg.

REFERENCES

R. C. Gibbs and H. E. White, Proc. Nat. Acad. Sci. **12**, 676 (1926). (C L)
P. G. Kruger and S. G. Weissberg, Phys. Rev. **52**, 316 (1937). (I P) (T) (C L)

Mn VII

Config.	Desig.	J	Level	Interval
$3p^6(^1S)3d$	$3d\ ^2D$	1½ 2½	0 1355	1355
$3p^6(^1S)4s$	$4s\ ^2S$	0½	318734	
$3p^6(^1S)4p$	$4p\ ^2P°$	0½ 1½	*397647* *400112*	2465
$3p^6(^1S)5s$	$5s\ ^2S$	0½	613934	
$3p^6(^1S)4f$	$4f\ ^2F°$	2½ 3½	*615957* *616108*	151
$3p^6(^1S)5f$	$5f\ ^2F°$	2½ 3½	*739771* *739945*	174
$3p^6(^1S)6s$	$6s\ ^2S$	0½	752144	

Mn VII

Config.	Desig.	J	Level	Interval
$3p^6(^1S)6f$	$6f\ ^2F°$	{ 2½ 3½ }	*807760*	
$3p^6(^1S)7f$	$7f\ ^2F°$	{ 2½ 3½ }	*848838*	
$3p^6(^1S)8f$	$8f\ ^2F°$	{ 2½ 3½ }	*875534*	
$3p^6(^1S)9f$	$9f\ ^2F°$	{ 2½ 3½ }	*893742*	
------------	------	-----	----------	
Mn VIII $(^1S_0)$	*Limit*	-----	**962001**	

May 1948.

Mn VIII

(A I sequence; 18 electrons) Z=25

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ {}^1S_0$

$3p^6\ {}^1S_0$ **1585000** cm^{-1} I. P. 196 volts

Two lines, at 122 A and 124 A, respectively, are classified as combinations with the ground term. The limit and the 5*s*-levels are apparently extrapolated from isoelectronic sequence data, as indicated by brackets in the table. The listed values have been rounded off in the last places.

For convenience, the Paschen notation has been added by the writer in column one under the heading "A I". As for A I, the *jl*-coupling notation in the general form suggested by Racah is here introduced, although *LS*-designations as indicated in column two under the heading "Authors" are perhaps preferable for the terms thus far identified.

REFERENCES

P. G. Kruger, S. G. Weissberg and L. W. Phillips, Phys. Rev. **51**, 1090 (1937). (I P) (T) (C L)
G. Racah, Phys. Rev. **61**, 537 (L) (1942).

Mn VIII

A I	Authors	Config.	Desig.	J	Level
$1p_0$	$3p^6\ {}^1S$	$3p^6$	$3p^6\ {}^1S$	0	0
$1s_4$	$3p^5\ 4s\ {}^3P°$	$3p^5(^2P^\circ_{1\frac{1}{2}})4s$	$4s\ [1\frac{1}{2}]°$	2 1	 *806100*
$1s_2$	$3p^5\ 4s\ {}^1P°$	$3p^5(^2P^\circ_{\frac{1}{2}})4s$	$4s'\ [0\frac{1}{2}]°$	0 1	 *818500*
$2s_4$	$3p^5\ 5s\ {}^3P°$	$3p^5(^2P^\circ_{1\frac{1}{2}})5s$	$5s\ [1\frac{1}{2}]°$	2 1	 [*1146000*]
$2s_2$	$3p^5\ 5s\ {}^1P°$	$3p^5(^2P^\circ_{\frac{1}{2}})5s$	$5s'\ [0\frac{1}{2}]°$	0 1	 [*1159000*]
		--------------	----------	---	--------
		Mn IX $(^2P^\circ_{1\frac{1}{2}})$	*Limit*	---	[1585000]

May 1948.

Mn IX

(Cl I sequence; 17 electrons) $Z=25$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^5\;{}^2P^\circ_{1\frac{1}{2}}$

$3p^5\;{}^2P^\circ_{1\frac{1}{2}}$ ***1791000*** cm^{-1} I. P. 222 volts

All of the terms except $3p^6\;{}^2S$ are from the paper by Edlén. Eleven lines in the region between 105 A and 395 A have been classified as combinations from the ground term. Edlén has estimated the value of the limit by extrapolation along the isoelectronic sequence, as indicated by brackets in the table. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

S. G. Weissberg and P. G. Kruger, Phys. Rev. **49**, 872 (A) (1936). (C L)
B. Edlén, Zeit. Phys. **104**, 407 (1937). (I P) (T) (C L)

Mn IX

Config.	Desig.	J	Level	Interval
$3s^2\,3p^5$	$3p^5\;{}^2P^\circ$	1½ 0½	*0* *12530*	−12530
$3p^6$	$3p^6\;{}^2S$	0½	265291	
$3s^2\,3p^4(^3P)4s$	$4s\;{}^4P$	2½ 1½ 0½	873580 880070	−6490
$3s^2\,3p^4(^3P)4s$	$4s\;{}^2P$	1½ 0½	889560 896860	−7300
$3s^2\,3p^4(^1D)4s$	$4s'\;{}^2D$	2½ 1½	910890 911310	−420
$3s^2\,3p^4(^1S)4s$	$4s''\;{}^2S$	0½	950060	
-----------	--------	-----	--------	
Mn X ($^3P_2$)	*Limit*	-----	[*1791000*]	

January 1948.

Mn x

(S i sequence; 16 electrons) Z=25

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ {}^3P_2$

$3p^4\ {}^3P_2$ **2004000 cm⁻¹** I. P. 248 volts

Edlén has classified 11 lines in the interval between 100 A and 104 A, and extrapolated a value of the limit from isoelectronic sequence data.

The singlet and triplet terms are not connected by observed intersystem combinations. By analogy with Fe xi, Edlén has revised the interpolated values of the singlet terms for inclusion here, and the uncertainty, x, is probably not large.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Zeit. Phys. **104**, 188 (1937). (I P) (T) (C L)
B. Edlén, letter (January 1950). (T)

Mn x

Config.	Desig.	J	Level	Interval
$3s^2\ 3p^4$	$3p^4\ {}^3P$	2 1 0	0 10000 11700	−10000 −1700
$3s^2\ 3p^4$	$3p^4\ {}^1D$	2	33810+x	
$3s^2\ 3p^4$	$3p^4\ {}^1S$	0	73400+x	
$3s^2\ 3p^3(^4S°)4s$	$4s\ {}^3S°$	1	*965990*	
$3s^2\ 3p^3(^2D°)4s$	$4s'\ {}^3D°$	1 2 3	*991770* *992200* *994180*	430 1980
$3s^2\ 3p^3(^2D°)4s$	$4s'\ {}^1D°$	2	*1002150*+x	
$3s^2\ 3p^3(^2P°)4s$	$4s''\ {}^1P°$	1	*1032080*+x	
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Mn xi ($^4S°_{1½}$)	*Limit*	-----	[2004000]	

January 1950.

Mn XIII

(Al I sequence; 13 electrons) $Z=25$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p\ ^2P^{\circ}_{0\frac{1}{2}}$

$3p\ ^2P^{\circ}_{0\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has classified 2 lines as follows:

I. A.	Int.	Wave No.	Desig.
66. 574	1	1502090	} $3p\ ^2P^{\circ}-4d\ ^2D$
67. 215	2	1487760	

His unit, 10^3 cm^{-1}, is here changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103,** 540 (1936). (C L)

December 1947.

Mn XIV

(Mg I sequence; 12 electrons) $Z=25$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\ ^1S_0$

$3s^2\ ^1S_0$ **3260000** cm^{-1} I. P. 404 volts

Edlén has classified 13 lines in the region between 57 A and 79 A. No intersystem combinations have been observed and the triplet terms are not all connected by observed combinations. He has determined the relative positions of the various groups of terms and also the ionization potential by extrapolation along the isoelectronic sequence. His estimated value of the limit is entered in brackets in the table.

His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103,** 536 (1936). (I P) (T) (C L)

Mn XIV

Config.	Desig.	*J*	Level	Interval	Config.	Desig.	*J*	Level	Interval
$3s^2$	$3s^2\ ^1S$	0	0		$3s(^2S)4d$	$4d\ ^3D$	1	1818250+*x*	
							2	1818750+*x*	500
$3s(^2S)3p$	$3p\ ^3P^{\circ}$	0	*218910+x*				3	1819640+*x*	890
		1	*223700+x*	4790					
		2	*235080+x*	11380	$3s(^2S)4f$	$4f\ ^3F^{\circ}$	2		
							3		
$3s(^2S)3d$	$3d\ ^3D$	1					4	*1892970+x*	
		2							
		3	640240+*x*		$3s(^2S)5f$	$5f\ ^3F^{\circ}$	2		
							3		
$3s(^2S)4s$	$4s\ ^3S$	1	1569110+*x*				4	*2387760+x*	
$3s(^2S)4p$	$4p\ ^1P^{\circ}$	1	*1685630*		------------	------	-----	----------	
					Mn XV ($^2S_{\frac{1}{2}}$)	*Limit*	-----	**[3260000]**	

August 1947.

Mn XV

(Na I sequence; 11 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s\ ^2\mathrm{S}_{0½}$

$3s\ ^2\mathrm{S}_{0½}$ **3511210** cm^{-1} I. P. 435 volts

Edlén has classified 12 lines in the interval 45 A to 75 A and extrapolated the absolute value of the ground term from isoelectronic sequence data. His unit, $10^3\ \mathrm{cm}^{-1}$, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **100,** 621 (1936). (I P) (T) (C L)

Mn XV

Config.	Desig.	J	Level	Interval
3*s*	3*s* ²S	0½	0	
3*p*	3*p* ²P°	0½	*259450*	17200
		1½	*276650*	
3*d*	3*d* ²D	1½	632760	2190
		2½	634950	
4*s*	4*s* ²S	0½	1666950	
4*p*	4*p* ²P°	0½	*1770410*	6740
		1½	*1777150*	
4*d*	4*d* ²D	1½	1906350	1120
		2½	1907470	
4*f*	4*f* ²F°	2½	*1962870*	380
		3½	*1963250*	
5*d*	5*d* ²D	1½		
		2½	2492130	
5*f*	5*f* ²F°	2½	*2520370*	230
		3½	*2520600*	
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Mn XVI (¹S₀)	*Limit*	-----	[3511210]	

June 1947.

Mn XVI

(Ne I sequence; 10 electrons) $Z=25$

Ground state $1s^2\ 2s^2\ 2p^6\ ^1\mathrm{S}_0$

$2p^6\ ^1\mathrm{S}_0$ **9164300** cm^{-1} I. P. 1135.9 volts

Tyrén has classified nine lines, between 13 A and 18 A, as combinations with the ground term. His absolute term values have been derived by extrapolation along the Ne I isoelectronic sequence.

By analogy with Ne I the *jl*-coupling notation in the general form suggested by Racah is introduced.

The unit adopted by Tyrén, $10^3\ \mathrm{cm}^{-1}$, has here been changed to cm^{-1}.

REFERENCES

F. Tyrén, Zeit. Phys. **111,** 314 (1938). (I P) (T) (C L)
G. Racah, Phys. Rev. **61,** 537 (L) (1942).

Mn XVI

Author	Config.	Desig.	J	Level
$2p\ ^1S^\circ_0$	$2s^2\ 2p^6$	$2p^6\ ^1S$	0	0
	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})3s$	$3s\ [1\frac{1}{2}]^\circ$	2	
$3s\ ^3P_1$			1	*5281200*
	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})3s$	$3s'[0\frac{1}{2}]^\circ$	0	
$3s\ ^1P_1$			1	*5360800*
	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})3d$	$3d\ [0\frac{1}{2}]^\circ$	0	
$3d\ ^3P_1$			1	*5849700*
$3d\ ^1P_1$		$3d\ [1\frac{1}{2}]^\circ$	1	*5923500*
$3d\ ^3D_1$	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})3d$	$3d'[1\frac{1}{2}]^\circ$	1	*6018300*
	$2s\ 2p^6(^2S)3p$	$3p\ ^3P^\circ$	2	
$3p'\ ^3P_1$			1	*6530800*
			0	
$3p\ ^1P_1$	$2s\ 2p^6(^2S)3p$	$3p\ ^1P^\circ$	1	*6562500*
$4d\ ^1P_1$	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})4d$	$4d\ [1\frac{1}{2}]^\circ$	1	*7348000*
$4d\ ^3D_1$	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})4d'$	$4d'[1\frac{1}{2}]^\circ$	1	*7429000*
	------------	--------	---	--------
	Mn XVII $(^2P^\circ_{1\frac{1}{2}})$	*Limit*	---	[***9164300***]
	Mn XVII $(^2P^\circ_{0\frac{1}{2}})$	*Limit*	---	9249600

April 1947.

Mn XVI Observed Levels*

Config. $1s^2+$	Observed Terms		
$2s^2\ 2p^6$	$2p^6\ ^1S$		
	$ns\ (n\geq 3)$	$np\ (n\geq 3)$	$nd\ (n\geq 3)$
$2s^2\ 2p^5(^2P^\circ)nx$	$3s\ ^3P^\circ$ $3s\ ^1P^\circ$		$3d\ ^3P^\circ$ 3, $4d\ ^3D^\circ$ 3, $4d\ ^1P^\circ$
$2s\ 2p^6(^2S)nx$		$3p\ ^3P^\circ$ $3p\ ^1P^\circ$	

jl-Coupling Notation

Config. $1s^2+$	Observed Pairs		
	$ns\ (n\geq 3)$		$nd\ (n\geq 3)$
$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})nx$	$3s\ [1\frac{1}{2}]^\circ$		$3d\ [0\frac{1}{2}]^\circ$ 3, $4d\ [1\frac{1}{2}]^\circ$
$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})nx'$	$3s'[0\frac{1}{2}]^\circ$		3, $4d'[1\frac{1}{2}]^\circ$

*For predicted levels in the spectra of the Ne I isoelectronic sequence see Vol. I, p. XXXI.

IRON

Fe I

26 electrons $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2\ {}^5D_4$

$a\ {}^5D_4$ **63700** cm^{-1} I. P. 7.90 ± 0.01 volts

The terms are from the paper by Russell, Moore, and Weeks, which is "based on the work of many investigators, including unpublished studies by Miguel A. Catalán," which were not published because of the Spanish war. He contributed 89 new levels including the first singlet terms to be found in Fe I. Their table of all classified lines that have been observed in the laboratory extends from 1855 A to 11973 A and includes 3,606 lines. In addition they give a table of 1,254 predicted lines that have been accepted as present in the solar spectrum and graded "Good" or "Fair". It is reasonably certain that more faint solar lines may be correctly attributed to Fe I than are included in the present conservative list.

Intersystem combinations connecting the terms of all four multiplicities have been observed. One small change has been incorporated here. The miscellaneous level labeled 8° is here designated $x\ {}^3S°$, as was tentatively suggested by the authors.

The ionization potential is well determined from three series.

The analysis could be carried further if laboratory observations of faint lines were extended. The present analysis is, however, remarkably complete for such a complex spectrum. The present lists contain 4,860 classified lines arising from combinations among 464 energy levels. With the aid of extensive Zeeman data all but 18 of these have been grouped into 147 terms, which combine to give 1,348 multiplets. "The general result of this analysis is that the iron arc spectrum, despite its complexity, is highly regular." The detailed confirmation of theory is conspicuous.

REFERENCES

H. N. Russell, C. E. Moore, and D. W. Weeks, Trans. Am. Phil. Soc. **34**, Part 2, 111–207 (1944). (I P) (T) (C L) (Z E)

J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

R. A. Fisher, unpublished infrared data (June 1950). ($x\ {}^7P°$ term added in proof.)

843210°—52——6

Fe I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6\,4s^2$	$a\ ^5D$	4	0.000	−415.933	1.496
		3	415.933	−288.070	1.497
		2	704.003	−184.129	1.494
		1	888.132	−89.942	1.498
		0	978.074		
$3d^7(a\ ^4F)4s$	$a\ ^5F$	5	6928.280	−448.495	1.404
		4	7376.775	−351.296	1.349
		3	7728.071	−257.724	1.248
		2	7985.795	−168.930	0.995
		1	8154.725		−0.014
$3d^7(a\ ^4F)4s$	$a\ ^3F$	4	11976.260	−584.693	1.254
		3	12560.953	−407.620	1.086
		2	12968.573		0.670
$3d^7(a\ ^4P)4s$	$a\ ^5P$	3	17550.210	−176.807	1.666
		2	17727.017	−200.394	1.820
		1	17927.411		2.499
$3d^6\,4s^2$	$a\ ^3P$	2	18378.215	−1174.278	1.506
		1	19552.493	−485.37	1.500
		0	20037.86		
$3d^6\,4s(a\ ^6D)4p$	$z\ ^7D^\circ$	5	*19350.894*	−211.563	1.597
		4	*19562.457*	−194.583	1.642
		3	*19757.040*	−155.471	1.746
		2	*19912.511*	−107.137	2.008
		1	*20019.648*		2.999
$3d^6\,4s^2$	$a\ ^3H$	6	19390.197	−230.839	1.163
		5	19621.036	−167.244	1.038
		4	19788.280		0.811
$3d^6\,4s^2$	$b\ ^3F$	4	20641.144	−233.377	1.235
		3	20874.521	−164.500	1.073
		2	21039.021		0.663
$3d^7(a\ ^2G)4s$	$a\ ^3G$	5	21715.770	−283.397	1.197
		4	21999.167	−250.294	1.051
		3	22249.461		0.756
$3d^6\,4s(a\ ^6D)4p$	$z\ ^7F^\circ$	6	*22650.427*	−195.453	1.498
		5	*22845.880*	−150.806	1.498
		4	*22996.686*	−114.262	1.493
		3	*23110.948*	−81.560	1.513
		2	*23192.508*	−52.339	1.504
		1	*23244.847*	−25.545	1.549
		0	*23270.392*		
$3d^7(a\ ^4P)4s$	$b\ ^3P$	2	22838.360	−108.500	1.498
		1	22946.860	−104.930	1.489
		0	23051.790		
$3d^6\,4s(a\ ^6D)4p$	$z\ ^7P^\circ$	4	*23711.467*	−469.409	1.747
		3	*24180.876*	−326.052	1.908
		2	*24506.928*		2.333
$3d^6\,4s^2$	$b\ ^3G$	5	23783.654	−335.200	1.200
		4	24118.854	−219.951	1.048
		3	24338.805		0.761
$3d^7(a\ ^2P)4s$	$c\ ^3P$	2	24335.804	−436.256	1.484
		1	24772.060	−319.56	1.466
		0	25091.62		
$3d^7(a\ ^2G)4s$	$a\ ^1G$	4	24574.690		1.001
$3d^6\,4s(a\ ^6D)4p$	$z\ ^5D^\circ$	4	*25900.002*	−240.191	1.502
		3	*26140.193*	−199.515	1.500
		2	*26339.708*	−139.685	1.503
		1	*26479.393*	−71.102	1.495
		0	*26550.495*		
$3d^7(a\ ^2H)4s$	$b\ ^3H$	6	26105.95	−245.14	1.165
		5	26351.09	−276.55	1.032
		4	26627.64		0.811
$3d^7(a\ ^2D)4s$	$a\ ^3D$	3	26225.03	−398.70	1.335
		2	26623.73	217.24	1.178
		1	26406.49		0.731

Fe I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6\,4s(a\ ^6D)4p$	$z\ ^5F^\circ$	5	*26874.562*	−292.275	1.399
		4	*27166.837*	−227.866	1.355
		3	*27394.703*	−164.895	1.250
		2	*27559.598*	−106.764	1.004
		1	*27666.362*		−0.012
$3d^7(a\ ^2P)4s$	$a\ ^1P$	1	27543.00		0.817
$3d^7(a\ ^2D)4s$	$a\ ^1D$	2	28604.61		1.028
$3d^7(a\ ^2H)4s$	$a\ ^1H$	5	28819.98		1.000
$3d^6\,4s(a\ ^6D)4p$	$z\ ^5P^\circ$	3	*29056.341*	−412.692	1.657
		2	*29469.033*	−263.716	1.835
		1	*29732.749*		2.487
$3d^6\,4s^2$	$a\ ^1I$	6	29313.04		1.014
$3d^6\,4s^2$	$b\ ^3D$	1	29320.05	36.73	
		2	29356.78	15.08	
		3	29371.86		1.326
$3d^6\,4s^2$	$b\ ^1G$	4	29798.96		0.979
$3d^6\,4s(a\ ^4D)4p$	$z\ ^3F^\circ$	4	*31307.272*	−497.825	1.250
		3	*31805.097*	−328.917	1.086
		2	*32134.014*		0.682
$3d^6\,4s(a\ ^4D)4p$	$z\ ^3D^\circ$	3	*31322.639*	−363.738	1.321
		2	*31686.377*	−250.973	1.168
		1	*31937.350*		0.513
$3d^8$	$c\ ^3F$	4	32873.68	−539.10	1.264
		3	33412.78	−352.55	1.066
		2	33765.33		0.677
$3d^7(a\ ^4F)4p$	$y\ ^5D^\circ$	4	*33095.962*	−411.182	1.496
		3	*33507.144*	−294.451	1.492
		2	*33801.595*	−215.532	1.495
		1	*34017.127*	−104.496	1.492
		0	*34121.623*		
$3d^7(a\ ^4F)4p$	$y\ ^5F^\circ$	5	*33695.418*	−344.122	1.417
		4	*34039.540*	−289.235	1.344
		3	*34328.775*	−218.460	1.244
		2	*34547.235*	−144.937	0.998
		1	*34692.172*		−0.016
$3d^6\,4s(a\ ^4D)4p$	$z\ ^3P^\circ$	2	*33946.965*	−415.925	1.493
		1	*34362.890*	−192.75	1.496
		0	*34555.64*		
$3d^6\,4s^2$	$b\ ^1D$	2	34636.82		
$3d^7(a\ ^4F)4p$	$z\ ^5G^\circ$	6	*34843.980*	61.532	1.332
		5	*34782.448*	−474.897	1.218
		4	*35257.345*	−354.304	1.103
		3	*35611.649*	−244.775	0.887
		2	*35856.424*		0.335
$3d^7(a\ ^4F)4p$	$z\ ^3G^\circ$	5	*35379.237*	−388.354	1.248
		4	*35767.591*	−311.804	1.100
		3	*36079.395*		0.791
$3d^7(a\ ^4F)4p$	$y\ ^3F^\circ$	4	*36686.204*	−476.566	1.246
		3	*37162.770*	−358.416	1.086
		2	*37521.186*		0.688
$3d^6\,4s(a\ ^4D)4p$	$y\ ^5P^\circ$	3	*36766.998*	−390.596	1.661
		2	*37157.594*	−251.981	1.836
		1	*37409.575*		2.502
$3d^7(b\ ^2F)4s$	$d\ ^3F$	2	36940.60	35.04	
		3	36975.64	70.36	
		4	37046.00		
$3d^7(a\ ^4F)4p$	$y\ ^3D^\circ$	3	*38175.382*	−502.685	1.324
		2	*38678.067*	−317.697	1.151
		1	*38995.764*		0.493

Fe I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6 4s(a\ ^4D)4p$	$x\ ^5D^\circ$	4	39625.829	−344.051	1.489
		3	39969.880	−261.485	1.504
		2	40231.365	−173.179	1.501
		1	40404.544	−86.768	1.498
		0	40491.312		
$3d^5 4s^2(a\ ^6S)4p$	$y\ ^7P^\circ$	2	40052.08	155.04	2.340
		3	40207.12	214.77	1.908
		4	40421.89		1.75:
$3d^6 4s(a\ ^4D)4p$	$x\ ^5F^\circ$	5	40257.367	−337.10	1.390
		4	40594.47	−247.66	1.328
		3	40842.13	−165.93	1.254
		2	41018.06	−112.56	0.998
		1	41130.62		−0.006
$3d^7(b\ ^2F)4s$	$a\ ^1F$	3	40534.18:		
	X	3	40871.46	−306.90	
		2	41178.36		
$3d^6 4s(b\ ^4P)4p$	$z\ ^5S^\circ$	2	40895.022		1.985
$3d^6 4s(b\ ^4P)4p$	$x\ ^5P^\circ$	3	42532.76	−327.07	1.650
		2	42859.829	−219.22	1.822
		1	43079.05		2.464
$3d^6 4s(a\ ^4H)4p$	$y\ ^5G^\circ$	6	42784.387	−127 531	1.342
		5	42911.918	−111.080	1.203
		4	43022.998	−114.513	1.024
		3	43137.511	−72.533	0.905
		2	43210.044		0.331
$3d^6 4s(a\ ^6D)5s$	$e\ ^7D$	5	42815.855	−347.472	1.585
		4	43163.327	−271.306	1.655
		3	43434.633	−198.902	1.755
		2	43633.535	−130.447	2.009
		1	43763.982		3.002
$3d^6 4s(a\ ^4H)4p$	$z\ ^5H^\circ$	7			
		6	43321.12:	329.46	
		5	42991.66	−117.28	1.054
		4	43108.944	−217.04	0.871
		3	43325.98		0.509
$3d^6 4s(b\ ^4P)4p$	$w\ ^5D^\circ$	4	43499.54	−423.16	1.492
		3	43922.70	−260.94	1.481
		2	44183.64	−227.54	1.533
		1	44411.18	−47.78	1.315
		0	44458.96		
$3d^6 4s(b\ ^4F)4p$	$w\ ^5F^\circ$	5	44243.67	221.12	1.382
		4	44022.55	−143.69	1.444
		3	44166.24	−119.24	1.351
		2	44285.48	−92.94	1.117
		1	44378.42:		0.283
$3d^6 4s(b\ ^4F)4p$	$v\ ^5D^\circ$	4	44415.13	−136.31	1.401
		3	44551.44	−112.69	1.386
		2	44664.13	−96.66	1.378
		1	44760.79	−66.13	1.389
		0	44826.92		
$3d^7(a\ ^4P)4p$	$y\ ^5S^\circ$	2	44511.86		1.888
$3d^6 4s(a\ ^6D)5s$	$e\ ^5D$	4	44677.010	−384.324	1.502
		3	45061.334	−272.546	1.508
		2	45333.880	−175.275	1.503
		1	45509.155	−85.929	1.518
		0	45595.084		
$3d^6 4s(b\ ^4P)4p$	$x\ ^3D^\circ$	3	45220.738	−61.151	1.352
		2	45281.889	−269.944	1.200
		1	45551.833		0.556
$3d^6 4s(a\ ^4H)4p$	$y\ ^3G^\circ$	5	45294.86	−133.60	1.207
		4	45428.456	−134.570	1.053
		3	45563.026		0.765

Fe I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6 4s(b\ ^4F)4p$	$x\ ^5G^\circ$	6	45608.35:	−117.83	1.336
		5	45726.18	−107.06	1.269
		4	45833.24	−80.29	1.158
		3	45913.53	−51.45	0.928
		2	45964.98		0.323
$3d^6 4s(a\ ^4H)4p$	$z\ ^3I^\circ$	7	45978.04:	−48.94	1.149
		6	46026.98	−108.94	1.040
		5	46135.92		0.833
$3d^5 4s^2(a\ ^6S)4p$	$w\ ^5P^\circ$	3	46137.14	−176.47	1.658
		2	46313.61	−96.83	1.822
		1	46410.44		2.436
$3d^6 4s(b\ ^4P)4p$	$z\ ^3S^\circ$	1	46600.884		1.888
$3d^7(a\ ^4P)4p$	$y\ ^3P^\circ$	0	46672.57	229.32	
		1	46901.892	−174.755	1.600
		2	46727.137		1.444
$3d^7(a\ ^4P)4p$	$u\ ^5D^\circ$	4	46720.85	−24.18	1.341
		3	46745.03	−143.55	1.397
		2	46888.582	−288.67	1.260
		1	47177.25	5.73	1.410
		0	47171.52:		
$3d^7(a\ ^2G)4p$	$x\ ^3F^\circ$	4	46889.207	−203.569	1.344
		3	47092.776	−104.298	1.159
		2	47197.074		0.743
$3d^6 4s(a\ ^4H)4p$	$z\ ^3H^\circ$	6	46982.383	−26.045	1.200
		5	47008.428	−98.116	1.060
		4	47106.544		0.880
$3d^7(a\ ^4F)5s$	$e\ ^5F$	5	47005.510	−372.457	1.421
		4	47377.967	−377.571	1.331
		3	47755.538	−281.129	1.236
		2	48036.667	−184.656	0.991
		1	48221.323		0.007
$3d^7(a\ ^4P)4p$	$w\ ^3D^\circ$	3	47017.239	−118.903	1.346
		2	47136.142	−135.953	1.216
		1	47272.095		0.767
$3d^6 4s(a\ ^4G)4p$	$w\ ^5G^\circ$	6	47363.39	−56.84	1.306
		5	47420.23	−169.84	1.305
		4	47590.07	−103.22	1.145
		3	47693.289	−137.91	0.931
		2	47831.20		0.472
	1°	2	47419.72		1.137
$3d^7(a\ ^2G)4p$:	$z\ ^1G^\circ$	4	47452.770		1.025
$3d^7(a\ ^4P)4p$	$y\ ^3S^\circ$	1	47555.63		1.884
$3d^6 4s(a\ ^4G)4p$	$v\ ^5F^\circ$	5	47606.10	−323.94	1.317
		4	47930.04	−192.93	1.264
		3	48122.97	−115.93	1.236
		2	48238.903	−111.72	1.267
		1	48350.62		0.230
$3d^6 4s(b\ ^4F)4p$	$x\ ^3G^\circ$	3	47834.26	−22.08	0.668
		4	47812.18	22.44	1.061
		5	47834.622		1.203
$3d^7(a\ ^4F)5s$	$e\ ^3F$	4	47960.973	−570.923	1.288
		3	48531.896	−396.527	1.107
		2	48928.423		0.622
$3d^7(a\ ^4P)4p$	$v\ ^5P^\circ$	3	47966.63	−196.86	1.646
		2	48163.49	−126.40	1.740
		1	48289.89		2.213
	$w\ ^3G^\circ$	5	48231.33	−130.59	1.27:
		4	48361.92	−113.82	0.934
		3	48475.74		0.584

Fe I—Continued

Config.	Desig	J	Level	Interval	Obs. g
$3d^6 4s(b\ ^4P)4p$	$x\ ^3P^\circ$	2	48304.707	−211.44	1.263
		1	48516.15	56.03	1.547
		0	48460.12		
$3d^7(a\ ^2G)4p$	$z\ ^1H^\circ$	5	48382.63		1.018
$3d^7(a\ ^2H)4p$:	$y\ ^1G^\circ$	4	48702.57		1.063
	2°	2	49052.93		
$3d^6 4s(b\ ^4F)4p$	$w\ ^3F^\circ$	4	49108.94	−134.01	1.181
		3	49242.950	−190.23	1.165
		2	49433.18		0.677
$3d^6 4s(b\ ^4F)4p$	$v\ ^3D^\circ$	3	49135.08	−107.60	1.211
		2	49242.68	−54.98	0.954
		1	49297.66		0.562
	3°	3	49227.16		
$3d^7(a\ ^2G)4p$	$y\ ^3H^\circ$	6	49434.20	−170.25	1.17:
		5	49604.45	−122.61	1.075
		4	49727.058		0.929
$3d^7(a\ ^2G)4p$	$v\ ^3G^\circ$	5	49460.92	−167.00	1.163
		4	49627.92	−222.69	0.914
		3	49850.61		0.763
	$z\ ^1D^\circ$	2	49477.10		0.92:
$3d^6 4s(a\ ^6D)5p$	$x\ ^7P^\circ$	4	49558.5	−246.4	
		3	49804.9	−241.0	
		2	50045.9		
$3d^7(a\ ^2D)4p$:	$w\ ^3P^\circ$	0	49951.36	91.89	
		1	50043.25	143.62	1.389
		2	50186.87		1.469
$3d^6 4s(a\ ^6D)4d$	$e\ ^7F$	6	50342.180	−491.305	1.490
		5	50833.485	−358.835	1.505
		4	51192.320	43.45	1.617
		3	51148.87	−182.22	1.499
		2	51331.090	123.05	
		1	51208.04		2.490
		0			
$3d^6 4s(a\ ^6D)4d$	$f\ ^7D$	5	50377.92	−430.13	1.510
		4	50808.053	−53.80	1.574
		3	50861.85	−136.84	
		2	50998.686	−49.41	1.844
		1	51048.10		
$3d^6 4s(a\ ^6D)4d$	$f\ ^5D$	4	50423.185	−111.250	1.514
		3	50534.435	−164.231	1.615
		2	50698.666	−181.486	1.614
		1	50880.152	−100.87	1.662
		0	50981.02		
$3d^6 4s(a\ ^6D)4d$	$e\ ^7P$	4	50475.32	−135.98	1.585
		3	50611.303	−250.02	1.687
		2	50861.32		
$3d^6 4s(a\ ^6D)4d$	$e\ ^5G$	6	50522.94	−180.97	1.351
		5	50703.912	−275.715	1.360
		4	50979.627	−239.432	1.238
		3	51219.059	−151.125	1.294
		2	51370.184		0.953
$3d^7(a\ ^2G)4p$:	$z\ ^1F^\circ$	3	50586.89		1.018
	$x\ ^1G^\circ$	4	50614.02		0.978
$3d^6 4s(a\ ^6D)4d$	$e\ ^7G$	7	50651.76:	−316.11	
		6	50967.873	−260.722	1.415
		5	51228.595	−106.34	1.379
		4	51334.94	−125.59	1.338
		3	51460.53	−79.24	1.244
		2	51539.77	−27.09	
		1	51566.86		−0.374

Fe I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6 4s(a\ ^6D)5p$	$u\ ^5F^\circ$	5	51016.72:	−364.76	
		4	51381.48	−237.66	
		3	51619.14:	−208.45	
		2	51827.59:	−118.27	
		1	51945.86:		
$3d^6 4s(a\ ^4G)4p$:	$x\ ^3H^\circ$	6	51023.19	−45.58	1.161
		5	51068.77		1.038
		4			
$3d^6 4s(a\ ^6D)5p$	$t\ ^5D^\circ$	4	51076.68	−284.78	1.486
		3	51361.46	−268.61	
		2	51630.07:	−206.80	
		1	51836.87:	−104.89	
		0	51941.76:		
$3d^6 4s(a\ ^6D)4d$	$f\ ^5F$	5	51103.237	−358.470	1.384
		4	51461.707	−142.439	1.355:
		3	51604.146	−100.906	
		2	51705.052	−49.482	0.967
		1	51754.534		
$3d^6 4s(a\ ^6D)4d$	$e\ ^5S$	2	51148.892		1.952
$3d^6 4s(a\ ^4G)4p$:	$v\ ^3F^\circ$	2	51201.33	163.97	0.803
		3	51365.30	−60.65	1.096
		4	51304.65		1.122
$3d^6 4s(a\ ^4D)5s$	$e\ ^3D$	3	51294.262	−445.702	1.345
		2	51739.964	−299.975	1.125
		1	52039.939		0.801
$3d^6 4s(a\ ^4D)5s$	$g\ ^5D$	4	51350.505	−420.072	1.487
		3	51770.577	−279.24	1.492
		2	52049.82	−164.51	1.57:
		1	52214.33	−43.00	
		0	52257.33		
$3d^7(a\ ^2H)4p$	$u\ ^3G^\circ$	5	51373.96	−294.26	1.140
		4	51668.22	−157.58	1.067
		3	51825.80		0.801
	4°	4	51409.18		0.953
	5°	3	51435.90:		
$3d^6 4s(a\ ^6D)4d$	$e\ ^7S$	3	51570.16		1.92:
	6°	5	51630.23		1.061
$3d^6 4s(a\ ^6D)5p$	$u\ ^5P^\circ$	3	51691.98:	−253.33	
		2	51945.31:	−165.0	
		1	52110.3:		2.633
$3d^7(a\ ^2P)4p$	$y\ ^1D^\circ$	2	51708.33		1.025
	7°	2	51756.16		
	$x\ ^1D^\circ$	2	51762.12		0.883
$3d^6 4s(a\ ^6D)4d$	$e\ ^5P$	3	51837.279	−230.17	1.664
		2	52067.45	47.74	
		1	52019.706		2.432
$3d^7(a\ ^2P)4p$	$u\ ^3D^\circ$	3	51969.14	−327.82	1.306
		2	52296.96	−215.50	1.156
		1	52512.46		0.700
$3d^7(a\ ^2D)4p$:	$t\ ^3D^\circ$	1?	52180.82	502.11	0.801
		2	52682.93	−469.64	1.145
		3	52213.29		1.317
$3d^7(a\ ^2H)4p$	$w\ ^3H^\circ$	6	52431.47	−181.61	1.177
		5	52613.08	−155.70	1.033
		4	52768.78		0.810
$3d^7(a\ ^2H)4p$	$y\ ^3I^\circ$	7	52655.04:	141.45	1.147
		6	52513.59	−385.47	1.019
		5	52899.06		0.830
$3d^7(a\ ^2P)4p$	$x\ ^3S^\circ$	1	52857.84		1.246

Fe I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^7(a\ ^2P)4p$:	$v\ ^3P°$	2	*52916. 33*	−892. 04	1. 495
		1	*53808. 37*		1. 418
		0			
	$s\ ^3D°$	3	*52953. 68:*	−321. 59	1. 231
		2	*53275. 27*		
		1			
$3d^7(a\ ^4F)4d$	$g\ ^5F$	5	53061. 28	−332. 44	
		4	53393. 715	−437. 24	
		3	53830. 96	−426. 56	
		2	54257. 52	−128. 64	
		1	54386. 16		
$3d^7(a\ ^2H)4p$	$z\ ^1I°$	6	*53093. 60*		1. 010
$3d^7(a\ ^4F)4d$	$h\ ^5D$	4	53155. 13	−390. 75	1. 435
		3	53545. 882	−420. 838	
		2	53966. 720	−165. 76	
		1	54132. 48		
		0			
$3d^7(a\ ^4F)4d$	$f\ ^5P$	3	53160. 53	−408. 19	
		2	53568. 72	−356. 54	
		1	53925. 26		
$3d^7(a\ ^4F)4d$	$f\ ^5G$	6	53169. 21	−112. 53	1. 323
		5	53281. 735	−487. 285	1. 221
		4	53769. 020	−392. 162	
		3	54161. 182	−214. 537	1. 142
		2	54375. 719		
$3d^7(a\ ^2P)4p$	$z\ ^1P°$	1	*53229. 94*		1. 266
$3d^7(a\ ^4F)4d$	$e\ ^5H$	7	53275. 20:	−77. 82	1. 30:
		6	53353. 02:	−521. 28	1. 191
		5	53874. 30:	−362. 90	1. 102
		4	54237. 20	−253. 88	0. 90:
		3	54491. 08		0. 484
	9°	4	*53328. 87*		
$3d^6\ 4s(b\ ^4D)4p$	$t\ ^5P°$	3	*53388. 68:*	−723. 62	
		2	*54112. 30*	−158. 81	1. 70:
		1	*54271. 11*		
	$y\ ^1F°$	3	*53661. 13*		1. 21:
$3d^7(a\ ^2H)4p$	$y\ ^1H°$	5	*53722. 44*		1. 03:
$3d^7(a\ ^4F)4d$	$e\ ^3G$	5	53739. 488	−327. 08	1. 248
		4	54066. 57	−312. 87	1. 096
		3	54379. 44		0. 842
$3d^7(a\ ^4F)4d$	$f\ ^3D$	3	53747. 547	−319. 274	1. 258
		2	54066. 821	−382. 51	
		1	54449. 33		
	$x\ ^1F°$	3	*53763. 28*		1. 079
$3d^6\ 4s(a\ ^6D)6s$	$g\ ^7D$	5	53800. 90	−323. 72	1. 586
		4	54124. 62	−289. 12	1. 65:
		3	54413. 74:	−197. 98	
		2	54611. 72	−136. 02	
		1	54747. 74:		
$3d^7(a\ ^4F)4d$	$e\ ^3H$	6	53840. 68:	−426. 08	1. 225
		5	54266. 76:	−288. 69	1. 109
		4	54555. 45:		0. 871
$3d^6\ 4s(b\ ^4D)4d$:	10°($^5D°$?)	3	*53891. 54*		1. 476
$3d^6\ 4s(a\ ^4G)4p$:	$t\ ^3G°$	5	*53983. 30*	−254. 16	1. 234
		4	*54237. 46*	−362. 89	1. 183
		3	*54600. 35*		0. 922
	11°	3	*54004. 82*		
$3d^6\ 4s(b\ ^4D)4d$:	12°($^5F°$?)	5	*54013. 78*		1. 356
	13°	4	*54301. 36*		
$3d^7(a\ ^4F)4d$	$f\ ^3F$	4	54683. 39	−441. 58	1. 141
		3	55124. 974	−253. 868	1. 071
		2	55378. 842		0. 676
	$w\ ^1G°$	4	*54810. 82*		1. 001
$3d^7(a\ ^4F)4d$	$e\ ^3P$	2	54879. 720	−496. 397	1. 459
		1	55376. 117	−350. 42	1. 459
		0	55726. 54:		
	$v\ ^3H°$	4	*55446. 06*	−16. 17	0. 804
		5	*55429. 89*	59. 92	1. 057
		6	*55489. 81*		1. 169
	$x\ ^1H°$	5	*55525. 58*		1. 018
$3d^7(a\ ^2D)4p$:	$w\ ^1D°$	2	*55754. 29*		0. 990
	$w\ ^1F°$	3	*55790. 72*		0. 908
	$s\ ^3G°$	5	*55907. 22*	1. 66	1. 145
		4	*55905. 56*	−192. 29	
		3	*56097. 85*		0. 857
$3d^6\ 4s(b\ ^2H)4p$:	$u\ ^3H°$	6	*56334. 01*	−48. 68	1. 166
		5	*56382. 69*	−40. 64	1. 029
		4	*56423. 33*		0. 859
$3d^6\ 4s(a\ ^6D)5d$	1	5	56428. 06		
$3d^6\ 4s(a\ ^6D)5d$	2	4, 5	56452. 04		
$3d^7(a\ ^2D)4p$:	$u\ ^3F°$	4	*56592. 76*	−190. 57	1. 148
		3	*56783. 33*	−75. 32	1. 077
		2	*56858. 65*		0. 687
$3d^6\ 4s(a\ ^6D)5d$	3	4	56842. 70		
	$v\ ^1G°$	4	*56951. 27*		1. 053
$3d^6\ 4s(b\ ^2H)4p$	$x\ ^3I°$	7	*57027. 56:*	−42. 69	1. 145
		6	*57070. 25*	−34. 01	1. 028
		5	*57104. 26*		0. 832
	$t\ ^3F°$	4	*57550. 09*	−90. 97	1. 235
		3	*57641. 06*	−67. 70	
		2	*57708. 76*		0. 698
$3d^6\ 4s(a\ ^4D)4d$	$i\ ^5D$	4	57697. 59	−116. 38	1. 384
		3	57813. 97	−160. 19	1. 415
		2	57974. 16		
		1			
		0			
$3d^6\ 4s(a\ ^6D)7s$	$h\ ^7D$	5	57897. 17		
		4			
		3			
		2			
		1			
$3d^6\ 4s(a\ ^4D)4d$	$g\ ^5G$	6	58001. 88	−269. 62	1. 40:
		5	58271. 50:	−248. 68	
		4	58520. 18:	−189. 91	
		3	58710. 09:	−114. 72	
		2	58824. 81		0. 343
$3d^6\ 4s(a\ ^4D)4d$	4	2	58213. 17		
	$r\ ^3G°$	5	*59926. 62:*	−245. 44	1. 190
		4	*60172. 06*	−192. 70	1. 030
		3	*60364. 76:*		0. 780
	$t\ ^3H°$	6	*60365. 70:*	−183. 48	1. 163
		5	*60549. 18*	−208. 50	1. 040
		4	*60757. 68*		0. 805
	$q\ ^3G°$	5	*60677. 23:*	−77. 48	
		4	*60754. 71:*	−52. 01	
		3	*60806. 72*		
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Fe II ($a\ ^6D_{4\frac{1}{2}}$)	*Limit*	-----	63700		

May 1949.

Fe I Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms						
	S	**P**	**D**	**F**	**G**	**H**	**I**
$3d^6\,4s^2$		*a* ^{3}P	*a* ^{5}D *b* ^{3}D *b* ^{1}D	*b* ^{3}F	*b* ^{3}G *b* ^{1}G	*a* ^{3}H	*a* ^{1}I
$3d^8$				*c* ^{3}F			

Config.	ns $(n\geq 4)$						np $(n\geq 4)$					
	P	**D**	**F**	**G**	**H**		**S°**	**P°**	**D°**	**F°**	**G°**	**H°** / **I°**
$3d^6\,4s(a\,^6D)nx$		*e*, *g*, *h* ^{7}D *e* ^{5}D						*z*, *x* ^{7}P° *z*, *u* ^{5}P°	*z* ^{7}D° *z*, *t* ^{5}D°	*z* ^{7}F° *z*, *u* ^{5}F°		
$3d^7(a\,^4F)nx$			*a*, *e* ^{5}F *a*, *e* ^{3}F						*y* ^{5}D° *y* ^{3}D°	*y* ^{5}F° *y* ^{3}F°	*z* ^{5}G° *z* ^{3}G°	
$3d^6\,4s(a\,^4D)nx$		*g* ^{5}D *e* ^{3}D						*y* ^{5}P° *z* ^{3}P°	*x* ^{5}D° *z* ^{3}D°	*x* ^{5}F° *z* ^{3}F°		
$3d^7(a\,^4P)nx$	*a* ^{5}P *b* ^{3}P						*y* ^{5}S° *y* ^{3}S°	*v* ^{5}P° *y* ^{3}P°	*u* ^{5}D° *w* ^{3}D°			
$3d^7(a\,^2G)nx$				*a* ^{3}G *a* ^{1}G						*x* ^{3}F° *z* ^{1}F°:	*v* ^{3}G° *z* ^{1}G°:	*y* ^{3}H° *z* ^{1}H°
$3d^7(a\,^2P)nx$	*c* ^{3}P *a* ^{1}P						*x* ^{3}S°	*v* ^{3}P°: *z* ^{1}P°	*u* ^{3}D° *y* ^{1}D°			
$3d^7(a\,^2H)nx$					*b* ^{3}H *a* ^{1}H						*u* ^{3}G° *y* ^{1}G°:	*w* ^{3}H° *y* ^{3}I° *y* ^{1}H° *z* ^{1}I°
$3d^7(a\,^2D)nx$		*a* ^{3}D *a* ^{1}D						*w* ^{3}P°:	*t* ^{3}D°: *w* ^{1}D°:	*u* ^{3}F°:		
$3d^6\,4s(b\,^4P)nx$							*z* ^{5}S° *z* ^{3}S°	*x* ^{5}P° *x* ^{3}P°	*w* ^{5}D° *x* ^{3}D°			
$3d^6\,4s(a\,^4H)nx$											*y* ^{5}G° *y* ^{3}G°	*z* ^{5}H° *z* ^{3}H° *z* ^{3}I°
$3d^6\,4s(b\,^4F)nx$									*v* ^{5}D° *v* ^{3}D°	*w* ^{5}F° *w* ^{3}F°	*x* ^{5}G° *x* ^{3}G°	
$3d^5\,4s^2(a\,^6S)nx$								*y* ^{7}P° *w* ^{5}P°				
$3d^6\,4s(a\,^4G)nx$										*v* ^{5}F° *v* ^{3}F°:	*w* ^{5}G° *t* ^{3}G°:	*x* ^{3}H°:
$3d^6\,4s(b\,^2H)nx$												*u* ^{3}H°: *x* ^{3}I°
$3d^6\,4s(b\,^4D)nx$								*t* ^{5}P°				
$3d^7(b\,^2F)nx$			*d* ^{3}F *a* ^{1}F									

Config.	nd $(n\geq 4)$					
	S	**P**	**D**	**F**	**G**	**H**
$3d^6\,4s(a\,^6D)nx$	*e* ^{7}S *e* ^{5}S	*e* ^{7}P *e* ^{5}P	*f* ^{7}D *f* ^{5}D	*e* ^{7}F *f* ^{5}F	*e* ^{7}G *e* ^{5}G	
$3d^7(a\,^4F)nx$		*f* ^{5}P *e* ^{3}P	*h* ^{5}D *f* ^{3}D	*g* ^{5}F *f* ^{3}F	*f* ^{5}G *e* ^{3}G	*e* ^{5}H *e* ^{3}H
$3d^6\,4s(a\,^4D)nx$			*i* ^{5}D		*g* ^{5}G	

*For predicted terms in the spectra of the Fe I isoelectronic sequence, see Vol. II, Introduction.

Fe II

(Mn I sequence; 25 electrons) $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s\ {}^6D_{4\frac{1}{2}}$

$a\ {}^6D_{4\frac{1}{2}}$ **130524 cm⁻¹** I. P. 16.18 volts

The early work on this spectrum by Meggers, Kiess, and Walters, and Russell was greatly extended by Dobbie, who in 1938 published a list of some 1,300 classified lines based on his observations covering the range between 2150 A and 6627 A. The listed terms are chiefly from this paper, supplemented by additional terms by Edlén and L. C. Green. A correction of 0.02 cm^{-1} has been subtracted from all of Dobbie's values (1938) in order to start with the ground state zero. In the course of his work on Fe III, Edlén has extended the analysis of Fe II and communicated 33 new terms in advance of publication. L. C. Green has observed the spectrum in the ultraviolet from 896 A to 2495 A, classified more than 450 lines, and published 57 levels. The arbitrary numbers he assigned to the miscellaneous levels are repeated here. For some of these levels two *J*-values are listed, denoting that the observed combinations do not indicate which of the two is correct. Edlén has been able to improve the values of some levels found by Green.

Two differences in interpretation have been handled as follows: Green's revision of Dobbie's incomplete $f\ {}^6D$ term as part of $e\ {}^6F$ has been adopted; Dobbie's $e\ {}^6P$ term, whose components are assigned numbers by Green, has been retained.

With four exceptions, the configurations are from Dobbie (1935 paper), Edlén, or Green. Russell in his investigation of the Fe I spectrum assigns $b\ {}^2F$ to $3d^7$ (instead of $3d^6(a\ {}^1F)4s$); $c\ {}^2F$ to $3d^6(a\ {}^1F)4s$; and $d\ {}^2D$ to $3d^7$. The writer has tentatively suggested the configuration of $e\ {}^4H$ as $3d^6(a\ {}^3H)5s$.

The limit from Dobbie's 1934 paper, 130978, is an average value based on the ${}^4D$ and ${}^6D$ terms from $3d^6(a\ {}^5D)ns$ ($n=4,5$). He used a Rydberg formula and corrected the results empirically to conform to a Ritz formula, as suggested by Russell. From a study of related spectra in which long series are known, Russell has suggested a further correction of -454 cm^{-1}, which has been adopted here.

The *g*-values have been determined by Miss Weeks from films of the Zeeman effect of Fe I automatically recorded from plates taken with the Bitter magnet at the Massachusetts Institute of Technology. Harrison generously supplied this observational material. and Miss Weeks derived the observed *g*-values especially for inclusion here.

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Fe II

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6(a\,^5D)4s$	$a\,^6D$	4½	0.00	−384.77	1.58
		3½	384.77	−282.87	1.58
		2½	667.64	−194.99	1.655
		1½	862.63	−114.40	1.862
		0½	977.03		3.31
$3d^7$	$a\,^4F$	4½	1872.60	−557.48	1.33
		3½	2430.08	−407.86	1.223
		2½	2837.94	−279.54	1.02
		1½	3117.48		0.385
$3d^6(a\,^5D)4s$	$a\,^4D$	3½	7955.24	−436.68	1.419
		2½	8391.92	−288.55	1.365
		1½	8680.47	−166.29	1.200
		0½	8846.76		−0.05
$3d^7$	$a\,^4P$	2½	13474.43	−198.78	1.609
		1½	13673.21	−231.66	1.737
		0½	13904.87		2.67
$3d^7$	$a\,^2G$	4½	15844.71	−524.68	
		3½	16369.39		
$3d^7$	$a\,^2P$	1½	18360.65	−526.10	1.28
		0½	18886.75		
$3d^7$	$a\,^2H$	5½	20340.36	−465.47	
		4½	20805.83		0.92
$3d^7$	$a\,^2D$	2½	20516.98	−791.10	1.22
		1½	21308.08		
$3d^6(a\,^3P)4s$	$b\,^4P$	2½	20830.52	−981.52	1.583
		1½	21812.04	−597.78	1.720
		0½	22409.82		2.68
$3d^6(a\,^3H)4s$	$a\,^4H$	6½	21251.55	−178.84	1.20
		5½	21430.39	−151.25	1.119
		4½	21581.64	−130.25	0.951
		3½	21711.89		0.661
$3d^6(a\,^3F)4s$	$b\,^4F$	4½	22637.19	−173.14	1.307
		3½	22810.33	−129.02	1.210
		2½	22939.35	−91.95	1.019
		1½	23031.30		0.398
$3d^5\,4s^2$	$a\,^6S$	2½	23317.60		1.996
$3d^6(a\,^3G)4s$	$a\,^4G$	5½	25428.80	−376.52	1.237
		4½	25805.32	−176.33	1.15
		3½	25981.65	−73.75	0.98
		2½	26055.40		0.574
$3d^6(a\,^3P)4s$	$b\,^2P$	1½	25787.60	−1145.14	1.33
		0½	26932.74		0.67
$3d^6(a\,^3H)4s$	$b\,^2H$	5½	26170.19	−182.61	1.09
		4½	26352.80		0.927
$3d^6(a\,^3F)4s$	$a\,^2F$	3½	27314.93	−305.46	1.129
		2½	27620.39		0.851
$3d^6(a\,^3G)4s$	$b\,^2G$	4½	30388.55	−375.91	1.10
		3½	30764.46		0.898
$3d^6(a\,^3D)4s$	$b\,^4D$	0½	31368.45	−3.98	
		1½	31364.47	23.51	
		2½	31387.98	95.22	1.327
		3½	31483.20		1.41
$3d^7$	$b\,^2F$	2½	31811.87	187.25	0.86
		3½	31999.12		1.124
$3d^6(a\,^1I)4s$	$a\,^2I$	6½	32875.63	−34.24	1.062
		5½	32909.87		0.92
$3d^6(a\,^1G)4s$	$c\,^2G$	4½	33466.50	−34.82	1.099
		3½	33501.32		0.88
$3d^6(a\,^3D)4s$	$b\,^2D$	1½	36126.41	126.55	0.799
		2½	36252.96		1.179
$3d^6(a\,^1S)4s$	$a\,^2S$	0½	37227.32		2.06

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6(a\,^1D)4s$	$c\,^2D$	2½	38164.24	−50.26	1.176
		1½	38214.50		0.79
$3d^6(a\,^5D)4p$	$z\,^6D^\circ$	4½	*38458.99*	−201.05	1.542
		3½	*38660.04*	−198.92	1.584
		2½	*38858.96*	−154.32	1.653
		1½	*39013.28*	−96.06	1.86
		0½	*39109.34*		3.35
$3d^6(a\,^5D)4p$	$z\,^6F^\circ$	5½	*41968.11*	−146.68	
		4½	*42114.79*	−122.26	1.43
		3½	*42237.05*	−97.81	1.399
		2½	*42334.86*	−66.47	1.304
		1½	*42401.33*	−38.55	1.04
		0½	*42439.88*		−0.647
$3d^6(a\,^5D)4p$	$z\,^6P^\circ$	3½	*42658.23*	−580.38	1.702
		2½	*43238.61*	−382.37	1.869
		1½	*43620.98*		2.398
$3d^6(a\,^5D)4p$	$z\,^4F^\circ$	4½	*44232.51*	−521.31	1.32
		3½	*44753.82*	−326.09	1.29
		2½	*45079.91*	−209.93	1.069
		1½	*45289.84*		0.445
$3d^6(a\,^5D)4p$	$z\,^4D^\circ$	3½	*44446.89*	−337.89	1.40
		2½	*44784.78*	−259.43	1.35
		1½	*45044.21*	−162.28	1.15
		0½	*45206.49*		−0.021
$3d^6(a\,^1F)4s$	$c\,^2F$	3½	44915.07	−14.52	
		2½	44929.59		
$3d^6(a\,^5D)4p$	$z\,^4P^\circ$	2½	*46967.47*	−422.35	1.592
		1½	*47389.82*	−236.32	1.717
		0½	*47626.14*		2.70
$3d^7$	$d\,^2D$	1½	47674.78	364.45	
		2½	48039.23		
$3d^6(b\,^3P)4s$	$c\,^4P$	0½	49101.09	405.90	
		1½	49506.99	705.94	
		2½	50212.93		
$3d^6(b\,^3F)4s$	$c\,^4F$	1½	50076.10	66.83	
		2½	50142.93	45.02	
		3½	50187.95	−30.34	
		4½	50157.61		
$3d^6(b\,^3P)4s$	$c\,^2P$	0½	54063.53	838.89	
		1½	54902.42		
$3d^5\,4s(a\,^7S)4p$	$z\,^8P^\circ$	4½, 3½, 2½	} *54490.2*		
$3d^6(b\,^3F)4s$	$d\,^2F$	2½	54870.62	33.88	
		3½	54904.50		
$3d^6(b\,^1G)4s$	$d\,^2G$	4½	58631.65	−34.71	
		3½	58666.36		
$3d^6(a\,^3P)4p$	$z\,^4S^\circ$	1½	*59663.45*		1.89
$3d^5\,4s^2$	$c\,^4D$	3½	60270.37	−174.91	
		2½	60445.28	4.23	
		1½	60441.05	56.59	
		0½	60384.46		
$3d^6(a\,^3P)4p$	$y\,^4P^\circ$	2½	*60402.38*	−930.44	1.58
		1½	*61332.82*	297.45	1.74
		0½	*61035.37*		2.613
$3d^6(a\,^3H)4p$	$z\,^4G^\circ$	5½	*60625.47*	−181.81	1.24
		4½	*60807.28*	−149.54	1.155
		3½	*60956.82*	−84.96	0.969
		2½	*61041.78*		0.799
$3d^6(a\,^3H)4p$	$z\,^4H^\circ$	6½	*60837.59*	−50.07	
		5½	*60887.66*	−101.82	
		4½	*60989.48*	−167.42	
		3½	*61156.90*		0.720

Fe II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6(a\ ^3P)4p$	$z\ ^2D^\circ$	2½	61093.44	−1032.22	1.01
		1½	62125.66		1.019
$3d^6(a\ ^3H)4p$	$z\ ^4I^\circ$	7½	61347.44	−180.15	
		6½	61527.59	−59.65	
		5½	61587.24	74.57	
		4½	61512.67		
$3d^6(a\ ^3P)4p$	$y\ ^4D^\circ$	3½	61726.09	−963.87	1.411
		2½	62689.96	−272.30	1.349
		1½	62962.26	133.10	1.14
		0½	62829.16		
$3d^6(a\ ^7S)4p$	$y\ ^6P^\circ$	1½	61975.11	74.06	
		2½	62049.17	122.59	
		3½	62171.76		1.68
$3d^6(a\ ^3F)4p$	$y\ ^4F^\circ$	4½	62158.19	92.62	1.33
		3½	62065.57	−86.04	1.198
		2½	62151.61	−92.96	1.025
		1½	62244.57		0.43
$3d^6(a\ ^3H)4p$	$z\ ^2G^\circ$	4½	62083.17	−239.33	1.097
		3½	62322.50		
$3d^6(a\ ^3H)4p$	$z\ ^2I^\circ$	6½	62293.20	−369.10	1.069
		5½	62662.30		0.910
$3d^6(a\ ^3F)4p$	$x\ ^4D^\circ$	3½	62945.12	−327.91	1.385
		2½	63273.03	−192.16	1.351
		1½	63465.19	−94.37	1.21
		0½	63559.56		0.013
$3d^6(a\ ^3F)4p$	$y\ ^4G^\circ$	5½	63876.38	−72.46	1.24
		4½	63948.84	−92.12	1.15
		3½	64040.96	−46.54	0.975
		2½	64087.50		0.617
$3d^6(a\ ^3F)4p$	$z\ ^2F^\circ$	3½	64286.44	−139.02	1.135
		2½	64425.46		0.82
$3d^6(a\ ^3P)4p$	$z\ ^2P^\circ$	0½	64806.52	27.60	
		1½	64834.12		1.329
$3d^6(a\ ^3F)4p$	$y\ ^2G^\circ$	4½	64832.00	−277.71	1.101
		3½	65109.71		0.896
$3d^6(a\ ^3H)4p?$	$z\ ^2H^\circ$	5½	65363.66	−192.68	1.066
		4½	65556.34		0.913
$3d^6(a\ ^3G)4p$	$x\ ^4G^\circ$	5½	65580.09	−116.02	
		4½	65696.11	−235.35	
		3½	65931.46	−146.88	1.00
		2½	66078.34		0.62
$3d^6(a\ ^3G)4p$	$x\ ^4F^\circ$	4½	66012.83	−364.54	
		3½	66377.37	−144.95	1.21
		2½	66522.32	−90.42	1.02
		1½	66612.74		
$3d^6(a\ ^3P)4p$	$z\ ^2S^\circ$	0½	66248.67		
$3d^6(a\ ^3G)4p$	$y\ ^4H^\circ$	6½	66411.70	−51.89	
		5½	66463.59	−125.58	1.13
		4½	66589.17	−83.22	0.959
		3½	66672.39		0.69
$3d^6(a\ ^3F)4p$	$y\ ^2D^\circ$	2½	67000.63	−273.23	1.16
		1½	67273.86		0.719
$3d^6(a\ ^3G)4p?$	$y\ ^2H^\circ$	5½	67516.37	−484.45	1.07
		4½	68000.82		0.907
$3d^5\ 4s(a\ ^5S)4p$	$x\ ^4P^\circ$	2½	69102.69	−199.66	
		1½	69302.35	−124.92	
		0½	69427.27		
$3d^6(a\ ^3G)4p?$	$y\ ^2F^\circ$	3½	69606.64	−43.90	1.13
		2½	69650.54		0.857
$3d^6(a\ ^3G)4p$	$x\ ^2G^\circ$	4½	70314.74	−208.99	1.11
		3½	70523.73		0.87
$3d^6(a\ ^1I)4p$	$z\ ^2K^\circ$	6½	70986.69	446.06	1.05
		7½	71432.75		
$3d^6(a\ ^3D)4p$	$w\ ^4P^\circ$	2½	71964.81	−78.40	
		1½	72043.21	−169.89	1.66
		0½	72213.10		
	$x\ ^2H^\circ$	4½	72130.44	131.39	0.91
		5½	72261.83		1.08
$3d^6(a\ ^3D)4p$	$w\ ^4F^\circ$	1½	72169.15	69.48	
		2½	72238.63	113.54	
		3½	72352.17	298.46	
		4½	72650.63		
$3d^6(a\ ^3D)4p$	$w\ ^4D^\circ$	0½	72429.74	94.88	
		1½	72524.62	94.99	
		2½	72619.61	32.30	
		3½	72651.91		
$3d^6(a\ ^3D)4p?$	$x\ ^2F^\circ$	3½	73016.33	−38.64	
		2½	73054.97		
$3d^6(a\ ^1G)4p$	$w\ ^2G^\circ$	4½	73091.70	−51.78	
		3½	73143.48		0.91
$3d^6(a\ ^3D)4p$	$y\ ^2P^\circ$	0½	73187.46	1.70	
		1½	73189.16		
	$w\ ^2H^\circ$	5½	73603.53	−147.81	
		4½	73751.34		
$3d^6(a\ ^1I)4p$	$y\ ^2I^\circ$	6½	73966.94	−2.77	
		5½	73969.71		
$3d^6(a\ ^3D)4p$	$x\ ^2D^\circ$	1½	74498.15	108.82	
		2½	74606.97		
	$w\ ^2F^\circ$	3½	75600.93	−314.28	1.125
		2½	75915.21		0.844
$3d^6(a\ ^1S)4p$	$x\ ^2P^\circ$	1½	76129.58	−447.92	1.34
		0½	76577.50		
$3d^6(a\ ^1D)4p$	$v\ ^2F^\circ$	2½	77742.78	394.75	
		3½	78137.53		1.13
$3d^6(a\ ^5D)5s$	$e\ ^6D$	4½	77861.47	−376.07	
		3½	78237.54	−287.73	
		2½	78525.27	−200.34	
		1½	78725.61	−118.11	
		0½	78843.72		
$3d^6(a\ ^1D)4p$	$w\ ^2D^\circ$	1½	78487.25	203.73	
		2½	78690.98		
$3d^6(a\ ^1D)4p$	$w\ ^2P^\circ$	0½	78841.97	401.76	
		1½	79243.73		
$3d^5\ 4s(a\ ^5S)4p$	$x\ ^6P^\circ$	1½	79246.13	38.97	
		2½	79285.10	46.39	
		3½	79331.49		
$3d^6(a\ ^5D)5s$	$e\ ^4D$	3½	79439.30	−446.02	
		2½	79885.32	−292.55	
		1½	80177.87	−168.04	
		0½	80345.91		
$3d^6(a\ ^5D)4d$	$e\ ^6F$	5½	82853.5	−125.4	
		4½	82978.9	−157.6	
		3½	83136.5	−171.9	
		2½	83308.4	−151.3	
		1½	83459.7	−98.8	
		0½	83558.5		
$3d^6(a\ ^1F)4p$	$v\ ^2G^\circ$	3½	83305.37	565.94	
		4½	83871.31		
$3d^6(a\ ^5D)4d?$	$30(^6D)$	3½	83713.3		
$3d^6(a\ ^5D)4d$	$e\ ^6P$	3½	83726.24	−540.24	
		2½	84266.48	−60.43	
		1½	84326.91		

Fe II—Continued

Config.	Desig.	J	Level	Interval	Obs. g.
$3d^6(a\ ^5D)4d$?	$32(^6D)$	2½	83812.1		
$3d^6(a\ ^1F)4p$	$v\ ^2D^\circ$	2½	83868.65	−491.25	
		1½	84359.90		
$3d^6(a\ ^5D)4d$?	$33(^6D)$	1½	83989.7		
$3d^6(a\ ^5D)4d$	$e\ ^6G$	6½	84035.09	−261.61	1.33
		5½	84296.70	−231.19	
		4½	84527.89	−182.77	
		3½	84710.66	−134.15	
		2½	84844.81	−93.32	
		1½	84938.13		
$3d^6(a\ ^5D)4d$?	$34(^6D)$	{1½, 0½}	84131.2		
$3d^6(a\ ^5D)4d$	$f\ ^4D$	3½	84685.16	−185.68	
		2½	84870.84	−177.72	
		1½	85048.56	−124.21	
		0½	85172.77		
$3d^6(a\ ^5D)4d$	$e\ ^4G$	5½	84863.14	−321.55	1.27
		4½	85184.69	−278.09	
		3½	85462.78	−216.86	
		2½	85679.64		
$3d^6(a\ ^5D)4d$	$e\ ^4F$	4½	86124.14	−292.08	1.29
		3½	86416.22	−183.44	
		2½	86599.66	−111.18	
		1½	86710.84		
$3d^6(b\ ^3P)4p$	$v\ ^4D^\circ$	0½	*86388.98*	155.16	
		1½	*86544.14*	223.73	
		2½	*86767.87*	162.05	
		3½	*86929.92*		
$3d^6(a\ ^1F)4p$	$u\ ^2F^\circ$	3½	*86482.75*	−64.80	
		2½	*86547.55*		
$3d^6(a\ ^5D)5p$	$y\ ^6F^\circ$	5½	*87340.4*	−130.4	
		4½	*87470.8*	−66.1	
		3½	*87536.9*	−34.9	
		2½	*87571.8*	−30.1	
		1½	*87601.9*	−33.3	
		0½	*87635.2*		
	$1^\circ(^6P^\circ)$	3½	*88208.6*		
	$2^\circ(^6P^\circ)$	3½	*89127.7*		
	$3^\circ(^6P^\circ)$	2½	*89443.7*		
	$4^\circ(^6P^\circ)$	1½	*89625.0*		
	5°	3½	*90300.0*		
	6°	{4½, 3½}	*90385.5*		
	$8^\circ(^4P^\circ)$	{1½, 0½}	*90828.4*		
	$9^\circ(^4P^\circ)$	1½	*90898.2*		
	$10^\circ(^4P^\circ)$	{2½, 1½}	*90981.5*		
	11°	2½	*91067.1*		
	$w\ ^6P^\circ$	3½	*91167.3*	−407.5	
		2½	*91574.8*	−268.3	
		1½	*91843.1*		
$3d^5\ 4s(a\ ^5G)4p$	$x\ ^4H^\circ$	3½	*92089.41*	27.57	
		4½	*92116.98*	49.83	
		5½	*92166.81*	83.46	
		6½	*92250.27*		
$3d^5\ 4s(a\ ^5G)4p$	$v\ ^4F^\circ$	4½	*92171.95*	−110.81	
		3½	*92282.76*	−47.3	
		2½	*92330.1*	−28.7	
		1½	*92358.8*		

Fe II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^6(b\ ^3F)4p$	$u\ ^2D^\circ$	1½	*92216.42*	479.20	
		2½	*92695.62*		
$3d^6(b\ ^3F)4p$	$u\ ^2G^\circ$	4½	*92427.22*	−175.72	
		3½	*92602.94*		
$3d^6(b\ ^3F)4p$	$u\ ^4F^\circ$	1½	*93328.6*	67.0	
		2½	*93395.6*	92.1	
		3½	*93487.71*	−2.96	
		4½	*93484.75*		
$3d^5\ 4s(a\ ^5G)4p$	$w\ ^4G^\circ$	2½	*93988.30*	85.16	
		3½	*94073.46*	75.25	
		4½	*94148.71*	41.31	
		5½	*94190.02*		
	14°	2½	*94210.1*		
	15°	3½	*94762.3*		
$3d^5\ 4s(a\ ^3G)4p$	$v\ ^2H^\circ$	5½	*96062.18*	−176.9	
		4½	*96239.1*		
$3d^6(b\ ^3F)4p$	$t\ ^2F^\circ$	2½	*96279.65*	77.42	
		3½	*96357.07*		
$3d^6(a\ ^3H)5s$	$e\ ^4H$	6½	98129.98	−164.62	
		5½	98294.60	−150.64	
		4½	98445.24	−123.51	
		3½	98568.75		
$3d^6(a\ ^3H)5s$	$e\ ^2H$	5½	99093.29	−238.66	
		4½	99331.95		
$3d^6(a\ ^3F)5s$	$f\ ^4F$	4½	99573.11	−115.09	
		3½	99688.20	−135.84	
		2½	99824.04	−94.26	
		1½	99918.30		
$3d^6(a\ ^3F)5s$	$e\ ^2F$	3½	100492.04	−257.71	
		2½	100749.75		
$3d^6(a\ ^3G)5s$	$f\ ^4G$	5½	102584.81		
		4½			
		3½			
		2½			
$3d^6(a\ ^3G)5s$	$e\ ^2G$	4½	103608.82	−374.53	
		3½	103983.35		
	16°	3½	*106863.2*		
	17°	{3½, 2½}	*107165.6*		
	18°	2½	*107196.2*		
	$20^\circ(^6D^\circ)$	3½	*107886.6*		
	$21^\circ(^6D^\circ)$	{4½, 3½}	*107964.7*		
	$22^\circ(^6D^\circ)$	2½	*108130.6*		
	$23^\circ(^6D^\circ)$	1½	*108191.6*		
	24°	3½	*108239.2*		
	25°	1½	*108371.7*		
	26°	3½	*108373.8*		
$3d^6(a\ ^1I)5s$	$e\ ^2I$	5½	108630.24	18.40	
		6½	108648.64		
	27°	1½	*108780.0*		
	28°	1½	*109780.0*		
	29°	2½	*111929.0*		
Fe III$(a\ ^5D_4)$	*Limit*	-----	**130524**		

April 1950.

Fe II Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms																		
	ns ($n\geq4$)							*np* ($n\geq4$)								*nd* ($n\geq4$)			
$3d^5\,4s^2$	a ^{6}S		c ^{4}D																
$3d^7$		a ^{4}P a ^{2}P	a ^{2}D d ^{2}D	a ^{4}F b ^{2}F	a ^{2}G	a ^{2}H													
$3d^6(a\,^5\mathrm{D})nx$			a, e ^{6}D a, e ^{4}D						z ^{6}P° z ^{4}P°	z ^{6}D° z ^{4}D°	z, y ^{6}F° z ^{4}F°					e ^{6}P	f ^{4}D	e ^{6}F e ^{4}F	e ^{6}G e ^{4}G
$3d^6(a\,^3\mathrm{P})nx$		b ^{4}P b ^{2}P						z ^{4}S° z ^{2}S°	y ^{4}P° z ^{2}P°	y ^{4}D° z ^{2}D°									
$3d^6(a\,^3\mathrm{H})nx$						a, e ^{4}H b, e ^{2}H						z ^{4}G° z ^{2}G°	z ^{4}H° z ^{2}H°	z ^{4}I° z ^{2}I°					
$3d^6(a\,^3\mathrm{F})nx$				b, f ^{4}F a, e ^{2}F						x ^{4}D° y ^{2}D°	y ^{4}F° z ^{2}F°	y ^{4}G° y ^{2}G°							
$3d^6(a\,^3\mathrm{G})nx$					a, f ^{4}G b, e ^{2}G						x ^{4}F° y ^{2}F°	x ^{4}G° x ^{2}G°	y ^{4}H° y ^{2}H°						
$3d^5\,4s(a\,^7\mathrm{S})nx$									z ^{8}P° y ^{6}P°										
$3d^6(a\,^1\mathrm{I})nx$							a, e ^{2}I							y ^{2}I°	z ^{2}K°				
$3d^6(a\,^3\mathrm{D})nx$			b ^{4}D b ^{2}D						w ^{4}P° y ^{2}P°	w ^{4}D° x ^{2}D°	w ^{4}F° x ^{2}F°								
$3d^6(a\,^1\mathrm{G})nx$					c ^{2}G							w ^{2}G°							
$3d^6(a\,^1\mathrm{S})nx$	a ^{2}S								x ^{2}P°										
$3d^6(a\,^1\mathrm{D})nx$			c ^{2}D						w ^{2}P°	w ^{2}D°	v ^{2}F°								
$3d^5\,4s(a\,^5\mathrm{S})nx$									x ^{6}P° x ^{4}P°										
$3d^6(a\,^1\mathrm{F})nx$				c ^{2}F						v ^{2}D°	u ^{2}F°	v ^{2}G°							
$3d^6(b\,^3\mathrm{P})nx$		c ^{4}P c ^{2}P								v ^{4}D°									
$3d^6(b\,^3\mathrm{F})nx$				c ^{4}F d ^{2}F						u ^{2}D°	u ^{4}F° t ^{2}F°	u ^{2}G°							
$3d^6(b\,^1\mathrm{G})nx$					d ^{2}G														
$3d^5\,4s(a\,^5\mathrm{G})nx$											v ^{4}F°	w ^{4}G°	x ^{4}H°						
$3d^5\,4s(b\,^3\mathrm{G})nx$													v ^{2}H°						

*For predicted terms in the spectra of the Mn I isoelectronic sequence, see Vol. II, Introduction.

Fe III

(Cr I sequence; 24 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^6\;{}^5D_4$

$a\;{}^5D_4$ **247200** cm^{-1} I. P. 30.64 volts

The early work on this spectrum was by Bowen and L. C. Green, who found a few multiplets. Later Edlén and Swings published a detailed analysis which includes a remarkably complete array of terms from the $3d^6$, $3d^5\,4s$, and $3d^5\,4p$ configurations. Their observations extend from about 500 A to 6500 A and their final tables contain some 320 energy levels and approximately 1500 classified lines. A few revisions and one new level have been furnished by Glad and entered in page proof.

In the present work the prefixes *a, b, . . . z, y, . . .* have been adopted throughout the spectrum, but the notation by Edlén and Swings is given in the first column for convenience in cross reference. A correction of 0.8 cm^{-1} has, also, here been added to their published values of all the levels in order to place the ground state at zero.

The terms of all four multiplicities recognized in this spectrum (1, 3, 5, 7), are connected by observed intersystem combinations.

REFERENCES

B. Edlén and P. Swings, Astroph. J. **95**, 532 (1942). (I P) (T) (C L)
S. Glad, unpublished material (Sept. 1951). (T)

Fe III

Authors	Config.	Desig.	J	Level	Interval
$3d\;{}^5D_4$	$3d^6$	$a\;{}^5D$	4	0.0	−436.2
${}^5D_3$			3	436.2	−302.7
${}^5D_2$			2	738.9	−193.5
${}^5D_1$			1	932.4	−94.9
${}^5D_0$			0	1027.3	
$3d\;{}^3P_2$	$3d^6$	$a\;{}^3P$	2	19404.8	−1283.6
${}^3P_1$			1	20688.4	−520.1
${}^3P_0$			0	21208.5	
$3d\;{}^3H_6$	$3d^6$	$a\;{}^3H$	6	20051.1	−249.7
${}^3H_5$			5	20300.8	−181.1
${}^3H_4$			4	20481.9	
$3d\;{}^3F_4$	$3d^6$	$a\;{}^3F$	4	21462.2	−237.7
${}^3F_3$			3	21699.9	−157.3
${}^3F_2$			2	21857.2	
$3d\;{}^3G_5$	$3d^6$	$a\;{}^3G$	5	24558.8	−382.1
${}^3G_4$			4	24940.9	−201.5
${}^3G_3$			3	25142.4	

Fe III

Authors	Config.	Desig.	J	Level	Interval
$4s\;{}^7S_3$	$3d^5(a\;{}^6S)4s$	$a\;{}^7S$	3	30088.84	
$3d\;{}^1I_6$	$3d^6$	$a\;{}^1I$	6	30356.2	
$3d\;{}^3D_1$	$3d^6$	$a\;{}^3D$	1	30725.8	−9.6
${}^3D_2$			2	30716.2	141.6
${}^3D_3$			3	30857.8	
$3d\;{}^1G_4$	$3d^6$	$a\;{}^1G$	4	30886.4	
$3d\;{}^1S_0$	$3d^6$	$a\;{}^1S$	0	34812.4	
$3d\;{}^1D_2$	$3d^6$	$a\;{}^1D$	2	35803.7	
$4s\;{}^5S_2$	$3d^5(a\;{}^6S)4s$	$a\;{}^5S$	2	40999.87	
$3d\;{}^1F_3$	$3d^6$	$a\;{}^1F$	3	42896.9	
$3d'\;{}^3P_0$	$3d^6$	$b\;{}^3P$	0	49148	429
${}^3P_1$			1	49576.9	835.4
${}^3P_2$			2	50412.3	

Fe III—Continued

Authors	Config.	Desig.	*J*	Level	Interval
$3d'\,^3F_2$	$3d^6$	$b\,^3F$	2	50184.9	110.3
$^3F_3$			3	50295.2	−19.1
$^3F_4$			4	50276.1	
$3d'\,^1G_4$	$3d^6$	$b\,^1G$	4	57221.7	
$a\,^5G_6$	$3d^5(a\,^4G)4s$	$a\,^5G$	6	63425.17	−41.22
$^5G_5$			5	63466.39	−20.39
$^5G_4$			4	63486.78	−7.22
$^5G_3$			3	63494.00	−0.56
$^5G_2$			2	63494.56	
$a\,^5P_3$	$3d^5(a\,^4P)4s$	$a\,^5P$	3	66464.64	−58.31
$^5P_2$			2	66522.95	−68.73
$^5P_1$			1	66591.68	
$a\,^5D_4$	$3d^5(a\,^4D)4s$	$b\,^5D$	4	69695.73	−141.10
$^5D_3$			3	69836.83	−0.93
$^5D_2$			2	69837.76	49.57
$^5D_1$			1	69788.19	40.79
$^5D_0$			0	69747.40	
$a\,^3G_5$	$3d^5(a\,^4G)4s$	$b\,^3G$	5	70694.03	−34.72
$^3G_4$			4	70728.75	3.74
$^3G_3$			3	70725.01	
$a\,^3P_2$	$3d^5(a\,^4P)4s$	$c\,^3P$	2	73727.64	−121.46
$^3P_1$			1	73849.10	−86.86
$^3P_0$			0	73935.96	
$a\,^3D_3$	$3d^5(a\,^4D)4s$	$b\,^3D$	3	76956.79	−145.64
$^3D_2$			2	77102.43	27.13
$^3D_1$			1	77075.30	
$a\,^3I_7$	$3d^5(a\,^2I)4s$	$a\,^3I$	7	79840.12	−4.62
$^3I_6$			6	79844.74	−15.68
$^3I_5$			5	79860.42	
$4p\,^7P_2$	$3d^5(a\,^6S)4p$	$z\,^7P°$	2	*82001.73*	332.19
$^7P_3$			3	*82333.92*	512.67
$^7P_4$			4	*82846.59*	
$b\,^3D_3$	$3d^5(a\,^2D)4s$	$c\,^3D$	3	82382.87	−28.07
$^3D_2$			2	82410.94	−83.94
$^3D_1$			1	82494.88	
$a\,^5F_5$	$3d^5(a\,^4F)4s$	$a\,^5F$	5	83138.23	−23.25
$^5F_4$			4	83161.48	−76.38
$^5F_3$			3	83237.86	−121.02
$^5F_2$			2	83358.88	−288.10
$^5F_1$			1	83646.98	
$a\,^1I_6$	$3d^5(a\,^2I)4s$	$b\,^1I$	6	83429.61	
$a\,^3F_4$	$3d^5(a\,^2F)4s$	$c\,^3F$	4	84159.55	−512.32
$^3F_3$			3	84671.87	301.95
$^3F_2$			2	84369.92	
$a\,^1D_2$	$3d^5(a\,^2D)4s$	$b\,^1D$	2	86847.11	
$a\,^1F_3$	$3d^5(a\,^2F)4s$	$b\,^1F$	3	87901.87	
$a\,^3H_4$	$3d^5(a\,^2H)4s$	$b\,^3H$	4	88663.87	30.80
$^3H_5$			5	88694.67	228.40
$^3H_6$			6	88923.07	
$4p\,^5P_3$	$3d^5(a\,^6S)4p$	$z\,^5P°$	3	*89084.79*	−249.80
$^5P_2$			2	*89334.59*	−156.85
$^5P_1$			1	*89491.44*	

Fe III—Continued

Authors	Config.	Desig.	*J*	Level	Interval
$b\,^3G_3$	$3d^5(a\,^2G)4s$	$c\,^3G$	3	89697.52	86.07
$^3G_4$			4	89783.59	124.26
$^3G_5$			5	89907.85	
$b\,^3F_2$	$3d^5(a\,^4F)4s$	$d\,^3F$	2	90423.68	60.26
$^3F_3$			3	90483.94	−11.41
$^3F_4$			4	90472.53	
$a\,^1H_5$	$3d^5(a\,^2H)4s$	$a\,^1H$	5	92523.91	
$c\,^3F_4$	$3d^5(b\,^2F)4s$	$e\,^3F$	4	93388.75	−3.70
$^3F_3$			3	93392.45	−20.48
$^3F_2$			2	93412.93	
$a\,^1G_4$	$3d^5(a\,^2G)4s$	$c\,^1G$	4	93512.64	
$b\,^1F_3$	$3d^5(b\,^2F)4s$	$c\,^1F$	3	97041.38	
$c\,^3D_1$	$3d^5(b\,^2D)4s$	$d\,^3D$	1	105895.35	10.88
$^3D_2$			2	105906.23	22.93
$^3D_3$			3	105929.16	
$b\,^1D_2$	$3d^5(b\,^2D)4s$	$c\,^1D$	2	109570.84	
$z\,^5G_2$	$3d^5(a\,^4G)4p$	$z\,^5G°$	2	*113584.20*	21.17
$^5G_3$			3	*113605.37*	29.97
$^5G_4$			4	*113635.34*	41.67
$^5G_5$			5	*113677.01*	62.61
$^5G_5$			6	*113739.62*	
$c\,^3G_5$	$3d^5(b\,^2G)4s$	$d\,^3G$	5	114325.35	−14.60
$^3G_4$			4	114339.95	−11.97
$^3G_3$			3	114351.92	
$z\,^5H_3$	$3d^5(a\,^4G)4p$	$z\,^5H°$	3	*114948.55*	162.37
$^5H_4$			4	*115110.92*	178.99
$^5H_5$			5	*115289.91*	184.34
$^5H_6$			6	*115474.25*	167.98
$^5H_7$			7	*115642.23*	
$z\,^5F_5$	$3d^5(a\,^4G)4p$	$z\,^5F°$	5	*116316.63*	−150.78
$^5F_4$			4	*116467.41*	−601.15
$^5F_3$			3	*117068.56*	93.51
$^5F_2$			2	*116975.05*	37.48
$^5F_1$			1	*116937.57*	
$z\,^5D_0$	$3d^5(a\,^4P)4p$	$z\,^5D°$	0	*116364.76*	15.31
$^5D_1$			1	*116380.07*	39.32
$^5D_2$			2	*116419.39*	56.05
$^5D_3$			3	*116475.44*	1046.47
$^5D_4$			4	*117521.91*	
$z\,^5S_2$	$3d^5(a\,^4P)4p$	$z\,^5S°$	2	*116898.22*	
$b\,^1G_4$	$3d^5(b\,^2G)4s$	$d\,^1G$	4	117950.32	
$z\,^3F_2$	$3d^5(a\,^4G)4p$	$z\,^3F°$	2	*118163.56*	82.96
$^3F_3$			3	*118246.52*	103.72
$^3F_4$			4	*118350.24*	
$z\,^3H_6$	$3d^5(a\,^4G)4p$	$z\,^3H°$	6	*118355.01*	−202.24
$^3H_5$			5	*118557.25*	−129.00
$^3H_4$			4	*118686.25*	
$z\,^5P_3$	$3d^5(a\,^4P)4p$	$y\,^5P°$	3	*118442.92*	−278.68
$^5P_2$			2	*118721.60*	−146.27
$^5P_1$			1	*118867.87*	

Fe III—Continued

Authors	Config.	Desig.	J	Level	Interval
$z\ ^3P_2$	$3d^5(a\ ^4P)4p$	$z\ ^3P°$	2	*119697.64*	−284.62
$^3P_1$			1	*119982.26*	−197.69
$^3P_0$			0	*120179.95*	
$y\ ^5F_1$	$3d^5(a\ ^4D)4p$	$y\ ^5F°$	1	*120697.10*	129.07
$^5F_2$			2	*120826.17*	182.61
$^5F_3$			3	*121008.78*	232.89
$^5F_4$			4	*121241.67*	227.15
$^5F_5$			5	*121468.82*	
$z\ ^3G_3$	$3d^5(a\ ^4G)4p$	$z\ ^3G°$	3	*121919.74*	21.55
$^3G_4$			4	*121941.29*	8.33
$^3G_5$			5	*121949.62*	
$z\ ^2D_3$	$3d^5(a\ ^4P)4p$	$z\ ^3D°$	3	*122346.61*	−281.73
$^3D_2$			2	*122628.34*	−214.69
$^3D_1$			1	*122843.03*	
$y\ ^5D_4$	$3d^5(a\ ^4D)4p$	$y\ ^5D°$	4	*122944.15*	114.60
$^5D_3$			3	*122829.55*	−69.29
$^5D_2$			2	*122898.84*	−22.53
$^5D_1$			1	*122921.37*	−534.55
$^5D_0$			0	*123455.92*	
$y\ ^5P_1$	$3d^5(a\ ^4D)4p$	$x\ ^5P°$	1	*123552.95*	144.23
$^5P_2$			2	*123697.18*	53.21
$^5P_3$			3	*123750.39*	
$y\ ^3D_3$	$3d^5(a\ ^4D)4p$	$y\ ^3D°$	3	*124854.04*	−49.88
$^3D_2$			2	*124903.92*	−50.96
$^3D_1$			1	*124954.88*	
$y\ ^3F_4$	$3d^5(a\ ^4D)4p$	$y\ ^3F°$	4	*125443.58*	−194.40
$^3F_3$			3	*125637.98*	−34.85
$^3F_2$			2	*125672.83*	
$z\ ^3S_1$	$3d^5(a\ ^4P)4p$	$z\ ^3S°$	1	*126390.57*	
$y\ ^3P_0$	$3d^5(a\ ^4D)4p$	$y\ ^3P°$	0	*128371.53*	234.12
$^3P_1$			1	*128605.65*	311.86
$^3P_2$			2	*128917.51*	
$z\ ^3I_7$	$3d^5(a\ ^2I)4p$	$z\ ^3I°$	7	*130040.56*	185.76
$^3I_6$			6	*129854.80*	−401.47
$^3I_5$			5	*130256.27*	
$z\ ^3K_6$	$3d^5(a\ ^2I)4p$	$z\ ^3K°$	6	*130756.84*	278.23
$^3K_7$			7	*131035.07*	−182.82
$^3K_8$			8	*130852.25*	
$z\ ^1D_2$	$3d^5(a\ ^2D)4p$	$z\ ^1D°$	2	*131445.03*	
$z\ ^1H_5$	$3d^5(a\ ^2I)4p$	$z\ ^1H°$	5	*131710.79*	
$z\ ^1K_7$	$3d^5(a\ ^2I)4p$	$z\ ^1K°$	7	*131991.58*	
$x\ ^3F_2$	$3d^5(a\ ^2D)4p$	$x\ ^3F°$	2	*132104.94*	−25.03
$^3F_3$			3	*132079.91*	705.45
$^3F_4$			4	*132785.36*	
$y\ ^3H_6$	$3d^5(a\ ^2I)4p$	$y\ ^3H°$	6	*132262.66*	−302.05
$^3H_5$			5	*132564.71*	−94.46
$^3H_4$			4	*132659.17*	
$x\ ^3P_2$	$3d^5(a\ ^2D)4p$	$x\ ^3P°$	2	*134265.42*	−284.0
$^3P_1$			1	*134549.4*	−538.7
$^3P_0$			0	*135088.1*	
$z\ ^1G_4$	$3d^5(a\ ^2F)4p$	$z\ ^1G°$	4	*134360.40*	

Fe III—Continued

Authors	Config.	Desig.	J	Level	Interval
$y\ ^3G_3$	$3d^5(a\ ^2F)4p$	$y\ ^3G°$	3	*134549.00*	1005.41
$^3G_4$			4	*135554.41*	180.90
$^3G_5$			5	*135735.31*	
$y\ ^5G_2$	$3d^5(a\ ^4F)4p$	$y\ ^5G°$	2	*134937.84*	159.00
$^5G_3$			3	*135096.84*	142.90
$^5G_4$			4	*135239.74*	76.68
$^5G_5$			5	*135316.42*	423.05
$^5G_6$			6	*135739.47*	
$x\ ^3D_3$	$3d^5(a\ ^2D)4p$	$x\ ^3D°$	3	*134976.22*	−302.8
$^3D_2$			2	*135279.0*	61.9
$^3D_1$			1	*135217.1*	
$z\ ^1I_6$	$3d^5(a\ ^2I)4p$	$z\ ^1I°$	6	*135582.08*	
$w\ ^3D_3$	$3d^5(a\ ^2F)4p$	$w\ ^3D°$	3	*135705.7*	−1088.1
$^3D_2$			2	*136793.8*	328.9
$^3D_1$			1	*136464.9*	
$x\ ^5F_5$	$3d^5(a\ ^4F)4p$	$x\ ^5F°$	5	*136185.17*	194.55
$^5F_4$			4	*135990.62*	−18.12
$^5F_3$			3	*136008.74*	−109.20
$^5F_2$			2	*136117.94*	−117.90
$^5F_1$			1	*136235.84*	
$z\ ^1F_3$	$3d^5(a\ ^2D)4p$	$z\ ^1F°$	3	*136200.13*	
$w\ ^3F_2$	$3d^5(a\ ^2F)4p$	$w\ ^3F°$	2	*136532.45*	264.60
$^3F_3$			3	*136797.05*	−184.27
$^3F_4$			4	*136612.78*	
$x\ ^5D_4$	$3d^5(a\ ^4F)4p$	$x\ ^5D°$	4	*137209.73*	−213.27
$^5D_3$			3	*137423.00*	−121.60
$^5D_2$			2	*137544.60*	−16.5
$^5D_1$			1	*137561.1*	−12.1
$^5D_0$			0	*137573.2*	
$x\ ^3H_4$	$3d^5(a\ ^2G)4p$	$x\ ^3H°$	4	*137527.92*	235.78
$^3H_5$			5	*137763.70*	500.77
$^3H_6$			6	*138264.47*	
$x\ ^3G_5$	$3d^5(a\ ^2H)4p$	$x\ ^3G°$	5	*138054.59*	−48.53
$^3G_4$			4	*138103.12*	−84.81
$^3G_3$			3	*138187.93*	
$z\ ^1P_1$	$3d^5(a\ ^2D)4p$	$z\ ^1P°$	1	*138691.81*	
$w\ ^3G_5$	$3d^5(a\ ^4F)4p$	$w\ ^3G°$	5	*139463.36*	−161.81
$^3G_4$			4	*139625.17*	−55.30
$^3G_3$			3	*139680.47*	
$y\ ^3I_5$	$3d^5(a\ ^2H)4p$	$y\ ^3I°$	5	*139509.44*	336.74
$^3I_6$			6	*139846.18*	350.15
$^3I_7$			7	*140196.33*	
$y\ ^1D_2$	$3d^5(a\ ^2F)4p$	$y\ ^1D°$	2	*139764.48*	
$y\ ^1G_4$	$3d^5(a\ ^2G)4p$	$y\ ^1G°$	4	*139827.17*	
$y\ ^1F_3$	$3d^5(a\ ^2F)4p$	$y\ ^1F°$	3	*140453.10*	
$v\ ^3F_2$	$3d^5(a\ ^2G)4p$	$v\ ^3F°$	2	*140750.98*	−57.62
$^3F_3$			3	*140693.36*	309.63
$^3F_4$			4	*141002.99*	
$v\ ^3D_3$	$3d^5(a\ ^4F)4p$	$v\ ^3D°$	3	*141466.53*	67.49
$^3D_2$			2	*141399.04*	−70.41
$^3D_1$			1	*141469.45*	
$y\ ^1I_6$	$3d^5(a\ ^2H)4p$	$y\ ^1I°$	6	*141539.55*	

Fe III—Continued

Authors	Config.	Desig.	J	Level	Interval
$u\ ^3F_4$	$3d^5(a\ ^4F)4p$	$u\ ^3F^\circ$	4	*142047.0*	−265.9
$^3F_3$			3	*142312.90*	−222.17
$^3F_2$			2	*142535.07*	
$w\ ^3H_4$	$3d^5(a\ ^2H)4p$	$w\ ^3H^\circ$	4	*142855.59*	52.89
$^3H_5$			5	*142908.48*	412.37
$^3H_6$			6	*143320.85*	
$v\ ^3G_5$	$3d^5(a\ ^2G)4p$	$v\ ^3G^\circ$	5	*143883.74*	−202.23
$^3G_4$			4	*144085.97*	−30.67
$^3G_3$			3	*144116.64*	
$t\ ^3F_4$	$3d^5(b\ ^2F)4p$	$t\ ^3F^\circ$	4	*144332.21*	−238.32
$^3F_4$			3	*144570.53*	68.79
$^3F_2$			2	*144501.74*	
$y\ ^1H_5$	$3d^5(a\ ^2G)4p$	$y\ ^1H^\circ$	5	*144586.83*	
$x\ ^1H_5$	$3d^5(a\ ^2H)4p$	$x\ ^1H^\circ$	5	*144843.24*	
$x\ ^1G_4$	$3d^5(a\ ^2H)4p$	$x\ ^1G^\circ$	4	*144968.50*	
$x\ ^1F_3$	$3d^5(a\ ^2G)4p$	$x\ ^1F^\circ$	3	*145038.61*	
$x\ ^1D_2$	$3d^5(b\ ^2F)4p$	$x\ ^1D^\circ$	2	*145618.39*	
$u\ ^3G_3$	$3d^5(b\ ^2F)4p$	$u\ ^3G^\circ$	3	*146891.0*	270.4
$^3G_4$			4	*147161.36*	244.78
$^3G_5$			5	*147406.14*	
$4d\ ^7D_1$	$3d^5(a\ ^6S)4d$	$e\ ^7D$	1	147281.72	9.48
$^7D_2$			2	147291.20	14.77
$^7D_3$			3	147305.97	20.87
$^7D_4$			4	147326.84	27.86
$^7D_5$			5	147354.70	
$u\ ^3D_1$	$3d^5(b\ ^2F)4p$	$u\ ^3D^\circ$	1	*147556.45*	58.20
$^3D_2$			2	*147614.65*	21.30
$^3D_3$			3	*147635.95*	
$w\ ^3P_0$	$3d^5(a\ ^2S)4p$	$w\ ^3P^\circ$	0	*148655*	260
$^3P_1$			1	*148915.3*	610.3
$^3P_2$			2	*149525.63*	
$w\ ^1G_4$	$3d^5(b\ ^2F)4p$	$w\ ^1G^\circ$	4	*149013.36*	
$5s\ ^7S_3$	$3d^5(a\ ^6S)5s$	$e\ ^7S$	3	149284.94	
$w\ ^1F_3$	$3d^5(b\ ^2F)4p$	$w\ ^1F^\circ$	3	*150654.9*	
$4d\ ^5D_0$	$3d^5(a\ ^6S)4d$	$e\ ^5D$	0	151537.83	−1.21
$^5D_1$			1	151536.62	−1.80
$^5D_2$			2	151534.82	−0.77
$^5D_3$			3	151534.05	3.65
$^5D_4$			4	151537.70	
$y\ ^1P_1$	$3d^5(a\ ^2S)4p$	$y\ ^1P^\circ$	1	*151637.3?*	
$5s\ ^5S_2$	$3d^5(a\ ^6S)5s$	$e\ ^5S$	2	151757.61	
$s\ ^3F_2$	$3d^5(b\ ^2D)4p$	$s\ ^3F^\circ$	2	*157684.3*	297.7
$^3F_3$			3	*157982.0*	580.7
$^3F_4$			4	*158562.7*	
$t\ ^3D_1$	$3d^5(b\ ^2D)4p$	$t\ ^3D^\circ$	1	*158257.3*	159.5
$^3D_2$			2	*158416.8*	312.5
$^3D_3$			3	*158729.3*	

Fe III—Continued

Authors	Config.	Desig.	J	Level	Interval
$v\ ^1F_3$	$3d^5(b\ ^2D)4p$	$v\ ^1F^\circ$	3	*159493.0*	
$v\ ^3P_2$	$3d^5(b\ ^2D)4p$	$v\ ^3P^\circ$	2	*160037.9*	
$^3P_1$			1		
$^3P_0$			0		
$w\ ^1D_2$	$3d^5(b\ ^2D)4p$	$w\ ^1D^\circ$	2	*162084.8?*	
$v\ ^3H_4$	$3d^5(b\ ^2G)4p$	$v\ ^3H^\circ$	4	*165719.1*	220.5
$^3H_5$			5	*165939.6*	247
$^3H_6$			6	*166187 ?*	
$5p\ ^7P_2$	$3d^5(a\ ^6S)5p$	$y\ ^7P^\circ$	2	*166144.66*	108.08
$^7P_3$			3	*166252.74*	168.61
$^7P_4$			4	*166421.35*	
$r\ ^3F_4$	$3d^5(b\ ^2G)4p$	$r\ ^3F^\circ$	4	*166222.2*	−276
$^3F_3$			3	*166498*	−504
$^3F_2$			2	*167002*	
$t\ ^3G_3$	$3d^5(b\ ^2G)4p$	$t\ ^3G^\circ$	3	*167085.0*	122.3
$^3G_4$			4	*167207.3*	91.6
$^3G_5$			5	*167298.9*	
$5p\ ^5P_3$	$3d^5(a\ ^6S)5p$	$w\ ^5P^\circ$	3	*168329.65*	−91.36
$^5P_2$			2	*168421.01*	−56.35
$^5P_1$			1	*168477.36*	
$w\ ^1H_5$	$3d^5(b\ ^2G)4p$	$w\ ^1H^\circ$	5	*168780.1*	
$v\ ^1G_4$	$3d^5(b\ ^2G)4p$	$v\ ^1G^\circ$	4	*169277.6?*	
$u\ ^1F_3$	$3d^5(b\ ^2G)4p$	$u\ ^1F^\circ$	3	*170310.6?*	
$4f\ ^7F_0$	$3d^5(a\ ^6S)4f$	$z\ ^7F^\circ$	0		
$^7F_1$			1		
$^7F_2$			2	*184247.3*	69.3
$^7F_3$			3	*184316.6*	58.1
$^7F_4$			4	*184374.7*	42.2
$^7F_5$			5	*184416.9*	30.8
$^7F_6$			6	*184447.7*	
$4f\ ^5F$	$3d^5(a\ ^6S)4f$	$w\ ^5F^\circ$	1 to 5	*184781±*	
$5d\ ^7D_1$	$3d^5(a\ ^6S)5d$	$f\ ^7D$	1	190393.30	4.44
$^7D_2$			2	190397.74	6.60
$^7D_3$			3	190404.34	9.25
$^7D_4$			4	190413.59	12.17
$^7D_5$			5	190425.76	
$6s\ ^7S_3$	$3d^5(a\ ^6S)6s$	$f\ ^7S$	3	190918.28	
$6s\ ^5S_2$	$3d^5(a\ ^6S)6s$	$f\ ^5S$	2	192006.99	
$5d\ ^5D_0$	$3d^5(a\ ^6S)5d$	$f\ ^5D$	0	193595.3	4.5
$^5D_1$			1	193599.8	6.3
$^5D_2$			2	193606.1	4.2
$^5D_3$			3	193610.3	0.5
$^5D_4$			4	193610.8	
$5g\ ^7G$	$3d^5(a\ ^6S)5g$	$e\ ^7G$	1 to 7	207641	
$5g\ ^5G$	$3d^5(a\ ^6S)5g$	$e\ ^5G$	2 to 6	207643±	
	Fe IV ($^6S_{2\frac{1}{2}}$)	***Limit***	-----	247200	

September 1951.

Fe III Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms																	
$3d^6$	$a\ ^1$S	$a, b\ ^3$P	$a\ ^5$D $a\ ^3$D $a\ ^1$D	$a, b\ ^3$F $a\ ^1$F	$a\ ^3$G $a, b\ ^1$G	$a\ ^3$H	$a\ ^1$I											
	ns $(n\geq 4)$							*np* $(n\geq 4)$								*nd* $(n\geq 4)$	*nf* $(n\geq 4)$	*ng* $(n\geq 5)$
$3d^5(a\ ^6$S$)nx$	$a, e, f\ ^7$S $a, e, f\ ^5$S								$z, y\ ^7$P° $z, w\ ^5$P°							$e, f\ ^7$D $e, f\ ^5$D	$z\ ^7$F° $w\ ^5$F°	$e\ ^7$G $e\ ^5$G
$3d^5(a\ ^4$G$)nx$					$a\ ^5$G $b\ ^3$G						$z\ ^5$F° $z\ ^3$F°	$z\ ^5$G° $z\ ^3$G°	$z\ ^5$H° $z\ ^3$H°					
$3d^5(a\ ^4$P$)nx$		$a\ ^5$P $c\ ^3$P						$z\ ^5$S° $z\ ^3$S°	$y\ ^5$P° $z\ ^3$P°	$z\ ^5$D° $z\ ^3$D°								
$3d^5(a\ ^4$D$)nx$			$b\ ^5$D $b\ ^3$D						$x\ ^5$P° $y\ ^3$P°	$y\ ^5$D° $y\ ^3$D°	$y\ ^5$F° $y\ ^3$F°							
$3d^5(a\ ^2$I$)nx$							$a\ ^3$I $b\ ^1$I						$y\ ^3$H° $z\ ^1$H°	$z\ ^3$I° $z\ ^1$I°	$z\ ^3$K° $z\ ^1$K°			
$3d^5(a\ ^2$D$)nx$			$c\ ^3$D $b\ ^1$D						$x\ ^3$P° $z\ ^1$P°	$x\ ^3$D° $z\ ^1$D°	$x\ ^3$F° $z\ ^1$F°							
$3d^5(a\ ^4$F$)nx$				$a\ ^5$F $d\ ^3$F						$x\ ^5$D° $v\ ^3$D°	$x\ ^5$F° $u\ ^3$F°	$y\ ^5$G° $w\ ^3$G°						
$3d^5(a\ ^2$F$)nx$				$c\ ^3$F $b\ ^1$F						$w\ ^3$D° $y\ ^1$D°	$w\ ^3$F° $y\ ^1$F°	$y\ ^3$G° $z\ ^1$G°						
$3d^5(a\ ^2$H$)nx$						$b\ ^3$H $a\ ^1$H						$x\ ^3$G° $x\ ^1$G°	$w\ ^3$H° $x\ ^1$H°	$y\ ^3$I° $y\ ^1$I°				
$3d^5(a\ ^2$G$)nx$					$c\ ^3$G $c\ ^1$G						$v\ ^3$F° $x\ ^1$F°	$v\ ^3$G° $y\ ^1$G°	$x\ ^3$H° $y\ ^1$H°					
$3d^5(b\ ^2$F$)nx$				$e\ ^3$F $c\ ^1$F						$u\ ^3$D° $x\ ^1$D°	$t\ ^3$F° $w\ ^1$F°	$u\ ^3$G° $w\ ^1$G°						
$3d^5(b\ ^2$D$)nx$			$d\ ^3$D $c\ ^1$D						$v\ ^3$P°	$t\ ^3$D° $w\ ^1$D°	$s\ ^3$F° $v\ ^1$F°							
$3d^5(b\ ^2$G$)nx$					$d\ ^3$G $d\ ^1$G						$r\ ^3$F° $u\ ^1$F°	$t\ ^3$G° $v\ ^1$G°	$v\ ^3$H° $w\ ^1$H°					
$3d^5(a\ ^2$S$)nx$									$w\ ^3$P° $y\ ^1$P°									

*For predicted terms in the spectra of the Cr I isoelectronic sequence, see Vol. II, Introduction.

Fe IV

(V I sequence; 23 electrons) Z=26

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ {}^6S_{2\frac{1}{2}}$

$a\ {}^6S_{2\frac{1}{2}}$ cm^{-1} I. P. volts

The analysis of the Fe IV spectrum is conspicuously incomplete. In 1931 Miss Gilroy published 11 terms, and 71 classified lines between 574 A and 1825 A. Later, Kruger and Gilroy reported that the three lines from the ground term, having the transition $3d^5\ {}^6S-4p\ {}^6P°$, were near 526 A, rather than between 574 A and 587 A as was stated in the earlier paper. Consequently, the relative term values published in 1931 need revision.

By analogy with Fe III, Edlén has estimated the positions of the lowest terms. These are entered in brackets in the table. The term $4p\ {}^6P°$ has been taken from the observed wave numbers of the combination with the ground state.

REFERENCES

H. T. Gilroy, Phys. Rev. **38,** 2217 (1931). (T) (C L)

P. G. Kruger and H. T. Gilroy, Phys. Rev. **48,** 720 (1935). (T) (C L)

B. Edlén, letter; Actualitées Scientifiques et Industrielles, No. 895, Part I(Hermann et Cie, Paris, 1941) (T)

Fe IV

Config.	Desig.	J	Level	Interval
$3d^5$	$3d^5\ {}^6S$	2½	0	
$3d^5$	$3d^5\ {}^4G$	2½ to 5½	[32000]	
$3d^5$	$3d^5\ {}^4P$	0½ to 2½	[35100]	
$3d^5$	$3d^5\ {}^4D$	0½ to 3½	[38500]	
$3d^5$	$3d^5\ {}^4F$	0½ to 4½	[52100]	
$3d^4(^5D)4p$	$4p\ {}^6P°$	1½ 2½ 3½	*189897* *190013* *190230*	116 217

January 1950.

Fe V

(Ti I sequence; 22 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^4\ ^5\mathrm{D}_0$

$a\ ^5\mathrm{D}_0$ cm^{-1} I. P. volts

The analysis is from Bowen who has extended White's early work and published 145 classified lines; 98 in the range from 364 A to 432 A, and 47 in the interval between 1302 A and 1554 A.

Intersystem combinations connecting the triplet and quintet systems of terms have been observed.

No series have been found and the spectrum needs further study. Bowen remarks that some ambiguity exists as to the assignment of some levels of the $z\ ^5\mathrm{D}^\circ$, $z\ ^5\mathrm{F}^\circ$ and $z\ ^3\mathrm{D}^\circ$ terms because of the overlapping of these terms. He states also that the term here labeled $x\ ^3\mathrm{G}^\circ$ may possibly be the $^3\mathrm{H}^\circ$ term from the same limit, $a\ ^2\mathrm{H}$.

REFERENCE

I. S. Bowen, Phys. Rev. **52**, 1153 (1937). (T) (C L)

Fe V

Config.	Desig.	J	Level	Interval
$3d^4$	$a\ ^5\mathrm{D}$	0	0	145
		1	145	274
		2	419	385
		3	804	481
		4	1285	
$3d^4$	$a\ ^3\mathrm{P}$	0	24054	919
		1	24973	1493
		2	26466	
$3d^4$	$a\ ^3\mathrm{H}$	4	24937	292
		5	25229	298
		6	25527	
$3d^4$	$a\ ^3\mathrm{F}$	2	26765	81
		3	26846	127
		4	26973	
$3d^4$	$a\ ^3\mathrm{G}$	3	29820	330
		4	30150	279
		5	30429	
$3d^3(a\ ^4\mathrm{F})4s$	$a\ ^5\mathrm{F}$	1	186437	299
		2	186736	426
		3	187162	563
		4	187725	676
		5	188401	
$3d^3(a\ ^4\mathrm{F})4s$	$b\ ^3\mathrm{F}$	2	195212	730
		3	195942	903
		4	196845	
$3d^3(a\ ^4\mathrm{F})4p$	$z\ ^5\mathrm{G}^\circ$	2	*254805*	601
		3	*255406*	773
		4	*256179*	963
		5	*257142*	1159
		6	*258301*	

Fe V

Config.	Desig.	J	Level	Interval
$3d^3(a\ ^4\mathrm{F})4p$	$z\ ^5\mathrm{D}^\circ$	0		
		1	*257746*	388
		2	*258134*	551
		3	*258685*	664
		4	*259349*	
$3d^3(a\ ^4\mathrm{F})4p$	$z\ ^5\mathrm{F}^\circ$	1	*258887*	493
		2	*259380*	579
		3	*259959*	569
		4	*260528*	526
		5	*261054*	
$3d^3(a\ ^4\mathrm{F})4p$	$z\ ^3\mathrm{D}^\circ$	1	*259994*	425
		2	*260419*	763
		3	*261182*	
$3d^3(a\ ^4\mathrm{F})4p$	$z\ ^3\mathrm{G}^\circ$	3	*263911*	534
		4	*264445*	672
		5	*265117*	
$3d^3(a\ ^4\mathrm{F})4p$	$z\ ^3\mathrm{F}^\circ$	2	*266625*	623
		3	*267248*	684
		4	*267932*	
$3d^3(a\ ^4\mathrm{P})4p$	$z\ ^5\mathrm{P}^\circ$	1	*273643*	493
		2	*274136*	792
		3	*274928*	
$3d^3(a\ ^2\mathrm{G})4p$	$y\ ^3\mathrm{G}^\circ$	3	*278800*	707
		4	*279507*	532
		5	*280039*	
$3d^3(a\ ^2\mathrm{H})4p$	$x\ ^3\mathrm{G}^\circ$	5	*292291*	−146
		4	*292437*	−81
		3	*292518*	

January 1949.

Fe v Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms				
$3d^4$	$a\,^3P$, $a\,^5D$, $a\,^3F$, $a\,^3G$, $a\,^3H$				
	ns ($n \geq 4$)	np ($n \geq 4$)			
$3d^3(a\,^4F)nx$	$a\,^5F$ $b\,^3F$		$z\,^5D^\circ$ $z\,^3D^\circ$	$z\,^5F^\circ$ $z\,^3F^\circ$	$z\,^5G^\circ$ $z\,^3G^\circ$
$3d^3(a\,^4P)nx$		$z\,^5P^\circ$			
$3d^3(a\,^2G)nx$					$y\,^3G^\circ$
$3d^3(a\,^2H)nx$					$x\,^3G^\circ$

*For predicted terms in the spectra of the Ti I isoelectronic sequence, see Vol. I, p. XXXVII.

Fe VI

(Sc I sequence; 21 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3\;^4F_{1\frac{1}{2}}$

$a\,^4F_{1\frac{1}{2}}$ cm^{-1} I. P. volts

The analysis is incomplete, but Bowen has classified about 100 lines in the region between 276 A and 318 A. Intersystem combinations connecting the doublet and quartet systems of terms have been observed.

REFERENCES

I. S. Bowen, Phys. Rev. **47**, 924 (1935). (T) (C L)
S. Pasternack, Astroph. J. **92**, 140 (1940). (T)

Fe VI

Config.	Desig.	J	Level	Interval
$3d^3$	$a\ ^4F$	1½	0	510
		2½	510	675
		3½	1185	809
		4½	1994	
$3d^3$	$a\ ^4P$	0½	18734	203
		1½	18937	664
		2½	19601	
$3d^3$	$a\ ^2G$	3½	20609	696
		4½	21305	
$3d^3$	$a\ ^2P$	1½	26204	−279
		0½	26483	
$3d^3$	$a\ ^2D$	2½	28469	−138
		1½	28607	
$3d^3$	$a\ ^2H$	4½	28723	473
		5½	29196	
$3d^2(a\ ^3F)4p$	$z\ ^4G°$	2½	*338256*	1221
		3½	*339477*	1452
		4½	*340929*	1794
		5½	*342723*	
$3d^2(a\ ^3F)4p$	$z\ ^4F°$	1½	*339538*	803
		2½	*340341*	1020
		3½	*341361*	1065
		4½	*342426*	
$3d^2(a\ ^3F)4p$	$z\ ^5F°$	2½	*342570*	1030
		3½	*343600*	
$3d^2(a\ ^3F)4p$	$z\ ^4D°$	0½	*343619*	−409
		1½	*343210*	1060
		2½	*344270*	1149
		3½	*345419*	
$3d^2(a\ ^3F)4p$	$z\ ^2D°$	1½	*344656*	1252
		2½	*345908*	
$3d^2(a\ ^3F)4p$	$z\ ^2G°$	3½	*348962*	1054
		4½	*350016*	
$3d^2(a\ ^3P)4p$	$z\ ^4S°$	1½	*355652*	
$3d^2(a\ ^3P)4p$	$y\ ^4D°$	0½	*359104*	680
		1½	*359784*	921
		2½	*360705*	1560
		3½	*362265*	
$3d^2(a\ ^3P)4p$	$z\ ^4P°$	0½	*363944*	446
		1½	*364390*	1102
		2½	*365492*	
$3d^2(a\ ^1G)4p$	$y\ ^2G°$	3½	*365077*	185
		4½	*365262*	
$3d^2(a\ ^1G(4p$	$z\ ^2H°$	4½	*372096*	1606
		5½	*373702*	

December 1948.

Fe VI Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms					
$3d^3$		$a\ ^4P$		$a\ ^4F$		
		$a\ ^2P$	$a\ ^2D$		$a\ ^2G$	$a\ ^2H$
	$np\ (n\geq 4)$					
$3d^2(a\ ^3F)nx$			$z\ ^4D°$	$z\ ^4F°$	$z\ ^4G°$	
			$z\ ^2D°$	$z\ ^2F°$	$z\ ^2G°$	
$3d^2(a\ ^3P)nx$	$z\ ^4S°$	$z\ ^4P°$	$y\ ^4D°$			
$3d^2(a\ ^1G)nx$					$y\ ^2G°$	$z\ ^2H°$

*For predicted terms in the spectra of the Sc I isoelectronic sequence, see Vol. I, p. XXXVI.

Fe VII

(Ca I sequence; 20 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^2\ {}^3F_2$

$a\ {}^3F_2$ cm^{-1} I. P. volts

The early analysis by Cady, who classified 33 lines between 231 A and 245 A, has been revised and extended by Edlén. The present term list is from Edlén's manuscript, kindly furnished by him for inclusion here in advance of publication.

The prefix "y" is assigned to the $^1P°$ and $^3D°$ terms from the $4f$ configuration on the assumption that the similar terms from the $4p$ configuration, which have not yet been found, will be lower and should, therefore, be assigned the prefix "z".

REFERENCES

W. M. Cady, Phys. Rev. **43**, 324 (1933). (T) (C L)
I. S. Bowen and B. Edlén, Nature **143**, 374 (1939). (T) (C L)
B. Edlén, unpublished material (Feb. 1949). (T)

Fe VII

Config.	Desig.	J	Level	Interval
$3d^2$	$a\ {}^3F$	2	0	1047
		3	1047	1280
		4	2327	
$3d^2$	$a\ {}^1D$	2	17475	
$3d^2$	$a\ {}^3P$	0	20037	391
		1	20428	847
		2	21275	
$3d^2$	$a\ {}^1G$	4	28915	
$3d(^2D)4p$	$z\ {}^1D°$	2	*425388*	
$3d(^2D)4p$	$z\ {}^3F°$	2		
		3	*431606*	2264
		4	*433870*	
$3d(^2D)4p$	$z\ {}^3P°$	0	*437010*	−47
		1	*436963*	604
		2	*437567*	
$3d(^2D)4p$	$z\ {}^1F°$	3	*439812*	
$3d(^2D)4f$	$z\ {}^1G°$	4	*659923*	

Fe VII

Config.	Desig.	J	Level	Interval
$3d(^2D)4f$	$y\ {}^3F°$	2	*660022*	338
		3	*660360*	816
		4	*661176*	
$3d(^2D)4f$	$z\ {}^3G°$	3	*663104*	849
		4	*663953*	530
		5	*664483*	
$3d(^2D)4f$	$y\ {}^1D°$	2	*663882*	
$3d(^2D)4f$	$y\ {}^1F°$	3	*665425*	
$3d(^2D)4f$	$y\ {}^3D°$	1	*665843*	82
		2	*665925*	738
		3	*666663*	
$3d(^2D)4f$	$y\ {}^3P°$	3	*667903*	−362
		1	*668265*	−232
		0	*668497*	
$3d(^2D)4f$	$z\ {}^1H°$	5	*669978*	
$3d(^2D)4f$	$y\ {}^1P°$	1	*671470*	

March 1949.

Fe VII Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms	
$3d^2$	$a\ {}^3P$, $a\ {}^1D$, $a\ {}^3F$, $a\ {}^1G$	
	$np\ (n\geq 4)$	$nf\ (n\geq 4)$
$3d(^2D)nx$	$z\ {}^3P°$, $z\ {}^1D°$, $z\ {}^3F°$, $z\ {}^1F°$	$y\ {}^3P°$, $y\ {}^1P°$, $y\ {}^3D°$, $y\ {}^1D°$, $y\ {}^3F°$, $y\ {}^1F°$, $z\ {}^3G°$, $z\ {}^1G°$, $z\ {}^1H°$

*For predicted terms in the spectra of the Ca I isoelectronic sequence, see Vol. I, p. xxxv.

Fe VIII

(K I sequence; 19 electrons) $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d\ ^2D_{1\frac{1}{2}}$

$3d\ ^2D_{1\frac{1}{2}}$ **1219360** cm^{-1} I. P. 151 volts

The analysis is by Kruger and Weissberg, who have classified 15 lines in the interval 93 A to 370 A.

REFERENCE

P. G. Kruger and S. G. Weissberg, Phys. Rev. **52**, 316 (1937). (I P) (T) (C L)

Fe VIII

Config.	Desig.	*J*	Level	Interval
$3p^6(^1S)3d$	$3d\ ^2D$	1½ 2½	0 1875	1875
$3p^6(^1S)4p$	$4p\ ^2P^\circ$	0½ 1½	*510084* *513447*	3363
$3p^6(^1S)4f$	$4f\ ^2F^\circ$	2½ 3½	*763714* *763821*	107
$3p^6(^1S)5s$	$5s\ ^2S$	0½	783402	
$3p^6(^1S)5f$	$5f\ ^2F^\circ$	2½ 3½	*927024* *927084*	60
$3p^6(^1S)6s$	$6s\ ^2S$	0½	960135	
$3p^6(^1S)6f$	$6f\ ^2F^\circ$	2½ 3½	*1016828* *1016877*	49
$3p^6(^1S)7f$	$7f\ ^2F^\circ$	2½ 3½	*1072765* *1072875*	110
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Fe IX ($^1S_0$)	*Limit*	---	**1219360**	

May 1948.

Fe IX

(A I sequence; 18 electrons) $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ ^1S_0$

$3p^6\ ^1S_0$ **1893000** cm^{-1} I. P. 235 volts

Two lines, at 103 A and 105 A, respectively, are classified as combinations with the ground term. The tabular values have been rounded off in the last places. Apparently the limit and the 5*s*-level are extrapolated from isoelectronic data, as indicated by brackets in the table.

For convenience, the Paschen notation has been added by the writer in column one under the heading "A I". As for A I, the *jl*-coupling notation in the general form suggested by Racah is here introduced, although *LS*-designations indicated in column two under the heading "Authors" are perhaps preferable for the terms thus far identified.

REFERENCES

P. G. Kruger, S. G. Weissberg and L. W. Phillips, Phys. Rev. **51**, 1090 (1937). (I P) (T) (C L)
G. Racah, Phys. Rev. **61**, 537 (L) (1942).

Fe IX

A I	Authors	Config.	Desig.	J	Level
$1p_0$	$3p^6\ ^1S$	$3p^6$	$3p^6\ ^1S$	0	0
$1s_4$	$3p^5\ 4s\ \ ^3P^\circ$	$3p^5(^2P^\circ_{1\frac{1}{2}})4s$	$4s\ [1\frac{1}{2}]^\circ$	2 1	*950200*
$1s_2$	$3p^5\ 4s\ \ ^1P^\circ$	$3p^5(^2P^\circ_{0\frac{1}{2}})4s$	$4s'\ [0\frac{1}{2}]^\circ$	0 1	*965400*
$2s_4$	$3p^5\ 5s\ \ ^3P^\circ$	$3p^5(^2P^\circ_{1\frac{1}{2}})5s$	$5s\ [1\frac{1}{2}]^\circ$	2 1	[*1355000*]
		-----------	-------	---	---------
		Fe x $(^2P^\circ_{1\frac{1}{2}})$	***Limit***	---	[***1893000***]

May 1948.

Fe X

(Cl I sequence; 17 electrons) $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ ^2P^\circ_{1\frac{1}{2}}$

$3p^5\ ^2P^\circ_{1\frac{1}{2}}$ ***2114000*** cm^{-1} I. P. 262 volts

Edlén has classified eight lines in the region between 94 A and 97 A, as combinations from the ground term. He has confirmed Grotrian's suggestion that the strong coronal line at 6374.51 A (wave number 15683.2 cm^{-1}) may be due to the forbidden transition $3p^5\ ^2P^\circ_{1\frac{1}{2}}-3p^5\ ^2P^\circ_{0\frac{1}{2}}$.

He has extrapolated the value of the limit along the isoelectronic sequence, as indicated by brackets in the table.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Zeit. Phys. **104**, 407 (1937). (I P) (T) (C L)
W. Grotrian, Naturwiss. **27**, 214 (1939).
B. Edlén, Zeit. Astroph. **22**, 30 (1942). (T) (C L)

Fe X

Config.	Desig.	J	Level	Interval
$3s^2\ 3p^5$	$3p^5\ ^2P^\circ$	$1\frac{1}{2}$ $0\frac{1}{2}$	*0* *15683*	−15683
$3s^2\ 3p^4(^3P)4s$	$4s\ \ ^4P$	$2\frac{1}{2}$ $1\frac{1}{2}$ $0\frac{1}{2}$	1022100 1029630	−7530
$3s^2\ 3p^4(^3P)4s$	$4s\ \ ^2P$	$1\frac{1}{2}$ $0\frac{1}{2}$	1040350 1048900	−8550
$3s^2\ 3p^4(^1D)4s$	$4s'\ ^2D$	$2\frac{1}{2}$ $1\frac{1}{2}$	1063690 1064190	−500
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Fe xi $(^3P_2)$	***Limit***	---	[***2114000***]	

January 1950.

Fe XI

(S I sequence; 16 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^4\;{}^3P_2$

$3p^4\;{}^3P_2$ **2342000 cm^{-1}** I. P. 290 volts

Edlén has classified 12 lines in the region from 86 A to 90 A. He has extrapolated the value of the limit from isoelectronic sequence data and also the value of $3p^4\;{}^1S_0$, entered in brackets in the table.

Following Grotrian's suggestion, Edlén has tentatively identified two coronal lines as due to the following forbidden transitions:

I. A.	Int.	Wave No.	Desig.
3986. 9	0. 7	25075	$3p^4\;{}^3P_1-3p^4\;{}^1D_2$
7891. 94	13	12667. 7	$3p^4\;{}^3P_2-3p^4\;{}^3P_1$

The singlet and triplet terms are connected by the intersystem combination furnished by the coronal line at 3986 A.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Zeit. Phys. **104,** 188 (1937). (I P) (T) (C L)
W. Grotrian, Naturwiss. **27,** 214 (1939).
B. Edlén, Zeit. Astroph. **22,** 30 (1942). (C L)
B. Edlén, letter (January 1950). (T)

Fe XI

Config.	Desig.	J	Level	Interval
$3s^2\,3p^4$	$3p^4\;{}^3P$	2 1 0	0 12668 14440	−12668 −1772
$3s^2\,3p^4$	$3p^4\;{}^1D$	2	37743	
$3s^2\,3p^4$	$3p^4\;{}^1S$	0	[80300]	
$3s^2\,3p^3(^4S^\circ)4s$	$4s\;\;{}^3S^\circ$	1	*1121270*	
$3s^2\,3p^3(^2D^\circ)4s$	$4s'\;{}^3D^\circ$	1 2 3	*1148650* *1149100* *1152450*	450 3350
$3s^2\,3p^3(^2D^\circ)4s$	$4s'\;{}^1D^\circ$	2	*1160020*	
$3s^2\,3p^3(^2P^\circ)4s$	$4s''\;{}^1P^\circ$	1	*1193640*	
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Fe XII ($^4S^\circ_{1\frac{1}{2}}$)	***Limit***	---	**[2342000]**	

January 1950.

Fe XIII

(Si I sequence; 14 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^2\,{}^3P_0$

$3p^2\,{}^3P_0$ cm^{-1} I. P. 355 volts

In his classical work on the identification of the coronal lines Edlén suggests that three strong coronal lines may be attributed to [Fe XIII] as follows:

I. A.	Int.	Wave No.	Desig.
3388. 1	16	29507	$3p^2\,{}^3P_2-3p^2\,{}^1D_2$
10746. 80	55	9302. 5	$3p^2\,{}^3P_0-3p^2\,{}^3P_1$
10797. 95	35	9258. 5	$3p^2\,{}^3P_1-3p^2\,{}^3P_2$

The coronal wave numbers are in satisfactory agreement with the theoretical values predicted from isoelectronic sequence data. The term values in the table have been calculated from the coronal wave numbers, with the exception of $3p^2\,{}^1S$ for which Edlén's estimated value is entered in brackets. Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Astroph. **22,** 40 (1942). (I P) (T) (C L)

Fe XIII

Config.	Desig.	J	Level	Interval
$3s^2\,3p^2$	$3p^2\,{}^3P$	0	0. 0	
		1	9302. 5	9302. 5
		2	18561. 0	9258. 5
$3s^2\,3p^2$	$3p^2\,{}^1D$	2	48068	
$3s^2\,3p^2$	$3p^2\,{}^1S$	0	[82000]	

October 1947.

Fe XIV

(Al I sequence; 13 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p\ ^2P^\circ_{½}$

$3p\ ^2P^\circ_{½}$ cm^{-1} I. P. 390 volts

Astrophysically, the spectrum of Fe XIV is one of the most significant, although only two lines have been classified in the laboratory spectrum. In his classical papers on the identification of the coronal lines Edlén has suggested that the conspicuous coronal line at 5302.86 A, wave number 18852.5 cm^{-1} and intensity 100, may be due to the forbidden transition that corresponds to the interval of the ground term of Fe XIV, i. e., $3p\ ^2P^\circ_{0½}-3p\ ^2P^\circ_{1½}$.

He also classifies two lines as follows:

I. A.	Int.	Wave No.	Desig.
58. 963	2	1695980	$3p\ ^2P^\circ - 4d\ ^2D$
59. 579	3	1678440	

His unit, 10^3 cm^{-1}, is here changed to cm^{-1}.

REFERENCES

B. Edlén, Zeit. Phys. **103,** 540 (1936). (C L)
B. Edlén, Zeit. Astroph. **22,** 47 (1942). (I P) (T) (C L)

December 1947.

Fe XV

(Mg I sequence; 12 electrons) $Z=26$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\ ^1S_0$

$3s^2\ ^1S_0$ **3684000** cm^{-1} I. P. 457 volts

Edlén has classified eight lines in the region between 55 A and 70 A. No singlet combinations have been observed and the triplet terms are not all connected by observed combinations. He has determined the relative positions of the terms and also the ionization potential by extrapolation along the isoelectronic sequence. Estimated values are denoted by brackets in the table.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103,** 536 (1936). (I P) (T) (C L)

Fe XV

Config.	Desig.	J	Level	Interval
$3s^2$	$3s^2\ ^1S$	0	0	
$3s(^2S)3p$	$3p\ ^3P^\circ$	0 1 2	[*235690*]+x *241490* +x *255610* +x	5800 14120
$3s(^2S)3d$	$3d\ ^3D$	1 2 3	 687570 +x	
$3s(^2S)4p$	$4p\ ^1P^\circ$	1	[*1889970*]	
$3s(^2S)4d$	$4d\ ^3D$	1 2 3	2033120 +x 2033830 +x 2034970 +x	710 1140
$3s(^2S)4f$	$4f\ ^3F^\circ$	2 3 4	 *2115040* +x	
$3s(^2S)5f$	$5f\ ^3F^\circ$	2 3 4	 *2682780* +x	
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Fe XVI ($^2S_{½}$)	***Limit***	---	[3684000]	

August 1947.

Fe XVI

(Na I sequence; 11 electrons) $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s\ ^2S_{½}$

$3s\ ^2S_{½}$ **3947840** cm^{-1} I. P. 489 volts

Edlén has classified 13 lines in the interval 39 A to 66 A, and extrapolated the absolute value of the ground term from isoelectronic sequence data. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **100,** 621 (1936). (I P) (T) (C L)

Fe XVI

Config.	Desig.	J	Level	Interval
$3s$	$3s\ ^2S$	$0\frac{1}{2}$	0	
$3p$	$3p\ ^2P^\circ$	$0\frac{1}{2}$ $1\frac{1}{2}$	*276500* *297470*	20970
$3d$	$3d\ ^2D$	$1\frac{1}{2}$ $2\frac{1}{2}$	676930 679770	2840
$4s$	$4s\ ^2S$	$0\frac{1}{2}$	1866860	
$4p$	$4p\ ^2P^\circ$	$0\frac{1}{2}$ $1\frac{1}{2}$	*1978040* *1986100*	8060
$4d$	$4d\ ^2D$	$1\frac{1}{2}$ $2\frac{1}{2}$	2123500 2124690	1190
$4f$	$4f\ ^2F^\circ$	$2\frac{1}{2}$ $3\frac{1}{2}$	*2186070* *2186570*	500
$5d$	$5d\ ^2D$	$1\frac{1}{2}$ $2\frac{1}{2}$	2787360 2787940	580
$5f$	$5f\ ^2F^\circ$	$2\frac{1}{2}$ $3\frac{1}{2}$	*2820050* *2820270*	220
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Fe XVII ($^1S_0$)	*Limit*	---	[3947840]	

June 1947.

Fe XVII

(Ne I sequence; 10 electrons) $Z=26$

Ground state $1s^2\ 2s^2\ 2p^6\ ^1S_0$

$2p^6\ ^1S_0$ **10211700** cm^{-1} I. P. 1266 volts

Tyrén has classified nine lines in the region 12 A to 17 A, as combinations with the ground term. His absolute term values have been derived by extrapolation along the Ne I isoelectronic sequence.

By analogy with Ne I, the *jl*-coupling notation in the general form suggested by Racah is introduced.

The unit adopted by Tyrén, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

F. Tyrén, Zeit. Phys. **111,** 314 (1938). (I P) (T) (C L)
G. Racah, Phys. Rev. **61,** 537 (L) (1942).

Fe XVII

Author	Config.	Desig.	J	Level
$2p\ ^1S_0$	$2s^2\ 2p^6$	$2p^6\ ^1S$	0	0
	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})3s$	$3s\ [1\frac{1}{2}]^\circ$	2	
$3s\ ^3P_1$			1	*5864800*
	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})3s$	$3s'[0\frac{1}{2}]^\circ$	0	
$3s\ ^1P_1$			1	*5961600*
	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})3d$	$3d\ [0\frac{1}{2}]^\circ$	0	
$3d\ ^3P_1$			1	*6471200*
$3d\ ^1P_1$	"	$3d\ [1\frac{1}{2}]^\circ$	1	*6552700*
$3d\ ^3D_1$	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})3d$	$3d'[1\frac{1}{2}]^\circ$	1	*6661300*
	$2s\ 2p^6(^2S)3p$	$3p\ ^3P^\circ$	2	
$3p'\ ^3P_1$			1	*7201000*
			0	
$3p'\ ^1P_1$	$2s\ 2p^6(^2S)3p$	$3p\ ^1P^\circ$	1	*7235900*
$4d\ ^1P_1$	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})4d$	$4d\ [1\frac{1}{2}]^\circ$	1	*8155000*
$4d\ ^3D_1$	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})4d$	$4d'[1\frac{1}{2}]^\circ$	1	*8250000*
	Fe XVIII $(^2P^\circ_{1\frac{1}{2}})$	***Limit***	-------	**[10211700]**
	Fe XVIII $(^2P^\circ_{0\frac{1}{2}})$	*Limit*	-------	[10313800]

March 1947.

Fe XVII Observed Levels*

Config. $1s^2+$	Observed Terms		
$2s^2\ 2p^6$	$2p^6\ ^1S$		
	$ns\ (n\geq 3)$	$np\ (n\geq 3)$	$nd\ (n\geq 3)$
$2s^2\ 2p^5(^2P^\circ)nx$	$3s\ ^3P^\circ$ $3s\ ^1P^\circ$		$3d\ ^3P^\circ$ $3,\ 4d\ ^1P^\circ$ $3,\ 4d\ ^3D^\circ$
$2s\ 2p^6(^2S)nx$		$3p\ ^3P^\circ$ $3p\ ^1P^\circ$	

jl—Coupling Notation

Config. $1s^2+$	Observed Pairs		
	$ns\ (n\geq 3)$		$nd\ (n\geq 3)$
$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})nx$	$3s\ [1\frac{1}{2}]^\circ$		$3d\ [0\frac{1}{2}]^\circ$ $3,\ 4d\ [1\frac{1}{2}]^\circ$
$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})nx'$	$3s'[0\frac{1}{2}]^\circ$		$3,\ 4d'[1\frac{1}{2}]^\circ$

*For predicted levels in the spectra of the Ne I isoelectronic sequence, see Vol. I, p. xxxi.

COBALT

Co I

27 electrons $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^2\ {}^4F_{4\frac{1}{2}}$

$a\ {}^4F_{4\frac{1}{2}}$ **63438 cm⁻¹** I. P. 7.86 ± 0.02 volts

The number of terms known in this complex spectrum is 99; in addition, there are 43 miscellaneous levels which are not yet grouped into terms. Combinations among these give 2725 classified lines in the range between 1814 A and 11894 A, and include 768 multiplets. The terms of all multiplicities are connected by observed intersystem combinations.

In 1936 Catalán and Antunes published a detailed analysis, classifying 2076 lines. The terms in the table are from the 1940 paper by Russell, King, and Moore. Their analysis was begun without knowledge that Catalán and Antunes were investigating the spectrum. It was continued because further observations in the infrared and ultraviolet, together with extensive data on the Zeeman effect, made it possible to revise and extend the earlier work.

Some of the electron configurations of the low even terms were assigned on the basis of the theoretical results by Marvin. Racah suggests that two of these assignments should be interchanged, as follows:

Term	R K M	Racah
$a\ {}^4P$	$3d^8\ 4s$	$3d^7\ 4s^2$
$b\ {}^4P$	$3d^7\ 4s^2$	$3d^8\ 4s$

This change was subsequently confirmed by Shenstone, and is adopted in the table. Further changes suggested by Shenstone by analogy with Ni II and Cu III have also been adopted, namely, the configuration assignments published in the 1940 reference below have been interchanged for the following pairs of terms: $y\ {}^2H^\circ$, $x\ {}^2H^\circ$; $y\ {}^4S^\circ$, $x\ {}^4S^\circ$.

Roth and Bartunek observed Zeeman patterns of 151 lines of Co I between 3200 A and 6500 A. Later and more extensive observations by R. B. King and A. S. King are in good general agreement with their results. The two-place entries in the table are from the Kings' observations. Those given to three places are from unpublished material by Miss Weeks, who derived them from the films made at the Massachusetts Institute of Technology and furnished by G. R. Harrison.

The limit has been determined by estimating the Rydberg denominators by comparison with neighboring elements. Russell's value is 63536 cm⁻¹, while that of Catalán and Antunes, using the same method, is 63339 cm⁻¹. The mean of these two values, 63438 cm⁻¹, is given here.

Russell has remarked that the convergence of the components of selected terms of Co I to the components of the limit terms in Co II is of interest: "Catalán and Antunes have shown that among the terms which have $d^8\ {}^3F$ as limit, the quartet and doublet components of lowest J go to ${}^3F_2$, those of next higher J to ${}^3F_3$, leaving *two* high J quartet components for ${}^3F_4$." This "inverted" convergence was found by Russell for the limit $d^9\ {}^2D$ in Ni II (see text for Ni I).

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H. H. Marvin, Phys. Rev. **47**, 521 (1935).
F. L. Roth and P. F. Bartunek, Phys. Rev. **47**, 526 (1935). (C L) (Z E)
M. A. Catalán and M. T. Antunes, Anal. Soc. Esp. de Fisica y Quimica (Madrid) **34**, 103–145, 207–297 (1936). (I P) (T) (C L)
H. N. Russell, R. B. King, and C. E. Moore, Phys. Rev. **58**, 407 (1940). (I P) (T) (C L) (Z E)
G. Racah, Phys. Rev. **61**, 537 (1942).
M. T. Antunes, Phys. Rev. **62**, 362 (1942).
A. G. Shenstone, private communication (April 1950).
J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)
D. W. Weeks, unpublished material (March 1951). (Z E)

Config.	Desig.	J	Level	Interval	Obs. g
$3d^7\,4s^2$	$a\ ^4F$	4½	0.00	−816.00	1.32
		3½	816.00	−590.84	1.237
		2½	1406.84	−402.49	1.028
		1½	1809.33		0.402
$3d^8(a\ ^3F)4s$	$b\ ^4F$	4½	3482.82	−659.84	1.336
		3½	4142.66	−547.52	1.239
		2½	4690.18	−385.65	1.031
		1½	5075.83		0.404
$3d^8(a\ ^3F)4s$	$a\ ^2F$	3½	7442.41	−1018.40	1.147
		2½	8460.81		0.862
$3d^7\,4s^2$	$a\ ^4P$	2½	13795.52	−240.76	1.604
		1½	14036.28	−363.00	1.722
		0½	14399.28		2.651
$3d^8(^3P)4s$	$b\ ^4P$	2½	15184.04	−590.00	1.515
		1½	15774.04	−421.64	1.476
		0½	16195.68		2.682
$3d^7\,4s^2$	$a\ ^2G$	4½	16467.90	−765.78	1.109
		3½	17233.68		0.883
$3d^8(^1D)4s$	$a\ ^2D$	1½	16470.60	307.56	1.101
		2½	16778.16		1.296
$3d^8(^3P)4s$	$a\ ^2P$	1½	18389.57	−385.44	1.300
		0½	18775.01		0.695
$3d^7\,4s^2$	$b\ ^2P$	1½	20500.71	−715.19	1.284
		0½	21215.90		0.680
$3d^7\,4s^2$	$a\ ^2H$	5½	21780.47	−694.89	1.100
		4½	22475.36		0.921
$3d^8(^1G)4s$	$b\ ^2D$	2½	21920.09	−1232.48	1.180
		1½	23152.57		0.955
$3d^7\,4s^2$	$b\ ^2G$	4½	23184.23	−23.53	1.098
		3½	23207.76		0.883
$3d^7\,4s(a\ ^5F)4p$	$z\ ^6F^\circ$	5½	23611.78	−243.84	1.466
		4½	23855.62	−470.49	1.481
		3½	24326.11	−407.17	1.436
		2½	24733.28	−307.88	1.336
		1½	25041.16	−191.63	1.118
		0½	25232.79		−0.622
$3d^7\,4s(a\ ^5F)4p$	$z\ ^6D^\circ$	4½	24627.79	−641.46	1.569
		3½	25269.25	−470.68	1.550
		2½	25739.93	−323.18	1.612
		1½	26063.11	−187.38	1.812
		0½	26250.49		3.286
$3d^7\,4s(a\ ^5F)4p$	$z\ ^6G^\circ$	6½	25138.88	−429.80	1.40
		5½	25568.68	−368.91	1.354
		4½	25937.59	−294.46	1.281
		3½	26232.05	−217.97	1.150
		2½	26450.02	−147.62	0.876
		1½	26597.64		0.006
$3d^9$	$c\ ^2D$	2½	27497.06	−973.45	1.200
		1½	28470.51		0.907
$3d^7\,4s(a\ ^5F)4p$	$z\ ^4F^\circ$	4½	28345.86	−431.41	1.330
		3½	28777.27	−439.10	1.247
		2½	29216.37	−346.80	1.033
		1½	29563.17		0.410
$3d^7\,4s(a\ ^5F)4p$	$z\ ^4G^\circ$	5½	28845.22	−424.51	1.276
		4½	29269.73	−465.45	1.175
		3½	29735.18	−367.78	0.995
		2½	30102.96		0.577
$3d^7\,4s(a\ ^5F)4p$	$z\ ^4D^\circ$	3½	29294.52	−654.24	1.425
		2½	29948.76	−494.87	1.359
		1½	30443.63	−299.02	1.192
		0½	30742.65		−0.006
$3d^7\,4s(b\ ^3F)4p$	$z\ ^2G^\circ$	4½	31699.69	−1033.38	1.126
		3½	32733.07		0.899

Config.	Desig.	J	Level	Interval	Obs. g
$3d^7\,4s(b\ ^3F)4p$	$z\ ^2F^\circ$	3½	31871.15	−910.56	1.177
		2½	32781.71		0.870
$3d^8(a\ ^3F)4p$	$y\ ^4D^\circ$	3½	32027.50	−627.00	1.395
		2½	32654.50	−496.18	1.366
		1½	33150.68	−298.50	1.195
		0½	33449.18		0.012
$3d^8(a\ ^3F)4p$	$y\ ^4G^\circ$	5½	32430.59	−34.14	1.287
		4½	32464.73	−708.63	1.154
		3½	33173.36	−501.02	1.039
		2½	33674.38		0.704
$3d^8(a\ ^3F)4p$	$y\ ^4F^\circ$	4½	32841.99	−624.88	1.313
		3½	33466.87	−479.03	1.155
		2½	33945.90	−250.31	0.900
		1½	34196.21		0.430
$3d^8(a\ ^3F)4p$	$y\ ^2G^\circ$	4½	33439.72	−693.87	1.165
		3½	34133.59		0.917
$3d^7\,4s(b\ ^3F)4p$	$z\ ^2D^\circ$	2½	33462.83	−889.59	1.186
		1½	34352.42		0.787
$3d^8(a\ ^3F)4p$	$y\ ^2F^\circ$	3½	35450.56	−879.30	1.145
		2½	36329.86		0.892
$3d^8(a\ ^3F)4p$	$y\ ^2D^\circ$	2½	36092.44	−782.69	1.186
		1½	36875.13		0.794
$3d^7\,4s(b\ ^3F)4p$	$x\ ^4D^\circ$	3½	39649.16	−696.79	1.428
		2½	40345.95	−481.82	1.370
		1½	40827.77	−274.03	1.240
		0½	41101.80		0.026
$3d^7\,4s(a\ ^5P)4p$	$z\ ^4S^\circ$	1½	40621.62		2.017
	1°	3½	41041.43		1.40
	2°	2½	41104.96		1.863
$3d^7\,4s(b\ ^3F)4p$	$x\ ^4F^\circ$	4½	41225.76	−692.65	1.319
		3½	41918.41	−515.82	1.248
		2½	42434.23	−362.44	1.024
		1½	42796 67		0.406
$3d^7\,4s(b\ ^3F)4p$	$x\ ^4G^\circ$	5½	41528.53	−740.79	1.291
		4½	42269.32	−542.12	1.169
		3½	42811.44	−388.21	1.004
		2½	43199.65		0.649
$3d^7\,4s(a\ ^5P)4p$	$z\ ^4P^\circ$	2½	41968.89	−13.77	1.627
		1½	41982.66	12.76	1.732
		0½	41969.90		2.51
	3°	3½	42988.12		
$3d^8(^1D)4p$	$z\ ^2P^\circ$	0½	43130.24	407.47	0.727
		1½	43537.71		1.120
$3d^7\,4s(a\ ^5P)4p$	$w\ ^4D^\circ$	3½	43398.62	155.67	1.334
		2½	43242.95	−20.62	1.101
		1½	43263.57	−172.01	1.191
		0½	43435.58		0.169
$3d^7\,4s(^3G)4p$	$w\ ^4F^\circ$	4½	43295.32	−552.66	1.295
		3½	43847.98	−353.94	1.197
		2½	44201.92	−353.79	0.950
		1½	44555.71		0.415
$3d^7\,4s(^3G)4p$:	$x\ ^2F^\circ$	2½	43425.71	129.51	1.119
		3½	43555.22		1.229
$3d^8(^1D)4p$	$x\ ^2D^\circ$	1½	43911.36	10.53	1.127
		2½	43921.89		1.230
$3d^7\,4s(^3G)4p$	$w\ ^4G^\circ$	5½	43952.06:	−231.28	1.279
		4½	44183.34	−211.13	1.163
		3½	44394.47	−174.00	1.004
		2½	44568.47		0.676
	4°	3½	43969.90		1.081

Co I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
	5°	1½	44381.32:		
$3d^7 4s(^3P)4p$:	$z\ ^2S^\circ$	0½	44454.51		2.10
$3d^8(^3P)4p$	$y\ ^4P^\circ$	2½ 1½ 0½	44480.14 44658.03 44857.57	−177.89 −199.54	1.557 1.674 2.371
$3d^8\ (a\ ^3F)5s$	$e\ ^4F$	4½ 3½ 2½ 1½	44782.13 45105.59 45876.58 46375.17	−323.46 −770.99 −498.59	1.33 1.21 1.01 0.44
$3d^7 4s(^3G)4p$	$z\ ^2H^\circ$	4½ 5½	45111.48 45540.28	428.80	0.897 1.097
$3d^7 4s(a\ ^5F)5s$	$e\ ^6F$	5½ 4½ 3½ 2½ 1½ 0½	45676.00 46223.01 46706.83 47090.65 47364.73 47528.44	−547.01 −483.82 −383.82 −274.08 −163.71	1.475 1.443 1.396 1.301 1.054 −0.666
$3d^8(^3P)4p$:	$w\ ^2D^\circ$	2½ 1½	45688.15 46454.95	−766.80	1.219 0.869
$3d^7 4s(^3G)4p$	$x\ ^2G^\circ$	3½ 4½	45766.63 46032.10	265.47	0.898 1.131
$3d^7 4s(^3P)4p$	$x\ ^4P^\circ$	0½ 1½ 2½	45957.29 45904.68 46002.83	−52.61 98.15	2.522 1.674 1.543
$3d^8(a\ ^3F)5s$	$e\ ^2F$	3½ 2½	45924.98 46746.00	−821.02	1.14 0.49:
$3d^8(^3P)4p$	$v\ ^4D^\circ$	3½ 2½ 1½ 0½	45971.19 46329.63 46260.02 46502.15	−358.44 69.61 −242.13	1.424 1.365 1.508 0.161
$3d^7 4s(^3P)4p$:	$v\ ^2D^\circ$	1½ 2½	46186.41 46671.94	485.53	1.218 1.233
$3d^7 4s(^3P)4p$	$y\ ^4S^\circ$	1½	46562.87		1.273
$3d^7 4s(^3P)4p$:	$y\ ^2P^\circ$	1½ 0½	46685.43 47091.14	−405.71	1.352 0.656
	$u\ ^4D^\circ$	3½ 2½ 1½ 0½	46872.74 47393.93 47612.18 47905.26	−521.19 −218.25 −293.08	1.332 1.324 1.122 0.016
$3d^8(^1D)4p$:	$w\ ^2F^\circ$	2½ 3½	47128.96 47225.11	96.15	0.858 1.229
$3d^7 4s(a\ ^5F)5s$	$f\ ^4F$	4½ 3½ 2½ 1½	47524.47 48201.60 48718.57 49078.43	−677.13 −516.97 −359.86	1.328 1.226 1.041 0.401
	6°	3½?	47839.15		
$3d^8(^3P)4p$:	$y\ ^2S^\circ$	0½	47977.94		2.093
$3d^7 4s(^3P)4p$:	$x\ ^2S^\circ$	0½	48026.34		1.699
$3d^8(^3P)4p$:	$x\ ^2P^\circ$	0½ 1½	48160.43: 48334.37	173.94	1.204 1.436
$3d^7 4s(^3P)4p$	$t\ ^4D^\circ$	3½ 2½ 1½ 0½	48217.32 48443.76 48546.07 48571.77	−226.44 −102.31 −25.70	1.211 1.340 1.050 0.452
	$v\ ^2F^\circ$	3½ 2½	48317.17 48615.56:	−298.39	1.173 0.619
$3d^8(^3P)4p$	$x\ ^4S^\circ$	1½	48753.72		1.728
	7°	2½	48828.87		

Co I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
	$w\ ^2S^\circ$	0½	48837.72		1.50:
	8°	1½	48851.58:		
$3d^7 4s(^3P)4p$:	$w\ ^2P^\circ$	1½ 0½	49025.42 49754.73	−729.31	1.099 1.365
	9°	{4½ 3½}	49197.74:		
	10°	3½	49484.05		1.260
	11°	2½	49847.08		1.079
	12°	1½	50105.05		0.569
$3d^8\ (^1G)4p$	$y\ ^2H^\circ$	4½ 5½	50210.80 50375.91	165.11	0.899 1.091
$3d^8\ (^1G)4p$	$u\ ^2F^\circ$	3½ 2½	50578.73 50712.45	−133.72	1.125 0.905
$3d^7 4s(^3H)4p$:	$w\ ^2G^\circ$	4½ 3½	50593.38 50611.22	−17.84	1.10 0.82
$3d^7 4s(^3H)4p$	$x\ ^2H^\circ$	5½ 4½	50703.08 50902.61	−199.53	1.110 0.941
	13°	{4½ 3½}	50738.20		
$3d^7 4s(^3D)4p$:	$s\ ^4D^\circ$	3½ 2½ 1½ 0½	50741.66 51139.38 51847.27 52264.01:	−397.72 −707.89 −416.74	1.458
	14°	2½	50806.55		1.136
	$v\ ^2P^\circ$	1½ 0½	50925.11 50945.47	−20.36	1.340 0.732
$3d^8\ (a^3F)4d$	$e\ ^4P$	2½ 1½ 0½	51042.26 52033.26 52915.92:	−991.00 −882.66	1.59 1.40
$3d^8\ (a^3F)4d$	$e\ ^4D$	3½ 2½ 1½ 0½	51052.98 51560.76 52264.49: 52634.62	−507.78 −703.73 −370.13	1.402 1.354 1.58:
$3d^8\ (a^3F)4d$	$e\ ^4H$	6½ 5½ 4½ 3½	51142.53 51174.28 52121.21 52716.70	−31.75 −946.93 −595.49	1.224 1.147 0.96 0.896
$3d^7 4s(^3D)4p$:	$w\ ^4P^\circ$	2½ 1½ 0½	51160.03 52014.45 52355.12	−854.42 −340.67	1.578 1.616 2.304
$3d^8\ (a^3F)4d$	$g\ ^4F$	4½ 3½ 2½ 1½	51170.14 51199.58 52070.00 52702.76	−29.44 −870.42 −632.76	1.337 1.16 1.08 0.76:
	15°	3½	51184.63		
$3d^8\ (a^3F)4d$	$e\ ^2P$	1½ 0½	51200.60 52041.14:	−840.54	1.368 0.48:
$3d^8\ (a^3F)4d$	$e\ ^4G$	5½ 4½ 3½ 2½	51203.75 51267.93 52162.02 52772.30	−64.18 −894.09 −610.28	1.21 1.083 1.13 0.74
	16°	2½	51863.18		
	$t\ ^2F^\circ$	3½ 2½	51896.75: 52796.13	−899.38	1.15: 0.883
	17°	2½	51989.31:		

Co I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^8\ (a^3F)4d$	$f\ ^2F$	3½ 2½	52095.00 52970.62	−875.62	1.11 1.13
$3d^8(a\ ^3F)4d$	$e\ ^2H$	5½ 4½	52113.91 52775.47	−661.56	1.13 0.97
$3d^8(a\ ^3F)4d$	$e\ ^2G$	4½ 3½	52156.46 52856.68	−700.22	1.12 0.92
$3d^8(a\ ^3F)4d$	$e\ ^2D$	2½ 1½	52460.10 53343.27	−883.17	0.92 0.80
	18°	3½	*52476.64*		
	19°	1½	*52498.17*		
	20°	{ 2½ 1½ }	*52526.04*		
$3d^7\ 4s(b\ ^3F)5s$	$g\ ^2F$	3½ 2½	52763.68 53704.14	−940.46	0.933 0.923
$3d^7\ 4s(b\ ^3F)5s$	$h\ ^4F$	4½ 3½ 2½ 1½	52864.41 53694.57 54258.75 54426.64	−830.16 −564.18 −167.89	1.307 1.28: 0.986 0.422
	21°	{ 4½ 3½ }	*53065.96:*		
	$u\ ^2D°$	1½ 2½	*53074.92* *53195.98*	121.06	0.823 1.206
	$s\ ^2F°$	3½ 2½	*53103.78* *53146.91:*	−43.13	1.136
$3d^8(^1G)4p$	$v\ ^2G°$	4½ 3½	*53276.02* *53373.53*	−97.51	1.124 0.888
	22°	3½	*53463.10*		
$3d^7\ 4s(a\ ^5F)4d$	$f\ ^4G$	5½ 4½ 3½ 2½	53511.83 54158.17 54514.67 55165.63:	−646.34 −356.50 −650.96	1.274 1.25: 1.23:
$3d^7\ 4s(a\ ^5F)4d$	$f\ ^4H$	6½ 5½ 4½ 3½	53618.08 54315.67 54860.93 55268.75	−697.59 −545.26 −407.82	1.227 1.168 1.10: 0.857
$3d^7\ 4s(a\ ^5F)4d$	$f\ ^6F$	5½ 4½ 3½ 2½ 1½ 0½	53660.37 54356.45 54896.57 55283.02 55577.28:	−696.08 −540.12 −386.45 −294.26	1.421 1.403 1.27 1.17 1.07
$3d^7\ 4s(a\ ^5F)4d$	$f\ ^4D$	3½ 2½ 1½ 0½	53702.13 54282.73:	−580.60	1.377
$3d^7\ 4s(a\ ^5F)4d$	$e\ ^6D$	4½ 3½ 2½ 1½ 0½	53725.20 54352.30 54946.90 55407.10:	−627.10 −594.60 −460.20	1.387 1.48 1.47: 2.14
$3d^7\ 4s(a\ ^5F)4d$	$e\ ^6G$	6½ 5½ 4½ 3½ 2½ 1½	53728.36: 54367.43 54682.91 54989.62: 55449.97 55389.73	−639.07 −315.48 −306.71 −460.35 60.24	1.35 1.320 1.23 1.23 1.199
$3d^7\ 4s(a\ ^5F)4d$	$i\ ^4F$	4½ 3½ 2½ 1½	53788.78 54477.07 54904.99	−688.29 −427.92	1.316 0.85

Co I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^7\ 4s(a\ ^5F)4d$	$e\ ^6P$	3½ 2½ 1½	53789.12 54445.61 54949.97	−656.49 −504.36	1.635 1.594 2.134
$3d^7\ 4s(a\ ^5F)4d$	$e\ ^6H$	7½ 6½ 5½ 4½ 3½ 2½	53822.08 54452.38 54947.68 55312.96 55520.64 55555.34	−630.30 −495.30 −365.28 −207.68 −34.70	1.34 1.289 1.22 1.108 0.922
$3d^7\ 4s(a\ ^5F)4d$	$f\ ^4P$	2½ 1½ 0½	53936.68		1.46
	23°	1½	*54165.35*		1.353
	24°	3½	*54398.60*		
	1	2½	54561.74		1.323
	$v\ ^4F°$	4½ 3½ 2½ 1½	*54791.2* *55314.04:* *55684.7* *55622.84*	−522.8 −370.7 61.9	
	25°	4½	*54874.08*		
	26°	3½	*54932.32*		
	27°	2½	*55061.49*		1.539
	2	1½	55078.76		1.46:
	28°	3½	*55120.30:*		
	3	3½	55223.14		1.14
	29°	2½	*55387.11:*		1.170
	30°	2½	*55508.78*		
	4	2½	55598.74		
	5	{ 2½ 1½ }	55721.01		
	31°	1½	*55737.87*		
	32°	1½	*55818.91*		1.31:
	6	0½	55826.81		
	33°	{ 2½ 1½ }	*55922.3*		
	34°	{ 2½ 1½ }	*56101.84:*		
	35°	{ 2½ 1½ }	*56222.04:*		
$3d^8\ (^3P)5s$	$g\ ^4P$	2½ 1½ 0½	56545.51:		
	$g\ ^4H$	6½ 5½ 4½ 3½	57922.06 58441.03 58673.73 59314.82:	−518.97 −232.70 −641.09	
	36°	{ 4½ 3½ }	*58187.39*		0.920
	37°	{ 3½ 2½ }	*59388.89*		
Co II $(a\ ^3F_4)$	*Limit*	------	**63438**		

March 1951.

843210°—52——8

Co I Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms															
$3d^7\,4s^2$	a ^{4}P b ^{2}P	b ^{2}D	a ^{4}F	a ^{2}G	a ^{2}H											
$3d^9$		c ^{2}D														
	ns ($n \geq 4$)					np ($n \geq 4$)						nd ($n \geq 4$)				
$3d^8(a\,^3F)nx$			b, e ^{4}F a, e ^{2}F					y ^{4}D° y ^{2}D°	y ^{4}F° y ^{2}F°	y ^{4}G° y ^{2}G°		e ^{4}P e ^{2}P	e ^{4}D e ^{2}D	g ^{4}F f ^{2}F	e ^{4}G e ^{2}G	e ^{4}H e ^{2}H
$3d^7\,4s(a\,^5F)nx$			e ^{6}F f ^{4}F					z ^{6}D° z ^{4}D°	z ^{6}F° z ^{4}F°	z ^{6}G° z ^{4}G°		e ^{6}P f ^{4}P	e ^{6}D f ^{4}D	f ^{6}F i ^{4}F	e ^{6}G f ^{4}G	e ^{6}H f ^{4}H
$3d^7\,4s(b\,^3F)nx$			h ^{4}F g ^{2}F					x ^{4}D° z ^{2}D°	x ^{4}F° z ^{2}F°	x ^{4}G° z ^{2}G°						
$3d^7\,4s(a\,^5P)nx$						z ^{4}S°	z ^{4}P°	w ^{4}D°								
$3d^8(^3P)nx$	b, g ^{4}P a ^{2}P					x ^{4}S° y ^{2}S°:	y ^{4}P° x ^{2}P°:	v ^{4}D° w ^{2}D°:								
$3d^8(^1D)nx$		a ^{2}D					z ^{2}P°	x ^{2}D°	w ^{2}F°:							
$3d^8(^1G)nx$				b ^{2}G					u ^{2}F°	v ^{2}G°	y ^{2}H°					
$3d^7\,4s(^3G)nx$									w ^{4}F° x ^{2}F°:	w ^{4}G° x ^{2}G°	z ^{2}H°					
$3d^7\,4s(^3P)nx$						y ^{4}S° z ^{2}S°:	x ^{4}P° y ^{2}P°:	t ^{4}D° v ^{2}D°:								
$3d^7\,4s(^3P)nx$						x ^{2}S°:	w ^{2}P°:									
$3d^7\,4s(^3H)nx$										w ^{2}G°:	x ^{2}H°					
$3d^7\,4s(^3D)nx$							w ^{4}P°	s ^{4}D°:								

*For predicted terms of the Co I isoelectronic sequence, see Vol. II, Introduction.

Limits with prefixes "a", "b" are known in Co II. The remaining limit terms are arranged in the order of their appearance in the term table.

Co II

(Fe I sequence; 26 electrons) Z=27

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^8\ {}^3F_4$

$a\ {}^3F_4$ **137572** cm^{-1} I. P. 17.05 volts

In 1930 Findlay published 15 terms and 194 classified lines in the range between 1940.64 A and 3621.22 A. With the aid of observed Zeeman patterns he revised and extended the early work by Meggers, using Meggers' line list and some additional observations of his own. From a Rydberg formula he determined an ionization potential based on the $ns\ {}^{5,3}F$ series (n=4,5). Russell has recently improved this value by applying a revised Ritz correction to the Rydberg series. The revised value of the limit is quoted here.

A set of plates taken by Kiess at the National Bureau of Standards for wave lengths greater than 2000 A, and a set taken in Shenstone's laboratory at Princeton for the region of wave length less than 2000 A, have made it possible to study the spectrum further. With this material Hager has recently extended the analysis especially for inclusion here. He has provisionally submitted in manuscript 10 additional terms and nearly 100 newly classified lines from his own measurements combined with the earlier ones. His line list extends from 1226.970 A to 5192.947 A. This work is now in progress and will doubtless be extended appreciably in the near future. He has suggested one change in Findlay's paper, namely, that the level at 63616.0 be designated ${}^3D^\circ_2$ instead of ${}^3P^\circ_2$.

All g-values in the table except those for the $4p\ {}^5P^\circ$ term, for $z\ {}^5D^\circ_0$, and for the changed level, have been determined by Miss Weeks from films taken at the Massachusetts Institute of Technology. Her manuscript was submitted in advance of publication.

The triplet and quintet systems of terms are connected by observed intersystem combinations.

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H. N. Russell, J. Opt. Soc. Am. **40**, 618 (1950). (I P)
D. W. Weeks, unpublished material (March 1950). (Z E)
N. E. Hager, Jr., unpublished material (April 1951). (T) (C L)

Config.	Desig.	J	Level	Interval	Obs. g
$3d^8$	$a\ ^3F$	4	0.0	−950.3	
		3	950.3	−646.9	
		2	1597.2		
$3d^7(a\ ^4F)4s$	$a\ ^5F$	5	3350.5	−678.4	1.406
		4	4028.9	−531.9	1.34
		3	4560.8	−389.2	1.26
		2	4950.0	−254.5	0.990
		1	5204.5		0.008
$3d^7(a\ ^4F)4s$	$b\ ^3F$	4	9812.7	−895.4	1.257
		3	10708.1	−613.4	1.087
		2	11321.5		0.683
$3d^8$	$a\ ^3P$	2	13261.1	−143.5	
		1	13404.6	−188.9	
		0	13593.5		
$3d^7(a\ ^4P)4s$	$a\ ^5P$	3	17771.5	−260.0	1.671
		2	18031.5	−307.0	1.82
		1	18338.5		2.50
$3d^7(a\ ^4P)4s$	$b\ ^3P$	2	24074.6	−193.2	
		1	24267.8	−143.7	
		0	24411.5		
$3d^7(a\ ^2P)4s$	$c\ ^3P$	2	24886.5		
		1			
		0			
	$a\ ^3D$	3	27484.3	−627.6	
		2	28111.9	526.6	
		1	27585.3		
$3d^6\ 4s^2$	$a\ ^5D$	4	40694.9	−619.0	
		3	41313.9	−423.9	
		2	41737.8	−270.8	
		1	42008.6		
		0			
$3d^7(a\ ^4F)4p$	$z\ ^5F^\circ$	5	*45197.8*	−181.0	1.396
		4	*45378.8*	−593.3	1.407
		3	*45972.1*	−480.5	1.303
		2	*46452.6*	−333.7	1.058
		1	*46786.3*		0.06
$3d^7(a\ ^4F)4p$	$z\ ^5D^\circ$	4	*46320.8*	−718.2	1.442
		3	*47039.0*	−498.1	1.43
		2	*47537.1*	−311.4	1.43
		1	*47848.5*	−146.6	1.42
		0	*47995.1*		0/0
$3d^7(a\ ^4F)4p$	$z\ ^5G^\circ$	6	*47078.2*	−267.5	1.350
		5	*47345.7*	−461.5	1.260
		4	*47807.2*	−343.5	1.154
		3	*48150.7*	−237.4	0.92
		2	*48388.1*		0.35

Config.	Desig.	J	Level	Interval	Obs. g
$3d^7(a\ ^4F)4p$	$z\ ^3G^\circ$	5	*48555.9*	−792.3	1.19
		4	*49348.2*	−687.7	1.111
		3	*50035.9*		0.811
$3d^7(a\ ^4F)4p$	$z\ ^3F^\circ$	4	*49697.5*	−684.1	1.197
		3	*50381.6*	−532.2	1.059
		2	*50913.8*		0.689
$3d^7(a\ ^4F)4p$	$z\ ^3D^\circ$	3	*51512.2*	−717.4	1.33
		2	*52229.6*	−454.9	1.167
		1	*52684.5*		0.524
$3d^7(a\ ^4P)4p$	$z\ ^5S^\circ$	2	*56010.6*		2.00
$3d^7(a\ ^4P)4p$	$y\ ^5D^\circ$	4	*61388.1*	147.3	1.442
		3	*61240.8*	−19.3	1.504
		2	*61260.1*	−88.4	1.490
		1	*61348.5?*	−109.4	
		0	*61457.9*		0.000
$3d^7(a\ ^4P)4p$	$z\ ^3S^\circ$	1	*62440.2*		
$3d^7(a\ ^4P)4p$	$z\ ^5P^\circ$	3	*63344.1*	−22.8	1.67
		2	*63366.9*	−298.1	1.86
		1	*63665.0*		2.62
$3d^7(a\ ^4P)4p$	$y\ ^3D^\circ$	3	*63587.0*	−29.0	
		2	*63616.0*	−249.2	1.33
		1	*63865.2*		
$3d^6\ 4s(a\ ^6D)4p$	$x\ ^5D^\circ$	4	*80299.2*	−243.6	
		3	*80542.8*	−245.9	
		2	*80788.7*	−182.7	
		1	*80971.4*	−195.3	
		0	*81066.7?*		
$3d^6\ 4s(a\ ^6D)4p$	$y\ ^5F^\circ$	5	*81970.9*	−373.0	
		4	*82343.9*	−284.3	
		3	*82628.2*		
		2			
		1			
$3d^7(a\ ^4F)5s$	$e\ ^5F$	5	84012.3	−572.5	
		4	84584.8	−580.5	1.34
		3	85165.3	−428.6	1.242
		2	85593.9	−280.2	
		1	85874.1		
$3d^6\ 4s(a\ ^6D)4p$	$y\ ^5P^\circ$	3	*85044.3*	−668.3	
		2	*85712.6*	−421.8	
		1	*86134.4*		
$3d^7(a\ ^4F)5s$	$e\ ^3F$	4	85479.2	−864.6	1.217
		3	86343.8	−593.9	1.08
		2	86937.7		0.472
Co III ($^4F_{4\frac{1}{2}}$)	*Limit*	-----	**137572**		

May 1951.

Co II Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms	
$3d^8$	$a\ ^3P$ $\quad a\ ^3F$	
$3d^6\ 4s^2$	$a\ ^5D$	
	$ns\ (n \geq 4)$	$np\ (n \geq 4)$
$3d^7(a\ ^4F)nx$	$a, e\ ^5F$ $b, e\ ^3F$	$z\ ^5D^\circ$ $\quad z\ ^5F^\circ$ $\quad z\ ^5G^\circ$ $z\ ^3D^\circ$ $\quad z\ ^3F^\circ$ $\quad z\ ^3G^\circ$
$3d^7(a\ ^4P)nx$	$a\ ^5P$ $b\ ^3P$	$z\ ^5S^\circ$ $\quad z\ ^5P^\circ$ $\quad y\ ^5D^\circ$ $z\ ^3S^\circ$ $\quad y\ ^3D^\circ$
$3d^6\ 4s(a\ ^6D)nx$		$y\ ^5P^\circ$ $\quad x\ ^5D^\circ$ $\quad y\ ^5F^\circ$
$3d^7(a\ ^2P)nx$	$c\ ^3P$	

*For predicted terms in the spectra of the Fe I isoelectronic sequence, see Vol. II, Introduction.

Co III

(Mn I sequence; 25 electrons) $\hfill Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ ^4F_{4\frac{1}{2}}$

$a\ ^4F_{4\frac{1}{2}}$ **270200** cm^{-1} $\hfill$ I. P. 33.49 volts

The analysis has been done by Shenstone especially for inclusion here. He has submitted, in manuscript form, the terms listed below. His observations extend from 650 A to 2250 A. There are at present more than 350 classified lines. Observed intersystem combinations connect the quartet and sextet systems of terms. His value of the ionization potential, determined from the $ns\ ^6D$ series (n=4, 5) on the assumption that the Ritz correction, α, is the same for Co III as for Fe III, is 268963 cm^{-1}. From a study of isoelectronic data Catalán has derived an improved value, which is quoted here.

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A. G. Shenstone, unpublished material (November 1951). (I P) (T) (C L)
M. A. Catalán, unpublished material (April 1952). (I P)

Co III

Config.	Desig.	J	Level	Interval
$3d^7$	$a\ ^4F$	4½	0.0	−841.2
		3½	841.2	−610.1
		2½	1451.3	−415.5
		1½	1866.8	
$3d^7$	$a\ ^4P$	2½	15201.9	−226.3
		1½	15428.2	−383.2
		0½	15811.4	
$3d^7$	$a\ ^2G$	4½	16977.7	−788.5
		3½	17766.2	
$3d^7$	$a\ ^2H$	5½	22720.3	−714.0
		4½	23434.3	
$3d^7$	$a\ ^2D$	2½	23058.8?	
		1½		
$3d^6(^5D)4s$	$a\ ^6D$	4½	46438.3	−564.8
		3½	47003.1	−412.3
		2½	47415.4	−283.2
		1½	47698.6	−166.2
		0½	47864.8	
$3d^6(^5D)4s$	$a\ ^4D$	3½	55729.2	−644.6
		2½	56373.8	−421.0
		1½	56794.8	−242.0
		0½	57036.8	
$3d^6(^3P)4s$	$b\ ^4P$	2½	70933.7	−1407.9
		1½	72341.6	−873.1
		0½	73214.7	
$3d^6(^3H)4s$	$a\ ^4H$	6½	71623.1	−250.6
		5½	71873.7	−209.6
		4½	72083.3	−186.8
		3½	72270.1	
$3d^6(^3F)4s$	$b\ ^4F$	4½	73286.0	−254.2
		3½	73540.2	−186.4
		2½	73726.6	−134.7
		1½	73861.3	
$3d^6(^3G)4s$	$a\ ^4G$	5½	76518.7	−602.7
		4½	77121.4	−261.7
		3½	77383.1	−88.9
		2½	77472.0	
$3d^6(^3H)4s$	$b\ ^2H$	5½	77411.5	−211.4
		4½	77622.9	
$3d^6(^3F)4s$	$a\ ^2F$	3½	78927.6	−497.4
		2½	79425.0	
$3d^6(^3G)4s$	$b\ ^2G$	4½	82363.2	−557.2
		3½	82920.4	
$3d^6(^1I)4s$	$a\ ^2I$	6½	85474.1	−43.2
		5½	85517.3	
$3d^6(^1G)4s$	$c\ ^2G$	4½	86283.7	−43.2
		3½	86326.9	
$3d^6(^5D)4p$	$z\ ^6D^\circ$	4½	*98290.3*	−255.3
		3½	*98545.6*	−277.6
		2½	*98823.2*	−220.3
		1½	*99043.5*	−138.7
		0½	*99182.2*	

Co III

Config.	Desig.	J	Level	Interval
$3d^6(^5D)4p$	$z\ ^6F^\circ$	5½	*103245.0*	−141.7
		4½	*103386.7*	−115.0
		3½	*103501.7*	−92.0
		2½	*103593.7*	−62.0
		1½	*103655.7*	−35.1
		0½	*103690.8*	
$3d^6(^5D)4p$	$z\ ^6P^\circ$	3½	*105008.7*	−956.4
		2½	*105965.1*	−626.8
		1½	*106591.9*	
$3d^6(^5D)4p$	$z\ ^4D^\circ$	3½	*106489.1*	−465.6
		2½	*106954.7*	−342.3
		1½	*107297.0*	−210.6
		0½	*107507.6*	
$3d^6(^5D)4p$	$z\ ^4F^\circ$	4½	*106764.9*	−765.2
		3½	*107530.1*	−522.8
		2½	*108052.9*	−350.5
		1½	*108403.4*	
$3d^6(^5D)4p$	$z\ ^4P^\circ$	2½	*110371.2*	−590.3
		1½	*110961.5*	−321.6
		0½	*111283.1*	
$3d^6(^3P)4p$	$y\ ^4P^\circ$	2½	*124597.1*?	
		1½		
		0½		
$3d^6(^3H)4p$	$z\ ^4G^\circ$	5½	*124766.1*	−246.3
		4½	*125012.4*	−214.6
		3½	*125227.0*	−141.9
		2½	*125368.9*	
$3d^6(^3H)4p$	$z\ ^4H^\circ$	6½	*125276.2*	−20.0
		5½	*125296.2*	−125.3
		4½	*125421.5*	−268.9
		3½	*125690.4*	
$3d^6(^3P)4p$	$z\ ^2D^\circ$	2½	*125769.8*?	
		1½		
$3d^6(^3H)4p$	$z\ ^4I^\circ$	7½	*126119.0*	−356.4
		6½	*126475.4*	−25.8
		5½	*126501.2*	261.8
		4½	*126239.4*	
$3d^6(^3P)4p$	$y\ ^4D^\circ$	3½	*126549.4*	−1535.8
		2½	*128085.2*	−337.9
		1½	*128423.1*	−113.2
		0½	*128536.3*	
$3d^6(^3F)4p$	$y\ ^4F^\circ$	1½	*126987.4*	−116.7
		2½	*126870.7*	21.4
		3½	*126892.1*	106.0
		4½	*126998.1*	
$3d^6(^3H)4p$	$z\ ^2G^\circ$	4½	*127050.8*	−266.8
		3½	*127317.6*	
$3d^6(^3H)4p$	$z\ ^2I^\circ$	6½	*127672.8*	−586.1
		5½	*128258.9*	
$3d^6(^3F)4p$	$x\ ^4D^\circ$	3½	*128017.8*	−507.2
		2½	*128525.0*	−279.7
		1½	*128804.7*	−132.2
		0½	*128936.9*	

Co III—Continued

Config.	Desig.	J	Level	Interval
$3d^6(^3F)4p$	$y\ ^4G^\circ$	5½	*129556.0*	−36.3
		4½	*129592.3*	−114.6
		3½	*129706.9*	−40.0
		2½	*129746.9*	
$3d^6(^3F)4p$	$z\ ^2F^\circ$	3½	*130183.9*	−223.4
		2½	*130407.3*	
$3d^6(^3F)4p$	$y\ ^2G^\circ$	4½	*130802.0*	*−477.4*
		3½	*131279.4*	
$3d^6(^3H)4p$	$z\ ^2H^\circ$	5½	*131054.2*	*−483.9*
		4½	*131538.1*	
$3d^6(^3G)4p$	$x\ ^4G^\circ$	5½, 4½	*131098.1*	−483.5
		3½	*131581.6*	−302.2
		2½	*131883.8*	
$3d^6(^3G)4p$	$x\ ^4F^\circ$	4½	*131887.1*	−390.1
		3½	*132277.2*	−211.8
		2½	*132489.0*	−103.3
		1½	*132592.3*	
$3d^6(^3G)4p$	$y\ ^4H^\circ$	6½	*132376.6*	−130.0
		5½	*132506.6*	−80.5
		4½	*132587.1*	−36.4
		3½	*132623.5*	
$3d^6(^3G)4p$	$y\ ^2H^\circ$	5½	*134696.0*	−708.0
		4½	*135404.0*	
$3d^6(^3G)4p$	$y\ ^2F^\circ$	2½	*136129.3*	160.8
		3½	*136290.1*	

Co III—Continued

Config.	Desig.	J	Level	Interval
$3d^6(^3G)4p$	$x\ ^2G^\circ$	4½	*137661.3*	−151.0
		3½	*137812.3*	
$3d^6(^1I)4p$	$x\ ^2H^\circ$	4½	*138920.7*	216.8
		5½	*139137.5*	
$3d^6(^1G)4p$	$w\ ^2G^\circ$	4½	*140358.3*	−24.6
		3½	*140382.9*	
$3d^6(^1G)4p$	$x\ ^2F^\circ$	3½	*140646.3*	−141.0
		2½	*140787.3*	
$3d^6(^1G)4p$	$w\ ^2H^\circ$	5½	*141190.8*	−156.4
		4½	*141347.2*	
$3d^6(^1I)4p$	$y\ ^2I^\circ$	6½	*141868.8*	−5.0
		5½	*141873.8*	
$3d^6(^3P')4p$	$z\ ^4S^\circ$	1½	*155702.4*	
$3d^6(^3P')4p$	$x\ ^4P^\circ$	2½	*156291.4*	
		1½		
		0½		
$3d^6(^5D)5s$	$e\ ^6D$	4½	169527.7	
		3½		
		2½		
		1½		
		0½		
Co IV ($^5D_4$)	*Limit*	---------	270200	

November 1951.

Co III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms	
$3d^7$	$a\ ^4P$, $a\ ^2D$, $a\ ^4F$, $a\ ^2G$, $a\ ^2H$	
	$ns\ (n \geq 4)$	$np\ (n \geq 4)$
$3d^6(^5D)nx$	$a, e\ ^6D$; $a\ ^4D$	$z\ ^6P^\circ$ $z\ ^6D^\circ$ $z\ ^6F^\circ$; $z\ ^4P^\circ$ $z\ ^4D^\circ$ $z\ ^4F^\circ$
$3d^6(^3P)nx$	$b\ ^4P$	$y\ ^4P^\circ$ $y\ ^4D^\circ$; $z\ ^2D^\circ$
$3d^6(^3H)nx$	$a\ ^4H$; $b\ ^2H$	$z\ ^4G^\circ$ $z\ ^4H^\circ$ $z\ ^4I^\circ$; $z\ ^2G^\circ$ $z\ ^2H^\circ$ $z\ ^2I^\circ$
$3d^6(^3F)nx$	$b\ ^4F$; $a\ ^2F$	$x\ ^4D^\circ$ $y\ ^4F^\circ$ $y\ ^4G^\circ$; $z\ ^2F^\circ$ $y\ ^2G^\circ$
$3d^6(^3G)nx$	$a\ ^4G$; $b\ ^2G$	$x\ ^4F^\circ$ $x\ ^4G^\circ$ $y\ ^4H^\circ$; $y\ ^2F^\circ$ $x\ ^2G^\circ$ $y\ ^2H^\circ$
$3d^6(^1I)nx$	$a\ ^2I$	$x\ ^2H^\circ$ $y\ ^2I^\circ$
$3d^6(^1G)nx$	$c\ ^2G$	$x\ ^2F^\circ$ $w\ ^2G^\circ$ $w\ ^2H^\circ$
$3d^6(^3P')nx$		$z\ ^4S^\circ$ $x\ ^4P^\circ$

*For predicted terms in the spectra of the Mn I isoelectronic sequence, see Vol. II, Introduction.

Co IV

(Cr I sequence; 24 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ {}^5D_4$

$a\ {}^5D_4$ cm^{-1} I. P. volts

From a study of isoelectronic sequence data, and especially by analogy with Fe III, Morell, in 1928, classified 9 lines between 1349 A and 1863 A as combinations between $3d^5(^6S)4s\ ^{7,5}S$ and $3d^5(^6S)4p\ ^{7,5}P°$. The present detailed analysis of Fe III indicates the urgent need of further investigation of the Co IV spectrum.

REFERENCE

L. Morell, Thesis (unpublished) Cornell University (1928). (T) (C L)

January 1950.

Co V

(V I sequence; 23 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ {}^6S_{2\frac{1}{2}}$

$a\ {}^6S_{2\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum is very incompletely known. In 1931 Miss Gilroy published 9 terms, and 57 classified lines between 412 A and 1488 A. Later, Kruger and Gilroy reported that the three lines from the ground term having the transition $3d^5\ {}^6S-4p\ {}^6P°$ were near 355 A, rather than near 414 A, as was stated in the earlier paper. Consequently, the relative term values as published in 1931 need revision. The accepted classifications are as follows:

Int.	I. A.	Wave No.	Desig.
20	355. 523	281275	$3d^5\ {}^6S_{2\frac{1}{2}}-4p\ {}^6P°_{3\frac{1}{2}}$
18	355. 876	280996	$3d^5\ {}^6S_{2\frac{1}{2}}-4p\ {}^6P°_{2\frac{1}{2}}$
12	356. 060	280851	$3d^5\ {}^6S_{2\frac{1}{2}}-4p\ {}^6P°_{1\frac{1}{2}}$

REFERENCES

H. T. Gilroy, Phys. Rev. **38**, 2217 (1931). (T) (C L)
P. G. Kruger and H. T. Gilroy, Phys. Rev. **48**, 720 (1935). (T) (C L)

January 1950.

Co VI

(Ti I sequence; 22 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ {}^5D_0$

$a\ {}^5D_0$ cm^{-1} I. P. volts

The analysis is by Bowen who has classified 103 lines in the range between 266 A and 306 A. Intersystem combinations connecting the triplet and quintet systems of terms have been observed, but no series are known.

Phillips and Kruger find the line measured by Bowen at 278.184 A as double, and classify the weaker component as $a\ {}^5D_3-z\ {}^5F_4^\circ$. This places $z\ {}^5F_4^\circ$ at 360588 cm^{-1}, which is 102 cm^{-1} lower than Bowen's value. Further study of this spectrum is needed.

REFERENCES

I. S. Bowen, Phys. Rev. **53**, 889 (1938). (T) (C L)
L. W. Phillips and P. G. Kruger, Phys. Rev. **54**, 839 (1938). (T) (C L)

Co VI

Config.	Desig.	J	Level	Interval
$3d^4$	$a\ {}^5D$	0	0	
				208
		1	208	
				378
		2	586	
				543
		3	1129	
				660
		4	1789	
$3d^4$	$a\ {}^3P$	0	27167	
				1291
		1	28458	
				2046
		2	30504	
$3d^4$	$a\ {}^3H$	4	28381	
				423
		5	28804	
				429
		6	29233	
$3d^4$	$a\ {}^3F$	2	30545	
				90
		3	30635	
				181
		4	30816	
$3d^4$	$a\ {}^3G$	3	34024	
				449
		4	34473	
				379
		5	34852	
$3d^3(a\ {}^4F)4p$	$z\ {}^5D^\circ$	0		
		1	*356754*	
				525
		2	*357279*	
				742
		3	*358021*	
				907
		4	*358928*	

Co VI

Config.	Desig.	J	Level	Interval
$3d^3(a\ {}^4F)4p$	$z\ {}^5F^\circ$	1	*358366*	
				670
		2	*359036*	
				790
		3	*359826*	
				864
		4	*360690*	
				573
		5	*361263*	
$3d^3(a\ {}^4F)4p$	$z\ {}^3D^\circ$	1	*359903*	
				559
		2	*360462*	
				1033
		3	*361495*	
$3d^3(a\ {}^4F)4p$	$z\ {}^3G^\circ$	3	*364343*	
				740
		4	*365083*	
				943
		5	*366026*	
$3d^3(a\ {}^4F)4p$	$z\ {}^3F^\circ$	2	*367560*	
				854
		3	*368414*	
				902
		4	*369316*	
$3d^3(a\ {}^4P)4p$	$z\ {}^5P^\circ$	1	*374556*	
				694
		2	*375250*	
				1113
		3	*376363*	
$3d^3(a\ {}^2G)4p$	$y\ {}^3G^\circ$	3	*380634*	
				1022
		4	*381656*	
				821
		5	*382477*	
$3d^3(a\ {}^2H)4p$	$x\ {}^3G^\circ$	5	*396229*	
				−191
		4	*396420*	
				−159
		3	*396579*	

January 1949.

Co VI Observed Terms*

Config $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms				
$3d^4$	$a\ ^3P$	$a\ ^5D$	$a\ ^3F$	$a\ ^3G$	$a\ ^3H$
	$np\ (n \geq 4)$				
$3d^3(a\ ^4F)nx$		$z\ ^5D^\circ$ $z\ ^3D^\circ$	$z\ ^5F^\circ$ $z\ ^3F^\circ$	$z\ ^3G^\circ$	
$3d^3(a\ ^4P)nx$		$z\ ^5P^\circ$			
$3d^3(a\ ^2G)nx$				$y\ ^3G^\circ$	
$3d^3(a\ ^2H)nx$				$x\ ^3G^\circ$	

*For predicted terms in the spectra of the Ti I isoelectronic sequence, see Vol. I, p. XXXVII.

Co VII

(Sc I sequence; 21 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ ^4F_{1\frac{1}{2}}$

$a\ ^4F_{1\frac{1}{2}}$ cm^{-1} I. P. volts

The analysis is by Anderson and Mack who have classified 133 lines in the region between 415 A and 484 A. They have been unable to locate with certainty the ^2P term having the configuration $3d^3$, but they suggest tentatively for this term two possible pairs of levels whose reality is not yet established, as follows:

J	Level	
$1\frac{1}{2}$	28876?	29244?
$0\frac{1}{2}$	29324?	29712?

Intersystem combinations connecting the doublet and quartet systems of terms have been observed.

REFERENCE

E. E. Anderson and J. E. Mack, Phys. Rev. **59**, 717 (1941). (T) (C L)

Co VII

Config.	Desig.	J	Level	Interval
$3d^3$	$a\ ^4F$	1½ 2½ 3½ 4½	0 698 1610 2723	698 912 1113
$3d^3$	$a\ ^4P$	0½ 1½ 2½	21096 21304 22187	208 883
$3d^3$	$a\ ^2G$	3½ 4½	24151 25063	912
$3d^3$	$a\ ^2D$	2½ 1½	31348 31555?	−207
$3d^3$	$a\ ^2H$	4½ 5½	33251 33873	622
$3d^2(a\ ^3F)4p$	$z\ ^4G°$	2½ 3½ 4½ 5½	*445761* *447314* *449305* *451810?*	1553 1991 2505
$3d^2(a\ ^3F)4p$	$z\ ^4F°$	1½ 2½ 3½ 4½	*446966* *448051* *449440* *450989*	1085 1389 1549
$3d^2(a\ ^3F)4p$	$z\ ^2F°$	2½ 3½	*450865* *452009*	1144
$3d^2(a\ ^3F)4p$	$z\ ^4D°$	0½ 1½ 2½ 3½	*451559* *451215* *452566* *454157*	−344 1351 1591
$3d^2(a\ ^3F)4p$	$z\ ^2D°$	1½ 2½	*452709* *454482?*	1773
$3d^2(a\ ^3F)4p$	$z\ ^2G°$	3½ 4½	*459170* *460587*	1417
$3d^2(a\ ^3P)4p$	$z\ ^4S°$	1½	*465290*	
$3d^2(a\ ^3P)4p$	$y\ ^4D°$	0½ 1½ 2½ 3½	*469358?* *470375* *471880* *474067*	1017 1505 2187
$3d^2(a\ ^3P)4p$	$z\ ^4P°$	0½ 1½ 2½	*474575* *475156* *476592*	581 1436
$3d^2(a\ ^1G)4p$	$y\ ^2G°$	3½ 4½	*476054* *476288*	234
$3d^2(a\ ^1G)4p$	$z\ ^2H°$	4½ 5½	*485616* *487584*	1968

December 1948.

Co VII Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms
$3d^3$	$a\ ^4P$ $a\ ^2D$ $a\ ^4F$ $a\ ^2G$ $a\ ^2H$
	np ($n\geq 4$)
$3d^2(a\ ^3F)nx$	$z\ ^4D°$ $z\ ^4F°$ $z\ ^4G°$ $z\ ^2D°$ $z\ ^2F°$ $z\ ^2G°$
$3d^2(a\ ^3P)nx$	$z\ ^4S°$ $z\ ^4P°$ $y\ ^4D°$
$3d^2(a\ ^1G)nx$	$y\ ^2G°$ $z\ ^2H°$

*For predicted terms in the spectra of the Sc I isoelectronic sequence, see Vol. I, p. XXXVI.

Co VIII

(Ca I sequence; 20 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ {}^3F_2$

$a\,{}^3F_2$ cm^{-1} I. P. volts

Although 27 lines between 181 A and 192 A were reported as classified in 1933, later study of the spectra of this sequence by Edlén indicates that the early interpretation is incorrect.

REFERENCES

W. M. Cady, Phys. Rev. **43**, 325 (1933). (T) (C L)
B. Edlén, letter (Feb. 1949).

February 1949.

Co XI

(Cl I sequence; 17 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ {}^2P^\circ_{1\frac{1}{2}}$

$3p^5\ {}^2P^\circ_{1\frac{1}{2}}$ ***2462000*** cm^{-1} I. P. 305 volts

Edlén has classified six lines in the region between 81 A and 84 A, as combinations from the ground term. He has estimated the value of the limit by extrapolation along the isoelectronic sequence, as indicated by brackets in the table.

His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **104**, 407 (1937). (I P) (T) (C L)

Co XI

Config.	Desig.	*J*	Level	Interval
$3s^2\ 3p^5$	$3p^5\ {}^2P^\circ$	1½ 0½	*0* *19280*	−19280
$3s^2\ 3p^4(^3P)4s$	$4s\ {}^4P$	2½ 1½ 0½	 1189920 	
$3s^2\ 3p^4(^3P)4s$	$4s\ {}^2P$	1½ 0½	1202070 1211730	−9660
$3s^2\ 3p^4(^1D)4s$	$4s'\ {}^2D$	2½ 1½	1226890 1227610	−720
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Co XII ($^3P_2$)	*Limit*	---	[*2462000*]	

January 1948.

Co XIV

(Si I sequence; 14 electrons) $Z=27$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^2\ ^3P_0$

$3p^2\ ^3P_0$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has predicted the interval between the two lowest levels ($3p^2\ ^3P_0-3p^2\ ^3P_1$) to be 8448 A, or 11834 cm^{-1}.

REFERENCE

B. Edlén, Zeit. Astroph. **22,** 58 (1942). (C L)

October 1947.

Co XV

(Al I sequence; 13 electrons) $Z=27$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p\ ^2P^\circ_{0\frac{1}{2}}$

$3p\,^2P^\circ_{0\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has classified 2 lines as follows:

I. A.	Int.	Wave No.	Desig.
52. 583	1	1901750	$3p\ ^2P^\circ-4d\ ^2D$
53. 173	2	1880650	

His unit, 10^3 cm^{-1}, is here changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103,** 540 (1936). (C L)

December 1947.

Co XVI

(Mg I sequence; 12 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ {}^1S_0$

$3s^2\ {}^1S_0$ **4133000** cm^{-1} I. P. 512 volts

Edlén has classified 8 lines in the region between 49 A and 61 A. No singlet combinations have been observed and the triplet terms are not connected by observed combinations. He has determined the relative positions of the terms and also the ionization potential by extrapolation along the isoelectronic sequence. Estimated values are denoted by brackets in the table.

Edlén's unit, $10^3\ cm^{-1}$, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **103,** 536 (1936). (I P) (T) (C L)

Co XVI

Config.	Desig.	J	Level	Interval
$3s^2$	$3s^2\ {}^1S$	0	0	
$3s(^2S)3p$	$3p\ {}^3P^\circ$	0		
		1	*[258310]+x*	17280
		2	*275590 +x*	
$3s(^2S)3d$	$3d\ {}^3D$	1		
		2		
		3	734890 +x	
$3s(^2S)4p$	$4p\ {}^1P^\circ$	1	*[2106020]*	
$3s(^2S)4d$	$4d\ {}^3D$	1	2259150 +x	840
		2	2259990 +x	1420
		3	2261410 +x	
$3s(^2S)4f$	$4f\ {}^3F^\circ$	2		
		3		
		4	*2348260 +x*	
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Co XVII ($^2S_{0\frac{1}{2}}$)	*Limit*	---	[4133000]	

August 1947.

Co XVII

(Na I sequence; 11 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s\ ^2S_{0½}$

$3s\ ^2S_{0½}$ **4410480** cm^{-1} I. P. 547 volts

Edlén has classified 10 lines in the interval 41 A to 58 A, and extrapolated the absolute value of the ground term from isoelectronic sequence data. His unit, $10^3\ cm^{-1}$, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **100**, 621 (1936). (I P) (T) (C L)

Co XVII

Config.	Desig.	*J*	Level	Interval
3*s*	3*s* ²S	0½	0	
3*p*	3*p* ²P°	0½ 1½	*293550* *318930*	25380
3*d*	3*d* ²D	1½ 2½	721600 725230	3630
4*s*	4*s* ²S	0½	2078910	
4*p*	4*p* ²P°	0½ 1½	*2196500* *2206580*	10080
4*d*	4*d* ²D	1½ 2½	2352650 2354220	1570
4*f*	4*f* ²F°	2½ 3½	*2421500* *2422130*	630
5*f*	5*f* ²F°	2½ 3½	 *3137080*	
-------------	------	-----	---------	
Co XVIII (¹S₀)	*Limit*	-----	[4410480]	

June 1947.

Co XVIII

(Ne I sequence; 10 electrons) $Z=27$

Ground state $1s^2\ 2s^2\ 2p^6\ {}^1S_0$

$2p^6\ {}^1S_0$ **11316400** cm^{-1} I P. 1403 volts

Tyrén has classified seven lines in the region 12 A to 15 A, as combinations with the ground term. His absolute term values have been derived by extrapolation along the Ne I isoelectronic sequence.

By analogy with Ne I the *jl*-coupling notation in the general form suggested by Racah is introduced.

The unit adopted by Tyrén, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

F. Tyrén, Zeit. Phys. **111,** 314 (1938). (I P) (T) (C L)
G. Racah, Phys. Rev. **61,** 537 (L) (1942).

Co XVIII

Author	Config.	Desig.	J	Level
$2p\ {}^1S_0$	$2s^2\ 2p^6$	$2p^6\ {}^1S$	0	0
	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})3s$	$3s\ [1\frac{1}{2}]^\circ$	2	
$3s\ {}^3P_1$			1	*6477900*
	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})3s$	$3s'\ [0\frac{1}{2}]^\circ$	0	
$3s\ {}^1P_1$			1	*6592400*
	$2s^2\ 2p^5(^2P^\circ_{1\frac{1}{2}})3d$	$3d\ [0\frac{1}{2}]^\circ$	0	
$3d\ {}^3P_1$			1	*7124500*
$3d\ {}^1P_1$	"	$3d\ [1\frac{1}{2}]^\circ$	1	*7214000*

Co XVIII

Author	Config.	Desig.	J	Level
$3d\ {}^3D_1$	$2s^2\ 2p^5(^2P^\circ_{0\frac{1}{2}})3d$	$3d'[1\frac{1}{2}]^\circ$	1	*7337300*
	$2s\ 2p^6(^2S)3p$	$3p\ {}^3P^\circ$	2	
$3p'\ {}^3P_1$			1	*7898300*
			0	
$3p'\ {}^1P_1$	$2s\ 2p^6(^2S)3p$	$3p\ {}^1P^\circ$	1	*7937100*
	Co XIX $(^2P^\circ_{1\frac{1}{2}})$	***Limit***	-------	**[11316400]**
	Co XIX $(^2P^\circ_{0\frac{1}{2}})$	*Limit*	-------	11437600

April 1947.

NICKEL

Ni I

28 electrons $Z=28$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2\ {}^3F_4$

$a\ {}^3F_4$ **61579** cm^{-1} I. P. 7.633 volts

The analysis is by Russell, who revised and extended the earlier work on this spectrum and published 1071 classified lines in the interval between 1963 A and 18040 A. Subsequently, Meggers and Kiess observed the infrared region and classified 39 lines between 8580 A and 10979 A. Eighty-one terms are known, and observed intersystem combinations connect the terms of all three multiplicities.

Burns and Sullivan have made accurate measurements with the interferometer, of Ni I lines observed in the vacuum arc between 2173 A and 8968 A. Their observations confirm in detail Russell's analysis, as well as the great majority of Ni I lines identified in the solar spectrum from predicted wavelengths. They have "measured by interference some four hundred Ni I lines not hitherto observed". From these accurate wavelengths they have derived many improved values of the known energy levels. Their results are recorded in the table except for the levels $f\ {}^3P_1$, $e\ {}^5G_4$, and $g\ {}^5F_5$, for which the writer has derived the values quoted here. For all remaining levels, Russell's values are given.

Loyarte and Williams have observed the absorption spectrum of nickel and suggested the following rearrangement of nine levels given by Russell:

Loyarte and Williams	Russell	Level	Obs. g
$z\ {}^3D_3$	1°_3	40361. 24	
$z\ {}^3D_2$	$y\ {}^3P^\circ_2$	42653. 58	
$z\ {}^3D_1$	$w\ {}^3D^\circ_1$	45122. 37	0. 57
$y\ {}^3\overline{F}_4$	$x\ {}^3F^\circ_4$	42584. 87	1. 35
$y\ {}^3\overline{F}_3$	$x\ {}^3F^\circ_3$?	43654. 82	1. 24
$y\ {}^3\overline{F}_2$	$x\ {}^1D^\circ_2$	43933. 39	1. 48
$x\ {}^3\overline{F}_4$	$x\ {}^3D^\circ_3$	42620. 94	
$x\ {}^3\overline{F}_3$	$w\ {}^3D^\circ_3$	42767. 79	1. 22
$x\ {}^3\overline{F}_2$	$x\ {}^3D^\circ_2$	42954. 77	0. 840

The observed g-value for the level at 43933 fits neither designation. The observed combinations confirm $J=3$ for the level at 42620. The intensity behavior in the multiplets supports Russell's assignments, and his interpretation is quoted in the table.

The observed g-values are chiefly from the paper by Lindsley, but some are from the two other papers quoted for Zeeman effect. A theoretical discussion of some of the configuration assignments is given by Marvin.

843210°—52——9

Ni I—Continued

Russell derives the limit 61579 cm^{-1} from the ^{3}D and ^{1}D terms of the $3d^9(a\,^2\mathrm{D})ns$ series [n=4,5,6], by using a Ritz formula. He remarks that the $^3\mathrm{D}_3$ and $^3\mathrm{D}_2$ levels evidently converge to the lower component, $a\,^2\mathrm{D}_{2\frac{1}{2}}$, of the ground term of Ni II; while $^3\mathrm{D}_1$ and $^1\mathrm{D}_2$ converge to $a\,^2\mathrm{D}_{1\frac{1}{2}}$, which lies 1507 cm^{-1} higher. He notes that "The correlation of the term components and their limits is of the inverted type pointed out by Shenstone . . . All the terms arising from the $a\,^2$D limit of Ni II show the same inverted convergence."

In "normal" convergence only *one* level converges to that component of the limit term having the larger J-value. The *shifting* that occurs when *two* levels converge to this component, etc., as in this case, is referred to as "inverted" convergence.

Racah has pointed out that for levels from the $3d^9\,nx$ configuration, the jl-coupling notation is preferable, as for the inert gases. This notation can be worked out for Ni I from the auxiliary table given in the text for Cu II.

REFERENCES

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R. G. Loyarte und A. T. Williams, Phys. Zeit. **30,** 634 (1929). (T) (C L)
W. F. Meggers and C. C. Kiess, Bur. Std. J. Research **9,** 323, RP 473 (1932). (C L)
H. H. Marvin and A. E. Baragar, Phys. Rev. **43,** 973 (1933). (Z E)
H. H. Marvin, Phys. Rev. **44,** 818 (1933).
H. Dijkstra, Physica **4,** 81 (1937). (Z E)
C. H. Lindsley, J. Opt. Soc. Am. **32,** 94 (1942). (Z E)
K. Burns and F. Sullivan, Science Studies St. Bonaventure College **13,** No. 3 (June 1947); **14,** No. 3 (June 1948). (T)
K. G. Kessler, Phys. Rev. **79,** 167 (L) (1950). (hfs)
G. Racah, Phys. Rev. **61,** 537 (L) (1942) and private communication (June 1951).

Ni I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^8\,4s^2$	$a\,^3$F	4 3 2	0.000 1332.153 2216.519	−1332.153 −884.366	1.250 1.083 0.671
$3d^9(a\,^2\mathrm{D})4s$	$a\,^3$D	3 2 1	204.786 879.813 1713.080	−675.027 −833.267	1.332 1.149 0.497
$3d^9(a\,^2\mathrm{D})4s$	$a\,^1$D	2	3409.925		1.014
$3d^8\,4s^2$	$b\,^1$D	2	13521.352		1.143
$3d^{10}$	$a\,^1$S	0	14728.847		
$3d^8\,4s^2$	$a\,^3$P	2 1 0	15609.861 15734.018 16017.317	−124.157 −283.299	1.356 1.497
$3d^8\,4s^2$	$a\,^1$G	4	22102.349		0.99
$3d^8\,4s(a\,^4\mathrm{F})4p$	$z\,^5$D°	4 3 2 1 0	*25753.578* *26665.903* *27414.893* *27943.543* *28212.997*	−912.325 −748.990 −528.650 −269.454	1.51 1.50 1.49 1.486
$3d^8\,4s(a\,^4\mathrm{F})4p$	$z\,^5$G°	6 5 4 3 2	*27260.891* *27580.411* *28068.091* *28578.046* *29013.228*	−319.520 −487.680 −509.955 −435.182	1.32 1.28 1.171 0.945 0.364
$3d^8\,4s(a\,^4\mathrm{F})4p$	$z\,^5$F°	5 4 3 2 1	*28542.113* *29084.478* *29832.810* *30163.140* *30392.052*	−542.365 −748.332 −330.330 −228.912	1.38 1.288 1.208 0.985 0.006

Ni I

Config.	Desig.	J	Level	Interval	Obs. g
$3d^9(a\,^2\mathrm{D})4p$	$z\,^3$P°	2 1 0	*28569.210* *29500.690* *30192.268*	−931.480 −691.578	1.485 1.426
$3d^9(a\,^2\mathrm{D})4p$	$z\,^3$F°	4 3 2	*29481.020* *29320.782* *30619.440*	160.238 −1298.658	1.287 1.086 0.740
$3d^9(a\,^2\mathrm{D})4p$	$z\,^3$D°	3 2 1	*29668.918* *29888.505* *30912.838*	−219.587 −1024.333	1.300 1.044 0.552
$3d^8\,4s(a\,^2\mathrm{F})4p$	$z\,^3$G°	5 4 3	*30922.763* *30979.789* *31786.210*	−57.026 −806.421	1.21 1.052 0.761
$3d^9(a\,^2\mathrm{D})4p$	$z\,^1$F°	3	*31031.042*		1.048
$3d^9(a\,^2\mathrm{D})4p$	$z\,^1$D°	2	*31441.665*		1.060
$3d^8\,4s(a\,^2\mathrm{F})4p$	$y\,^3$F°	4 3 2	*32973.414* *33112.368* *33610.916*	−138.954 −498.548	1.22 1.193 0.79
$3d^9(a\,^2\mathrm{D})4p$	$z\,^1$P°	1	*32982.280*		1.005
$3d^8\,4s(a\,^2\mathrm{F})4p$	$y\,^3$D°	3 2 1	*33500.854* *34163.294* *34408.574*	−662.440 −245.280	1.198 1.19 0.511
$3d^8\,4s(a\,^2\mathrm{F})4p$	$z\,^1$G°	4	*33590.159*		1.035
$3d^8\,4s(a\,^2\mathrm{F})4p$	$y\,^1$F°	3	*35639.148*		1.013
$3d^8\,4s(a\,^2\mathrm{F})4p$	$y\,^1$D°	2	*36600.805*		1.013
	1°	3	*40361.254*		
	2°	2	*40484.282*		

Ni I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^8 4s(b\ ^2D)4p$	$x\ ^3F^\circ$	4	*42585.296*	−1069.678	1.35
		3	*43654.974?*		1.24
		2			
$3d^9(a\ ^2D)5s$	$e\ ^3D$	3	42605.964	−184.063	1.34
		2	42790.027	−1322.165	1.085
		1	44112.192		
$3d^8 4s(b\ ^2D)4p$	$x\ ^3D^\circ$	3	*42621.048*	−333.186	
		2	*42954.234*		0.840
		1			
$3d^8 4s(b\ ^2D)4p$	$y\ ^3P^\circ$	2	*42653.723*	−2.594	
		1	*42656.317*		1.32
		0			
$3d^8 4s(a\ ^4F)4p$	$w\ ^3D^\circ$	3	*42767.900*	−1707.258	1.22
		2	*44475.158*	−647.302	1.16
		1	*45122.460*		0.57
$3d^8 4s(a\ ^4F)4p$	$y\ ^3G^\circ$	5	*43089.636*	−1225.344	1.23
		4	*44314.980*	−966.172	1.18
		3	*45281.152*		0.78
$3d^8 4s(a\ ^4F)4p$	$w\ ^3F^\circ$	4	*43258.792*	−1306.31	1.25
		3	*44565.10*	−853.76	1.04
		2	*45418.858*		0.68
$3d^8 4s(b\ ^2D)4p$	$y\ ^1P^\circ$	1	*43464.019*		1.39
$3d^8 4s(b\ ^2D)4p$	$x\ ^1D^\circ$	2	*43933.428*		1.48
$3d^8 4s(b\ ^2D)4p$	$x\ ^1F^\circ$	3	*44206.185*		
$3d^9(a\ ^2D)5s$	$e\ ^1D$	2	44262.619		1.09
	3°		*44336.10*		
$3d^8 4s(a\ ^4P)4p$	$x\ ^3P^\circ$	2	*46522.965*	−685.263	
		1	*47208.228*	−478.397	
		0	*47686.625?*		
$3d^8 4s(a\ ^4P)4p$	$v\ ^3D^\circ$	3	*47030.148*	−109.244	1.331
		2	*47139.392*	−285.438	1.209
		1	*47424.830*		0.726
	4°	2	*47328.85*		
$3d^8 4s(a\ ^4F)5s$	$e\ ^5F$	5	48466.530	−619.500	1.40
		4	49086.030	−691.589	1.33
		3	49777.619	−568.858	1.23
		2	50346.477	−398.116	0.95
		1	50744.593		0.07
$3d^9(a\ ^2D)5p$	$v\ ^3F^\circ$	4	*48715.2*	43.3	
		3	*48671.9*	−1367.3	
		2	*50039.18*		
$3d^9(a\ ^2D)5p$	$w\ ^3P^\circ$	2	*48735.308*	−668.11	
		1	*49403.42*	−735.11	
		0	*50138.53*		
	5°	2, 1	*48817.6*		
$3d^9(a\ ^2D)4d$	$e\ ^3S$	1	48953.344		1.92
	6°	3	*49032.589*		
$3d^9(a\ ^2D)4d$	$e\ ^3G$	5	49158.529	−16.282	1.20
		4	49174.811	−1502.788	1.05
		3	50677.599		0.77
$3d^9(a\ ^2D)4d$	$e\ ^3P$	2	49159.060	−12.127	1.43
		1	49171.187	−1105.167	1.00
		0	50276.354		

Ni I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^9(a\ ^2D)4d$	$f\ ^3D$	3	49271.578	−56.267	1.32
		2	49327.845	−1389.082	
		1	50716.927		0.45
$3d^9(a\ ^2D)5p$	$u\ ^3D^\circ$	3	*49327.56*	142.41	
		2	*49185.146*	−1666.07	
		1	*50851.22*		
$3d^9(a\ ^2D)4d$	$e\ ^3F$	4	49332.643	18.792	
		3	49313.851	−1520.584	
		2	50834.435		
$3d^9(a\ ^2D)5p$	$w\ ^1F^\circ$	3	*50142.8*		
$3d^9(a\ ^2D)5p$	$x\ ^1P^\circ$	1	*50458.187*		
$3d^8 4s(a\ ^4F)5s$	$f\ ^3F$	4	50466.172	−839.913	1.27
		3	51306.085	−734.483	1.08
		2	52040.568		
$3d^9(a\ ^2D)4d$	$e\ ^1P$	1	50536.742		1.54
$3d^9(a\ ^2D)5p$	$w\ ^1D^\circ$	2	*50689.490*		
$3d^9(a\ ^2D)4d$	$e\ ^1G$	4	50706.310		1.02
$3d^9(a\ ^2D)4d$	$f\ ^1D$	2	50754.137		
$3d^8 4s(a\ ^2G)4p$	$u\ ^3F^\circ$	4	*50789.5*	−335.3	
		3	*51124.8*	−219.0	
		2	*51343.80*		
$3d^9(a\ ^2D)4d$	$e\ ^1F$	3	50832.039		
$3d^9(a\ ^2D)4d$	$e\ ^1S$	0	51457.285		
$3d^9(a\ ^2D)6s$	$g\ ^3D$	3	52197.482	−74.234	
		2	52271.716	−1432.183	
		1	53703.899		
$3d^9(a\ ^2D)6s$	$g\ ^1D$	2	53754.036		
$3d^8 4s(a\ ^2F)5s$	$g\ ^3F$	4	54237.136	−14.217	1.27
		3	54251.353	−1622.43	
		2	55873.78		
$3d^9(a\ ^2D)5d$	$f\ ^3S$	1	54574.64		
$3d^9(a\ ^2D)5d$	$f\ ^3G$	5	54659.759	−8.169	
		4	54667.928	−1504.776	1.03
		3	56172.704		
$3d^9(a\ ^2D)5d$	$h\ ^3D$	3	54699.852	−32.573	
		2	54732.425?		
		1			
$3d^9(a\ ^2D)5d$	$h\ ^3F$	4	54761.346	−11.594	
		3	54772.940	−1501.576	
		2	56274.516		
$3d^8 4s(a\ ^2F)5s$	$f\ ^1F$	3	55576.905		
$3d^9(a\ ^2D)5d$	$f\ ^1G$	4	56183.51		
$3d^9(a\ ^2D)5d$	$g\ ^1F$	3	56262.92		
$3d^8 4s(a\ ^4F)4d$	$e\ ^3H$	6	56624.668	−1052.981	
		5	57677.649	−840.46	
		4	58518.11		
$3d^8 4s(a\ ^4F)4d$	$f\ ^3P$	2	56710.889	−1056.63	
		1	57767.52	−681.27	
		0	58448.79		
$3d^8 4s(a\ ^4F)4d$	$i\ ^3F$	4	56766.523	−1201.56	
		3	57968.08	−661.76	
		2	58629.84		

Ni I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$3d^8\,4s(a\,^4F)4d$	$g\,^3G$	5 4 3	56801. 654 57789. 611 58530. 35	−987. 957 −740. 74	
$3d^8\,4s(a\,^4F)4d$	$e\,^5P$	3 2 1	56821. 553 57586. 7 58525. 507	−765. 1 −938. 8	
$3d^8\,4s(a\,^4F)4d$	$e\,^5D$	4 3 2 1 0	56857. 933 57743. 596	−885. 663	
$3d^8\,4s(a\,^4F)4d$	$e\,^5H$	7 6 5 4 3	56885. 249 57762. 106 58520. 923 59039. 693 59188. 78	−876. 857 −758. 817 −518. 770 −149. 09	1. 26
$3d^8\,4s(a\,^4F)4d$	$e\,^5G$	6 5 4 3 2	56954. 167 57829. 405 58872. 57 58629. 55 59118. 06	−875. 238 −1043. 16 243. 02 −488. 51	
$3d^8\,4s(a\,^4F)4d$	$f\,^5F$	5 4 3 2 1	56973. 707 57810. 494 58588. 168 58992. 52 59226. 03	−836. 787 −777. 674 −404. 35 −233. 51	
$3d^8\,4s(a\,^4F)4d$	$i\,^3D$	3 2 1	57103. 946		
$3d^8\,4s(a\,^4F)6s$	$g\,^5F$	5 4 3 2 1	59862. 69		
Ni II ($a\,^2D_{2½}$)	*Limit*	-----	**61579**		
$3d^8\,4s(a\,^2F)4d$	$j\,^3F$	4 3 2	61832. 47		
$3d^8\,4s(a\,^2F)4d$	$h\,^3G$	5 4 3	61843. 28		
$3d^8\,4s(a\,^2F)4d$	$f\,^3H$	6 5 4	61957. 517		
$3d^8\,4s(a\,^4F)5d$	$f\,^5H$	7 6 5 4 3	62782. 614		
$3d^8\,4s(a\,^4F)5d$	$f\,^5G$	6 5 4 3 2	62808. 03		
$3d^8\,4s(a\,^4F)5d$	$h\,^5F$	5 4 3 2 1	62815. 34?		

October 1949.

Ni I Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms		
$3d^8\,4s^2$	$a\,^3P$, $b\,^1D$, $a\,^3F$, $a\,^1G$		
$3d^{10}$	$a\,^1S$		
	ns ($n\geq4$)	np ($n\geq4$)	nd ($n\geq4$)
$3d^9(a\,^2D)nx$	$a, e, g\,^3D$ $a, e, g\,^1D$	$z, w\,^3P°$ $z, u\,^3D°$ $z, v\,^3F°$ $z, x\,^1P°$ $z, w\,^1D°$ $z, w\,^1F°$	$e, f\,^3S$ $e\,^3P$ $f, h\,^3D$ $e, h\,^3F$ $e, f\,^3G$ $e\,^1S$ $e\,^1P$ $f\,^1D$ $e, g\,^1F$ $e, f\,^1G$
$3d^8\,4s(a\,^4F)nx$	$e, g\,^5F$ $f\,^3F$	$z\,^5D°$ $z\,^5F°$ $z\,^5G°$ $w\,^3D°$ $w\,^3F°$ $y\,^3G°$	$e\,^5P$ $e\,^5D$ $f, h\,^5F$ $e, f\,^5G$ $e, f\,^5H$ $f\,^3P$ $i\,^3D$ $i\,^3F$ $g\,^3G$ $e\,^3H$
$3d^8\,4s(a\,^2F)nx$	$g\,^3F$ $f\,^1F$	$y\,^3D°$ $y\,^3F°$ $z\,^3G°$ $y\,^1D°$ $y\,^1F°$ $z\,^1G°$	$j\,^3F$ $h\,^3G$ $f\,^3H$
$3d^8\,4s(b\,^2D)nx$		$y\,^3P°$ $x\,^3D°$ $x\,^3F°$ $y\,^1P°$ $x\,^1D°$ $x\,^1F°$	
$3d^8\,4s(a\,^4P)nx$		$x\,^3P°$ $v\,^3D°$	
$3d^3\,4s(a\,^2G)nx$		$u\,^3F°$	

*For predicted terms in the spectra of the Ni I isoelectronic sequence, see Vol. II, Introduction.

Ni II

(Co I sequence; 27 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9\ {}^2D_{2\frac{1}{2}}$

$a\ {}^2D_{2\frac{1}{2}}$ **146408** cm^{-1} I. P. 18.15 volts

The analysis is chiefly by Shenstone who has classified 242 lines in the interval from 1812 A to 4362 A, from measurements by Meggers between 3500 A and 2150 A, supplemented by his own observations in the short wave region. Further observations in the ultraviolet were needed to locate the ground term, $a\ {}^2D$. This term was found independently by both Lang and Menzies, who classified about 50 lines between 1252 A and 1952 A. The discovery of this term indicated that 8391 cm^{-1} (Lang) or 8392.9 (Menzies) should be added to all of Shenstone's values. An improved value by Shenstone, 8394.1, has been adopted here.

Intersystem combinations connecting the doublet and quartet systems of terms, have been observed.

Shenstone has calculated the limit from the two levels a, $e\ {}^4F_{4\frac{1}{2}}$, by assuming a Rydberg series. This is known to be too high. The correction derived from longer series in related spectra has been estimated by H. N. Russell as about -2792 cm^{-1}. This adjustment has been made in the limit quoted here.

The listed g-values are from Lindsley; they are derived from measurements of Zeeman patterns of 128 lines observed at the Massachusetts Institute of Technology.

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R. J. Lang, Phys. Rev. **31**, 773 (1928); **33**, 547 (1929). (T) (C L)

A. C. Menzies, Proc. Roy. Soc. London [A] **122**, 134 (1929). (T) (C L)

C. H. Lindsley, J. Opt. Soc. Am. **32**, 387 (1942). (Z E)

A. G. Shenstone, letter (Oct. 1949). (T)

H. N. Russell, J. Opt. Soc. Am. **40**, 619 (1950). (I P)

Ni II

Shenstone	Config.	Desig.	J	Level	Interval	Obs. g
	$3d^9$	$a\ {}^2D$	2½	0.0	−1506.9	
			1½	1506.9		
$a\ {}^4F'_5$	$3d^8({}^3F)4s$	$a\ {}^4F$	4½	8394.1	−936.4	1.35
$a\ {}^4F'_4$			3½	9330.5	−785.4	1.24
$a\ {}^4F'_3$			2½	10115.9	−548.3	1.023
$a\ {}^4F'_2$			1½	10664.2		0.397
$a\ {}^2F'_4$	$3d^8({}^3F)4s$	$a\ {}^2F$	3½	13550.3	−1445.3	1.141
$a\ {}^2F'_3$			2½	14995.6		0.866
$a\ {}^2D_3$	$3d^8({}^1D)4s$	$b\ {}^2D$	2½	23108.1	−688.0	1.428
$a\ {}^2D_2$			1½	23796.1		1.045
$a\ {}^4P'_1$	$3d^8({}^3P)4s$	$a\ {}^4P$	0½	24835.9	−47.8	2.667
$a\ {}^4P'_2$			1½	24788.1	247.7	1.498
$a\ {}^4P'_3$			2½	25035.8		1.368
$a\ {}^2P'_2$	$3d^8({}^3P)4s$	$a\ {}^2P$	1½	29070.6	−522.5	1.322
$a\ {}^2P'_1$			0½	29593.1		0.670
$a\ {}^2G_5$	$3d^8({}^1G)4s$	$a\ {}^2G$	4½	32499.4	−24.0	1.135
$a\ {}^2G_4$			3½	32523.4		0.895

Ni II

Shenstone	Config.	Desig.	J	Level	Interval	Obs. g
$a\ {}^4D'_4$	$3d^8({}^3F)4p$	$z\ {}^4D^\circ$	3½	*51558.1*	−1180.5	1.420
$a\ {}^4D'_3$			2½	*52738.6*	−896.5	1.356
$a\ {}^4D'_2$			1½	*53635.1*	−541.0	1.186
$a\ {}^4D'_1$			0½	*54176.1*		−0.005
$a\ {}^4G'_6$	$3d^8({}^3F)4p$	$z\ {}^4G^\circ$	5½	*53496.8*	131.6	1.305
$a\ {}^4G'_5$			4½	*53365.2*	−897.5	1.156
$a\ {}^4G_4$			3½	*54262.7*	−756.1	1.02
$a\ {}^4G'_3$			2½	*55018.8*		0.616
$a\ {}^4F_5$	$3d^8({}^3F)4p$	$z\ {}^4F^\circ$	4½	*54557.3*	−860.6	1.26
$a\ {}^4F_4$			3½	*55417.9*	−657.3	1.184
$a\ {}^4F_3$			2½	*56075.2*	−349.4	0.985
$a\ {}^4F_2$			1½	*56424.6*		0.412
$a\ {}^2G'_5$	$3d^8({}^3F)4p$	$z\ {}^2G^\circ$	4½	*55300.0*	−1071.6	1.152
$a\ {}^2G'_4$			3½	*56371.6*		0.940
$a\ {}^2F_4$	$3d^8({}^3F)4p$	$z\ {}^2F^\circ$	3½	*57080.3*	−1412.7	1.154
$a\ {}^2F_3$			2½	*58493.0*		0.946
$a\ {}^2D'_3$	$3d^8({}^3F)4p$	$z\ {}^2D^\circ$	2½	*57419.7*	−1285.9	1.116
$a\ {}^2D'_2$			1½	*58705.6*		0.795

Ni II—Continued

Shenstone	Config.	Desig.	J	Level	Interval	Obs. g
$b\,^4P_3$	$3d^8(^3P)4p$	$z\,^4P^\circ$	2½	*66570.9*	−8.6	1.48
$b\,^4P_2$			1½	*66579.5*	−451.2	1.550
$b\,^4P_1$			0½	*67030.7*		2.331
$b\,^2F_3$	$3d^8(^1D)4p$	$y\,^2F^\circ$	2½	*67694.2*	436.8	0.960
$b\,^2F_4$			3½	*68131.0*		1.200
$b\,^2D'_2$	$3d^8(^1D)4p$	$y\,^2D^\circ$	1½	*68154.1*	581.2	1.02
$b\,^2D'_3$			2½	*68735.3*		1.26
$b\,^2P_1$	$3d^8(^1D)4p$	$z\,^2P^\circ$	0½	*68281.4*	684.1	1.008
$b\,^2P_2$			1½	*68965.5*		1.305
$b\,^4D'_1$	$3d^8(^3P)4p$	$y\,^4D^\circ$	0½	*70748.5*	−41.9	
$b\,^4D'_2$			1½	*70706.6*	−71.4	1.190
$b\,^4D'_3$			2½	*70635.2*	142.2	1.32
$b\,^4D'_4$			3½	*70777.4*		1.38
$c\,^2D'_3$	$3d^8(^3P)4p$	$x\,^2D^\circ$	2½	*71770.9*	−604.2	1.240
$c\,^2D'_2$			1½	*72375.1*		0.844
$c\,^2P_2$	$3d^8(^3P)4p$	$y\,^2P^\circ$	1½	*72985.2*	−917.5	1.326
$c\,^2P_1$			0½	*73902.7*		1.039

Ni II—Continued

Shenstone	Config.	Desig.	J	Level	Interval	Obs. g
$c\,^2S'_1$	$3d^8(^3P)4p$	$z\,^2S^\circ$	0½	*74283.0*		
$b\,^4S'_2$	$3d^8(^3P)4p$	$z\,^4S^\circ$	1½	*74300.3*		
$b\,^2H_5$	$3d^8(^1G)4p$	$z\,^2H^\circ$	4½	*75149.6*	572.0	0.903
$b\,^2H_6$			5½	*75721.6*		1.119
$c\,^2F_3$	$3d^8(^1G)4p$	$x\,^2F^\circ$	2½	*75889.5?*	27.8	
$c\,^2F_4$			3½	*75917.3?*		1.16
$b\,^2G'_4$	$3d^8(^1G)4p$	$y\,^2G^\circ$	3½	*79822.7*	101.1	
$b\,^2G'_5$			4½	*79923.8*		
$d\,^4F'_5$	$3d^8(^3F)5s$	$e\,^4F$	4½	91798.5	−525.4	1.350
$d\,^4F'_4$			3½	92323.9	−1064.1	1.188
$d\,^4F'_3$			2½	93388.0	−677.1	1.02
$d\,^4F'_2$			1½	94065.1		0.39
$d\,^2F'_4$	$3d^8(^3F)5s$	$e\,^2F$	3½	93526.3	−1200.8	1.166
$d\,^2F'_3$			2½	94727.1		0.865
	Ni III ($^3F_4$)	***Limit***	----	146408		

October 1949.

Ni II Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms	
$3d^9$	$a\,^2D$	
	$ns\ (n\geq 4)$	$np\ (n\geq 4)$
$3d^8(^3F)nx$	$a,e\,^4F$; $a,e\,^2F$	$z\,^4D^\circ$ $z\,^4F^\circ$ $z\,^4G^\circ$; $z\,^2D^\circ$ $z\,^2F^\circ$ $z\,^2G^\circ$
$3d^8(^3P)nx$	$a\,^4P$; $a\,^2P$	$z\,^4S^\circ$ $z\,^4P^\circ$ $y\,^4D^\circ$; $z\,^2S^\circ$ $y\,^2P^\circ$ $x\,^2D^\circ$
$3d^8(^1G)nx$	$a\,^2G$	$x\,^2F^\circ$ $y\,^2G^\circ$ $z\,^2H^\circ$
$3d^8(^1D)nx$	$b\,^2D$	$z\,^2P^\circ$ $y\,^2D^\circ$ $y\,^2F^\circ$

*For predicted terms in the spectra of the Co I isoelectronic sequence, see Vol. II, Introduction.

Ni III

(Fe I sequence; 26 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^8\ {}^3F_4$

$a\ {}^3F_4$ **283700** cm^{-1} I. P. 36.16 volts

This spectrum has been analyzed by Shenstone especially for inclusion here. His observations cover the range 700 A to 3000 A. There are 165 classified lines, and the triplet and quintet terms are connected by observed intersystem combinations.

Shenstone has determined the limit from the $ns\ {}^5F$ series (n=4,5) by using a Ritz formula and assuming $\alpha=0.17\times10^{-6}$, to be 284400 cm^{-1}. From a study of isoelectronic data Catalán has derived an improved value, which is quoted here.

REFERENCES

A. G. Shenstone, unpublished material (May 1950). (I P) (T) (C L)

M. A. Catalán, unpublished material (April 1952). (I P).

Ni III

Config.	Desig.	J	Level	Interval
$3d^8$	$a\ {}^3F$	4 3 2	0.0 1360.7 2269.6	−1360.7 −908.9
$3d^8$	$a\ {}^3P$	2 1 0	16661.6 16977.8 17230.7	−316.2 −252.9
$3d^7(^4F)4s$	$a\ {}^5F$	5 4 3 2 1	53703.7 54657.9 55406.1 55952.0 56308.2	−954.2 −748.2 −545.9 −356.2
$3d^7(^4F)4s$	$b\ {}^3F$	4 3 2	61339.3 62606.3 63472.6	−1267.0 −866.3
$3d^7(^4P)4s$	$a\ {}^5P$	3 2 1	71067.0 71383.7 71841.9	−316.7 −458.2
$3d^7(^2G)4s$	$a\ {}^3G$	5 4 3	75123.8 75646.9 76237.8	−523.1 −590.9
$3d^7(^4P)4s$	$b\ {}^3P$	2 1 0	79143.3	
$3d^7(^4F)4p$	$z\ {}^5F°$	5 4 3 2 1	*110212.4* *110371.1* *111220.9* *111914.1* *112401.5*	−158.7 −849.8 −693.2 −487.4
$3d^7(^4F)4p$	$z\ {}^5D°$	4 3 2 1 0	*111898.5* *112935.3* *113651.0* *114095.4* *114295.2*	−1036.8 −715.7 −444.4 −199.8
$3d^7(^4F)4p$	$z\ {}^5G°$	6 5 4 3 2	*112787.4* *113140.8* *113705.0* *114109.9* *114370.8*	−353.4 −564.2 −404.9 −260.9
$3d^7(^4F)4p$	$z\ {}^3G°$	5 4 3	*115272.5* *116674.5* *117543.1*	−1402.0 −868.6
$3d^7(^4F)4p$	$z\ {}^3F°$	4 3 2	*116192.1* *117251.0* *118115.3*	−1058.9 −864.3

Ni III

Config.	Desig.	J	Level	Interval
$3d^7(^4F)4p$	$z\ {}^3D°$	3 2 1	*118745.7* *119670.0* *120272.7*	−924.3 −602.7
$3d^7(^4P)4p$	$z\ {}^5S°$	2	*122282.3*	
$3d^7(^4P)4p$	$y\ {}^5D°$	0 1 2 3 4	 *129957.6* *129912.8* *129953.9* *130312.3*	−44.8 41.1 358.4
$3d^7\ 4p$	1°	5, 4	*131500.3*	
$3d^7(^2G)4p$	$y\ {}^3F°$	4 3 2	*131792.4* *133158.3* *134232.7*	−1365.9 −1074.4
$3d^7\ 4p$	2°	4	*132156.6*	
$3d^7\ 4p$	3°	3	*133095.7*	
$3d^7\ 4p$	4°	2, 1	*133276.8*	
$3d^7\ 4p$	5°	5, 4	*133325.1*	
$3d^7(^4P)4p$	$z\ {}^5P°$	3 2 1	*133390.8* *133500.2*	109.4
$3d^7(^2G)4p$	$y\ {}^3G°$	5 4 3	*133691.8* *134415.4*	−723.6
$3d^7\ 4p$	6°	5, 4	*134217.8*	
$3d^7\ 4p$	7°	3, 2	*134334.9*	
$3d^7\ 4p$	8°	3	*136967.4*	
$3d^7\ 4p$	9°	3	*138487.5*	
$3d^7\ 4p$	10°	2, 1	*140885.5*	
$3d^7(^4F)5s$	$e\ {}^5F$	5 4 3 2 1	181018.7	
$3d^7(^4F)5s$	$e\ {}^3F$	4 3 2	183053.1	
Ni IV ($^4F_{4½}$)	*Limit*	---------	283700	

March 1951.

Ni III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms					
$3d^8$	$a\,^3P$ $a\,^3F$					
	$ns\ (n\geq4)$	$np\ (n\geq4)$				
$3d^7(^4F)nx$	$a,\ e\,^5F$ $b,\ e\,^3F$			$z\,^5D^\circ$ $z\,^3D^\circ$	$z\,^5F^\circ$ $z\,^3F^\circ$	$z\,^5G^\circ$ $z\,^3G^\circ$
$3d^7(^4P)nx$	$a\,^5P$ $b\,^3P$	$z\,^5S^\circ$	$z\,^5P^\circ$	$y\,^5D^\circ$		
$3d^7(^2G)nx$	$a\,^3G$				$y\,^3F^\circ$	$y\,^3G^\circ$

*For predicted terms in the spectra of the Fe I isoelectronic sequence, see Vol. II, Introduction.

Ni V

(Cr I sequence; 24 electrons) $Z=28$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ ^5D_4$

$a\,^5D_4$ cm^{-1} I. P. volts

From a study of isoelectronic sequence data, and especially by analogy with Fe III, Morell in 1928 classified 10 lines between 1123 A and 1501 A as combinations between $3d^5(^6S)4s\ ^{7,5}S$ and $3d^5(^6S)4p\ ^{7,5}P^\circ$. The present detailed analysis of Fe III indicates the urgent need of further investigation of the Ni V spectrum.

REFERENCE

L. Morell, Thesis (unpublished) Cornell University (1928). (T) (C L)

January 1950.

Ni VI

(V I sequence; 23 electrons) $Z=28$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ ^6S_{2\frac{1}{2}}$

$a\,^6S_{2\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum is very incompletely known. In 1931 Miss Gilroy published 6 terms, and 25 classified lines between 844 A and 1191 A. Later, Kruger and Gilroy classified three lines as transitions from the ground term to $3d^4\ 4p\ ^6P^\circ$ as follows:

Int.	I. A.	Wave No.	Desig.
400 300 250	260. 348 260. 591 260. 713	384101 383743 383564	$3d^5\ ^6S_{2\frac{1}{2}}-4p\ ^6P^\circ_{3\frac{1}{2}}$ $3d^5\ ^6S_{2\frac{1}{2}}-4p\ ^6P^\circ_{2\frac{1}{2}}$ $3d^5\ ^6S_{2\frac{1}{2}}-4p\ ^6P^\circ_{1\frac{1}{2}}$

The later work indicates that the terms published in 1931 need revision.

REFERENCES

H. T. Gilroy, Phys. Rev. **38**, 2217 (1931). (T) (CL)
P. G. Kruger and H. T. Gilroy, Phys. Rev. **48**, 720 (1935). (T) (C L)

January 1950.

Ni VII

(Ti I sequence; 22 electrons) $Z=28$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ {}^5D_0$

$a\ {}^5D_0$ cm^{-1} I. P. volts

The analysis is incomplete. Phillips and Kruger have classified 92 lines in the range between 205 A and 229 A. Intersystem combinations connecting the triplet and quintet systems of terms have been observed. No series have been found.

REFERENCE

L. W. Phillips and P. G. Kruger, Phys. Rev. **54**, 839 (1938). (T) (C L)

Ni VII

Config.	Desig.	J	Level	Interval
$3d^4$	$a\ {}^5D$	0	0	275
		1	275	527
		2	802	718
		3	1520	859
		4	2379	
$3d^4$	$a\ {}^3P$	0	29334	1766
		1	31100	2606
		2	33706	
$3d^4$	$a\ {}^3H$	4	31052	616
		5	31668	599
		6	32267	
$3d^4$	$a\ {}^3F$	2	33592	113
		3	33705	256
		4	33961	
$3d^4$	$a\ {}^3G$	3	37551	590
		4	38141	497
		5	38638	
$3d^4(a\ {}^4F)4p$	$z\ {}^5D^\circ$	0		
		1	*467048*	682
		2	*467730*	987
		3	*468717*	1153
		4	*469870*	
$3d^3(a\ {}^4F)4p$	$z\ {}^5F^\circ$	1	*469191*	884
		2	*470075*	1040
		3	*471115*	959
		4	*472074*	856
		5	*472930*	
$3d^3(a\ {}^4F)4p$	$z\ {}^3D^\circ$	1	*470528*	730
		2	*471258*	1256
		3	*472514*	
$3d^3(a\ {}^4F)4p$	$z\ {}^3G^\circ$	3	*475657*	1002
		4	*476659*	1277
		5	*477936*	
$3d^3(a\ {}^4F)4p$	$z\ {}^3F^\circ$	2	*479348*	1146
		3	*480494*	1145
		4	*481639*	
$3d^3(a\ {}^4P)4p$	$z\ {}^5P^\circ$	1	*486170*	1058
		2	*487228*	1445
		3	*488673*	
$3d^3(a\ {}^2G)4p$	$y\ {}^3G^\circ$	3	*493139*	1357
		4	*494496*	1251
		5	*495747*	
$3d^3(a\ {}^2H)4p$	$x\ {}^3G^\circ$	5	*510873*	−228
		4	*511101*	−301
		3	*511402*	

January 1949.

Ni VII Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms				
$3d^4$	$a\ ^3P$	$a\ ^5D$	$a\ ^3F$	$a\ ^3G$	$a\ ^3H$
			np ($n \geq 4$)		
$3d^3\ (a\ ^4F)\ nx$		$z\ ^5D^\circ$ $z\ ^3D^\circ$	$z\ ^5F^\circ$ $z\ ^3F^\circ$	$z\ ^3G^\circ$	
$3d^3\ (a\ ^4P)\ nx$	$z\ ^5P^\circ$				
$3d^3\ (a\ ^2G)\ nx$				$y\ ^3G^\circ$	
$3d^3\ (a\ ^2H)\ nx$				$x\ ^3G^\circ$	

*For predicted terms in the spectra of the Ti I isoelectronic sequence, see Vol. I, p. xxxvii.

Ni VIII

(Sc I sequence; 21 electrons) $Z=28$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ ^4F_{1\frac{1}{2}}$

$a\ ^4F_{1\frac{1}{2}}$ cm^{-1} I. P. volts

The analysis is by Anderson and Mack, who have classified 132 lines in the region between 530 A and 611 A. They have been unable to locate with certainty the ^2P term having the configuration $3d^3$, but suggest tentatively for this term two possible pairs of levels whose reality is not yet established, as follows:

J	Level	
1½	31515?	32261?
0½	32089?	32939?

Intersystem combinations connecting the doublet and quartet systems of terms have been observed.

REFERENCE

E. E. Anderson and J. E. Mack, Phys. Rev. **59**, 717 (1941). (T) (C L)

Ni VIII

Config.	Desig.	J	Level	Interval
$3d^3$	$a\,^4F$	1½ 2½ 3½ 4½	0 1012 2184 3721	1012 1172 1537
$3d^3$	$a\,^4P$	0½ 1½ 2½	23261 23710 24669	449 959
$3d^3$	$a\,^2G$	3½ 4½	26977 28068	1091
$3d^3$	$a\,^2D$	2½ 1½	34689 35120	−431
$3d^3$	$a\,^2H$	4½ 5½	36754 37475	721
$3d^2(a\,^3F)4p$	$z\,^4G^\circ$	2½ 3½ 4½ 5½	*565124* *566964* *569564* *572969*	1840 2600 3405
$3d^2(a\,^3F)4p$	$z\,^4F^\circ$	1½ 2½ 3½ 4½	*565388* *566831* *568746* *570960*	1443 1915 2214
$3d^2(a\,^3F)4p$	$z\,^2D^\circ$	1½ 2½	*569667* *571845*	2178
$3d^2(a\,^3F)4p$	$z\,^4D^\circ$	0½ 1½ 2½ 3½	*570353* *569839* *571517* *573327*	−514 1678 1810
$3d^2(a\,^3F)4p$	$z\,^2F^\circ$	2½ 3½	*570546* *571804*	1258
$3d^2(a\,^3F)4p$	$z\,^2G^\circ$	3½ 4½	*581337* *583241*	1904
$3d^2(a\,^3P)4p$	$z\,^4S^\circ$	1½	*587305*	
$3d^2(a\,^3P)4p$	$y\,^4D^\circ$	0½ 1½ 2½ 3½	*590764* *592175* *594068* *596908*	1411 1893 2840
$3d^2(a\,^3P)4p$	$z\,^4P^\circ$	0½ 1½ 2½	*596770* *596905?* *598570*	135 1665
$3d^2(a\,^1G)4p$	$y\,^2G^\circ$	3½ 4½	*598638* *599079*	441
$3d^2(a\,^1G)4p$	$z\,^2H^\circ$	4½ 5½	*613417* *615725*	2308

December 1948.

Ni VIII Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms					
$3d^3$		$a\,^4P$	$a\,^2D$	$a\,^4F$	$a\,^2G$	$a\,^2H$
	$np\ (n\geq 4)$					
$3d^2(a\,^3F)nx$			$z\,^4D^\circ$ $z\,^2D^\circ$	$z\,^4F^\circ$ $z\,^2F^\circ$	$z\,^4G^\circ$ $z\,^2G^\circ$	
$3d^2(a\,^3P)nx$	$z\,^4S^\circ$	$z\,^4P^\circ$	$y\,^4D^\circ$			
$3d^2(a\,^1G)nx$					$y\,^2G^\circ$	$z\,^2H^\circ$

*For predicted terms in the spectra of the Sc I isoelectronic sequence, see Vol. I, p. XXXVI.

Ni IX

(Ca I sequence; 20 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^2\;{}^3F_2$

$a\;{}^3F_2$ cm^{-1} **I. P.** volts

Although 20 lines between 146 A and 154 A were reported as classified in 1933, later study of the spectra of this sequence by Edlén indicates that the early interpretation is incorrect.

REFERENCES

W. M. Cady, Phys. Rev. **43,** 325 (1933). (T) (C L)
B. Edlén, letter (Feb. 1949).

February 1949.

Ni XII

(Cl I sequence; 17 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^5\;{}^2P^\circ_{1\frac{1}{2}}$

$3p^5\;{}^2P^\circ_{1\frac{1}{2}}$ cm^{-1} I. P. 350 volts

This spectrum has not been analyzed. Edlén has tentatively attributed the faint coronal line at 4231.4 A (wave number 23626 cm^{-1}) to the transition $3p^5\;{}^2P^\circ_{1\frac{1}{2}}-3p^5\;{}^2P^\circ_{\frac{1}{2}}$ of [Ni XII], since this interval for the ground term is confirmed by extrapolation along the isoelectronic sequence.

REFERENCE

B. Edlén, Zeit. Astroph. **22,** 32 (1942). (I P) (T) (C L)

January 1948.

Ni XIII

(S I sequence; 16 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^4\;{}^3P_2$

$3p^4\;{}^3P_2$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has calculated the relative positions of the five lowest levels, in his work on the identification of the coronal lines. He has tentatively attributed two coronal lines to [Ni XIII] as follows:

I. A.	Int.	Wave No.	Desig.
3642. 9		27443	$3p^4\;{}^3P_1-3p^4\;{}^1D_2$
5116. 03	4. 3	19541. 0	$3p^4\;{}^3P_2-3p^4\;{}^3P_1$

These lines have been used to calculate three levels listed in the table. The remaining two are Edlén's estimated values and are entered in brackets.

REFERENCE

B. Edlén, Zeit. Astroph. **22,** 47 (1942). (T) (C L)

Ni XIII

Config.	Desig.	J	Level	Interval
$3s^2\,3p^4$	$3p^4\,{}^3P$	2 1 0	0 19541 [20200]	−19541 [− 659]
$3s^2\,3p^4$	$3p^4\,{}^1D$	2	46984	
$3s^2\,3p^4$	$3p^4\,{}^1S$	0	[97000]	

January 1948.

Ni XV

(Si I sequence; 14 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^2\,{}^3P_0$

$3p^2\,{}^3P_0$ cm^{-1} I. P. 455 volts

This spectrum has not been analyzed. Edlén has, however, suggested that two coronal lines may tentatively be ascribed to the [Ni XV] transitions corresponding to the intervals of the ground term. The coronal data are as follows:

I. A.	Int.	Wave No.	Desig.
6701. 83	5. 4	14917. 2	$3p^2\,{}^3P_0-3p^2\,{}^3P_1$
8024. 21	0. 5	12458. 9	$3p^2\,{}^3P_1-3p^2\,{}^3P_2$

The listed term values have been calculated from the coronal wave numbers, except for the last two, which are Edlén's estimated values and are entered in brackets.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Astroph. **22**, 40 (1942). (I P) (T) (C L)

Ni XV

Config.	Desig.	J	Level	Interval
$3s^2\,3p^2$	$3p^2\,{}^3P$	0 1 2	0. 0 14917. 2 27376. 1	14917. 2 12458. 9
$3s^2\,3p^2$	$3p^2\,{}^1D$	2	[62900]	
$3s^2\,3p^2$	$3p^2\,{}^1S$	0	[100000]	

October 1947.

Ni XVI

(Al I sequence; 13 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p\;^2P^\circ_{0\frac{1}{2}}$

$3p\;^2P^\circ_{0\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed. Edlén has, however, suggested that the faint coronal line at 3601.0 A, wave number 27762, may be classified as due to the forbidden transition that corresponds to the interval of the ground term of Ni XVI, i. e., $3p\;^2P^\circ_{0\frac{1}{2}}-3p\;^2P^\circ_{1\frac{1}{2}}$.

REFERENCE

B. Edlén, Zeit. Astroph. **22**, 47 (1942). (T) (C L)

December 1947.

Ni XVIII

(Na I sequence; 11 electrons) $Z=28$

Ground state $1s^2\,2s^2\,2p^6\,3s\;^2S_{\frac{1}{2}}$

$3s\;^2S_{0\frac{1}{2}}$ **4897400** cm^{-1} I. P. 607 volts

Edlén has classified four lines in the interval 43 A to 52 A, and extrapolated the absolute value of the ground term from isoelectronic sequence data.

One term, $4d\;^2D$, has been calculated from the observed combination with $3p\;^2P^\circ$ listed by Edlén, and added to his published list.

The unit adopted by Edlén, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **100**, 621 (1936). (I P) (T) (C L).

Ni XVIII

Config.	Desig.	*J*	Level	Interval
3*s*	3*s* ²S	0½	0	
3*p*	3*p* ²P°	½ 1½	*310600* *341000*	30400
3*d*	3*d* ²D	1½ 2½	766700 771300	4600
4*d*	4*d* ²D	1½ 2½	2593000 2595900	2900
4*f*	4*f* ²F°	2½ 3½	*2667400* *2668200*	800
---------	------	---	---------	
Ni XIX (¹S₀)	*Limit*	---	[4897400]	

June 1947.

COPPER

Cu I

29 electrons Z=29

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ ^2S_{0\frac{1}{2}}$

$4s\ ^2S_{0\frac{1}{2}}$ **62317.2** cm^{-1} I. P. 7.724 volts

The analysis of the arc spectrum of copper affords one of the finest examples of a beautifully complete interpretation of a fairly complex spectrum. Shenstone has verified all of the earlier observations, extended them to include the ultraviolet region, and published a detailed analysis in his 1948 Monograph. This spectrum now furnishes accurate ultraviolet wave lengths for use as standards in investigating other spectra in this region. The number of classified lines totals 732, and the observations extend from 1504 A to 18229 A. Many intersystem combinations have been observed, connecting the terms of both multiplicities.

Shenstone remarks that all of the predictable types of electron structure have been identified. To quote, "The spectrum is unique in having many more identified levels above the point of easiest ionization, than below. There are a great many series converging to complex limits and showing various degrees of perturbation". The above limit is from both the ^{2}S and ^{2}D doublet series fitted to an extended Ritz formula, the differences in the calculated values being less than 0.4 cm^{-1}.

Shenstone (August 1948) calls attention to the important fact that "The $3d^9\ 4s\ ns$ series is of special interest because it is the only known complex series in which individual series can be unambiguously assigned to the components of a limit of greater complexity than a doublet". Whenever he has designated the component of the ^{3}D term which forms the limit of the separate components of Cu I terms, the *J*-value is entered in the configuration column of the table. (Lidén has recently reported a similar case in F I, Ark. Phys. (Stockholm) 1, No. 9, 229, 1949.)

In the term array the writer has tentatively assigned the limits ^{3}D and ^{1}D to the appropriate terms having the configuration $3d^9\ 4s\ 4p$, although Shenstone states that "it appears more reasonable to describe the electron coupling as $3d^9\ ^2D+4s\ 4p\ ^3P,\ ^1P$ . . ." He adds that "the arrangement of levels in the next series member, $3d^9\ 4s\ 5p$, should approach much more closely to a grouping which can be correlated to $3d^9\ 4s\ ^3D,\ ^1D+p$." This is also discussed by Racah.

Shenstone has listed the levels in order of increasing numerical value. In order to conform to the general plan of the present volumes they are here grouped into terms on the basis of his assigned designations. Similarly, in column three under "Desig." the notation adopted for series spectra, and described in detail in Volume I, is entered, but Shenstone's notation is retained in column one.

Zeeman observations of Cu I are limited in both number and accuracy, except for the $4p\ ^2P°-4d\ ^2D$ multiplet "which has been shown by Green to fit exceptionally well the formulae for the partial Paschen-Back effect developed by Darwin". The writer has derived the following tentative *g*-values from published and unpublished observations, using, for blended patterns, the formulae given by Russell, which are an extension of those by Shenstone and Blair. The *g*-values given by Sommer are included in the final means. A colon indicates that there is only one or a very weak mean determination of the *g*-value. Three place values are from measurements by Kiess who found selected Cu lines as impurities on plates of other spectra taken at Massachusetts Institute of Technology and at the National Bureau of Standards.

Cu I—Continued

Desig.	J	Obs. g
$4s\ ^2S$	0½	2. 004
$4s^2\ ^2D$	2½	1. 22
	1½	0. 806
$4p\ ^2P^{\circ}$	0½	0. 659
	1½	1. 338
$4p'\ ^4P^{\circ}$	2½	1. 60
	1½	1. 75
	0½	2. 63
$4p'\ ^4F^{\circ}$	4½	1. 34
	3½	1. 25
	2½	1. 01
	1½	0. 43
$4p'\ ^4D^{\circ}$	3½	1. 45
	2½	1. 38
	1½	1. 18
	0½	0. 10
$4p'\ ^2F^{\circ}$	2½	0. 92:
	3½	1. 21

Desig.	J	Obs. g
$4p'\ ^2P^{\circ}$	0½	0. 48
	1½	1. 28
$4p'\ ^2D^{\circ}$	1½	1. 00:
	2½	1. 20
$5p\ ^2P^{\circ}$	1½	1. 35:
$4d\ ^2D$	1½	0. 82:
	2½	1. 19:
$6s\ ^2S$	0½	1. 99
$5d\ ^2D$	1½	0. 77:
	2½	1. 22
$4p''\ ^2F^{\circ}$	3½	1. 14:
	2½	0. 84:
$4p''\ ^2P^{\circ}$	1½	1. 27:
$4p''\ ^2D^{\circ}$	2½	1. 17:

Desig.	J	Obs. g
$7p\ ^2P^{\circ}$	0½	0. 69:
$5s'\ ^4D$	3½	1. 42
	0½	0. 00
$5s'\ ^2D$	2½	1. 27:
$4d'\ ^4S$	1½	1. 74:
$4d'\ ^2F$	3½	1. 09
$4d'\ ^4G$	5½	1. 27:
	4½	1. 18:
	2½	0. 53:
$4d'\ ^4D$	3½	1. 44
	2½	1. 36
$4d'\ ^4F$	4½	1. 29:
	3½	1. 19
	2½	1. 05
$5d'\ ^4G$	5½	1. 27:

REFERENCES

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C. S. Beals, Proc. Roy. Soc. London [A] **111,** 168 (1926). (T) (C L) (Z E)
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J. B. Green, Phys. Rev. **36,** 157 (1930). (Z E)
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G. Racah, Phys. Rev. **62,** 525 (1942).
A. G. Shenstone, Phil. Trans. Roy. Soc. (London) [A] **241,** No. 832,297 (1948). (I P) (T) (C L) (Z E) (hfs)
C. C. Kiess, unpublished material (January 1950). (Z E)

Cu I

Author	Config.	Desig.	J	Level	Interval
$4s\ ^2S_{\frac{1}{2}}$	$3d^{10}\ (^1S)4s$	$4s\ ^2S$	0½	0. 000	
$m\ ^2D_{2\frac{1}{2}}$	$3d^9\ 4s^2$	$4s^2\ ^2D$	2½	11202. 565	−2042. 858
$m\ ^2D_{1\frac{1}{2}}$			1½	13245. 423	
$4p\ ^2P^{\circ}_{\frac{1}{2}}$	$3d^{10}\ (^1S)4p$	$4p\ ^2P^{\circ}$	0½	*30535. 302*	248. 384
$4p\ ^2P^{\circ}_{1\frac{1}{2}}$			1½	*30783. 686*	
$z\ ^4P^{\circ}_{2\frac{1}{2}}$	$3d^9\ 4s(^3D)4p$	$4p'\ ^4P^{\circ}$	2½	*39018. 652*	−1095. 34
$z\ ^4P^{\circ}_{1\frac{1}{2}}$			1½	*40113. 99*	−829. 74
$z\ ^4P^{\circ}_{\frac{1}{2}}$			0½	*40943. 73*	
$z\ ^4F^{\circ}_{4\frac{1}{2}}$	$3d^9\ 4s(^3D)4p$	$4p'\ ^4F^{\circ}$	4½	*40909. 138*	−244. 295
$z\ ^4F^{\circ}_{3\frac{1}{2}}$			3½	*41153. 433*	−409. 462
$z\ ^4F^{\circ}_{2\frac{1}{2}}$			2½	*41562. 895*	−739. 57
$z\ ^4F^{\circ}_{1\frac{1}{2}}$			1½	*42302. 47*	
$5s\ ^2S_{\frac{1}{2}}$	$3d^{10}\ (^1S)5s$	$5s\ ^2S$	0½	43137. 209	
$z\ ^4D^{\circ}_{3\frac{1}{2}}$	$3d^9\ 4s(^3D)4p$	$4p'\ ^4D^{\circ}$	3½	*43513. 95*	−892. 32
$z\ ^4D^{\circ}_{2\frac{1}{2}}$			2½	*44406. 268*	−137. 885
$z\ ^4D^{\circ}_{1\frac{1}{2}}$			1½	*44544. 153*	−371. 46
$z\ ^4D^{\circ}_{\frac{1}{2}}$			0½	*44915. 61*	
$z\ ^2F^{\circ}_{2\frac{1}{2}}$	$3d^9\ 4s(^3D)4p$	$4p'\ ^2F^{\circ}$	2½	*43726. 191*	237. 032
$z\ ^2F^{\circ}_{3\frac{1}{2}}$			3½	*44963. 223*	
$z\ ^2P^{\circ}_{\frac{1}{2}}$	$3d^9\ 4s(^3D)4p$	$4p'\ ^2P^{\circ}$	0½	*45821. 00*	58. 31
$z\ ^2P^{\circ}_{1\frac{1}{2}}$			1½	*45879. 311*	
$z\ ^2D^{\circ}_{1\frac{1}{2}}$	$3d^9\ 4s(^3D)4p$	$4p'\ ^2D^{\circ}$	1½	*46172. 842*	425. 50
$z\ ^2D^{\circ}_{2\frac{1}{2}}$			2½	*46598. 34*	
$5p\ ^2P^{\circ}_{1\frac{1}{2}}$	$3d^{10}\ (^1S)5p$	$5p\ ^2P^{\circ}$	1½	*49382. 95*	−0. 31
$5p\ ^2P^{\circ}_{\frac{1}{2}}$			0½	*49383. 26*	
$4d\ ^2D_{1\frac{1}{2}}$	$3d^{10}\ (^1S)4d$	$4d\ ^2D$	1½	49935. 200	6. 857
$4d\ ^2D_{2\frac{1}{2}}$			2½	49942. 057	
$6s\ ^2S$	$3d^{10}\ (^1S)6s$	$6s\ ^2S$	0½	52848. 749	
$6p\ ^2P^{\circ}_{1\frac{1}{2}}$	$3d^{10}\ (^1S)6p$	$6p\ ^2P^{\circ}$	1½	*54784. 06*	−243. 68
$6p\ ^2P^{\circ}_{\frac{1}{2}}$			0½	*55027. 74*	
$5d\ ^2D_{1\frac{1}{2}}$	$3d^{10}\ (^1S)5d$	$5d\ ^2D$	1½	55387. 668	3. 624
$5d\ ^2D_{2\frac{1}{2}}$			2½	55391. 292	
$4f\ ^2F^{\circ}_{3\frac{1}{2}}$	$3d^{10}\ (^1S)4f$	$4f\ ^2F^{\circ}$	3½	*55426. 3*	−3. 5
$4f\ ^2F^{\circ}_{2\frac{1}{2}}$			2½	*55429. 8*	
$y\ ^2F^{\circ}_{3\frac{1}{2}}$	$3d^9\ 4s(^1D)4p$	$4p''\ ^2F^{\circ}$	3½	*56029. 95*	−2089. 33
$y\ ^2F^{\circ}_{2\frac{1}{2}}$			2½	*58119. 28*	
$y\ ^2P^{\circ}_{1\frac{1}{2}}$	$3d^9\ 4s(^1D)4p$	$4p''\ ^2P^{\circ}$	1½	*56343. 74*	−2020. 99
$y\ ^2P^{\circ}_{\frac{1}{2}}$			0½	*58364. 73*	
$y\ ^2D^{\circ}_{2\frac{1}{2}}$	$3d^9\ 4s(^1D)4p$	$4p''\ ^2D^{\circ}$	2½	*56651. 48*	−2039. 38
$y\ ^2D^{\circ}_{1\frac{1}{2}}$			1½	*58690. 86*	

Cu I—Continued

Author	Config.	Desig.	J	Level	Interval
$7s\ ^2S_{1/2}$	$3d^{10}(^1S)7s$	$7s\ ^2S$	$0\frac{1}{2}$	56671. 387	
$7p\ ^2P^\circ_{1/2}$	$3d^{10}(^1S)7p$	$7p\ ^2P^\circ$	$0\frac{1}{2}$	*57419. 31*	529. 40
$7p\ ^2P^\circ_{1\frac{1}{2}}$			$1\frac{1}{2}$	*57948. 71*	
$6d\ ^2D_{1\frac{1}{2}}$	$3d^{10}(^1S)6d$	$6d\ ^2D$	$1\frac{1}{2}$	57893. 05	2. 05
$6d\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	57895. 10	
$5f\ ^2F^\circ_{2\frac{1}{2}}$	$3d^{10}(^1S)5f$	$5f\ ^2F^\circ$	$2\frac{1}{2}$	*57905. 2*	3. 5
$5f\ ^2F^\circ_{3\frac{1}{2}}$			$3\frac{1}{2}$	*57908. 7*	
$8s\ ^2S_{1/2}$	$3d^{10}(^1S)8s$	$8s\ ^2S$	$0\frac{1}{2}$	58568. 92	
$7d\ ^2D_{1\frac{1}{2}}$	$3d^{10}(^1S)7d$	$7d\ ^2D$	$1\frac{1}{2}$	59249. 46	1. 26
$7d\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	59250. 72	
$8p\ ^2P^\circ_{1\frac{1}{2}}$	$3d^{10}(^1S)8p$	$8p\ ^2P^\circ$	$1\frac{1}{2}$	*59275. 33*	−47. 84
$8p\ ^2P^\circ_{1/2}$			$0\frac{1}{2}$	*59323. 17*	
$9s\ ^2S_{1/2}$	$3d^{10}(^1S)9s$	$9s\ ^2S$	$0\frac{1}{2}$	59647. 88	
$8d\ ^2D_{1\frac{1}{2}}$	$3d^{10}(^1S)8d$	$8d\ ^2D$	$1\frac{1}{2}$	60065. 51	0. 82
$8d\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	60066. 33	
$9p\ ^2P^\circ_{1\frac{1}{2}}$	$3d^{10}(^1S)9p$	$9p\ ^2P^\circ$	$1\frac{1}{2}$	*60070. 6*	−14. 6
$9p\ ^2P^\circ_{1/2}$			$0\frac{1}{2}$	*60085. 2*	
$9d\ ^2D_{1\frac{1}{2}}$	$3d^{10}(^1S)9d$	$9d\ ^2D$	$1\frac{1}{2}$	60594. 53	0. 52
$9d\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	60595. 05	
$10p\ ^2P^\circ_{1\frac{1}{2}}$	$3d^{10}(^1S)10p$	$10p\ ^2P^\circ$	$1\frac{1}{2}$	*60595. 0*	−6. 9
$10p\ ^3P^\circ_{1/2}$			$0\frac{1}{2}$	*60601. 9*	
$10d\ ^2D_{1\frac{1}{2}}$	$3d^{10}(^1S)10d$	$10d\ ^2D$	$1\frac{1}{2}$	60956. 92	0. 43
$10d\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	60957. 35	
$11p\ ^2P^\circ$	$3d^{10}(^1S)11p$	$11p\ ^2P^\circ$	{$1\frac{1}{2}$, $0\frac{1}{2}$}	*60958*	
	$3d^{10}(^1S)11d$	$11d\ ^2D$	$1\frac{1}{2}$		
$11d\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	61215. 59	
	Cu II ($^1S_0$)	*Limit*	----	**62317. 2**	
$e\ ^4D_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_3)5s$	$5s'\ ^4D$	$3\frac{1}{2}$	62403. 320	−544. 97
$e\ ^4D_{2\frac{1}{2}}$	''		$2\frac{1}{2}$	62948. 29	−636. 28
$e\ ^4D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_2)5s$		$1\frac{1}{2}$	63584. 57	−887. 73
$e\ ^4D_{1/2}$	$3d^9\ 4s(^3D_1)5s$		$0\frac{1}{2}$	64472. 300	
$e\ ^2D_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_2)5s$	$5s'\ ^2D$	$2\frac{1}{2}$	64657. 8	−602. 3
$e\ ^2D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_1)5s$		$1\frac{1}{2}$	65260. 1	
$f\ ^2D_{2\frac{1}{2}}$	$3d^9\ 4s(^1D)5s$	$5s''\ ^2D$	$2\frac{1}{2}$	67142. 7	−829. 2
$f\ ^2D_{1\frac{1}{2}}$			$1\frac{1}{2}$	67971. 94	
	$3d^9\ 4s(^3D)5p$	$5p'\ ^4P^\circ$	$2\frac{1}{2}$		
$x\ ^4P^\circ_{1\frac{1}{2}}$			$1\frac{1}{2}$	*70281 ?*	−723
$x\ ^4P^\circ_{1/2}$			$0\frac{1}{2}$	*71004 ?*	
	$3d^9\ 4s(^3D)5p$	$5p'\ ^4F^\circ$	$4\frac{1}{2}$		
$x\ ^4F^\circ_{3\frac{1}{2}}$			$3\frac{1}{2}$	*70336. 5 ?*	−77. 6
$x\ ^4F^\circ_{2\frac{1}{2}}$			$2\frac{1}{2}$	*70414. 1*	
			$1\frac{1}{2}$		
$x\ ^4D^\circ_{3\frac{1}{2}}$	$3d^9\ 4s(^3D)5p$	$5p'\ ^4D^\circ$	$3\frac{1}{2}$	*70441. 0 ?*	−120. 2
$x\ ^4D^\circ_{2\frac{1}{2}}$			$2\frac{1}{2}$	*70561. 2 ?*	−468. 4
$x\ ^4D^\circ_{1\frac{1}{2}}$			$1\frac{1}{2}$	*71029. 6*	
			$0\frac{1}{2}$		
$g\ ^2P_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^2P$	$1\frac{1}{2}$	70853. 39	−1298. 10
$g\ ^2P_{1/2}$	$3d^9\ 4s(^3D_2)4d$		$0\frac{1}{2}$	72151. 49?	
$g\ ^2S_{1/2}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^2S$	$0\frac{1}{2}$	70853. 9 ?	
$g\ ^2G_{4\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^2G$	$4\frac{1}{2}$	70859. 53	−1157. 23
$g\ ^2G_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$3\frac{1}{2}$	72016. 76	
$x\ ^2F^\circ_{2\frac{1}{2}}$	$3d^9\ 4s(^3D)5p$	$5p'\ ^2F^\circ$	$2\frac{1}{2}$	*70959. 7 ?*	654. 2
$x\ ^2F^\circ_{3\frac{1}{2}}$			$3\frac{1}{2}$	*71613. 9 ?*	

Cu I—Continued

Author	Config.	Desig.	J	Level	Interval
$g\ ^4S_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^4S$	$1\frac{1}{2}$	70998. 12	
$g\ ^2D_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^2D$	$2\frac{1}{2}$	71098. 17	−1006. 6
$g\ ^2D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$1\frac{1}{2}$	72104. 8	
$g\ ^2F_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^2F$	$3\frac{1}{2}$	71127. 81	−1023. 37
$g\ ^2F_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$2\frac{1}{2}$	72151. 18	
$g\ ^4G_{5\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^4G$	$5\frac{1}{2}$	71130. 69	−848. 01
$g\ ^4G_{4\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$4\frac{1}{2}$	71978. 70	−1124. 04
$g\ ^4G_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_1)4d$		$3\frac{1}{2}$	73102. 74	−95. 97
$g\ ^4G_{2\frac{1}{2}}$	''		$2\frac{1}{2}$	73198. 71	
$g\ ^4P_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^4P$	$2\frac{1}{2}$	71178. 19	−749. 03
$g\ ^4P_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$1\frac{1}{2}$	71927. 22	44. 26
$g\ ^4P_{1/2}$	''		$0\frac{1}{2}$	71882. 96	
$g\ ^4D_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^4D$	$3\frac{1}{2}$	71268. 21	−798. 76
$g\ ^4D_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$2\frac{1}{2}$	72066. 97	−1037. 91
$g\ ^4D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_1)4d$		$1\frac{1}{2}$	73104. 88	
			$0\frac{1}{2}$		
$g\ ^4F_{4\frac{1}{2}}$	$3d^9\ 4s(^3D_3)4d$	$4d'\ ^4F$	$4\frac{1}{2}$	71290. 54	−802. 54
$g\ ^4F_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_2)4d$		$3\frac{1}{2}$	72093. 08	−1211. 59
$g\ ^4F_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_1)4d$		$2\frac{1}{2}$	73304. 67	−11. 79
$g\ ^4F_{1\frac{1}{2}}$	''		$1\frac{1}{2}$	73316. 46	
$x\ ^2D^\circ_{2\frac{1}{2}}$	$3d^9\ 4s(^3D)5p$	$5p'\ ^2D^\circ$	$2\frac{1}{2}$	*71745. 5*	−278. 7
$x\ ^2D^\circ_{1\frac{1}{2}}$			$1\frac{1}{2}$	*72024. 2?*	
	$3d^9\ 4s(^3D)5p$	$5p'\ ^2P^\circ$	$0\frac{1}{2}$		
$x\ ^2P^\circ_{1\frac{1}{2}}$			$1\frac{1}{2}$	*71917 ?*	
$i\ ^4D_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_3)6s$	$6s'\ ^4D$	$3\frac{1}{2}$	73995. 15	−317. 76
$i\ ^4D_{2\frac{1}{2}}$	''		$2\frac{1}{2}$	74312. 91	−730. 70
$i\ ^4D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_2)6s$		$1\frac{1}{2}$	75043. 61	−1020. 76
$i\ ^4D_{1/2}$	$3d^9\ 4s(^3D_1)6s$		$0\frac{1}{2}$	76064. 37	
$w\ ^2P^\circ_{1\frac{1}{2}}$	$3d^9\ 4s(^1D)5p$	$5p''\ ^2P^\circ$	$1\frac{1}{2}$	*74259. 5?*	−831. 1
$w\ ^2P^\circ_{1\frac{1}{2}}$			$0\frac{1}{2}$	*75090. 6?*	
$w\ ^2F^\circ_{3\frac{1}{2}}$	$3d^9\ 4s(^1D)5p$	$5p''\ ^2F^\circ$	$3\frac{1}{2}$	*74341. 9*	−581. 8
$w\ ^2F^\circ_{2\frac{1}{2}}$			$2\frac{1}{2}$	*74923. 7?*	
$w\ ^2D^\circ$	$3d^9\ 4s(^1D)5p$	$5p''\ ^2D^\circ$	{$2\frac{1}{2}$, $1\frac{1}{2}$}	*74507. 6?*	
$h\ ^2P_{1/2}$	$3d^9\ 4s(^1D)4d$	$4d''\ ^2P$	$0\frac{1}{2}$	75109. 46	153. 99
$h\ ^2P_{1\frac{1}{2}}$			$1\frac{1}{2}$	75263. 45	
$i\ ^2D_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_2)6s$	$6s'\ ^2D$	$2\frac{1}{2}$	75170. 25	−1162. 0
$i\ ^2D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_1)6s$		$1\frac{1}{2}$	76332. 3	
$h\ ^2G_{3\frac{1}{2}}$	$3d^9\ 4s(^1D)4d$	$4d''\ ^2G$	$3\frac{1}{2}$	75206. 4	139. 7
$h\ ^2G_{4\frac{1}{2}}$			$4\frac{1}{2}$	75346. 1?	
$h\ ^2S_{1/2}$	$3d^9\ 4s(^1D)4d$	$4d''\ ^2S$	$0\frac{1}{2}$	75386. 7	
$h\ ^2D_{1\frac{1}{2}}$	$3d^9\ 4s(^1D)4d$	$4d''\ ^2D$	$1\frac{1}{2}$	75440. 1	6. 4
$h\ ^2D_{2\frac{1}{2}}$			$2\frac{1}{2}$	75446. 5	
$h\ ^2F_{2\frac{1}{2}}$	$3d^9\ 4s(^1D)4d$	$4d''\ ^2F$	$2\frac{1}{2}$	75536. 2	36. 6
$h\ ^2F_{3\frac{1}{2}}$			$3\frac{1}{2}$	75572. 85	
$j\ ^2G_{4\frac{1}{2}}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^2G$	$4\frac{1}{2}$	76824. 3	−1074. 6
$j\ ^2G_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_2)5d$		$3\frac{1}{2}$	77898. 9	
$j\ ^2P_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^2P$	$1\frac{1}{2}$	76831. 31	
			$0\frac{1}{2}$		
$i\ ^2D_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^2D$	$2\frac{1}{2}$	76949. 2	−984. 1
$j\ ^2D_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_2)5d$		$1\frac{1}{2}$	77933. 3	
$^4S_{1\frac{1}{2}}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^4S$	$1\frac{1}{2}$	76959. 0	
$j\ ^2F_{3\frac{1}{2}}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^2F$	$3\frac{1}{2}$	76960. 2	−999. 1
$j\ ^2F_{2\frac{1}{2}}$	$3d^9\ 4s(^3D_2)5d$		$2\frac{1}{2}$	77959. 3	

843210°—52——10

Cu I—Continued

Author	Config.	Desig.	J	Level	Interval
$j\ ^4G_{5½}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^4G$	5½	77014. 1	
$j\ ^4G_{4½}$	$3d^9\ 4s(^3D_2)5d$		4½	77854. 0	−839. 9
$j\ ^4G_{3½}$	$3d^9\ 4s(^3D_1)5d$		3½	78988. 3	−1134. 3
$j\ ^4G_{2½}$	"		2½	79053. 4	−65. 1
$j\ ^4P_{2½}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^4P$	2½	77030. 59	
$j\ ^4P_{1½}$	$3d^9\ 4s(^3D_2)5d$		1½	77840. 9	−810. 3
$j\ ^4P_{½}$	"		0½	77814. 5	26. 4
$j\ ^4D_{3½}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^4D$	3½	77068. 2	
$j\ ^4D_{2½}$	$3d^9\ 4s(^3D_2)5d$		2½	77905. 5	−837. 3
$j\ ^4D_{1½}$	$3d^9\ 4s(^3D_1)5d$		1½	79003. 1	−1097. 6
			0½		
$j\ ^4F_{4½}$	$3d^9\ 4s(^3D_3)5d$	$5d'\ ^4F$	4½	77080. 5	
$j\ ^4F_{3½}$	$3d^9\ 4s(^3D_2)5d$		3½	77919. 4	−838. 9
$j\ ^4F_{2½}$	$3d^9\ 4s(^3D_1)5d$		2½	79116. 5	−1197. 1
$j\ ^4F_{1½}$	"		1½	79119. 3	−2. 8
$k\ ^4D_{3½}$	$3d^9\ 4s(^3D_3)7s$	$7s'\ ^4D$	3½	78261. 2	
$k\ ^4D_{2½}$	"		2½	78486. 5	−225. 3
$k\ ^4D_{1½}$	$3d^9\ 4s(^3D_2)7s$		1½	79257. 8	−771. 3
$k\ ^4D_{½}$	$3d^9\ 4s(^3D_1)7s$		0½	80330. 4	−1072. 6
$p\ ^2D_{2½}$	$3d^9\ 4s(^1D)6s$	$6s''\ ^2D$	2½	78349. 6	−228. 4
$p\ ^2D_{1½}$			1½	78578. 0	
$k\ ^2D_{2½}$	$3d^9\ 4s(^3D_2)7s$	$7s'\ ^2D$	2½	79268. 0	−1188. 4
$k\ ^2D_{1½}$	$3d^9\ 4s(^3D_1)7s$		1½	80456. 4?	
$l\ ^4S_{1½}$	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^4S$	1½	79641. 4	
$l\ ^4G_{5½}$	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^4G$	5½	79667. 9	
$l\ ^4G_{4½}$	$3d^9\ 4s(^3D_2)6d$		4½	80505. 5	−837. 6
			3½		
			2½		
$l\ ^4P_{2½}$	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^4P$	2½	79675. 1	
			1½		
			0½		
$l\ ^4D_{3½}$	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^4D$	3½	79694. 5	
$l\ ^4D_{2½}$	$3d^9\ 4s(^3D_2)6d$		2½	80542. 2	−847. 7
			1½		
			0½		
$l\ ^4F_{4½}$	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^4F$	4½	79700. 5	
$l\ ^4F_{3½}$	$3d^9\ 4s(^3D_2)6d$		3½	80560. 0	−859. 5
			2½		
			1½		
$n\ ^4D_{3½}$	$3d^9\ 4s(^3D_3)8s$	$8s'\ ^4D$	3½	80318. 4	
			2½		
			1½		
			0½		
	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^2G$	4½		
$l\ ^2G_{3½}$	$3d^9\ 4s(^3D_2)6d$		3½	80553. 8	
	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^2F$	3½		
$l\ ^2F_{2½}$	$3d^9\ 4s(^3D_2)6d$		2½	80574	
	$3d^9\ 4s(^3D_3)6d$	$6d'\ ^2D$	2½		
$l\ ^2D_{1½}$	$3d^9\ 4s(^3D_2)6d$		1½	80586. 7?	
$o\ ^2D_{2½}$	$3d^9\ 4s(^1D)5d$	$5d''\ ^2D$	2½	81292. 5	
$o\ ^2D_{1½}$			1½	81313. 7	−21. 2
$o\ ^2F_{2½}$	$3d^9\ 4s(^1D)5d$	$5d''\ ^2F$	2½	81362. 7	
$o\ ^2F_{3½}$			3½	81376. 2	13. 5

December 1949.

Cu I Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms			
$3d^9\ 4s^2$	$4s^2\ ^2D$			
	$ns\ (n\geq 4)$	$np\ (n\geq 4)$	$nd\ (n\geq 4)$	$nf\ (n\geq 4)$
$3d^{10}(^1S)nx$	$4\text{–}9s\ ^2S$	$4\text{–}11p\ ^2P^\circ$	$4\text{–}11d'\ ^2D$	$4,\ 5f\ ^2F^\circ$
$3d^9\ 4s(^3D)nx'$	$5\text{–}8s'\ ^4D$ $5\text{–}7s'\ ^2D$	$4,\ 5p'\ ^4P^\circ$ $4,\ 5p'\ ^4D^\circ$ $4,\ 5p'\ ^4F^\circ$ $4,\ 5p'\ ^2P^\circ$ $4,\ 5p'\ ^2D^\circ$ $4,\ 5p'\ ^2F^\circ$	$4\text{–}6d'\ ^4S$ $4\text{–}6d'\ ^4P$ $4\text{–}6d'\ ^4D$ $4\text{–}6d'\ ^4F$ $4\text{–}6d'\ ^4G$ $4d'\ ^2S$ $4,\ 5d'\ ^2P$ $4\text{–}6d'\ ^2D$ $4\text{–}6d'\ ^2F$ $4\text{–}6d'\ ^2G$	
$3d^9\ 4s(^1D)nx''$	$5\text{–}6s''\ ^2D$	$4,\ 5p''\ ^2P^\circ$ $4,\ 5p''\ ^2D^\circ$ $4,\ 5p''\ ^2F^\circ$	$4d''\ ^2S$ $4d''\ ^2P$ $4,\ 5d''\ ^2D$ $4,\ 5d''\ ^2F$ $4d''\ ^2G$	

*For predicted terms in the spectra of the Cu I isoelectronic sequence, see Vol. II, Introduction.

Cu II

(Ni I sequence; 28 electrons) Z=29

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ {}^1S_0$

$3d^{10}\ {}^1S_0$ **163665.6** cm^{-1} I. P. 20.29 volts

The unique honor of having produced a practically complete analysis of a complex spectrum is due Shenstone for his investigation of the Cu II spectrum. This spectrum has been photographed from 600 A to 10000 A. Of the 1350 lines observed only a few faint lines remain unclassified. He has extended the earlier work to include over 40 series of three or more levels; and identified $d^9\,f$ and $d^9\,g$ structures completely for the first time. He remarks that "the most striking feature is the number of levels which show the effects of mixed configurations." A theoretical discussion of the spin-orbit interaction of the almost closed shell as exhibited by the Cu II spectrum, is given by Shortley and Fried.

Shenstone has determined the limit from the $3d^9\ ns\ {}^3D\ {}^1D$ series (n=4 to 8), using an extended Ritz formula described in detail in his Monograph (1936). The series are so long, and the separation of the components of the ${}^2D$ limit term in Cu III is so large, that for this limit it can be determined without ambiguity which component is the limit of the separate components of the Cu II terms. The J-values indicating the components of this limit term are included with the configuration in column two of the table. When the J-value of the limit is the same for all components of the Cu II term, only one entry is given in this column, as for example, for the term $4f\ {}^3P^\circ$(135902 cm^{-1}). Shenstone remarks also that the intensities of the lines from the transition $4f-5g$ "indicate very strongly that each empirical level is in reality double . . . ". This is completely explained by jl-coupling.

In addition to the analysis, the accurate ultraviolet wavelengths of Cu II provide excellent standards for the measurement of other spectra in this region.

In Shenstone's Monograph the levels are given in numerical order "because to group them as terms in such a spectrum as this would be quite misleading". In the present table, as in Volume I, those levels which he gives as components of a term are grouped together. Shenstone's notation, which appears in column one, has, similarly, been altered in column three to conform to the notation adopted for other series spectra.

Racah has also emphasized the similarity of coupling between levels from the $3d^9\ nx$ configuration of Cu II and those of the inert gases from $p^5\ nx$. He has furnished the writer with the following data indicating the jl-coupling notation for levels of Cu II.

Cu II—Continued

Author	Config.	Desig.	J	Author	Config.	Desig.	J
$ns\ ^3D_3$ $^3D_2$	$3d^9(^2D_{2\frac{1}{2}})ns$	ns [2½]	3 2	$nf\ ^3P^\circ_1$ $^1P^\circ_0$	$3d^9(^2D_{2\frac{1}{2}})nf$	nf [0½]°	1 0
$ns\ ^3D_1$ $^1D_2$	$3d^9(^2D_{1\frac{1}{2}})ns$	ns' [1½]	1 2	$nf\ ^3P^\circ_2$ $^1P^\circ_1$	"	nf [1½]°	2 1
$np\ ^3P^\circ_2$ $^3P^\circ_1$	$3d^9(^2D_{2\frac{1}{2}})np$	np [1½]°	2 1	$nf\ ^3H^\circ_6$ $^3H^\circ_5$	"	nf [5½]°	6 5
$np\ ^3F^\circ_3$ $^3F^\circ_4$	"	np [3½)°	3 4	$nf\ ^3D^\circ_3$ $^3D^\circ_2$	"	nf [2½]°	3 2
$np\ ^3D^\circ_3$ $^3D^\circ_2$	"	np [2½]°	3 2	$nf\ ^3F^\circ_3$ $^3F^\circ_4$	"	nf [3½]°	3 4
$np\ ^3P^\circ_0$ $^1P^\circ_1$	$3d^9(^2D_{1\frac{1}{2}})np$	np' [0½]°	0 1	$nf\ ^3G^\circ_5$ $^3G^\circ_4$	"	nf [4½]°	5 4
$np\ ^3F^\circ_2$ $^1F^\circ_3$	"	np' [2½]°	2 3	$nf\ ^1D^\circ_2$ $^3D^\circ_1$	$3d^9(^2D_{1\frac{1}{2}})nf$	nf' [1½]°	2 1
$np\ ^3D^\circ_1$ $^1D^\circ_2$	"	np' [1½]°	1 2	$nf\ ^1H^\circ_5$ $^3H^\circ_4$	"	nf' [4½]°	5 4
$nd\ ^3S_1$	$3d^9(^2D_{2\frac{1}{2}})nd$	nd [0½]	1	$nf\ ^1F^\circ_3$ $^3F^\circ_2$	"	nf' [2½]°	3 2
$nd\ ^3G_5$ $^3G_4$	"	nd [4½]	5 4	$nf\ ^1G^\circ_4$ $^3G^\circ_3$	"	nf' [3½]°	4 3
$nd\ ^3P_2$ $^3P_1$	"	nd [1½]	2 1	$ng\ ^3D_{1,\ 2}$	$3d^9(^2D_{2\frac{1}{2}})ng$	ng [1½]	1, 2
$nd\ ^3D_3$ $^3D_2$	"	nd [2½]	3 2	$ng\ ^3I_{6,\ 7}$	"	ng [6½]	6, 7
$nd\ ^3F_3$ $^3F_4$	"	nd [3½]	3 4	$ng\ ^1D_2,\ ^3D_3$	"	ng [2½]	2, 3
$nd\ ^3P_0$	"	nd [0½]	0	$ng\ ^3F_{3,4}$	"	ng [3½]	3, 4
$nd\ ^1P_1$	$3d^9(^2D_{1\frac{1}{2}})nd$	nd' [0½]	1	$ng\ ^3H_{5,6}$	"	ng [5½]	5, 6
$nd\ ^3G_3$ $^1G_4$	"	nd' [3½]	3 4	$ng\ ^3G_{4,5}$	"	ng [4½]	4, 5
$nd\ ^3D_1$ $^1D_2$	"	nd' [1½]	1 2	$ng\ ^3F_2,\ ^1F_3$	$3d^9(^2D_{1\frac{1}{2}})ng$	ng' [2½]	2, 3
$nd\ ^1F_3$ $^3F_2$	"	nd' [2½]	3 2	$ng\ ^3I_5,\ ^1I_6$	"	ng' [5½]	5, 6
$nd\ ^1S_0$	"	nd' [0½]	0	$ng\ ^3G_3,\ ^1G_4$	"	ng' [3½]	3, 4
				$ng\ ^3H_4,\ ^1H_5$	"	ng' [4½]	4, 5

Intersystem combinations have been observed.

The g-values given below have been determined by the writer from the observed Zeeman patterns published in Shenstone's 1927 paper. The formulae for blended patterns as given by Russell were used in making these calculations. These formulas are an extension of those by Shenstone and Blair.

Desig.	J	Obs. g	Desig.	J	Obs. g
$4s\ ^3D$	3 2 1	1.32 1.16 0.48	$4p\ ^3D^\circ$	2 1	1.08 0.47
$4s\ ^1D$	2	1.00	$4p\ ^1D^\circ$	2	0.99
$4p\ ^3P^\circ$	2 1	1.49 1.49	$4p\ ^1P^\circ$	1	1.04
$4p\ ^3F^\circ$	4 3 2	1.23 1.06 0.67	$5s\ ^3D$	3 2 1	1.31 1.14 0.49:
			$5s\ ^1D$	2	1.04

Cu II—Continued

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Author	Config.	Desig.	J	Level	Interval
$a\ ^1S_0$	$3d^{10}$	$3d^{10}\ ^1S$	0	0. 00	
$4s\ ^3D_3$	$3d^9(^2D_{2\frac{1}{2}})4s$	$4s\ ^3D$	3	21928. 60	−918. 43
$^3D_2$	"		2	22847. 03	−1151. 28
$^3D_1$	$3d^9(^2D_{1\frac{1}{2}})4s$		1	23998. 31	
$4s\ ^1D_2$	$3d^9(^2D_{1\frac{1}{2}})4s$	$4s\ ^1D$	2	26264. 52	
$4p\ ^3P^o_2$	$3d^9(^2D_{2\frac{1}{2}})4p$	$4p\ ^3P^o$	2	*66418. 65*	−1497. 92
$^3P^o_1$	"		1	*67916. 57*	−933. 68
$^3P^o_0$	$3d^9(^2D_{1\frac{1}{2}})4p$		0	*68850. 25*	
$4p\ ^3F^o_4$	$3d^9(^2D_{2\frac{1}{2}})4p$	$4p\ ^3F^o$	4	*68730. 82*	283. 07
$^3F^o_3$	"		3	*68447. 75*	−1420. 36
$^3F^o_2$	$3d^9(^2D_{1\frac{1}{2}})4p$		2	*69868. 11*	
$s^2\ ^3F_4$	$3d^8\ 4s^2$	$4s^2\ ^3F$	4	69704. 8	−1826. 7
$^3F_3$			3	71531. 5	−1192. 5
$^3F_2$			2	72724. 0	
$4p\ ^3D^o_3$	$3d^9(^2D_{2\frac{1}{2}})4p$	$4p\ ^3D^o$	3	*70841. 50*	−652. 42
$^3D^o_2$	"		2	*71493. 92*	−1608. 18
$^3D^o_1$	$3d^9(^2D_{1\frac{1}{2}})4p$		1	*73102. 10*	
$4p\ ^1F^o_3$	$3d^9(^2D_{1\frac{1}{2}})4p$	$4p\ ^1F^o$	3	*71920. 13*	
$4p\ ^1D^o_2$	$3d^9(^2D_{1\frac{1}{2}})4p$	$4p\ ^1D^o$	2	*73353. 43*	
$4p\ ^1P^o_1$	$3d^9(^2D_{1\frac{1}{2}})4p$	$4p\ ^1P^o$	1	*73595. 86*	
$s^2\ ^1D_2$	$3d^8\ 4s^2$	$4s^2\ ^1D$	2	85388. 77	
$s^2\ ^3P_2$	$3d^8\ 4s^2$	$4s^2\ ^3P$	2	88362. 03	−243. 13
$^3P_1$			1	88605. 16	−320. 93
$^3P_0$			0	88926. 09	
$s^2\ ^1G_4$	$3d^8\ 4s^2$	$4s^2\ ^1G$	4	95565. 65	
$sp\ ^5D^o_4$	$3d^8\ 4s(^4F)4p$	$4p'\ ^5D^o$	4	*107942. 1*	−1333. 8
$^5D^o_3$			3	*109275. 9*	−1087. 5
$^5D^o_2$			2	*110363. 4*	−760. 6
$^5D^o_1$			1	*111124. 0?*	
$^5D^o_0$			0		
$5s\ ^3D_3$	$3d^9(^2D_{2\frac{1}{2}})5s$	$5s\ ^3D$	3	108014. 86	−320. 83
$^3D_2$	"		2	108335. 69	−1748. 93
$^3D_1$	$3d^9(^2D_{1\frac{1}{2}})5s$		1	110084. 62	
$5s\ ^1D_2$	$3d^9(^2D_{1\frac{1}{2}})5s$	$5s\ ^1D$	2	110366. 25	
	$3d^8\ 4s(^4F)4p$	$4p'\ ^5G^o$	6		
$sp\ ^5G^o_5$			5	*110631. 6*	−587. 2
$^5G^o_4$			4	*111218. 8*	−657. 8
$^5G^o_3$			3	*111876. 6*	−547. 9
$^5G^o_2$			2	*112424. 5*	
	$3d^8\ 4s(^4F)4p$	$4p'\ ^5F^o$	5		
$sp\ ^5F^o_4$			4	*113302. 8*	−697. 2
$^5F^o_3$			3	*114000. 0*	−482. 5
$^5F^o_2$			2	*114482. 5*	−273. 9
$^5F^o_1$			1	*114756. 4*	

Cu II

Author	Config.	Desig.	J	Level	Interval
$4d\ ^3S_1$	$3d^9(^2D_{2\frac{1}{2}})4d$	$4d\ ^3S$	1	114511. 44	
$z\ ^3G^o_5$	$3d^8\ 4s(^2F)4p$	$4p''\ ^3G^o$	5	*115546. 3*	186. 5
$^3G^o_4$			4	*115359. 8*	−1783. 2
$^3G^o_3$			3	*118142. 97*	
$4d\ ^3G_5$	$3d^9(^2D_{2\frac{1}{2}})4d$	$4d\ ^3G$	5	115569. 20	−93. 57
$^3G_4$	"		4	115662. 77	−2084. 68
$^3G_3$	$3d^9(^2D_{1\frac{1}{2}})4d$		3	117747. 45	
$4d\ ^3P_2$	$3d^9(^2D_{2\frac{1}{2}})4d$	$4d\ ^3P$	2	115639. 02	−26. 38
$^3P_1$			1	115665. 40	−911. 41
$^3P_0$			0	116576. 81	
$4d\ ^3D_3$	$3d^9(^2D_{2\frac{1}{2}})4d$	$4d\ ^3D$	3	116080. 46	−307. 54
$^3D_2$	"		2	116388. 00	−1540. 48
$^3D_1$	$3d^9(^2D_{1\frac{1}{2}})4d$		1	117928. 48	
$4d\ ^3F_4$	$3d^9(^2D_{2\frac{1}{2}})4d$	$4d\ ^3F$	4	116371. 41	45. 25
$^3F_3$	"		3	116326. 16	−1205. 99
$^3F_2$	$3d^9(^2D_{1\frac{1}{2}})4d$		2	118532. 15	
$z\ ^3D^o_3$	$3d^8\ 4s(^2F)4p$	$4p''\ ^3D^o$	3	*116375. 47*	−754. 89
$^3D^o_2$			2	*117130. 36*	−940. 98
$^3D^o_1$			1	*118071. 34*	
$4d\ ^1P_1$	$3d^9(^2D_{1\frac{1}{2}})4d$	$4d\ ^1P$	1	117231. 69	
$z\ ^3F^o_4$	$3d^8\ 4s(^2F)4p$	$4p''\ ^3F^o$	4	*117666. 6*	1022. 6
$^3F^o_3$			3	*116643. 96*	−2395. 72
$^3F^o_2$			2	*119039. 68*	
$4d\ ^1G_4$	$3d^9(^2D_{1\frac{1}{2}})4d$	$4d\ ^1G$	4	117883. 14	
$4d\ ^1D_2$	$3d^9(^2D_{1\frac{1}{2}})4d$	$4d\ ^1D$	2	118163. 50	
$4d\ ^1F_3$	$3d^9(^2D_{1\frac{1}{2}})4d$	$4d\ ^1F$	3	118484. 00	
$z\ ^1G^o_4$	$3d^8\ 4s(^2F)4p$	$4p''\ ^1G^o$	4	*118991. 5*	
$5p\ ^3P^o_2$	$3d^9(^2D_{2\frac{1}{2}})5p$	$5p\ ^3P^o$	2	*120092. 36*	−827. 32
$^3P^o_1$	"		1	*120919. 68*	−1304. 44
$^3P^o_0$	$3d^9(^2D_{1\frac{1}{2}})5p$		0	*122224. 12*	
$5p\ ^3F^o_4$	$3d^9(^2D_{2\frac{1}{2}})5p$	$5p\ ^3F^o$	4	*120789. 83*	105. 07
$^3F^o_3$	"		3	*120684. 76*	−2061. 27
$^3F^o_2$	$3d^9(^2D_{1\frac{1}{2}})5p$		2	*122746. 03*	
$z\ ^1D^o_2$	$3d^8\ 4s(^2F)4p$	$4p''\ ^1D^o$	2	*120876. 13*	
$z\ ^1F^o_3$	$3d^8\ 4s(^2F)4p$	$4p''\ ^1F^o$	3	*121079. 12*	
$5p\ ^3D^o_3$	$3d^9(^2D_{2\frac{1}{2}})5p$	$5p\ ^3D^o$	3	*121524. 88*	−457. 03
$^3D^o_2$	"		2	*121981. 91*	−1323. 05
$^3D^o_1$	$3d^9(^2D_{1\frac{1}{2}})5p$		1	*123304. 96*	
$4d\ ^1S_0$	$3d^9(^2D_{1\frac{1}{2}})4d$	$4d\ ^1S$	0	122416. 1	
$5p\ ^1P^o_1$	$3d^9(^2D_{1\frac{1}{2}})5p$	$5p\ ^1P^o$	1	*122867. 92*	
$5p\ ^1F^o_3$	$3d^9(^2D_{1\frac{1}{2}})5p$	$5p\ ^1F^o$	3	*123016. 93*	

Cu II—Continued

Author	Config.	Desig.	*J*	Level	Interval
$5p\ ^1D^\circ_2$	$3d^9(^2D_{1\frac{1}{2}})5p$	$5p\ ^1D^\circ$	2	*123556.94*	
$y\ ^3D^\circ_3$	$3d^8\ 4s(^2D)4p$	$4p'''\,^3D^\circ$	3	*125230.6*	−17.2
$^3D^\circ_2$			2	*125247.8*	−320.9
$^3D^\circ_1$			1	*125568.7*	
$y\ ^1P^\circ_1$	$3d^8\ 4s(^2D)4p$	$4p'''\,^1P^\circ$	1	*125399.8*	
$x\ ^5S^\circ_2$	$3d^8\ 4s(^4P)4p$	$4p^{IV}\,^5S^\circ$	2	*128365.7*	
$y\ ^3F^\circ_2$	$3d^8\ 4s(^2D)4p$	$4p'''\,^3F^\circ$	2	*128569.6*	−10.7
$^3F^\circ_3$			3	*128558.9*	219.2
$^3F^\circ_4$			4	*128778.1*	
$x\ ^5P^\circ_3$	$3d^8\ 4s(^4P)4p$	$4p^{IV}\,^5P^\circ$	3	*129116.9*	263.6
$^5P^\circ_2$			2	*128853.3*	−906.3
$^5P^\circ_1$			1	*129759.6*	
$y\ ^3P^\circ_2$	$3d^8\ 4s(^2D)4p$	$4p'''\,^3P^\circ$	2	*130386.4*	
			1		
			0		
$y\ ^1D^\circ_2$	$3d^8\ 4s(^2D)4p$	$4p'''\,^1D^\circ$	2	*130632.4*	
$x\ ^5D^\circ_0$	$3d^8\ 4s(^4P)4p$	$4p^{IV}\,^5D^\circ$	0	*131206.0*	−261
$^5D^\circ_{2,1}$			{1, 2	}*130945*	368
$^5D^\circ_3$			3	*131312.7*	
			4		
$y\ ^1F^\circ_3$	$3d^8\ 4s(^2D)4p$	$4p'''\,^1F^\circ$	3	*131044.1*	
$6s\ ^3D_3$	$3d^9(^2D_{2\frac{1}{2}})6s$	$6s\ ^3D$	3	133594.23	−133.84
$^3D_2$	″		2	133728.07	−1936.54
$^3D_1$	$3d^9(^2D_{1\frac{1}{2}})6s$		1	135664.61	
$w\ ^3P^\circ_2$	$3d^8\ 4s(^2P)4p$	$4p^{V}\,^3P^\circ$	2	*133826.2*	−533.7
$^3P^\circ_1$			1	*134359.9*	−1124.4
$^3P^\circ_0$			0	*135484.3*	
$w\ ^3D^\circ_3$	$3d^8\ 4s(^2P)4p$	$4p^{V}\,^3D^\circ$	3	*133984.6*	−691.0
$^3D^\circ_2$			2	*134675.6*	−460.0
$^3D^\circ_1$			1	*135135.6*	
$v\ ^3G^\circ_5$	$3d^8\ 4s(^4F)4p$	$4p'\ ^3G^\circ$	5	*134110.6*	−1724.3
$^3G^\circ_4$			4	*135834.9*	−1242.7
$^3G^\circ_3$			3	*137077.6*	
$v\ ^3F^\circ_4$	$3d^8\ 4s(^4F)4p$	$4p'\ ^3F^\circ$	4	*134743.0*	−1699.0
$^3F^\circ_3$			3	*136442.05*	−1207.1
$^3F^\circ_2$			2	*137649.1*	
$v\ ^3D^\circ_3$	$3d^8\ 4s(^4F)4p$	$4p'\ ^3D^\circ$	3	*135733.6*	−1065.7
$^3D^\circ_2$			2	*136799.3*	−1114.5
$^3D^\circ_1$			1	*137913.8*	
$6s\ ^1D_2$	$3d^9(^2D_{1\frac{1}{2}})6s$	$6s\ ^1D$	2	135760.27	
$4f\ ^3P^\circ_0$	$3d^9(^2D_{2\frac{1}{2}})4f$	$4f\ ^3P^\circ$	0	*135902.43*	−38.50
$^3P^\circ_1$			1	*135863.93*	47.06
$^3P^\circ_2$			2	*135910.99*	
$4f\ ^3H^\circ_6$	$3d^9(^2D_{2\frac{1}{2}})4f$	$4f\ ^3H^\circ$	6	*135931.27*	−2.88
$^3H^\circ_5$	″		5	*135934.15*	−2139.52
$^3H^\circ_4$	$3d^9(^2D_{1\frac{1}{2}})4f$		4	*138073.67*	
$w\ ^1D^\circ_2$	$3d^8\ 4s(^2P)4p$	$4p^{V}\,^1D^\circ$	2	*135952.55*	
$4f\ ^1P^\circ_1$	$3d^9(^2D_{2\frac{1}{2}})4f$	$4f\ ^1P^\circ$	1	*135958.46*	
$4f\ ^3D^\circ_3$	$3d^9(^2D_{2\frac{1}{2}})4f$	$4f\ ^3D^\circ$	3	*135990.15*	−24.11
$^3D^\circ_2$	″		2	*136014.26*	−2014.44
$^3D^\circ_1$	$3d^9(^2D_{1\frac{1}{2}})4f$		1	*138028.70*	

Cu II—Continued

Author	Config.	Desig.	*J*	Level	Interval
$4f\ ^3F^\circ_4$	$3d^9(^2D_{2\frac{1}{2}})4f$	$4f\ ^3F^\circ$	4	*136133.06*	97.42
$^3F^\circ_3$	″		3	*136035.64*	−2141.58
$^3F^\circ_2$	$3d^9(^2D_{1\frac{1}{2}})4f$		2	*138177.22*	
$4f\ ^3G^\circ_5$	$3d^9(^2D_{2\frac{1}{2}})4f$	$4f\ ^3G^\circ$	5	*136160.93*	−109.33
$^3G^\circ_4$	″		4	*136270.26*	−1991.57
$^3G^\circ_3$	$3d^9(^2D_{1\frac{1}{2}})4f$		3	*138261.83*	
$5d\ ^3S_1$	$3d^9(^2D_{2\frac{1}{2}})5d$	$5d\ ^3S$	1	136336.88	
	$3d^8\ 4s(^2G)4p$	$4p^{VI}\,^3H^\circ$	6		
			5		
$u\ ^3H^\circ_4$			4	*136694.1*	
$5d\ ^3G_5$	$3d^9(^2D_{2\frac{1}{2}})5d$	$5d\ ^3G$	5	136725.93	−39.45
$^3G_4$	″		4	136765.38	−2053.79
$^3G_3$	$3d^9(^2D_{1\frac{1}{2}})5d$		3	138819.17	
$5d\ ^3P_2$	$3d^9(^2D_{2\frac{1}{2}})5d$	$5d\ ^3P$	2	136754.11	−19.1
$^3P_1$			1	136773.2	−841.1
$^3P_0$			0	137614.3	
$5d\ ^3D_3$	$3d^9(^2D_{2\frac{1}{2}})5d$	$5d\ ^3D$	3	136919.35	−154.40
$^3D_2$	″		2	137073.75	−1824.68
$^3D_1$	$3d^9(^2D_{1\frac{1}{2}})5d$		1	138898.43	
$5d\ ^3F_4$	$3d^9(^2D_{2\frac{1}{2}})5d$	$5d\ ^3F$	4	137044.45	−9.48
$^3F_3$	″		3	137034.97	−2107.1
$^3F_2$	$3d^9(^2D_{1\frac{1}{2}})5d$		2	139142.1	
$u\ ^1H^\circ_5$	$3d^8\ 4s(^2G)4p$	$4p^{VI}\,^1H^\circ$	5	*137082.5*	
$w\ ^1P^\circ_1$	$3d^8\ 4s(^2P)4p$	$4p^{V}\,^1P^\circ$	1	*137212.7*	
$u\ ^3F^\circ_4$	$3d^8\ 4s(^2G)4p$	$4p^{VI}\,^3F^\circ$	4	*137938.9*	−463.3
$^3F^\circ_3$			3	*138402.2*	−626.0
$^3F^\circ_2$			2	*139028.2*	
$4f\ ^1D^\circ_2$	$3d^9(^2D_{1\frac{1}{2}})4f$	$4f\ ^1D^\circ$	2	*138003.20*	
$4f\ ^1H^\circ_5$	$3d^9(^2D_{1\frac{1}{2}})4f$	$4f\ ^1H^\circ$	5	*138064.32*	
$4f\ ^1F^\circ_3$	$3d^9(^2D_{1\frac{1}{2}})4f$	$4f\ ^1F^\circ$	3	*138130.81*	
$4f\ ^1G^\circ_4$	$3d^9(^2D_{1\frac{1}{2}})4f$	$4f\ ^1G^\circ$	4	*138220.07*	
$5d\ ^1P_1$	$3d^9(^2D_{1\frac{1}{2}})5d$	$5d\ ^1P$	1	138593.10	
$5d\ ^1G_4$	$3d^9(^2D_{1\frac{1}{2}})5d$	$5d\ ^1G$	4	138883.0	
$5d\ ^1D_2$	$3d^9(^2D_{1\frac{1}{2}})5d$	$5d\ ^1D$	2	138981.3	
$5d\ ^1F_3$	$3d^9(^2D_{1\frac{1}{2}})5d$	$5d\ ^1F$	3	139119.5	
$6p\ ^3P^\circ_2$	$3d^9(^2D_{2\frac{1}{2}})6p$	$6p\ ^3P^\circ$	2	*139217.3*	−24.3
$^3P^\circ_1$			1	*139241.6*	
			0		
$6p\ ^3F^\circ_4$	$3d^9(^2D_{2\frac{1}{2}})6p$	$6p\ ^3F^\circ$	4	*139395.8*	64.5
$^3F^\circ_3$	″		3	*139331.3*	−2402.6
$^3F^\circ_2$	$3d^9(^2D_{1\frac{1}{2}})6p$		2	*141733.9*	
$6p\ ^3D^\circ_3$	$3d^9(^2D_{2\frac{1}{2}})6p$	$6p\ ^3D^\circ$	3	*139741.1*	30.9
$^3D^\circ_2$	″		2	*139710.2*	−1534.4
$^3D^\circ_1$	$3d^9(^2D_{1\frac{1}{2}})6p$		1	*141244.6*	
1°_1	$3d^8\ 4s(^4P)4p$	$4p^{IV}\ 1^\circ$	1	*140481.7?*	
$5d\ ^1S_0$	$3d^9(^2D_{1\frac{1}{2}})5d$	$5d\ ^1S$	0	140589.4	
$6p\ ^1P^\circ_1$	$3d^9(^2D_{1\frac{1}{2}})6p$	$6p\ ^1P^\circ$	1	*140984.2*	
$6p\ ^1F^\circ_3$	$3d^9(^2D_{1\frac{1}{2}})6p$	$6p\ ^1F^\circ$	3	*141204.1*	

Cu II—Continued

Author	Config.	Desig.	J	Level	Interval
$6p\ ^1D^\circ_2$	$3d^9(^2D_{1½})6p$	$6p\ ^1D^\circ$	2	*141542.1*	
3°_1	$3d^8\ 4s(^4P)4p$	$4p^{IV}\ 3^\circ$	1	*144240.6*	
$7s\ ^3D_3$	$3d^9(^2D_{2½})7s$	$7s\ ^3D$	3	144814.93	−68.16
$^3D_2$	"		2	144883.09	−2003.22
$^3D_1$	$3d^9(^2D_{1½})7s$		1	146886.31	
$5f\ ^3P^\circ_0$	$3d^9(^2D_{2½})5f$	$5f\ ^3P^\circ$	0	*145889.6*	11.5
$^3P^\circ_1$			1	*145901.1*	26.4
$^3P^\circ_2$			2	*145927.5*	
$5f\ ^3H^\circ_6$	$3d^9(^2D_{2½})5f$	$5f\ ^3H^\circ$	6	*145951.7*	5.9
$^3H^\circ_5$	"		5	*145945.8*	−2087.9
$^3H^\circ_4$	$3d^9(^2D_{1½})5f$		4	*148033.7*	
$5f\ ^1P^\circ_1$	$3d^9(^2D_{2½})5f$	$5f\ ^1P^\circ$	1	*145955.7*	
$5f\ ^3D^\circ_3$	$3d^9(^2D_{2½})5f$	$5f\ ^3D^\circ$	3	*145978.4*	−7.0
$^3D^\circ_2$	"		2	*145985.4*	−2030.9
$^3D^\circ_1$	$3d^9(^2D_{1½})5f$		1	*148016.3*	
$5f\ ^3F^\circ_4$	$3d^9(^2D_{2½})5f$	$5f\ ^3F^\circ$	4	*146024.0*	2.5
$^3F^\circ_3$	"		3	*146021.5*	−2044.8
$^3F^\circ_2$	$3d^9(^2D_{1½})5f$		2	*148066.3*	
$5f\ ^3G^\circ_5$	$3d^9(^2D_{2½})5f$	$5f\ ^3G^\circ$	5	*146032.5*	3.0
$^3G^\circ_4$	"		4	*146029.5*	−2073.7
$^3G^\circ_3$	$3d^9(^2D_{1½})5f$		3	*148103.2*	
$5g\ ^3D_1$	$3d^9(^2D_{2½})5g$	$5g\ ^3D$	1	146051.34	0.00
$^3D_2$			2	146051.34	21.61
$^3D_3$			3	146072.95	
$5g\ ^3I_7$	$3d^9(^2D_{2½})5g$	$5g\ ^3I$	7	146069.01	0.00
$^3I_6$	"		6	146069.01	−2076.76
$^3I_5$	$3d^9(^2D_{1½})5g$		5	148145.77	
$5g\ ^1D_2$	$3d^9(^2D_{2½})5g$	$5g\ ^1D$	2	146072.95	
$5g\ ^3F_4$	$3d^9(^2D_{2½})5g$	$5g\ ^3F$	4	146094.11	0.00
$^3F_3$	"		3	146094.11	−2039.88
$^3F_2$	$3d^9(^2D_{1½})5g$		2	148133.99	
$5g\ ^3H_6$	$3d^9(^2D_{2½})5g$	$5g\ ^3H$	6	146103.42	0.00
$^3H_5$	"		5	146103.42	−2075.88
$^3H_4$	$3d^9(^2D_{1½})5g$		4	148179.30	
$5g\ ^3G_5$	$3d^9(^2D_{2½})5g$	$5g\ ^3G$	5	146107.33	0.00
$^3G_4$	"		4	146107.33	−2060.44
$^3G_3$	$3d^9(^2D_{1½})5g$		3	148167.77	
$6d\ ^3S_1$	$3d^9(^2D_{2½})6d$	$6d\ ^3S$	1	146215.7	
$6d\ ^3G_5$	$3d^9(^2D_{2½})6d$	$6d\ ^3G$	5	146402.9	−20.5
$^3G_4$	"		4	146423.4	−2058.6
$^3G_3$	$3d^9(^2D_{1½})6d$		3	148482.0	
$6d\ ^3P_2$	$3d^9(^2D_{2½})6d$	$6d\ ^3P$	2	146415.7	−11.9
$^3P_1$	"		1	146427.6	−670.5
$^3P_0$	$3d^9(^2D_{1½})6d$		0	147098.1	
$6d\ ^3D_3$	$3d^9(^2D_{2½})6d$	$6d\ ^3D$	3	146496.2	−79.1
$^3D_2$	"		2	146575.3	−1946.5
$^3D_1$	$3d^9(^2D_{1½})6d$		1	148521.8	
$6d\ ^3F_4$	$3d^9(^2D_{2½})6d$	$6d\ ^3F$	4	146559.8	3.2
$^3F_3$	"		3	146556.6	−2086.0
$^3F_2$	$3d^9(^2D_{1½})6d$		2	148642.6	
$7s\ ^1D_2$	$3d^9(^2D_{1½})7s$	$7s\ ^1D$	2	146936.48	
$5f\ ^1D^\circ_2$	$3d^9(^2D_{1½})5f$	$5f\ ^1D^\circ$	2	*147987.7*	

Cu II—Continued

Author	Config.	Desig.	J	Level	Interval
$5f\ ^1H^\circ_5$	$3d^9(^2D_{1½})5f$	$5f\ ^1H^\circ$	5	*148028.8*	
$5f\ ^1F^\circ_3$	$3d^9(^2D_{1½})5f$	$5f\ ^1F^\circ$	3	*148061.7*	
$5f\ ^1G^\circ_4$	$3d^9(^2D_{1½})5f$	$5f\ ^1G^\circ$	4	*148105.6*	
$5g\ ^1F_3$	$3d^9(^2D_{1½})5g$	$5g\ ^1F$	3	148133.99	
$5g\ ^1I_6$	$3d^9(^2D_{1½})5g$	$5g\ ^1I$	6	148145.77	
$5g\ ^1G_4$	$3d^9(^2D_{1½})5g$	$5g\ ^1G$	4	148167.77	
$5g\ ^1H_5$	$3d^9(^2D_{1½})5g$	$5g\ ^1H$	5	148179.30	
$6d\ ^1P_1$	$3d^9(^2D_{1½})6d$	$6d\ ^1P$	1	148361.7	
$6d\ ^1G_4$	$3d^9(^2D_{1½})6d$	$6d\ ^1G$	4	148515.6	
$6d\ ^1D_2$	$3d^9(^2D_{1½})6d$	$6d\ ^1D$	2	148559.3	
$6d\ ^1F_3$	$3d^9(^2D_{1½})6d$	$6d\ ^1F$	3	148631.2	
$6d\ ^1S_0$	$3d^9(^2D_{1½})6d$	$6d\ ^1S$	0	149203.1	
$t\ ^3P^\circ_2$	$3d^8\ 4s(^2S)4p$	$4p^{VII}\ ^3P^\circ$	2	*150250*	
			1		
			0		
$8s\ ^3D_3$	$3d^9(^2D_{2½})8s$	$8s\ ^3D$	3	150742.9	−39.7
$^3D_2$			2	150782.6	
			1		
$6f\ ^3H^\circ_6$	$3d^9(^2D_{2½})6f$	$6f\ ^3H^\circ$	6	*151377.8*	5.5
$^3H^\circ_5$	"		5	*151372.3*	−2083.2
$^3H^\circ_4$	$3d^9(^2D_{1½})6f$		4	*153455.5?*	
$6f\ ^3P^\circ_2$	$3d^9(^2D_{2½})6f$	$6f\ ^3P^\circ$	2	*151375.3*	
			1		
			0		
$6f\ ^3D^\circ_3$	$3d^9(^2D_{2½})6f$	$6f\ ^3D^\circ$	3	*151402.4?*	−1.4
$^3D^\circ_2$			2	*151403.8?*	
			1		
	$3d^9(^2D_{2½})6f$	$6f\ ^3F^\circ$	4		
$6f\ ^3F^\circ_3$			3	*151419.2?*	
			2		
$7d\ ^3S_1$	$3d^9(^2D_{2½})7d$	$7d\ ^3S$	1	151550.0?	
$7d\ ^3G_5$	$3d^9(^2D_{2½})7d$	$7d\ ^3G$	5	151656.4	−12.0
$^3G_4$	"		4	151668.4	−2075.0
$^3G_3$	$3d^9(^2D_{1½})7d$		3	153743.4?	
$7d\ ^3P_2$	$3d^9(^2D_{2½})7d$	$7d\ ^3P$	2	151663.4	−6.8
$^3P_1$			1	151670.2	
			0		
$7d\ ^3D_3$	$3d^9(^2D_{2½})7d$	$7d\ ^3D$	3	151708.3	
			2		
			1		
$7d\ ^3F_4$	$3d^9(^2D_{2½})7d$	$7d\ ^3F$	4	151745.1	1.5
$^3F_3$			3	151743.6	
			2		
$6f\ ^1H^\circ_5$	$3d^9(^2D_{1½})6f$	$6f\ ^1H^\circ$	5	*153450.1?*	
	Cu III $(^2D_{2½})$	*Limit*	----	**163665.6**	

November 1949.

Cu II Observed Terms*

Config. $1s^2 2s^2 2p^6 3s^2 3p^6+$	Observed Terms		
$3d^8 4s^2$	$4s^2\ ^3P$, $4s^2\ ^1D$, $4s^2\ ^3F$, $4s^2\ ^1G$		
$3d^{10}$	$3d^{10}\ ^1S$		
	ns $(n\geq4)$	*np* $(n\geq4)$	
$3d^9(^2D)nx$	4–8$s\ ^3D$ 4–7$s\ ^1D$	4–6$p\ ^3P^\circ$ 4–6$p\ ^3D^\circ$ 4–6$p\ ^3F^\circ$ 4–6$p\ ^1P^\circ$ 4–6$p\ ^1D^\circ$ 4–6$p\ ^1F^\circ$	
$3d^8 4s(^4F)nx'$		$4p'\ ^5D^\circ$ $4p'\ ^5F^\circ$ $4p'\ ^5G^\circ$ $4p'\ ^3D^\circ$ $4p'\ ^3F^\circ$ $4p'\ ^3G^\circ$	
$3d^8 4s(^2F)nx''$		$4p''\ ^3D^\circ$ $4p''\ ^3F^\circ$ $4p''\ ^3G^\circ$ $4p''\ ^1D^\circ$ $4p''\ ^1F^\circ$ $4p''\ ^1G^\circ$	
$3d^8 4s(^2D)nx'''$		$4p'''\ ^3P^\circ$ $4p'''\ ^3D^\circ$ $4p'''\ ^3F^\circ$ $4p'''\ ^1P^\circ$ $4p'''\ ^1D^\circ$ $4p'''\ ^1F^\circ$	
$3d^8 4s(^4P)nx^{IV}$		$4p^{IV}\ ^5S^\circ$ $4p^{IV}\ ^5P^\circ$ $4p^{IV}\ ^5D^\circ$	
$3d^8 4s(^2P)nx^{V}$		$4p^{V}\ ^3P^\circ$ $4p^{V}\ ^3D^\circ$ $4p^{V}\ ^1P^\circ$ $4p^{V}\ ^1D^\circ$	
$3d^8 4s(^2G)nx^{VI}$		$4p^{VI}\ ^3F^\circ$ $4p^{VI}\ ^3H^\circ$ $4p^{VI}\ ^1H^\circ$	
$3d^8 4s(^2S)nx^{VII}$		$4p^{VII}\ ^3P^\circ$	
	nd $(n\geq4)$	*nf* $(n\geq4)$	*ng* $(n\geq5)$
$3d^9(^2D)nx$	4–7$d\ ^3S$ 4–7$d\ ^3P$ 4–7$d\ ^3D$ 4–7$d\ ^3F$ 4–7$d\ ^3G$ 4–6$d\ ^1S$ 4–6$d\ ^1P$ 4–6$d\ ^1D$ 4–6$d\ ^1F$ 4–6$d\ ^1G$	4–6$f\ ^3P^\circ$ 4–6$f\ ^3D^\circ$ 4–6$f\ ^3F^\circ$ 4, 5$f\ ^3G^\circ$ 4–6$f\ ^3H^\circ$ 4, 5$f\ ^1P^\circ$ 4, 5$f\ ^1D^\circ$ 4, 5$f\ ^1F^\circ$ 4, 5$f\ ^1G^\circ$ 4–6$f\ ^1H^\circ$	$5g\ ^3D$ $5g\ ^3F$ $5g\ ^3G$ $5g\ ^3H$ $5g\ ^3I$ $5g\ ^1D$ $5g\ ^1F$ $5g\ ^1G$ $5g\ ^1H$ $5g\ ^1I$

*For predicted terms in the spectra of the Ni I isoelectronic sequence, see Vol. II, Introduction.

Cu III

(Co I sequence; 27 electrons) $Z=29$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9\ {}^2D_{2\frac{1}{2}}$

$a\ {}^2D_{2\frac{1}{2}}$ **297100** cm^{-1} I. P. 36.83 volts

The analysis of the Cu III spectrum was begun by Gibbs and Vieweg, who reported in 1929 that they had some important multiplets. It has been seriously incomplete until recently, when Shenstone and Wilets undertook a detailed study of the spectrum, especially for inclusion here.

There are at present approximately 325 classified lines in the interval 672 A to 2822 A. According to Shenstone, not a single line of any considerable intensity remains unclassified.

He has determined the limit from the ${}^4F$ series, by using a Ritz formula, with the assumption that $\alpha=0.18\times10^{-6}$, as 299145 cm^{-1}. From a study of isoelectronic data Catalán has derived an improved value, which is quoted here.

The doublet and quartet systems of terms are connected by observed intersystem combinations.

REFERENCES

R. C. Gibbs and A. M. Vieweg, Phys. Rev. **33**, 1092 (A) (1929).
A. G. Shenstone and L. Wilets, Phys. Rev. **83**, 104 (1951). (I P) (T) (C L)
M. A. Catalán, unpublished material (April 1952). (I P)

Cu III

Config.	Desig.	J	Level	Interval
$3d^9$	$a\ {}^2D$	2½	0.0	−2071.8
		1½	2071.8	
$3d^8(^3F)4s$	$a\ {}^4F$	4½	60804.9	−1260.1
		3½	62065.0	−1078.6
		2½	63143.6	−742.7
		1½	63886.3	
$3d^8(^3F)4s$	$a\ {}^2F$	3½	67016.6	−1947.0
		2½	68963.6	
$3d^8(^1D)4s$	$b\ {}^2D$	2½	77967.6	−811.8
		1½	78779.4	
$3d^8(^3P)4s$	$a\ {}^4P$	0½	80422.8	−117.6
		1½	80305.2	246.3
		2½	80551.5	
$3d^8(^3P)4s$	$a\ {}^2P$	1½	85446.4	−686.6
		0½	86133.0	
$3d^8(^1G)4s$	$a\ {}^2G$	4½	89017.7	−28.2
		3½	89045.9	
$3d^8(^3F)4p$	$z\ {}^4D°$	3½	*118864.3*	−1713.2
		2½	*120577.5*	−1286.2
		1½	*121863.7*	−773.5
		0½	*122637.2*	

Cu III

Config.	Desig.	J	Level	Interval
$3d^8(^3F)4p$	$z\ {}^4G°$	5½	*121698.5*	361.3
		4½	*121337.2*	−1166.4
		3½	*122503.6*	−936.6
		2½	*123440.2*	
$3d^8(^3F)4p$	$z\ {}^4F°$	4½	*123549.9*	−1007.6
		3½	*124557.5*	−824.3
		2½	*125381.8*	−362.8
		1½	*125744.6*	
$3d^8(^3F)4p$	$z\ {}^2G°$	4½	*124442.5*	−1651.3
		3½	*126093.8*	
$3d^8(^3F)4p$	$z\ {}^2F°$	3½	*126829.4*	−1850.0
		2½	*128679.4*	
$3d^8(^3F)4p$	$z\ {}^2D°$	2½	*126891.9*	−1543.4
		1½	*128435.3*	
$3d^8(^3P)4p$	$z\ {}^4P°$	2½	*136607.3*	124.4
		1½	*136482.9*	−558.1
		0½	*137041.0*	
$3d^8(^1D)4p$	$y\ {}^2F°$	2½	*138084.0*	898.0
		3½	*138982.0*	
$3d^8(^1D)4p$	$y\ {}^2D°$	1½	*138988.1*	768.5
		2½	*139756.6*	
$3d^8(^1D)4p$	$z\ {}^2P°$	0½	*139260.7*	940.2
		1½	*140200.9*	

Cu III—Continued

Config.	Desig.	J	Level	Interval
$3d^8(^3P)4p$	$y\ ^4D^\circ$	0½	*142550.1*	
		1½	*142512.3*	−37.8
		2½	*142426.3*	−86.0
		3½	*142819.7*	393.4
$3d^8(^3P)4p$	$x\ ^2D^\circ$	2½	*144194.2*	
		1½	*144875.2*	−681.0
$3d^8(^3P)4p$	$y\ ^2P^\circ$	1½	*145353.0*	
		0½	*146675.9*	−1322.9
$3d^8(^1G)4p$	$z\ ^2H^\circ$	4½	*146533.6*	
		5½	*147647.0*	1113.4
$3d^8(^3P)4p$	$z\ ^2S^\circ$	0½	*147652.5*	
$3d^8(^1G)4p$	$x\ ^2F^\circ$	3½	*147805.9*	
		2½	*148662.9*	−857.0
$3d^8(^3P)4p$	$z\ ^4S^\circ$	1½	*147816.4*	
$3d^8(^1G)4p$	$y\ ^2G^\circ$	3½	*153609.2*	
		4½	*153808.4*	199.2
$3d^8(^3F)5s$	$e\ ^4F$	4½	193369.0	
		3½	194115.6	−746.6
		2½	195553.2	−1437.6
		1½	196444.9	−891.7
$3d^8(^3F)4d$	1	3½, 4½	193519.2	
$3d^8(^3F)4d$	3	3½, 4½	194031.6	
$3d^8(^3F)4d$	$e\ ^4G$	2½		
		3½		
		4½		
		5½	194330.8	
$3d^8(^3F)4d$	4	3½, 4½	195060.4	
$3d^8(^3F)4d$	5	3½	195342.2	
$3d^8(^3F)4d$	6	3½, 4½	195516.9	
$3d^8(^3F)5s$	$e\ ^2F$	3½	195787.1	
		2½	197398.4	−1611.3
$3d^8(^3F)4d$	7	2½	196740.2	
$3d^8(^3F)4d$	8	2½, 3½	197053.9	
$3d^8(^3F)4d$	$f\ ^2F$	2½		
		3½	197373.9	
$3d^8(^3F)4d$	9	1½, 2½	197898.7	
$3d^8(^3F)4d$	10	3½	198299.4	
Cu IV ($^3F_4$)	*Limit*	---------	297100	

March 1951.

Cu III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms		
$3d^9$	$a\ ^2D$		
	ns ($n \geq 4$)	np ($n \geq 4$)	nd ($n \geq 4$)
$3d^8(^3F)nx$	$a, e\ ^4F$ $a, e\ ^2F$	$z\ ^4D^\circ$ $z\ ^4F^\circ$ $z\ ^4G^\circ$ $z\ ^2D^\circ$ $z\ ^2F^\circ$ $z\ ^2G^\circ$	$e\ ^4G$ $f\ ^2F$
$3d^8(^3P)nx$	$a\ ^4P$ $a\ ^2P$	$z\ ^4S^\circ$ $z\ ^4P^\circ$ $y\ ^4D^\circ$ $z\ ^2S^\circ$ $y\ ^2P^\circ$ $x\ ^2D^\circ$	
$3d^8(^1G)nx$	$a\ ^2G$	$x\ ^2F^\circ$ $y\ ^2G^\circ$ $z\ ^2H^\circ$	
$3d^8(^1D)nx$	$b\ ^2D$	$z\ ^2P^\circ$ $y\ ^2D^\circ$ $y\ ^2F^\circ$	

*For predicted terms in the spectra of the Co I isoelectronic sequence, see Vol. II, Introduction.

Cu VII

(V I sequence; 23 electrons) $Z=29$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ {}^6S_{2½}$

$a\ {}^6S_{2½}$ cm^{-1} I. P. volts

This spectrum is very incompletely known. Kruger and Gilroy have classified three lines as transitions from the ground term to $3d^4\ 4p\ {}^6P°$, as follows:

Int.	I. A.	Wave No.	Desig.
200	200. 665	498343	$3d^5\ {}^6S_{2½}-4p\ {}^6P°_{3½}$
150	200. 851	497881	$3d^5\ {}^6S_{2½}-4p\ {}^6P°_{2½}$
100	200. 948	497640	$3d^5\ {}^6S_{2½}-4p\ {}^6P°_{1½}$

REFERENCE

P. G. Kruger and H. T. Gilroy, Phys. Rev. **48,** 720 (1935). (T) (C L)

January 1950.

Cu XIX

(Na I sequence; 11 electrons) $Z=29$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s\ {}^2S_{0½}$

$3s\ {}^2S_{0½}$ **5410000** cm^{-1} I. P. 671 volts

The terms are from Edlén, who lists one pair of classified lines at 47 A. He has extrapolated the absolute value of the ground term from isoelectronic sequence data.

The unit adopted by Edlén, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, Zeit. Phys. **100,** 621 (1936). (I P) (T) (C L)

Cu XIX

Config.	Desig.	J	Level	Interval
3s	3s ²S	0½	0	
3p	3p ²P°	0½ 1½	*327700* *363800*	36100
3d	3d ²D	1½ 2½	812300 818100	5800
4f	4f ²F°	2½ 3½	*2925200* *2926200*	1000
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Cu XX (¹S₀)	*Limit*	---	[5410000]	

June 1947.

ZINC

Zn I

30 electrons $Z=30$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ {}^1S_0$

$4s^2\ {}^1S_0$ **75766.8** cm^{-1} I. P. 9.391 volts

The well established series of Zn I are given by Paschen-Götze and by Fowler.

Hetzler, Boreman, and Burns observed the "*Spectrum of the Zinc Arc in Vacuum*" from 2138 A to 7799 A for the purpose of obtaining accurate wave lengths. From their prism, grating, and interferometric measurements they derived precise term values for the leading series terms. Their values are quoted in the table and are the only entries given to two or more decimal places. The limit, and remaining regular series terms are from Fowler. The term $13d\ {}^3D$ has been calculated from its combination with $4p\ {}^3P_2^\circ$, since the absolute value given by Fowler does not fit the observed wave number. Brackets denote that the entry for $5f\ {}^3F^\circ$ is calculated from the series formula. The ${}^1D$ and ${}^3P$ terms from the $4p^2$ configuration are from Sawyer's paper. These and Fowler's values have been adjusted slightly by the writer, to fit the scale of Hetzler, Boreman, and Burns.

Beutler and Guggenheimer have observed in absorption 24 lines between 713A and 1109 A which they classify as transitions from the ground term to terms above the ionization limit having the configurations $3d^9\ 4s^2(^2D)np$ and $3d^9\ 4s^2(^2D)nf$. The J-values of the limit term in Zn II, (^2D), are quoted from their paper. Their values of $8p''\ {}^3P^\circ$ and $9p''\ {}^3P^\circ$, counted from zero, have here been decreased by 10 cm^{-1} to fit the observed wave numbers on which these levels are based. For triplet terms only the component with $J=1$ is indicated in the table, since only combinations with the ground term $(J=0)$ are relevant.

Intersystem combinations connecting the singlet and triplet systems of terms have been observed.

Long before the development of the quantum theory of the Zeeman effect, the lines of the Zn I triplet $4p\ {}^3P^\circ-5s\ {}^3S$, 4680 A, 4722 A, and 4810 A, were among those used to test Preston's postulate that corresponding series lines of different elements are separated in the same manner in a magnetic field of the same strength. Although observed g-values have apparently not been published for Zn I, these lines serve excellently for the calibration of the magnetic field strength in determining the observed Zeeman patterns of various spectra. The quoted values are from Kiess, who furnished them especially for inclusion here.

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C. C. Kiess, unpublished material (March 1950). (Z E)
J. E. Mack, Rev. Mod. Phys. **22,** No. 1, 64 (1950). (Summary hfs)

Config.	Desig.	*J*	Level	Interval	Obs. *g*
$3d^{10}\,4s^2$	$4s^2\ ^1S$	0	0.000		
$3d^{10}\,4s(^2S)4p$	$4p\ ^3P^\circ$	0 1 2	*32311.308* *32501.390* *32890.317*	190.082 388.927	1.496 1.505
$3d^{10}\,4s(^2S)4p$	$4p\ ^1P^\circ$	1	*46745.37*		
$3d^{10}\,4s(^2S)5s$	$5s\ ^3S$	1	53672.241		2.001
$3d^{10}\,4s(^2S)5s$	$5s\ ^1S$	0	55789.220		
$3d^{10}\,4s(^2S)5p$	$5p\ ^3P^\circ$	0 1 2	*61247.2* *61273.9* *61330.1*	26.7 56.2	
$3d^{10}\,4s(^2S)4d$	$4d\ ^1D$	2	62458.51		
$3d^{10}\,4s(^2S)4d$	$4d\ ^3D$	1 2 3	62768.75 62772.00 62776.95	3.25 4.95	
$3d^{10}\,4s(^2S)5p$	$5p\ ^1P^\circ$	1	*62910.0*		
$3d^{10}\,4s(^2S)6s$	$6s\ ^3S$	1	65432.32		
$3d^{10}\,4s(^2S)6s$	$6s\ ^1S$	0	66037.60		
$3d^{10}\,4s(^2S)6p$	$6p\ ^3P^\circ$	0 1 2	*68070.854* *68080.669* *68101.784*	9.815 21.115	
$3d^{10}\,4s(^2S)5d$	$5d\ ^1D$	2	68338.48		
$3d^{10}\,4s(^2S)5d$	$5d\ ^3D$	1 2 3	68579.13 68580.60 68583.03	1.47 2.43	
$3d^{10}\,4s(^2S)6p$	$6p\ ^1P^\circ$	1	*68607.26*		
$3d^{10}\,4s(^2S)4f$	$4f\ ^3F^\circ$	2, 3, 4	*68834.4*		
$3d^{10}\,4s(^2S)7s$	$7s\ ^3S$	1	69745.94		
$3d^{10}\,4s(^2S)7s$	$7s\ ^1S$	0	70003.72		
$3d^{10}\,4s(^2S)7p$	$7p\ ^3P^\circ$	0 1 2	*70977.14* *70981.97* *70992.16*	4.83 10.19	
$3d^{10}\,4s(^2S)6d$	$6d\ ^1D$	2	71050.45		
$3d^{10}\,4s(^2S)6d$	$6d\ ^3D$	1 2 3	71212.13 71212.90 71214.24	0.77 1.34	
$3d^{10}\,4s(^2S)7p$	$7p\ ^1P^\circ$	1	*71219.08*		
$3d^{10}\,4s(^2S)5f$	$5f\ ^3F^\circ$	2, 3, 4	*[71323.4]*		
$3d^{10}\,4s(^2S)8s$	$8s\ ^3S$	1	71822.5		
$3d^{10}\,4s(^2S)8s$	$8s\ ^1S$	0	71956.20		
$3d^{10}\,4s(^2S)7d$	$7d\ ^1D$	2	72489.13		
$3d^{10}\,4s(^2S)8p$	$8p\ ^3P^\circ$	0 1 2	*72495.8* *72498.56* *72504.20*	2.8 5.64	
$3d^{10}\,4s(^2S)8p$	$8p\ ^1P^\circ$	1	*72626.2*		
$3d^{10}\,4s(^2S)7d$	$7d\ ^3D$	1, 2, 3	72627.9		
$3d^{10}\,4s(^2S)9s$	$9s\ ^3S$	1	72985.4		
$3d^{10}\,4s(^2S)9s$	$9s\ ^1S$	0	73060.63		
$3d^{10}\,4s(^2S)9p$	$9p\ ^3P^\circ$	0 1 2	*73390.7* *73392.27* *73395.86*	1.6 3.59	
$3d^{10}\,4s(^2S)9p$	$9p\ ^1P^\circ$	1	*73469.7*		
$3d^{10}\,4s(^2S)8d$	$8d\ ^3D$	1, 2, 3	73471.1		
$3d^{10}\,4s(^2S)10s$	$10s\ ^3S$	1	73698.6		
$3d^{10}\,4s(^2S)10p$	$10p\ ^1P^\circ$	1	*74012.4*		
$3d^{10}\,4s(^2S)9d$	$9d\ ^3D$	1, 2, 3	74016.7		
$3d^{10}\,4s(^2S)11s$	$11s\ ^3S$	1	74169.0		
$3d^{10}\,4s(^2S)10d$	$10d\ ^3D$	1, 2, 3	74387.7		
$3d^{10}\,4s(^2S)12s$	$12s\ ^3S$	1	74495.8		
$3d^{10}\,4s(^2S)11d$	$11d\ ^3D$	1, 2, 3	74651.3		
$3d^{10}\,4s(^2S)12d$	$12d\ ^3D$	1, 2, 3	74855.1		
$3d^{10}\,4s(^2S)13d$	$13d\ ^3D$	1, 2, 3	74994.0		
$3d^{10}\,4s(^2S)14d$	$14d\ ^3D$	1, 2, 3	75112.2		
Zn II ($^2S_{½}$)	***Limit***	------	**75766.8**		
$3d^{10}\,4p^2$	$4p^2\ ^3P$	0 1 2	80176 80395	219	
$3d^{10}\,4p^2$	$4p^2\ ^1D$	2	80795		
$3d^9\,4s^2(^2D_{2½})4p$	$4p'\ ^1P^\circ$	1	*90158*		
$3d^9\,4s^2(^2D_{1½})4p$	$4p'\ ^3P^\circ$	1	*94717*		
$3d^9\,4s^2(^2D_{1½})4p$	$4p'\ ^3D^\circ$	1	*95257*		
$3d^9\,4s^2(^2D_{2½})5p$	$5p'\ ^1P^\circ$	1	*123470*		
$3d^9\,4s^2(^2D_{1½})5p$	$5p'\ ^3P^\circ$	1	*125968*		
$3d^9\,4s^2(^2D_{1½})5p$	$5p'\ ^3D^\circ$	1	*126255*		
$3d^9\,4s^2(^2D_{2½})6p$	$6p'\ ^1P^\circ$	1	*130617*		
$3d^9\,4s^2(^2D_{2½})4f$	$4f'\ ^3P^\circ$?	1	*131671*		
$3d^9\,4s^2(^2D_{1½})6p$	$6p'\ ^3P^\circ$	1	*133214*		
$3d^9\,4s^2(^2D_{1½})6p$	$6p'\ ^3D^\circ$	1	*133349*		
$3d^9\,4s^2(^2D_{1½})4f$	$4f'\ ^1P^\circ$?	1	*133478*		
$3d^9\,4s^2(^2D_{2½})7p$	$7p'\ ^1P^\circ$	1	*133638*		
$3d^9\,4s^2(^2D_{2½})5f$	$5f'\ ^3P^\circ$?	1	*133989*		
$3d^9\,4s^2(^2D_{2½})8p$	$8p'\ ^1P^\circ$	1	*135185*		
$3d^9\,4s^2(^2D_{2½})9p$	$9p'\ ^1P^\circ$	1	*136066*		
$3d^9\,4s^2(^2D_{1½})7p$	$7p'\ ^3P^\circ$	1	*136292*		
$3d^9\,4s^2(^2D_{2½})10p$	$10p'\ ^1P^\circ$	1	*136656*		
$3d^9\,4s^2(^2D_{2½})11p$	$11p'\ ^1P^\circ$	1	*137060*		
$3d^9\,4s^2(^2D_{2½})12p$	$12p'\ ^1P^\circ$	1	*137344*		
$3d^9\,4s^2(^2D_{1½})8p$	$8p'\ ^3P^\circ$	1	*137883*		
$3d^9\,4s^2(^2D_{1½})9p$	$9p'\ ^3P^\circ$	1	*138813*		
$3d^9\,4s^2(^2D_{1½})10p$	$10p'\ ^3P^\circ$	1	*139377*		
$3d^9\,4s^2(^2D_{1½})11p$	$11p'\ ^3P^\circ$	1	*139762*		
$3d^9\,4s^2(^2D_{1½})12p$	$12p'\ ^3P^\circ$	1	*140059*		

February 1950.

Zn I OBSERVED TERMS*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms			
$3d^{10}\,4s^2$	$4s^2\ ^1S$			
$3d^{10}\,4p^2$	$4p^2\ ^3P$ $4p^2\ ^1D$			
	$ns\ (n\geq5)$	$np\ (n\geq4)$	$nd\ (n\geq4)$	$nf\ (n\geq4)$
$3d^{10}\,4s(^2S)nx$	5–12s ^3S 5– 9s ^1S	4– 9p $^3P^\circ$ 4–10p $^1P^\circ$	4–14d ^3D 4– 7d ^1D	$4f\ ^3F^\circ$
$3d^9\,4s^2(^2D)nx'$		4–12p' $^3P^\circ$ 4–6p' $^3D^\circ$ 4–12p' $^1P^\circ$		4, 5f' $^3P^\circ$ $4f'$ $^1P^\circ$

*For predicted terms in the spectra of the Zn I isoelectronic sequence, see Vol. II, Introduction.

Zn II

(Cu I sequence; 29 electrons) $Z=30$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s\ ^2S_{0\frac{1}{2}}$

$4s\ ^2S_{0\frac{1}{2}}$ **144890.6** cm^{-1} I. P. 17.96 volts

In 1925 von Salis published an analysis giving well established doublet series in Zn II, from which most of the terms in the table are taken. He derived the limit from the ^2D-series, by using a Ritz formula.

From infrared observations Paschen and Ritschl resolved the $4f\ ^2F^\circ$ term and found the $5g\ ^2G$-term.

By analogy with Cu I, terms from $3d^9\,4s\,nx$ are to be expected. Takahashi, Kalia, and Mazumder have published, respectively, 21, 8, and 26 levels, and grouped some of them into terms from this configuration. The first and last of these three papers are, however, not independent. Mazumder utilizes 6 levels given by Takahashi in making up the 6 terms he suggests.

More recently Shenstone and Gibson have investigated this spectrum and furnished their results in advance of publication, for inclusion here. They ascribe 8 terms to $3d^9\,4s\,4p$ and confirm 6 levels by Takahashi and 10 by Mazumder, of which 4 are common to both lists. Shenstone's interpretation of the terms from this configuration has been adopted here. He has also revised $7p\ ^2P^\circ$, added $8p\ ^2P^\circ$, and resolved $8f\ ^2F^\circ$. His revised term values have been used throughout, for the present compilation. The remaining published levels have been omitted, awaiting further confirmation.

There are approximately 120 classified lines in the interval between 984 A and 9950 A, including the infrared data, Lang's ultraviolet material, and the lists by von Salis and Shenstone. Observed intersystem combinations connect the doublet and quartet systems of terms.

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Zn II

Config.	Desig.	J	Level	Interval
$3d^{10}\,(^1S)4s$	$4s\ ^2S$	0½	0.0	
$3d^{10}(^1S)4p$	$4p\ ^2P^{\circ}$	0½ 1½	*48480.6* *49354.4*	873.8
$3d^9\,4s^2$	$4s^2\ ^2D$	2½ 1½	62721.9 65441.1	−2719.2
$3d^{10}(^1S)5s$	$5s\ ^2S$	0½	88436.8	
$3d^{10}(^1S)4d$	$4d\ ^2D$	1½ 2½	96909.0 96959.7	50.7
$3d^{10}(^1S)5p$	$5p\ ^2P^{\circ}$	0½ 1½	*101365.3* *101610.8*	245.5
$3d^9\,4s(^3D)4p$	$4p'\ ^4P^{\circ}$	2½ 1½ 0½	*103690.2* *105322.5* *106527.3*	−1632.3 −1204.8
$3d^9\,4s(^3D)4p$	$4p'\ ^4F^{\circ}$	4½ 3½ 2½ 1½	 *106841.9* *107267.6* 	−425.7
$3d^9\,4s(^3D)4p$	$4p'\ ^4D^{\circ}$	3½ 2½ 1½ 0½	 *111743.2* *111993.7* *112534.7*	−250.5 −541.0
$3d^9\,4s(^3D)4p$	$4p'\ ^2P^{\circ}$	0½ 1½	*113492.7* *113499.0*	6.3
$3d^9\,4s(^3D)4p$	$4p'\ ^2D^{\circ}$	1½ 2½	*114044.1* *114834.0*	789.9
$3d^9\,4s(^3D)4p$	$4p'\ ^2F^{\circ}$	3½ 2½	*114208.3*	
$3d^{10}\,(^1S)6s$	$6s\ ^2S$	0½	114498.5	
$3d^{10}(^1S)4f$	$4f\ ^2F^{\circ}$	3½ 2½	*117262.7* *117263.3*	−0.6
$3d^{10}(^1S)5d$	$5d\ ^2D$	1½ 2½	117968.7 117992.9	24.2
$3d^{10}(^1S)6p$	$6p\ ^2P^{\circ}$	0½ 1½	*119887.9* *119959.0*	71.1
$3d^{10}(^1S)7s$	$7s\ ^2S$	0½	125879.5	
$3d^{10}(^1S)5f$	$5f\ ^2F^{\circ}$	3½ 2½	*127199.0* *127208.6*	−9.6

Zn II

Config.	Desig.	J	Level	Interval
$3d^{10}(^1S)5g$	$5g\ ^2G$	4½ 3½	127310.1 127310.2	−0.1
$3d^{10}(^1S)6d$	$6d\ ^2D$	1½ 2½	127629.9 127643.1	13.2
$3d^{10}(^1S)7p$	$7p\ ^2P^{\circ}$	1½ 0½	*128343.5* *128517.9*	−174.4
$3d^9\,4s(^1D)4p$	$4p''\ ^2P^{\circ}$	1½ 0½	*130371.4* 	
$3d^9\,4s(^1D)4p$	$4p''\ ^2D^{\circ}$	2½ 1½	 *131651.7*	
$3d^{10}(^1S)8s$	$8s\ ^2S$	0½	131876.0	
$3d^{10}(^1S)6f$	$6f\ ^2F^{\circ}$	2½ 3½	*132603.3* *132638.7*	35.4
$3d^{10}(^1S)6g$	$6g\ ^2G$	{ 4½ 3½ }	132683.4	
$3d^{10}(^1S)7d$	$7d\ ^2D$	1½ 2½	132879.8 132887.7	7.9
$3d^{10}(^1S)8p$	$8p\ ^2P^{\circ}$	{ 1½ 0½ }	*133805*	
$3d^{10}(^1S)9s$	$9s\ ^2S$	0½	135423.0	
$3d^{10}(^1S)7f$	$7f\ ^2F^{\circ}$	3½ 2½	*135889.3* *135892.2*	−2.9
$3d^{10}(^1S)7g$	$7g\ ^2G$	{ 4½ 3½ }	135923.3	
$3d^{10}(^1S)8d$	$8d\ ^2D$	1½ 2½	136051.2 136056.3	5.1
$3d^{10}(^1S)8f$	$8f\ ^2F^{\circ}$	3½ 2½	*138001.3* *138002.6*	−1.3
$3d^{10}(^1S)9d$	$9d\ ^2D$	1½ 2½	138113.7 138117.3	3.6
Zn III $(^1S_0)$	*Limit*	---------	**144890.6**	

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Zn II Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms				
$3d^9\,4s^2$	$4s^2\ ^2D$				
	$ns\ (n\geq4)$	$np\ (n\geq4)$	$nd\ (n\geq4)$	$nf\ (n\geq4)$	$ng\ (n\geq5)$
$3d^{10}(^1S)nx$	4–9s ^2S	4–8p $^2P^{\circ}$	4–9d ^2D	4–8f $^2F^{\circ}$	5–7g ^2G
$3d^9\,4s(^3D)nx'$	{	$4p'\ ^4P^{\circ}$ $4p'\ ^4D^{\circ}$ $4p'\ ^4F^{\circ}$ $4p'\ ^2P^{\circ}$ $4p'\ ^2D^{\circ}$ $4p'\ ^2F^{\circ}$			
$3d^9\,4s(^1D)nx''$		$4p''\ ^2P^{\circ}$ $4p''\ ^2D^{\circ}$			

*For predicted terms of the Cu I isoelectronic sequence, see Vol. II, Introduction.

Zn III

(Ni I sequence; 28 electrons) Z=30

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\;{}^1S_0$

$3d^{10}\;{}^1S_0$ **320300** cm^{-1} I. P. 39.70 volts

The analysis is incomplete. In 1927 Laporte and Lang published 9 terms from the ^{2}D limit in Zn IV, and classified 37 lines between 677 A and 1839 A. By extrapolation along the isoelectronic sequence they estimated the limit to be about 325000 cm^{-1}.

From more extensive observations, Mazumder has classified 219 more lines and found 24 new terms in the range between 497 A and 3133 A. His value of the limit, based on the $ns\;{}^3D$ series (n=4,5) and derived from a Rydberg formula, is 324405 cm^{-1}. From a study of isoelectronic data Catalán has derived an improved value, which is quoted here.

The terms in the table are from these two papers. On the suggestion of Mack, Laporte, and Lang the two levels $4p\;{}^3D^\circ_1$ and $4p\;{}^1P^\circ_1$ have been interchanged, in order to agree better with the isoelectronic sequence data for Ga IV and Ge V.

The terms of all three multiplicities are connected by observed intersystem combinations.

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M. A. Catalán, unpublished material (April 1952). (I P)

Zn III

Config.	Desig.	J	Level	Interval
$3d^{10}$	$3d^{10}\;{}^1S$	0	0	
$3d^9(^2D)4s$	$4s\;{}^3D$	3 2 1	78105 79283 80859	−1178 −1576
$3d^9(^2D)4s$	$4s\;{}^1D$	2	83509	
$3d^9(^2D)4p$	$4p\;{}^3P^\circ$	2 1 0	*137876* *140080* *141401*	−2204 −1321
$3d^9(^2D)4p$	$4p\;{}^3F^\circ$	4 3 2	*141335* *140664* *142491*	671 −1827
$3d^9(^2D)4p$	$4p\;{}^3D^\circ$	3 2 1	*144511* *145252* *147577*	−741 −2325
$3d^9(^2D)4p$	$4p\;{}^1F^\circ$	3	*145974*	
$3d^9(^2D)4p$	$4p\;{}^1P^\circ$	1	*147505*	
$3d^9(^2D)4p$	$4p\;{}^1D^\circ$	2	*147928*	
$3d^9(^2D)4d$	$4d\;{}^3S$	1	214362	
$3d^9(^2D)5s$	$5s\;{}^3D$	3 2 1	214885 215347 217669	−462 −2322
$3d^9(^2D)4d$	$4d\;{}^1G$	4	215121	
$3d^9(^2D)4d$	$4d\;{}^1S$	0	215476	
$3d^9(^2D)4d$	$4d\;{}^3G$	5 4 3	216617 216473 217082	144 −609
$3d^9(^2D)4d$	$4d\;{}^1D$	2	216903	
$3d^9(^2D)4d$	$4d\;{}^3P$	2 1 0	217664 218918 221363	−1254 −2445
$3d^9(^2D)4d$	$4d\;{}^3D$	3 2 1	218048 218548 221350	−500 −2802
$3d^9(^2D)4d$	$4d\;{}^1F$	3	219352	
$3d^9(^2D)4d$	$4d\;{}^3F$	4 3 2	219368 219692 220674	−324 −982
$3d^9(^2D)4d$	$4d\;{}^1P$	1	221332	
$3d^9(^2D)5s$	$5s\;{}^1D$	2	227854	
$3d^8\,4s(^4F)4p$	$4p'\;{}^5G^\circ$	6 5 4 3 2	 *252029* *252580* *256301*	−551 −3721
$3d^8\,4s(^4F)4p$	$4p'\;{}^5F^\circ$	5 4 3 2 1	 *252287* *252415* *253703* *255635*	−128 −1288 −1932

Zn III—Continued

Config.	Desig.	J	Level	Interval
$3d^8\,4s(^4F)4p$	$4p'\ ^5D^\circ$	4	252311	−1821
		3	254132	393
		2	253739	−1708
		1	255447	−2625
		0	258072	
$3d^8\,4s(^4F)4p$	$4p'\ ^3G^\circ$	5		
		4	263829	306
		3	263523	
$3d^8\,4s(^4F)4p$	$4p'\ ^3D^\circ$	3	265492	−4511
		2	270003	−2101
		1	272104	
$3d^8\,4s(^4F)4p$	$4p'\ ^3F^\circ$	4	265538	−423
		3	265961	−6175
		2	272136	
$3d^8\,4s(^2F)4p$	$4p''\ ^3G^\circ$	5		
		4	274154	−1113
		3	275267	
$3d^8\,4s(^2F)4p$	$4p''\ ^1D^\circ$	2	274339	
$3d^8\,4s(^2F)4p$	$4p''\ ^3D^\circ$	3	276128	−2111
		2	278239	−1977
		1	280216	
$3d^8\,4s(^2F)4p$	$4p''\ ^1F^\circ$	3	276748	
$3d^8\,4s(^2F)4p$	$4p''\ ^1G^\circ$	4	277604	
$3d^8\,4s(^2F)4p$	$4p''\ ^3F^\circ$	2	277968	−644
		3	277324	815
		4	278139	
Zn IV ($^2D_{2\frac{1}{2}}$)	*Limit*		320300	

March 1951.

Zn III Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms		
$3d^{10}$	$3d^{10}\ ^1S$		
	ns ($n\geq4$)	np ($n\geq4$)	nd ($n\geq4$)
$3d^9(^2D)nx$	4, 5s ^3D 4, 5s ^1D	$4p\ ^3P^\circ$ $4p\ ^3D^\circ$ $4p\ ^3F^\circ$ $4p\ ^1P^\circ$ $4p\ ^1D^\circ$ $4p\ ^1F^\circ$	$4d\ ^3S$ $4d\ ^3P$ $4d\ ^3D$ $4d\ ^3F$ $4d\ ^3G$ $4d\ ^1S$ $4d\ ^1P$ $4d\ ^1D$ $4d\ ^1F$ $4d\ ^1G$
$3d^8\,4s(^4F)nx'$		$4p'\ ^5D^\circ$ $4p'\ ^5F^\circ$ $4p'\ ^5G^\circ$ $4p'\ ^3D^\circ$ $4p'\ ^3F^\circ$ $4p'\ ^3G^\circ$	
$3d^8\,4s(^2F)nx''$		$4p''\ ^3D^\circ$ $4p''\ ^3F^\circ$ $4p''\ ^3G^\circ$ $4p''\ ^1D^\circ$ $4p''\ ^1F^\circ$ $4p''\ ^1G^\circ$	

*For predicted terms in the spectra of the Ni I isoelectronic sequence, see Vol. II, Introduction.

Zn IV

(Co I sequence; 27 electrons) $Z=30$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9\ ^2D_{2\frac{1}{2}}$

$3d^9\ ^2D_{2\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed. Nine terms and 48 classified lines between 1029 A and 1443 A have been suggested by Subbaraya. Bloch and Bloch have also published 32 classified lines between 466 A and 1449 A but give no terms. A tolerance in the intervals of 35 cm^{-1} in the former paper and 22 cm^{-1} in the latter makes the analysis appear dubious in both cases, particularly since only one interval and possibly four lines are common to both papers.

REFERENCES

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March 1950.

GALLIUM

Ga I

31 electrons $Z=31$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p\;^2P^{\circ}_{0\frac{1}{2}}$

$4p\;^2P^{\circ}_{0\frac{1}{2}}$ **48380** cm^{-1} I. P. 6.00 volts

Uhler and Tanch observed the spectrum from 2200 to 4172 A, and extended two of the doublet series (^{2}S and ^{2}D) given by Fowler and by Paschen-Götze. Later Sawyer and Lang found the two terms $4p^2\;^2S$ and $4p^2\;^4P$ from their combination with $4p\;^2P^{\circ}$. Garton has since observed six intense absorption lines between 1500 and 1650 A, which he classifies as combinations of the ground term with $4p^2\;^2S$ and $4p^2\;^2P$. His absolute values for these two terms, calculated from the limit 48380, have been used for the present compilation. His work indicates a revision of Sawyer's value of $4p^2\;^2S$, which, counted from zero, is 40265.

Meggers and Murphy have recently photographed the spectrum from 6396 to 12109 A. They find the strong lines due to the transition $5s\;^2S-5p\;^2P^{\circ}$ at 11949.24 and 12109.93 A, thus confirming the early predictions which placed them near 12000 A. They have also extended the two series $5p\;^2P^{\circ}-ns\;^2S$, and $5p\;^2P^{\circ}-nd\;^2D$ to $n=12$ and 11, respectively, and have observed the $nf\;^2F^{\circ}$ series (n=4–7).

The writer has recalculated all of the term values with the aid of the new data. Fowler's limit, quoted above, is confirmed. The number of classified lines is now approximately 70.

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Ga I

Config.	Desig.	*J*	Level	Interval
$4s^2(^1S)4p$	$4p\;^2P^{\circ}$	0½ 1½	*0.00* *826.24*	826.24
$4s^2(^1S)5s$	$5s\;^2S$	0½	24788.58	
$4s^2(^1S)5p$	$5p\;^2P^{\circ}$	0½ 1½	*33044.06* *33155.03*	110.97
$4s^2(^1S)4d$	$4d\;^2D$	1½ 2½	34781.67 34787.92	6.25
$4s^2(^1S)6s$	$6s\;^2S$	0½	37584.62	
$4s\,4p^2$	$4p^2\;^4P$	0½ 1½ 2½	37972 38338 38913	366 575

Ga I

Config.	Desig.	*J*	Level	Interval
$4s^2(^1S)6p$	$6p\;^2P^{\circ}$	0½ 1½	*40376.46* *40417.62*	41.16
$4s^2(^1S)5d$	$5d\;^2D$	1½ 2½	40802.72 40811.20	8.48
$4s^2(^1S)7s$	$7s\;^2S$	0½	42158.44	
$4s^2(^1S)7p$	$7p\;^2P^{\circ}$	0½ 1½	*43440.8* *43461.7*	20.9
$4s^2(^1S)6d$	$6d\;^2D$	1½ 2½	43575.38 43580.59	5.21
$4s^2(^1S)4f$	$4f\;^2F^{\circ}$	2½, 3½	*43954.71*	
$4s^2(^1S)8s$	$8s\;^2S$	0½	44331.9	

Ga I—Continued

Config.	Desig.	*J*	Level	Interval
$4s^2(^1S)7d$	$7d\ ^2D$	1½	45072.0	4.1
		2½	45076.11	
$4s^2(^1S)9s$	$9s\ ^2S$	0½	45536.66	
$4s^2(^1S)8d$	$8d\ ^2D$	1½	45969.2	2.8
		2½	45972.00	
$4s^2(^1S)5f$	$5f\ ^2F^\circ$	2½, 3½	*46130.7*	
$4s^2(^1S)10s$	$10s\ ^2S$	0½	46273.9	
$4s^2(^1S)9d$	$9d\ ^2D$	1½	46548.3	0.6
		2½	46548.9	
$4s^2(^1S)6f$	$6f\ ^2F^\circ$	2½, 3½	*46660.8*	
$4s^2(^1S)11s$	$11s\ ^2S$	0½	46758.2	

Ga I—Continued

Config.	Desig.	*J*	Level	Interval
$4s^2(^1S)10d$	$10d\ ^2D$	1½, 2½	46941.6	
$4s^2(^1S)7f$	$7f\ ^2F^\circ$	2½, 3½	*47022.0*	
$4s^2(^1S)12s$	$12s\ ^2S$	0½	47092.52	
$4s^2(^1S)11d$	$11d\ ^2D$	1½, 2½	47222.10	
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Ga II ($^1S_0$)	***Limit***	----------	***48380***	
$4s\ 4p^2$	$4p^2\ ^2S$	0½	62100	
$4s\ 4p^2$	$4p^2\ ^2P$	0½	65796	626
		1½	66422	

November 1951.

Ga I Observed Terms*

Config. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}+$	Observed Terms			
$4s^2(^1S)4p$	$4p\ ^2P^\circ$			
$4s\ 4p^2$	{ $4p^2\ ^2S$; $4p^2\ ^4P$; $4p^2\ ^2P$			
	ns ($n\geq 5$)	*np* ($n\geq 5$)	*nd* ($n\geq 4$)	*nf* ($n\geq 4$)
$4s^2(^1S)nx$	5–12*s* ^2S	5–7*p* $^2P^\circ$	4–11*d* ^2D	4–7*f* $^2F^\circ$

*For predicted terms in the spectra of the Ga I isoelectronic sequence, see Vol. II, Introduction.

Ga II

(Zn I sequence; 30 electrons) $Z=31$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ ^1S_0$

$4s^2\ ^1S_0$ **165458** cm^{-1} I. P. 20.51 volts

The analysis has not been extended since 1929 when Sawyer and Lang classified about 90 lines in the region between 829 A and 7793 A. The terms are from their paper, predicted series members being entered in brackets. They have derived absolute values from the various series "in such a way as to make the deviations from true Rydberg type similar to those found in Al II." An evident misprint in their value of $7p\ ^1P^\circ$ has here been corrected to fit the observed combinations.

The singlet and triplet terms are connected by observed intersystem combinations.

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R. A. Sawyer and R. J. Lang, Phys. Rev. **34**, 712 (1929). (I P) (T) (C L)
J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

Ga II

Config.	Desig.	*J*	Level	Interval
$4s^2$	$4s^2\ ^1S$	0	0	
$4s(^2S)4p$	$4p\ ^3P^\circ$	0 1 2	*47370* *47816* *48750*	446 934
$4s(^2S)4p$	$4p\ ^1P^\circ$	1	*70700*	
$4s(^2S)5s$	$5s\ ^3S$	1	102943	
$4s(^2S)5s$	$5s\ ^1S$	0	106656	
$4s(^2S)4d$	$4d\ ^1D$	2	107719	
$4s(^2S)4d$	$4d\ ^3D$	1 2 3	113816 113841 113875	25 34
$4p^2$	$4p^2\ ^3P$	0 1 2	114701 115225 116137	524 912
$4s(^2S)5p$	$5p\ ^3P^\circ$	0 1 2	*118427* *118516* *118726*	89 210
$4s(^2S)5p$	$5p\ ^1P^\circ$	1	*120540*	
$4s(^2S)5d$	$5d\ ^1D$	2	[127190]	
$4s(^2S)6s$	$6s\ ^3S$	1	133012	
$4s(^2S)6s$	$6s\ ^1S$	0	[134310]	
$4s(^2S)5d$	$5d\ ^3D$	1 2 3	137154 137166 137183	12 17
$4s(^2S)4f$	$4f\ ^3F^\circ$	2, 3, 4	*137333*	
$4s(^2S)4f$	$4f\ ^1F^\circ$	3	*137343*	
$4s(^2S)6p$	$6p\ ^3P^\circ$	0, 1, 2	[*139260*]	
$4s(^2S)6p$	$6p\ ^1P^\circ$	1	[*139660*]	
$4s(^2S)6d$	$6d\ ^1D$	2	139694	
$4s(^2S)7s$	$7s\ ^3S$	1	145493	
$4s(^2S)7s$	$7s\ ^1S$	0	146013	
$4s(^2S)5f$	$5f\ ^3F^\circ$	2, 3, 4	*147483*	
$4s(^2S)5f$	$5f\ ^1F^\circ$	3	*147492*	
$4s(^2S)6d$	$6d\ ^3D$	1 2 3	147516 147524 147533	8 9
$4s(^2S)7d$	$7d\ ^1D$	2	148437	
$4s(^2S)7p$	$7p\ ^3P^\circ$	0, 1, 2	[*148620*]	
$4s(^2S)7p$	$7p\ ^1P^\circ$	1	*148707*	
$4s(^2S)8s$	$8s\ ^3S$	1	151919	
$4s(^2S)8s$	$8s\ ^1S$	0	152193	
$4s(^2S)6f$	$6f\ ^3F^\circ$	2, 3, 4	*153000*	
$4s(^2S)6f$	$6f\ ^1F^\circ$	3	[*153020*]	
$4s(^2S)7d$	$7d\ ^3D$	1, 2, 3	153061	
Ga III ($^2S_{½}$)	*Limit*	---------	165458	

March 1950.

Ga II Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms			
$4s^2$	$4s^2\ ^1S$			
$4p^2$		$4p^2\ ^3P$		
	ns ($n \geq 4$)	*np* ($n \geq 4$)	*nd* ($n \geq 4$)	*nf* ($n \geq 4$)
$4s(^2S)nx$	{ 5 – 8s ^3S { 5, 7, 8s ^1S	4, 5p $^3P^\circ$ 4, 5, 7p $^1P^\circ$	4–7d ^3D 4, 6, 7d ^1D	4–6f $^3F^\circ$ 4, 5f $^1F^\circ$

*For predicted terms in the spectra of the Zn I isoelectronic sequence see Vol. II, Introduction.

Ga III

(Cu I sequence; 29 electrons) $Z=31$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ {}^2S_{0\frac{1}{2}}$

$4s\ {}^2S_{0\frac{1}{2}}$ **247700** cm^{-1} I. P. 30.70 volts

The early analysis was by Carroll, who reported six doublet series terms in 1925, and determined the limit as 247790 by assuming an absolute value of $5g\ {}^2G$ consistent with extrapolated isoelectronic sequence data.

From improved measurements Lang revised Carroll's absolute term values slightly and added the second member of the principal series. His classification of two faint lines at 632.92 A and 635.02 A, respectively, as $4s\ {}^2S-5p\ {}^2P^{\circ}$ was confirmed only by a rough extrapolation of the Rydberg formula. This places $5p\ {}^2P^{\circ}_{1\frac{1}{2}}$ at 157998 and $5p\ {}^2P^{\circ}_{0\frac{1}{2}}$ at 157475 (with $4s\ {}^2S=0$). The quoted value of the limit is an estimate by Catalán based on isoelectronic data.

Subsequently Rao extended the observations, added the terms $6s\ {}^2S$ and $5d\ {}^2D$, and revised Lang's value of $5p\ {}^2P^{\circ}$ on the basis of combinations of this term with $5s\ {}^2S$ and $4d\ {}^2D$. The revised value of $5p\ {}^2P^{\circ}$ has been adopted here. With this exception, Lang's values have been used in the present compilation, supplemented by the new terms from Rao. A correction of 10 cm^{-1} has here been added to the three terms from Rao's paper (from the ground state zero) to reduce them to Lang's scale. About 20 lines have been classified in the interval 1267 A to 5992 A.

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R. J. Lang, Phys. Rev. **30,** 762 (1927). (I P) (T) (C L)
K. R. Rao, A. L. Narayan, and A. S. Rao, Indian J. Phys. **2,** 483 (1928). (C L)
M. A. Catalán, unpublished material (April 1952). (I P)

Ga III

Config.	Desig.	J	Level	Interval
4s	$4s\ {}^2S$	0½	0	
4p	$4p\ {}^2P^{\circ}$	0½ 1½	*65167* *66885*	1718
5s	$5s\ {}^2S$	0½	140744	
4d	$4d\ {}^2D$	1½ 2½	144078 144195	117
5p	$5p\ {}^2P^{\circ}$	0½ 1½	*160761* *161300*	539
4f	$4f\ {}^2F^{\circ}$	2½ 3½	*185431* *185438*	7
6s	$6s\ {}^2S$	0½	187562	
5d	$5d\ {}^2D$	1½ 2½	189183 189246	63
5g	$5g\ {}^2G$	{ 3½ 4½ }	208252	
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Ga IV ($^1S_0$)	*Limit*	-----	247700	

March 1951.

Ga IV

(Ni I sequence; 28 electrons) $Z=31$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ {}^1S_0$

$3d^{10}\ {}^1S_0$ **517600** cm^{-1} I. P. 64.2 volts

Mack, Laporte, and Lang have classified 39 lines in the interval 422 A to 1465 A, as combinations among 9 terms. They have determined the limit by linear extrapolation of the Moseley diagram "slightly modified by a consideration of the first order screening numbers." The value of the limit calculated from their quoted ionization potential is entered in brackets in the table.

Intersystem combinations connecting the singlet and triplet terms, have been observed.

REFERENCE

J. E. Mack, O. Laporte, and R. J. Lang, Phys. Rev. **31,** 748 (1928). (I P) (T) (C L)

Ga IV

Config.	Desig.	J	Level	Interval
$3d^{10}$	$3d^{10}\ {}^1S$	0	0	
$3d^9\ ({}^2D)4s$	$4s\ {}^3D$	3 2 1	149298 150753 152873	−1455 −2120
$3d^9({}^2D)4s$	$4s\ {}^1D$	2	155810	
$3d^9({}^2D)4p$	$4p\ {}^3P^\circ$	2 1 0	*224028* *227109* *228929*	−3081 −1820
$3d^9({}^2D)4p$	$4p\ {}^3F^\circ$	4 3 2	*228742* *227470* *229828*	1272 −2358
$3d^9({}^2D)4p$	$4p\ {}^3D^\circ$	3 2 1	*232976* *233612* *236692*	−636 −3080
$3d^9({}^2D)4p$	$4p\ {}^1F^\circ$	3	*234724*	
$3d^9({}^2D)4p$	$4p\ {}^1P^\circ$	1	*236099*	
$3d^9({}^2D)4p$	$4p\ {}^1D^\circ$	2	*237243*	
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Ga V $({}^2D_{2\frac{1}{2}})$	*Limit*	-----	[517600]	

November 1949.

Ga IV OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6+$	Observed Terms	
$3d^{10}$	$3d^{10}\ {}^1S$	
	$ns\ (n\geq 4)$	$np\ (n\geq 4)$
$3d^9({}^2D)nx$	$4s\ {}^3D$ $4s\ {}^1D$	$4p\ {}^3P^\circ$ $4p\ {}^3D^\circ$ $4p\ {}^3F^\circ$ $4p\ {}^1P^\circ$ $4p\ {}^1D^\circ$ $4p\ {}^1F^\circ$

*For predicted terms in the spectra of the Ni I isoelectronic sequence, see Vol. II, Introduction.

GERMANIUM

Ge I

32 electrons $Z=32$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2\ {}^3P_0$

$4p^2\ {}^3P_0$ **63600** cm^{-1} I. P. 7.88 volts

K. R. Rao, in 1929, revised and extended the early work of Gartlein and others, and published a list of 139 classified lines between 1639 A and 4685 A. Kiess, in 1940, added 7 terms, from the 5*p* and 6*p* configurations, and 25 classified lines from his observations between 5265 A and 11144 A. The terms in the table are from these two sources, although it is difficult to choose between the arrangement suggested by Gartlein and that by Rao for the terms which they interpret differently.

Andrew and Meissner have contributed new terms from the *np* configuration ($n=5$ to 7), and adjusted some other values. Their results are from unpublished material furnished especially for inclusion here.

The limit is from Gartlein, who derived it from the $ns\ {}^{1,3}P^{\circ}$ series ($n=5$ to 7) and the $nd\ {}^1P^{\circ}D^{\circ}F^{\circ},{}^3P^{\circ}D^{\circ}F^{\circ}$ series ($n=5$, 6) by the use of a Rydberg formula. Rao's value from the $ns\ {}^{1,3}P^{\circ}$ series ($n=5$ to 7) is 63790 cm^{-1}.

Two miscellaneous levels given by Rao have been omitted from the table. With the ground state equal to zero they are as follows:

Desig.	Level
${}^1X_1^{\circ}$	*59522.5*
${}^3X_2^{\circ}$	*61250.9*

The singlet and triplet systems of terms are connected by observed intersystem combinations.

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K. L. Andrew and K. W. Meissner, unpublished material (October 1951). (T) (C L)

Ge I

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2 4p^2$	$4p^2\ ^3P$	0 1 2	0.00 557.10 1409.90	557.11 852.80	 1.476 1.514
$4s^2 4p^2$	$4p^2\ ^1D$	2	7125.26		0.989
$4s^2 4p^2$	$4p^2\ ^1S$	0	16367.14		
$4s^2 4p(^2P^\circ)5s$	$5s\ ^3P^\circ$	0 1 2	*37451.53* *37702.15* *39117.77*	250.62 1415.62	 1.442 1.499
$4s^2 4p(^2P^\circ)5s$	$5s\ ^1P^\circ$	1	*40020.43*		1.058
$4s^2 4p(^2P^\circ)5p$	$5p\ ^1P$	1	45985.45		
$4s^2 4p(^2P^\circ)5p$	$5p\ ^3D$	1 2 3	46765.12 46834.23 48103.97	69.11 1269.74	
$4s^2 4p(^2P^\circ)5p$	$5p\ ^3P$	0 1 2	47502.50 48088.20 48725.96	585.70 637.76	
$4s^2 4p(^2P^\circ)4d$	$4d\ ^1D^\circ$	2	*48479.7*		
$4s^2 4p(^2P^\circ)4d$	$4d\ ^3D^\circ$	1 2 3	*48962.3* *48881.9* *49144.1*	−80.4 262.2	
$4s^2 4p(^2P^\circ)5p$	$5p\ ^3S$	1	49075.76		
$4s^2 4p(^2P^\circ)5p$	$5p\ ^1D$	2	49649.47		
$4s^2 4p(^2P^\circ)4d$	$4d\ ^3F^\circ$	2 3 4	*50068.7* *50322.8*	254.1	
$4s^2 4p(^2P^\circ)5p$	$5p\ ^1S$	0	51011.32		
$4s^2 4p(^2P^\circ)4d$	$4d\ ^3P^\circ$	2 1 0	*51437.4* *51704.6* *51979.8*	−267.2 −275.2	1.50
$4s^2 4p(^2P^\circ)6s$	$6s\ ^3P^\circ$	0 1 2	*52170.3* *52148.2* *53910.5*	−22.1 1762.3	
$4s^2 4p(^2P^\circ)4d$	$4d\ ^1F^\circ$	3	*52592.0*		
$4s^2 4p(^2P^\circ)4d$	$4d\ ^1P^\circ$	1	*52847.0*		1.03
$4s^2 4p(^2P^\circ)6s$	$6s\ ^1P^\circ$	1	*54174.6*		
$4s^2 4p(^2P^\circ)6p$	$6p\ ^1P$	1	54935.74		
$4s^2 4p(^2P^\circ)6p$	$6p\ ^3D$	1 2 3	55235.68 55265.98 56767.55?	30.30 1501.57	
$4s^2 4p(^2P^\circ)5d$	$5d\ ^3D^\circ$	1 2 3	*55469.7* *55372.4* *55685.6*	−97.3 313.2	

Ge I

Config.	Desig.	J	Level	Interval	Obs. g
$4s 4p^3$	$4p^3\ ^1P^\circ$	1	*55473.6*		
$4s^2 4p(^2P^\circ)6p$	$6p\ ^3P$	0 1 2	55503.10 56686.99 56947.63	1183.89 260.64	
$4s^2 4p(^2P^\circ)5d$	$5d\ ^1D^\circ$	2	*55717.6*		
$4s 4p^3$	$4p^3\ ^3P^\circ$	2 1 0	*56654.9* *57397.1* *57675.1*	−742.2 −278.0	
$4s^2 4p(^2P^\circ)6p$	$6p\ ^1S$	0	56772.63		
$4s^2 4p(^2P^\circ)5d$	$5d\ ^3F^\circ$	2 3 4	 *56828.3*		
$4s^2 4p(^2P^\circ)6p$	$6p\ ^3S$	1	57083.07		
$4s^2 4p(^2P^\circ)7s$	$7s\ ^3P^\circ$	0 1 2	57166.5 56920.6 58931.4	−245.9 2010.8	
$4s^2 4p(^2P^\circ)5d$	$5d\ ^3P^\circ$	2 1 0	57178.5 57430.7 57696.1	−252.2 −265.4	
$4s^2 4p(^2P^\circ)6p$	$6p\ ^1D$	2	57250.84		
$4s^2 4p(^2P^\circ)5d$	$5d\ ^1P^\circ$	1	58056.6		
$4s 4p^3$	$4p^3\ ^1D^\circ$	2	58091.3		
$4s^2 4p(^2P^\circ)7p$	$7p\ ^3D$	1 2 3	58560.69 58586.76	26.07	
$4s^2 4p(^2P^\circ)5d$	$5d\ ^1F^\circ$	3	58941.6		
$4s^2 4p(^2P^\circ)7s$	$7s\ ^1P^\circ$	1	59113.7		
$4s 4p^3$	$4p^3\ ^3D^\circ$	3 2 1	59655.1 59688.1 59724.7	−33.0 −36.6	
$4s^2 4p(^2P^\circ)6d$	$6d\ ^1D^\circ$	2	60885.2		
$4s^2 4p(^2P^\circ)6d$	$6d\ ^1P^\circ$	1	61151.9		
$4s^2 4p(^2P^\circ)6d$	$6d\ ^1F^\circ$	3	61266.8		
$4s^2 4p(^2P^\circ)8s$	$8s\ ^1P^\circ$	1	61342.8		
Ge II ($^2P^\circ_{0½}$)	*Limit*	-----	**63600**		

October 1951.

Ge I Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms		
$4s^2\ 4p^2$	$4p^2\ ^3P$; $4p^2\ ^1S$ $4p^2\ ^1D$		
$4s\ 4p^3$	$4p^3\ ^3P^\circ$ $4p^3\ ^3D^\circ$; $4p^3\ ^1P^\circ$ $4p^3\ ^1D^\circ$		
	ns ($n \geq 5$)	np ($n \geq 5$)	nd ($n \geq 4$)
$4s^2\ 4p(^2P^\circ)nx$	5–7s $^3P^\circ$; 5–8s $^1P^\circ$	5, 6p ^3S 5, 6p ^3P 5–7p ^3D; 5, 6p ^1S 5, 6p ^1P 5, 6p ^1D	4, 5d $^3P^\circ$ 4, 5d $^3D^\circ$ 4, 5d $^3F^\circ$; 4–6d $^1P^\circ$ 4–6d $^1D^\circ$ 4–6d $^1F^\circ$

*For predicted terms in the spectra of the Ge I isoelectronic sequence, see Vol. II, Introduction.

Ge II

(Ga I sequence; 31 electrons) $Z=32$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p\ ^2P^\circ_{0\frac{1}{2}}$

$4p\ ^2P^\circ_{0\frac{1}{2}}$ ***128518*** cm^{-1} I. P. 15.93 volts

The analysis of this spectrum was begun by Lang, who classified 33 lines and found 10 terms. Rao and Narayan also reported 8 terms and an estimated value of the limit. It has been greatly extended by Gartlein, who has furnished his unpublished data especially for inclusion here. He has observed the spectrum from 813 A to 6484 A and now has 131 classified lines.

From three series, $ns\ ^2S$ ($n=5$–9), $nd\ ^2D$ ($n=4$–10), and $nf\ ^2F^\circ$ ($n=4$–11) he determines the limit quoted here. It is based on a Hicks formula and is derived by the method suggested by Shenstone. Meissner and Andrew have made further observations between 4741 and 7145 A that have enabled the writer to derive improved term values for inclusion here. They have resolved the 4–7f $^2F^\circ$ terms by combining their data with those of Gartlein. The three place entries in the table are from their interferometer observations.

The quartet terms are connected with the doublet terms by observed intersystem combinations.

The observed g-values have been determined by the writer from the Zeeman patterns published in the 1941 reference below.

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Ge II

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2(^1S)4p$	$4p\ ^2P°$	0½ 1½	*0.0* *1767.1*	1767.1	
$4s\ 4p^2$	$4p^2\ ^4P$	0½ 1½ 2½	51575.5 52290.5 53366.7	715.0 1076.2	
$4s^2(^1S)5s$	$5s\ ^2S$	0½	62402.360		2.00
$4s\ 4p^2$	$4p^2\ ^2D$	1½ 2½	65015.0 65184.070	169.1	
$4s^2(^1S)5p$	$5p\ ^2P°$	0½ 1½	*79006.205* *79365.847*	359.642	0.67 1.33
$4s^2(^1S)4d$	$4d\ ^2D$	1½ 2½	80836.05 81011.80	175.75	
$4s\ 4p^2$	$4p^2\ ^2S$	0½	85889.9		
$4s\ 4p^2$	$4p^2\ ^2P$	0½ 1½	91014.8 92122.1	1107.3	
$4s^2(^1S)6s$	$6s\ ^2S$	0½	94783.758		
$4s^2(^1S)5d$	$5d\ ^2D$	1½ 2½	100089.32 100130.18	40.86	0.77 1.20
$4s^2(^1S)4f$	$4f\ ^2F°$	3½ 2½	*100316.50* *100317.14*	−0.64	
$4s^2(^1S)6p$	$6p\ ^2P°$	{0½, 1½}	*101242.8*		
$4s^2(^1S)7s$	$7s\ ^2S$	0½	107935.40		
$4s^2(^1S)6d$	$6d\ ^2D$	1½ 2½	110377.39 110396.93	19.54	
$4s^2(^1S)5f$	$5f\ ^2F°$	3½ 2½	*110503.69* *110504.43*	−0.74	
$4s^2(^1S)7p$	$7p\ ^2P°$	{0½, 1½}	*111016.2*		
$4s^2(^1S)8s$	$8s\ ^2S$	0½	114637.84		
$4s^2(^1S)7d$	$7d\ ^2D$	1½ 2½	115977.10 115987.14	10.04	
$4s^2(^1S)6f$	$6f\ ^2F°$	3½ 2½	*116040.62* *116041.16*	−0.54	
$4s^2(^1S)6g$	$6g\ ^2G$	{3½, 4½}	116265.94		
$4s^2(^1S)9s$	$9s\ ^2S$	0½	118522.4		
$4s^2(^1S)8d$	$8d\ ^2D$	1½ 2½	119337.8 119345.2	7.4	
$4s^2(^1S)7f$	$7f\ ^2F°$	3½ 2½	*119373.27* *119373.72*	−0.45	
$4s^2(^1S)7g$	$7g\ ^2G$	{3½, 4½}	119521.03		
$4s^2(^1S)10s$	$10s\ ^2S$	0½	120975.9		
$4s^2(^1S)9d$	$9d\ ^2D$	{1½, 2½}	121512.7		
$4s^2(^1S)8f$	$8f\ ^2F°$	{2½, 3½}	*121531.4*		
$4s\ 4p(^3P°)5s$:	$5s\ ^2P°$	0½ 1½	*121914.1* *123099.8*	1185.7	
$4s\ 4p(^3P°)5s$:	$5s\ ^4P°$	0½ 1½ 2½	*122693.7?* *123401.4* *124730.5*	707.7 329.1	
$4s^2(^1S)10d$	$10d\ ^2D$	{1½, 2½}	122996.0		
$4s^2(^1S)9f$	$9f\ ^2F°$	{2½, 3½}	*123007.0*		
$4s^2(^1S)11d$	$11d\ ^2D$	{1½, 2½}	124053.7		
$4s^2(^1S)10f$	$10f\ ^2F°$	{2½, 3½}	*124061.6*		
$4s^2(^1S)11f$	$11f\ ^2F°$	{2½, 3½}	*124840.3*		
$4s^2(^1S)12f$	$12f\ ^2F°$	{2½, 3½}	*125431.5*		
Ge III ($^1S_0$)	***Limit***		***128518***		
$4p^3$	$4p^3\ ^4S°$	1½	*136237.3*		

November 1951.

Ge II Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2\ 3d^{10}+$	Observed Terms				
$4s^2(^1S)4p$	$4p\ ^2P°$				
$4s\ 4p^2$	{ $4p^2\ ^4P$; $4p^2\ ^2S$ $4p^2\ ^2P$ $4p^2\ ^2D$				
$4p^3$	$4p^3\ ^4S°$:				
	ns ($n\geq5$)	*np* ($n\geq5$)	*nd* ($n\geq4$)	*nf* ($n\geq4$)	*ng* ($n\geq5$)
$4s^2(^1S)nx$	5–10s ^2S	5–7*p* $^2P°$	4–11*d* ^2D	4–12*f* $^2F°$	6, 7*g* ^2G
$4s\ 4p(^3P°)nx$	{ 5s $^4P°$:; 5s $^2P°$:				

*For predicted terms in the spectra of the Ga I isoelectronic sequence, see Vol. II, Introduction.

Ge III

(Zn I sequence; 30 electrons) $Z=32$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\;{}^1S_0$

$4s^2\;{}^1S_0$ **276036** cm^{-1} I. P. 34.21 volts

The analysis is from Lang, who has revised and extended the earlier work on this spectrum, and published a list of 86 classified lines between 542 A and 5256 A. His term values "depend upon an arbitrary choice of 65500 cm^{-1}" for the absolute value of $4f\;{}^3F^\circ_4$. This choice is based on isoelectronic sequence data and "has been made with reasonable accuracy."

Rao and Narayan list in addition 6 "even" miscellaneous levels that are not included here.

The writer has derived the tabulated g-values from the observed Zeeman patterns given in the 1941 reference below.

The singlet and triplet systems of terms are connected by observed intersystem combinations.

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J. C. van den Bosch and P. F. A. Klinkenberg, Proc. Ned. Akad. v. Wetensch. Amsterdam **44**, No. 5, 560 (1941). (Z E)

Ge III

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2$	$4s^2\;{}^1S$	0	0		
$4s(^2S)4p$	$4p\;{}^3P^\circ$	0 1 2	*61733* *62496* *64138*	763 1642	
$4s(^2S)4p$	$4p\;{}^1P^\circ$	1	*91873*		
$4s(^2S)4d$	$4d\;{}^1D$	2	144972		
$4p^2$	$4p^2\;{}^3P$	0 1 2	147691 148644 150373	953 1729	
$4p^2$	$4p^2\;{}^1D$	2	148776		
$4s(^2S)5s$	$5s\;{}^3S$	1	158576. 2		1. 99
$4s(^2S)4d$	$4d\;{}^3D$	1 2 3	162851. 0 162921. 8 163028. 3	70. 8 106. 5	
$4s(^2S)5s$	$5s\;{}^1S$	0	167450		
$4s(^2S)5p$	$5p\;{}^3P^\circ$	0 1 2	*181871* *182039* *182498*	168 459	 1. 48 1. 49
$4s(^2S)5p$	$5p\;{}^1P^\circ$	1	*184308. 8*		

Ge III

Config.	Desig.	J	Level	Interval	Obs. g
$4p(^2P^\circ)4d$	$4d\;{}^1D^\circ$	2	*197122*		
$4s(^2S)4f$	$4f\;{}^3F^\circ$	2 3 4	*210455. 3* *210472. 7* *210536*	17. 4 63	
$4s(^2S)4f$	$4f\;{}^1F^\circ$	3	*210531*		
$4s(^2S)6s$	$6s\;{}^3S$	1	211149		1. 94
$4p(^2P^\circ)4d$	$4d\;{}^1P^\circ$	1	*212359*		
$4s(^2S)5d$	$5d\;{}^3D$	1 2 3	213133. 2 213163. 8 213208. 0	30. 6 44. 2	0. 50 1. 16 1. 32
$4p(^2P^\circ)4d$	$4d\;{}^1F^\circ$	3	*213579*		
$4s(^2S)5g$	$5g\;{}^1G$	4	234910??		
$4s(^2S)5g$	$5g\;{}^3G$	3, 4, 5	234928?		
$4d^2$?	$4d^2\;{}^1D$	2	235908		
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Ge IV ($^2S_{1/2}$)	*Limit*	-----	**276036**		

March 1950.

Ge III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms				
$4s^2$	$4s^2\ ^1S$				
$4p^2$	$4p^2\ ^3P$ $4p^2\ ^1D$				
$4d^2$	$4d^2\ ^1D$?				
	ns $(n\geq5)$	*np* $(n\geq4)$	*nd* $(n\geq4)$	*nf* $(n\geq4)$	*ng* $(n\geq5)$
$4s(^2S)nx$	$5{,}6s\ ^3S$ $5s\ ^1S$	$4{,}5p\ ^3P^\circ$ $4{,}5p\ ^1P^\circ$	$4{,}5d\ ^3D$ $4d\ ^1D$	$4f\ ^3F^\circ$ $4f\ ^1F^\circ$	$5g\ ^3G$? $5g\ ^1G$?
$4p(^2P^\circ)nx$			$4d\ ^1P^\circ$ $4d\ ^1D^\circ$ $4d\ ^1F^\circ$		

*For predicted terms of the Zn I isoelectronic sequence, see Vol. II, Introduction.

Ge IV

(Cu I sequence; 29 electrons) $Z=32$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ ^2S_{0\frac{1}{2}}$

$4s\ ^2S_{0\frac{1}{2}}$ **368701** cm^{-1} I. P. 45.7 volts

Carroll, in 1925, reported five doublet series terms, and determined the limit by assuming an absolute value of $4f\ ^2F^\circ$ (111200 cm^{-1}) consistent with extrapolated isoelectronic sequence data.

In 1929 Lang remeasured the spectrum, and revised and extended the earlier term values, retaining the same assumed absolute value of $4f\ ^2F^\circ$. He concludes from a study of the isoelectronic sequence that this value is as nearly accurate as can be hoped for at present. Lang's values have been used in the present compilation. Two probable misprints in his term list have been corrected, namely, the terms $4s^2\ ^2D$ and $4f\ ^2F^\circ$ are here entered as inverted.

The observed *g*-values have been derived by the writer from the observed Zeeman patterns given in the 1941 reference below.

There are 34 classified lines between 440 A and 3676 A.

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Ge IV

Config.	Desig.	J	Level	Interval	Obs. g
$3d^{10}(^1S)4s$	$4s\ ^2S$	0½	0		
$3d^{10}(^1S)4p$	$4p\ ^2P^\circ$	0½ 1½	*81315* *84103*	2788	
$3d^{10}(^1S)4d$	$4d\ ^2D$	1½ 2½	190607 190861	254	0. 82 1. 26
$3d^{10}(^1S)5s$	$5s\ ^2S$	0½	199269		2. 04
$3d^{10}(^1S)5p$	$5p\ ^2P^\circ$	0½ 1½	*226459* *227397*	938	0. 68 1. 34
$3d^{10}(^1S)4f$	$4f\ ^2F^\circ$	3½ 2½	*257496* *257501*	−5	
$3d^9\ 4s^2$	$4s^2\ ^2D$	2½ 1½	259942 264445	−4503	
$3d^{10}(^1S)5d$	$5d\ ^2D$	1½ 2½	266637 266717	80	0. 80 1. 19
$3d^{10}(^1S)6s$	$6s\ ^2S$	0½	270058		
$3d^{10}(^1S)6p$	$6p\ ^2P^\circ$	0½ 1½	*283621* *283763*	142	
$3d^{10}(^1S)5g$	$5g\ ^2G$	{3½ 4½}	298379		
Ge V ($^1S_0$)	***Limit***		**368701**		

February 1950.

Ge v

(Ni I sequence; 28 electrons) $Z=32$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\;{}^1S_0$

$3d^{10}\;{}^1S_0$ **753800** cm^{-1} I. P. 93.4 volts

Mack, Laporte, and Lang have found 8 terms and classified 33 lines between 942 A and 1222 A by using the observations by Carroll. From three lines at 294 A, 295 A, and 304 A, the ground term was found by Kruger and Shoupp; who also determined the limit from an empirical formula based on extrapolation of isoelectronic sequence data. Their value of the limit, rounded off, is entered in brackets in the table. The observations in the far ultraviolet indicate a correction of +234231 cm^{-1} to the terms by Mack, Laporte, and Lang, in order to reduce them to the ground term zero. This correction has been made in compiling the table below.

The singlet and triplet terms are connected by observed intersystem combinations.

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Ge v

Config.	Desig.	J	Level	Interval
$3d^{10}$	$3d^{10}\;{}^1S$	0	0	
$3d^9(^2D)4s$	$4s\;{}^3D$	3	234231	−1740
		2	235971	−2796
		1	238767	
$3d^9(^2D)4s$	$4s\;{}^1D$	2	241947	
$3d^9(^2D)4p$	$4p\;{}^3P^\circ$	2	*323772*	−4083
		1	*327855*	−2487
		0	*330342*	
$3d^9(^2D)4p$	$4p\;{}^3F^\circ$	4	*329879*	2113
		3	*327766*	−3039
		2	*330805*	
$3d^9(^2D)4p$	$4p\;{}^3D^\circ$	3	*335187*	−362
		2	*335549*	−4005
		1	*339554*	
$3d^9(^2D)4p$	$4p\;{}^1F^\circ$	3	*337192*	
$3d^9(^2D)4p$	$4p\;{}^1P^\circ$	1	*338255*	
$3d^9(^2D)4p$	$4p\;{}^1D^\circ$	2	*340311*	
Ge VI ($^2D_{2\frac{1}{2}}$)	*Limit*		[753800]	

November 1949.

Ge v Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms	
$3d^{10}$	$3d^{10}\;{}^1S$	
	ns ($n\geq 4$)	np ($n\geq 4$)
$3d^9(^2D)nx$	$4s\;{}^3D$ $4s\;{}^1D$	$4p\;{}^3P^\circ$ $4p\;{}^3D^\circ$ $4p\;{}^3F^\circ$ $4p\;{}^1P^\circ$ $4p\;{}^1D^\circ$ $4p\;{}^1F^\circ$

* For predicted terms in the spectra of the Ni I isoelectronic sequence, see Vol. II, Introduction.

ARSENIC

As I

33 electrons $Z=33$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3\ {}^4S^{\circ}_{1\frac{1}{2}}$

$4p^3\ {}^4S^{\circ}_{1\frac{1}{2}}$ ***79165*** cm^{-1} I. P. 9.81 volts

Meggers has extended and revised the earlier work by himself and others. His observations extend from 1407 A to 11679 A, those of wavelength shorter than 2000 A being from arc spectrograms made by Shenstone.

The present analysis has been submitted in manuscript especially for inclusion here. There are 246 classified lines, and the doublet and quartet terms are connected by observed intersystem combinations. More than 74 percent of the total number and 97 percent of the total intensity of observed lines have been explained as combinations of 30 odd energy levels arising from $4s^2\ 4p^3$ and $4s^2\ 4p^2\ np$ electrons, and 58 even levels from $4s\ 4p^4$, $4s^2\ 4p^2\ ns$, and $4s^2\ 4p^2\ nd$.

The limit is derived from the *ns* ^{4}P series ($n=5, 6$), and is based on a Ritz formula with the assumption that $\alpha=2.5\times10^{-6}$, as suggested by Shenstone.

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As I

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\ 4p^3$	$4p^3\ {}^4S^{\circ}$	1½	*0.0*		
$4s^2\ 4p^3$	$4p^3\ {}^2D^{\circ}$	1½ 2½	*10592.5* *10914.6*	322.1	0.813 1.208
$4s^2\ 4p^3$	$4p^3\ {}^2P^{\circ}$	0½ 1½	*18186.1* *18647.5*	461.4	0.687 1.313
$4s^2\ 4p^2(^3P)5s$	$5s\ {}^4P$	0½ 1½ 2½	50693.8 51610.2 52897.9	916.4 1287.7	2.617 1.706
$4s^2\ 4p^2(^3P)5s$	$5s\ {}^2P$	0½ 1½	53135.6 54605.3	1469.7	0.736 1.327
$4s\ 4p^4$	$4p^4\ {}^4P$	2½ 1½ 0½	55366.4 56863.6 57488.1	−1497.2 −624.5	

As I

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\ 4p^2(^3P)5p$	$5p\ {}^4D^{\circ}$	0½ 1½ 2½ 3½	*60791.5* *60860.0* *61685.0* *62871.2*	68.5 825.0 1186.2	
$4s^2\ 4p^2(^1D)5s$	$5s'\ {}^2D$	2½ 1½	60815.0 60834.8	−19.8	0.84
$4s^2\ 4p^2(^3P)5p$	$5p\ {}^4P^{\circ}$	0½ 1½ 2½	*62026.3* *62398.0* *63282.8*	371.7 884.8	
$4s^2\ 4p^2(^3P)5p$	$5p\ {}^2D^{\circ}$	1½ 2½	*62554.4* *64169.2*	1614.8	
$4s^2\ 4p^2(^3P)4d$	$4d\ {}^4P$	2½ 1½ 0½	62751.1 63503.6 63981.7	−752.5 −478.1	

As I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2 4p^2(^3P)5p$	$5p\ ^4S^\circ$	1½	63647. 0		
$4s^2 4p^2(^3P)5p$	$5p\ ^2S^\circ$	0½	64059. 0		
$4s^2 4p^2(^3P)4d$	$4d\ ^2P$	0½ 1½	64122. 0 66485. 2	2363. 2	
$4s^2 4p^2(^3P)5p$	$5p\ ^2P^\circ$	0½ 1½	64323. 8 64687. 6	363. 8	
$4s^2 4p^2(^3P)4d$	$4d\ ^2D$	1½ 2½	64342. 4 66725. 4	2383. 0	
$4s^2 4p^2(^3P)4d$	$4d\ ^2F$	2½ 3½	64639. 5 66785. 2	2145. 7	
$4s\ 4p^4$	$4p^4\ ^2P$	1½ 0½	64811. 5 65497. 4	−685. 9	
$4s\ 4p^4$	$4p^4\ ^2S$	0½	66588. 3		
$4s^2 4p^2(^3P)6s$	$6s\ ^4P$	0½ 1½ 2½	67008. 7 67920. 2 69314. 8	911. 5 1394. 6	
$4s\ 4p^4$	$4p^4\ ^2D$	1½ 2½	68300. 6 68402. 7	102. 1	
$4s^2 4p^2(^3P)6s$	$6s\ ^2P$	0½ 1½	68314. 5 69696. 2	1381. 7	
	1	0½, 1½	69644. 8		
	2	1½, 2½	69698. 3		
$4s^2 4p^2(^3P)6p$	$6p\ ^4P^\circ$	0½ 1½ 2½	69881. 5 70849. 7 72501. 9	968. 2 1652. 2	
$4s^2 4p^2(^1D)5p$	$5p'\ ^2D^\circ$	1½ 2½	70108. 4 70376. 6	268. 2	
$4s^2 4p^2(^3P)6p$	$6p\ ^4D^\circ$	0½ 1½ 2½ 3½	70274. 9 70516. 6 71131. 0 72341. 6	241. 7 614. 4 1210. 6	
$4s^2 4p^2(^1D)5p$	$5p'\ ^2F^\circ$	2½ 3½	70821. 4 70927. 5	106. 1	
	3	1½	71055. 2		
$4s^2 4p^2(^3P)6p$	$6p\ ^2S^\circ$	0½	71199. 1		
$4s^2 4p^2(^3P)6p$	$6p\ ^2D^\circ$	1½ 2½	71621. 4 72944. 4	1323. 0	
$4s^2 4p^2(^1D)5p$	$5p'\ ^2P^\circ$	0½ 1½	71796. 2 71931. 7	135. 5	
$4s^2 4p^2(^1D)4d$	$4d'\ ^2P$	0½ 1½	71924. 4 72125. 0	200. 6	
$4s^2 4p^2(^1S)5s$	$5s''\ ^2S$	0½	72399. 4		
	4	1½	72519. 4		
$4s^2 4p^2(^3P)6p$	$6p\ ^4S^\circ$	1½	72620. 3		
	5	1½	72779. 0		
$4s^2 4p^2(^3P)6p$	$6p\ ^2P^\circ$	0½ 1½	72800. 6 73244. 8	444. 2	
	6	1½, 2½	73566. 0		
	7	1½	73635. 0		
	8	1½, 2½	74049. 7		
	9	0½, 1½	74143. 8		
$4s^2 4p^2(^1S)4d$	$4d''\ ^2D$	2½ 1½	74453. 1 74810. 5	−357. 4	
	10	0½, 1½	75086. 0		
	11	1½, 2½	75176. 4		
	12	1½, 2½	75578. 7		
	13	0½, 1½	75799. 4		
	14	1½	76076. 2		
	15	1½, 2½	76835. 6		
	16	1½, 2½	77121. 7		
	17	1½, 2½	77272. 5		
As II ($^3P_0$)	*Limit*	------	79165		

May 1950.

As I Observed Terms*

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}+$	Observed Terms		
$4s^2 4p^3$	{ $4p^3\ ^4S^\circ$ $4p^3\ ^2P^\circ$ $4p^3\ ^2D^\circ$		
$4s\ 4p^4$	{ $4p^4\ ^2S$ $4p^4\ ^4P$ $4p^4\ ^2P$ $4p^4\ ^2D$		
	$ns\ (n\geq 5)$	$np\ (n\geq 5)$	$nd\ (n\geq 4)$
$4s^2 4p^2(^3P)nx$	{ 5, 6s ^4P 5, 6s ^2P	5, 6p $^4S^\circ$ 5, 6p $^4P^\circ$ 5, 6p $^4D^\circ$ 5, 6p $^2S^\circ$ 5, 6p $^2P^\circ$ 5, 6p $^2D^\circ$	$4d\ ^4P$ $4d\ ^2P$ $4d\ ^2D$ $4d\ ^2F$
$4s^2 4p^2(^1D)nx'$	$5s'\ ^2D$	$5p'\ ^2P^\circ$ $5p'\ ^2D^\circ$ $5p'\ ^2F^\circ$	$4d'\ ^2P$
$4s^2 4p^2(^1S)nx''$	$5s''\ ^2S$		$4d''\ ^2D$

*For predicted terms in the spectra of the As I isoelectronic sequence, see Introduction.

As II

(Ge I sequence; 32 electrons) $Z=33$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2\ {}^3P_0$

$4p^2\ {}^3P_0$ **163000** cm^{-1} I. P. 20.2 volts

A. S. Rao has published 187 classified lines in the interval 802 A to 6528 A, 22 terms, and 14 miscellaneous levels. C. W. Gartlein has also studied this spectrum and confirmed 15 of these terms and four of the miscellaneous levels, with the conclusion that the spectrum needs careful observation over the entire range for three reasons: existing wavelengths need to be improved in precision, the lines due only to As II need to be carefully selected, and the series should be extended.

The writer has adopted Gartlein's term values when available, supplemented by those of Rao, adding $5d\ {}^3F^\circ_2$ and $5d\ {}^3D^\circ_2$ from the paper by Green and Barrows on Zeeman Effect. Decimals are omitted throughout, since the discordances between the two term lists exceed 1 cm^{-1} in many cases. All g-values are from the 1935 paper, that for 4°_1 having been derived by the writer. All others are either the g-values adopted by these authors, or means taken by the writer from the individual g-values they derive.

Miscellaneous levels have here been assigned numbers as follows: those labeled by Rao "*a* to *g*" are here called 1° to 7° respectively; and, similarly those called "A to G" are here designated 1 to 7, respectively. The combinations do not indicate which of the two J-values entered in the table is correct for the levels 1, 2, 3, 5, and 6.

Rao has determined the limit 162788 cm^{-1} by applying a Rydberg formula to the lines designated as $5s\ {}^1P^\circ_1-4p^2\ {}^1D_2$ and $5s\ {}^1P^\circ_1-5p\ {}^1D_2$. Similarly, the writer obtains the value 163040 cm^{-1} from the $ns\ {}^3P^\circ_2$ series (n=5,6). The round figure 163000 is adopted in the table pending further observations.

Observed intersystem combinations connect the singlet and triplet systems of terms.

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As II

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\ 4p^2$	$4p^2\ {}^3P$	0 1 2	0 1061 2540	1061 1479	
$4s^2\ 4p^2$	$4p^2\ {}^1D$	2	10093		
$4s^2\ 4p^2$	$4p^2\ {}^1S$	0	22593		
$4s\ 4p^3$	$4p^3\ {}^3D^\circ$	1 2 3	*73748* *73860* *74242*	112 382	0. 508 1. 176 1. 335
$4s^2\ 4p(^2P^\circ)5s$	$5s\ {}^3P^\circ$	0 1 2	*78729* *79128* *81506*	399 2378	0/0 1. 424 1. 492

As II

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2 4p(^2P^\circ)5s$	$5s\ {}^1P^\circ$	1	*82818*		1. 075
$4s\ 4p^3$	$4p^3\ {}^1P^\circ$	1	*83099*		
$4s\ 4p^3$	$4p^3\ {}^3P^\circ$	0 1 2	*84449* *84638* *85105*	189 467	
$4s^2\ 4p(^2P^\circ)4d$	$4d\ {}^3F^\circ$	2 3 4	*88827* *89545*	718	0. 58 1. 07
$4s^2\ 4p(^2P^\circ)5p$	$5p\ {}^1P$	1	95327		0. 812

As II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^3D$	1	96912	202	0.895
		2	97114	2081	1.174
		3	99195		1.325
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^3P$	0	98235	944	0/0
		1	99179	1081	1.389
		2	100260		1.433
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^3D^\circ$	1	*99063*	482	0.895
		2	*99545*	845	1.27
		3	*100390*		
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^3S$	1	101088		1.896
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^1P^\circ$	1	*101486*		
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^1D$	2	102388		1.046
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^1D^\circ$	2	*102486*		0.94
	1°	1	*102602*		
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^1S$	0	105786		0/0
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^1F^\circ$	3	*109872*		
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^3P^\circ$	2	*111846*	−475	
		1	*112321*	80	
		0	*112241*		
	2°	1	*117741*		1.11
	3°	1	*118884?*		
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^3F^\circ$	2	*118887*		0.698
		3			
		4			

As II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
	4°	1	*120769*		1.60
	5°	1	*121355*		0.726
	1	2, 3	121519		
$4s^2\,4p(^2P^\circ)4f$	$4f\ ^3F$	2	121623	−55	0.88
		3	121568	1064	1.06
		4	122632		
	2	2, 3	121625		
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^3D^\circ$	1			
		2	*123190*		1.110
		3			
$4s^2\,4p(^2P^\circ)6s$	$6s\ ^3P^\circ$	0			
		1			
		2	*123223*		1.14
	6°	1	*123784*		1.135
	3	1, 2	124065		
	4	3	124137		0.93
	5	2, 3	124206		
	7°	1	*124547*		
	6	2, 3	124867		
	7	2	125243		
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As III ($^2P^\circ_{0\frac{1}{2}}$)	*Limit*	------	163000		

January 1951.

As II Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Observed Terms			
$4s^2\,4p^2$	{ $4p^2\ ^3P$; $4p^2\ ^1S$, $4p^2\ ^1D$			
$4s\,4p^3$	{ $4p^3\ ^3P^\circ$, $4p^3\ ^3D^\circ$; $4p^3\ ^1P^\circ$			
	$ns\ (n\geq 5)$	$np\ (n\geq 5)$	$nd\ (n\geq 4)$	$nf\ (n\geq 4)$
$4s^2\,4p(^2P^\circ)5s$	{ 5, 6s $^3P^\circ$; 5s $^1P^\circ$	$5p\ ^3S$ $5p\ ^3P$ $5p\ ^3D$; $5p\ ^1S$ $5p\ ^1P$ $5p\ ^1D$	$4d\ ^3P^\circ$ 4, $5d\ ^3D^\circ$ 4, $5d\ ^3F^\circ$; $4d\ ^1P^\circ$ $4d\ ^1D^\circ$ $4d\ ^1F^\circ$	$4f\ ^3F$

*For predicted terms in the spectra of the Ge I isoelectronic sequence, see Vol. II, Introduction.

As III

(Ga I sequence; 31 electrons) $Z=33$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p\ ^2P^{\circ}_{0\frac{1}{2}}$

$4p\ ^2P^{\circ}_{0\frac{1}{2}}$ **228400** cm^{-1} I. P. 28.3 volts

This spectrum needs further study. In 1928 Lang published 10 terms, and 35 classified lines in the interval between 603 A and 4226 A. He estimated the limit from isoelectronic sequence data to be 226500±1500 cm^{-1}.

K. R. Rao, in 1931, extended and revised Lang's analysis slightly, and from an assumed absolute value of $5g\ ^2G=39500$ cm^{-1} derived the limit 228406 cm^{-1}. The latter value in round numbers is entered in brackets in the table. The terms in the table are also from this paper.

Six additional series members and five multiplets involving suggested quartet combinations are given in the 1929 reference below. They are omitted here awaiting confirmation.

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As III

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2(^1S)4p$	$4p\ ^2P^{\circ}$	0½ 1½	*0* *2940*	2940	
$4s\,4p^2$	$4p^2\ ^2D$	1½ 2½	85309 85630	321	
$4s^2(^1S)5s$	$5s\ ^2S$	0½	106694		1. 996
$4s\,4p^2$	$4p^2\ ^2S$	0½	107806		
$4s\,4p^2$	$4p^2\ ^2P$	0½ 1½	113938 115425	1487	
$4s^2(^1S)4d$	$4d\ ^2D$	1½ 2½	117651 117742	91	

As III

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2(^1S)5p$	$5p\ ^2P^{\circ}$	0½ 1½	*131458* *132181*	723	1. 333 0. 658
$4s^2(^1S)6s$	$6s\ ^2S$	0½	162889		
$4s^2(^1S)4f$	$4f\ ^2F^{\circ}$	3½ 2½	*164105* *164114*	−9	
$4s^2(^1S)5d$	$5d\ ^2D$	1½ 2½	165623 165708	85	
$4s^2(^1S)5g$	$5g\ ^2G$	3½, 4½	188906		
As IV ($^1S_0$)	*Limit*	-------	[*228400*]		

April 1950.

As IV

(Zn I sequence; 30 electrons) $Z=33$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,{}^1S_0$

$4s^2\,{}^1S_0$ **404369** cm^{-1} I. P. 50.1 volts

Three triplet terms $4p\,{}^3P^\circ$, $4d\,{}^3D$, and $5s\,{}^3S$, and also the combinations $4p\,{}^3P^\circ-4p^2\,{}^3P$ and $4s^2\,{}^1S_0-4p\,{}^1P^\circ_1$, were found by Sawyer and Humphreys, who classified 16 lines between 692 A and 980 A. Later Rao extended the analysis from observations in the interval 530 A to 4533 A, and added about 70 newly classified lines including intersystem combinations connecting the singlet and triplet systems of terms. He determined the limit from the two series $5p\,{}^3P^\circ-nd\,{}^3D$ ($n=4, 5$) and $5p\,{}^3P^\circ-ns\,{}^3S$ ($n=5, 6$) by using a Rydberg formula.

Three miscellaneous levels called, respectively, α, β, γ by Rao have been omitted here.

REFERENCES

R. A. Sawyer and C. J. Humphreys, Phys. Rev. **32**, 583 (1928). (T) (C L)
K. R. Rao, Proc. Roy. Soc. (London) [A] **134**, 604 (1931). (I P) (T) (C L)
J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

As IV

Config.	Desig.	J	Level	Interval
$4s^2$	$4s^2\,{}^1S$	0	0	
$4s(^2S)4p$	$4p\,{}^3P^\circ$	0	*75812*	1150
		1	*76962*	2530
		2	*79492*	
$4s(^2S)4p$	$4p\,{}^1P^\circ$	1	*112022*	
$4s(^2S)4d$	$4d\,{}^1D$	2	179563	
$4p^2$	$4p^2\,{}^3P$	0	179934	1534
		1	181468	2926
		2	184394	
$4p^2$	$4p^2\,{}^1D$	2	204658	
$4s(^2S)4d$	$4d\,{}^3D$	1	210597.0	132.8
		2	210729.8	202.8
		3	210932.6	
$4p^2$	$4p^2\,{}^1S$	0	211683	
$4s(^2S)5s$	$5s\,{}^3S$	1	220127.6	
$4s(^2S)5s$	$5s\,{}^1S$	0	229420.5	
$4s(^2S)5p$	$5p\,{}^3P^\circ$	0	*251212.0*	254.9
		1	*251466.9*	818.1
		2	*252285.0*	
$4s(^2S)5p$	$5p\,{}^1P^\circ$	1	*254039.9*	
$4s(^2S)4f$	$4f\,{}^3F^\circ$	2	*284456*	274
		3	*284730*	413
		4	*285143*	
$4s(^2S)4f$	$4f\,{}^1F^\circ$	3	*285730*	
$4s(^2S)5d$	$5d\,{}^1D$	2	293834.4	
$4s(^2S)5d$	$5d\,{}^3D$	1	295580.8	58.2
		2	295639.0	91.2
		3	295730.2	
$4s(^2S)6s$	$6s\,{}^3S$	1	298875.1	
$4s(^2S)6s$	$6s\,{}^1S$	0	300698.9	
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As V ($^2S_{0\frac{1}{2}}$)	*Limit*	----------	**404369**	

March 1950.

As IV OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms			
$4s^2$	$4s^2\ {}^1S$			
	$\{4p^2\ {}^1S$; $4p^2\ {}^3P$; $4p^2\ {}^1D$			
	$ns\ (n\geq 5)$	$np\ (n\geq 4)$	$nd\ (n\geq 4)$	$nf\ (n\geq 4)$
$4s(^2S)nx$	$\{5,6s\ {}^3S$ $5,6s\ {}^1S$	$4,5p\ {}^3P^\circ$ $4,5p\ {}^1P^\circ$	$4,5d\ {}^3D$ $4,5d\ {}^1D$	$4f\ {}^3F^\circ$ $4f\ {}^1F^\circ$

*For predicted terms in the spectra of the Zn I isoelectronic sequence, see Vol. II, Introduction.

As V

(Cu I sequence; 29 electrons) $Z=33$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ {}^2S_{0\frac{1}{2}}$

$4s\ {}^2S_{0\frac{1}{2}}$ **505136** cm^{-1} I. P. 62.6 volts

This spectrum is incompletely analyzed. By extrapolation along the isoelectronic sequence Sawyer and Humphreys have classified 9 lines between 600 A and 1056 A and determined the limit quoted here.

REFERENCE

R. A. Sawyer and C. J. Humphreys, Phys. Rev. **32**, 583 (1928). (I P) (T) (C L).

As V

Config.	Desig.	J	Level	Interval
4s	$4s\ {}^2S$	0½	0	
4p	$4p\ {}^2P^\circ$	0½ 1½	*97135* *101245*	4110
4d	$4d\ {}^2D$	1½ 2½	236897 237342	445
5s	$5s\ {}^2S$	0½	263596	
4f	$4f\ {}^2F^\circ$	{3½ 2½}	*331987*	
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As VI ($^1S_0$)	*Limit*	-----	**505136**	

February 1950.

As VI

(Ni I sequence; 28 electrons) $Z=33$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\ {}^1S_0$

$3d^{10}\ {}^1S_0$ **1028800** cm^{-1} I. P. 127.5 volts

Mack and Borg have found 8 terms and classified about 30 lines between 803 A and 1050 A. Kruger and Shoupp subsequently observed 4 lines in the interval 219 A to 232 A, and classified 3 as combinations from the ground term. These later observations indicate a correction of +331180 cm^{-1} to Mack's values, to reduce them to the ground term zero. In compiling the terms in the table this correction has been made, and the last figure has been rounded off throughout.

Kruger and Shoupp have determined the limit from an empirical formula based on extrapolation of isoelectronic sequence data. Their limit is entered in brackets in the table.

The singlet and triplet terms are connected by observed intersystem combinations.

REFERENCES

J. E. Mack and D. Borg, Phys. Rev. **37**, 470 (A) (1931) and unpublished material (see 1934 ref. below). (T)

P. G. Kruger and W. E. Shoupp, Phys. Rev. **46**, 124 (1934). (I P) (T) (C L)

J. E. Mack, letter (Dec. 1949).

As VI

Config.	Desig.	J	Level	Interval
$3d^{10}$	$3d^{10}\ {}^1S$	0	0	
$3d^9(^2D)4s$	$4s\ {}^3D$	3	331180	−2050
		2	333230	−3640
		1	336870	
$3d^9(^2D)4s$	$4s\ {}^1D$	2	340230	
$3d^9(^2D)4p$	$4p\ {}^3P^\circ$	2	*435430*	−5460
		1	*440890*	−3170
		0	*444060*	
$3d^9(^2D)4p$	$4p\ {}^3F^\circ$	4	*443070*	3160
		3	*439910*	−3890
		2	*443800*	
$3d^9(^2D)4p$	$4p\ {}^3D^\circ$	3	*449470*	10
		2	*449460*	−5110
		1	*454570*	
$3d^9(^2D)4p$	$4p\ {}^1F^\circ$	3	*451800*	
$3d^9(^2D)4p$	$4p\ {}^1P^\circ$	1	*452400*	
$3d^9(^2D)4p$	$4p\ {}^1D^\circ$	2	*455560*	
As VII ($^2D_{2\frac{1}{2}}$)	*Limit*	----------	[1028800]	

December 1949.

As VI Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6+$	Observed Terms	
$3d^{10}$	$3d^{10}\ {}^1S$	
	$ns\ (n\geq 4)$	$np\ (n\geq 4)$
$3d^9(^2D)nx$	$4s\ {}^3D$ $4s\ {}^1D$	$4p\ {}^3P^\circ$ $4p\ {}^3D^\circ$ $4p\ {}^3F^\circ$ $4p\ {}^1P^\circ$ $4p\ {}^1D^\circ$ $4p\ {}^1F^\circ$

*For predicted terms in the spectra of the Ni I isoelectronic sequence, see Vol. II, Introduction.

SELENIUM

Se I

34 electrons $Z=34$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^4\;{}^3P_2$

$4p^4\;{}^3P_2$ **78658.22 cm⁻¹** I. P. 9.75 volts

The analysis is by Ruedy and Gibbs. They photographed the spectrum, as excited by means of a positive column discharge in helium, from 300 A to 11000 A. Out of a total of 510 observed lines they have classified 391. Their limit is well determined from two long series: $5p\;{}^5P-ns\;{}^5S^\circ(n=5$ to $11)$, and $5p\;{}^5P_3-nd\;{}^5D^\circ_4$ $(n=4$ to $11)$. Observed intersystem combinations connect the terms of all three multiplicities.

An analysis of the Se I spectrum has also been published independently by Meissner, Bartelt, and Eckstein, who observed it from 3588 A to 9665 by A, using a condensed discharge through selenium vapor as the source.

The two published line lists are surprisingly discordant with regard to the wavelengths of a number of lines common to both, and also with regard to the number of lines recorded independently from the two sets of observations, i. e., not common to both lists. This raises two questions: (1) the proper source of excitation to be used in observing the spectrum, and (2) the accuracy of the measured wavelengths. Further observations are needed to clarify this puzzling situation.

REFERENCES

K. W. Meissner, O. Bartelt und L. Eckstein, Zeit. Phys. **91**, 427 (1934). (I P) (T) (C L)
J. E. Ruedy and R. C. Gibbs, Phys. Rev. **46**, 880 (1934). (I P) (T) (C L)
J. E. Ruedy and R. C. Gibbs, Zeit. Phys. **94**, 808 (1935).
K. W. Meissner, Zeit. Phys. **94**, 810 (1935).
J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

Se I

Config.	Desig.	J	Level	Interval
$4p^4$	$4p^4\;{}^3P$	2	0.00	−1989.49
		1	1989.49	−544.86
		0	2534.35	
$4p^4$	$4p^4\;{}^1D$	2	9576.08	
$4p^4$	$4p^4\;{}^1S$	0	22446.03	
$4p^3(^4S^\circ)5s$	$5s\;{}^5S^\circ$	2	*48182.19*	
$4p^3(^4S^\circ)5s$	$5s\;{}^3S^\circ$	1	*50996.93*	
$4p^3(^4S^\circ)5p$	$5p\;{}^5P$	1	59242.88	45.03
		2	59287.91	103.47
		3	59391.38	
$4p^3(^4S^\circ)5p$	$5p\;{}^3P$	2	60677.46	55.09
		1	60622.37	−73.70
		0	60696.07	
$4p^3(^2D^\circ)5s$	$5s'\;{}^3D^\circ$	1	*61681.31*	147.21
		2	*61828.52*	419.10
		3	*62247.62*	

Se I

Config.	Desig.	J	Level	Interval
$4p^3(^4S^\circ)4d$	$4d\;{}^5D^\circ$	4	*63370.07*	−17.39
		3	*63387.46*	14.27
		2	*63373.19*	−9.55
		1	*63382.74*	1.90
		0	*63380.84*	
$4p^3(^2D^\circ)5s$	$5s'\;{}^1D^\circ$	2	*63479.31*	
$4p^3(^4S^\circ)4d$	$4d\;{}^3D^\circ$	1	*65299.44*	−21.48
		2	*65277.96*	61.76
		3	*65339.72*	
$4p^3(^4S^\circ)6s$	$6s\;{}^5S^\circ$	2	*65989.12*	
$4p^3(^4S^\circ)6s$	$6s\;{}^3S^\circ$	1	*66623.12*	
$4p^3(^4S^\circ)6p$	$6p\;{}^5P$	1	69263.45	14.33
		2	69277.78	36.80
		3	69314.58	
$4p^3(^4S^\circ)6p$	$6p\;{}^3P$	2	69614.07	14.58
		1	69599.49	−29.98
		0	69629.47	

Se I—Continued

Config.	Desig.	J	Level	Interval
$4p^3(^4S^\circ)5d$	$5d\ ^5D^\circ$	0		
		1	*70388.56*	0.50
		2	*70389.06*	2.66
		3	*70391.72*	−0.68
		4	*70391.04*	
$4p^3(^2P^\circ)5s$	$5s''\ ^3P^\circ$	0	*70995.0*	204.6
		1	*71199.6*	459.4
		2	*71659.02*	
$4p^3(^4S^\circ)5d$	$5d\ ^3D^\circ$	1	*71106.25*	−10.01
		2	*71096.24*	58.72
		3	*71154.96*	
$4p^3(^4S^\circ)7s$	$7s\ ^5S^\circ$	2	*71638.28*	
$4p^3(^2D^\circ)5p$	$5p'\ ^3D$	1	71856.09	571.22
		2	72427.31	603.62
		3	73030.93	
$4p^3(^4S^\circ)7s$	$7s\ ^3S^\circ$	1	*71890.33*	
$4p^3(^2P^\circ)5s$	$5s''\ ^1P^\circ$	1	*72568.56*	
$4p^3(^2D^\circ)5p$	$5p'\ ^3F$	2	72618.29	−1.67
		3	72716.62	537.48
		4	73254.10	
$4p^3(^2D^\circ)5p$	$5p'\ ^1P$	1	72866.21	
$4p^3(^4S^\circ)7p$	$7p\ ^3P$	0	73042 05	0.99
		1	73043.04	9.51
		2	73052.55	
$4p^3(^4S^\circ)7p$	$7p\ ^5P$	1	73083.23	11.19
		2	73094.42	6.78
		3	73101.20	
$4p^3(^2D^\circ)5p$	$5p'\ ^1F$	3	73264.03	
$4p^3(^4S^\circ)6d$	$6d\ ^5D^\circ$	0		
		1	*73543.68*	−2.26
		2	*73541.42*	6.14
		3	*73547.56*	0.1
		4	*73547.7*	
$4p^3(^4S^\circ)6d$	$6d\ ^3D^\circ$	1	*73863.88*	−43.89
		2	*73819.99*	40.69
		3	*73860.68*	
$4p^3(^2D^\circ)5p$	$5p'\ ^3P$	0	74034.06	49.51
		1	74083.57	8.53
		2	74092.10	
$4p^3(^2D^\circ)4d$	$4d'\ 1^\circ$	2	*74161.70*	
$4p^3(^4S^\circ)8s$	$8s\ ^5S^\circ$	2	*74210.06*	
$4p^3(^4S^\circ)6f$	$6f\ ^5F$	1 to 5	74232.47	
$4p^3(^4S^\circ)6f$	$6f\ ^3F$	2 to 4	74234.58	
$4p^3(^4S^\circ)8s$	$8s\ ^3S^\circ$	1	*74318.20*	
$4p^3(^4S^\circ)8p$	$8p\ ^5P$	1	74948.23	3.69
		2	74951.92	8.38
		3	74960.30	
$4p^3(^4S^\circ)8p$	$8p\ ^3P$	0	75137.89	4.43
		1	75142.32	4.39
		2	75146.71	
$4p^3(^4S^\circ)7d$	$7d\ ^5D^\circ$	0		
		1	*75154.12*	42.91
		2	*75197.03*	−1.26
		3	*75195.77*	−0.1
		4	*75195.7*	

Se I—Continued

Config.	Desig.	J	Level	Interval
$4p^3(^2D^\circ)4d$	$4d'\ 2^\circ$	1	*75258.47*	
$4p^3(^2D^\circ)5p$	$5p'\ ^1D$	2	75309.88	
$4p^3(^4S^\circ)7d$	$7d\ ^3D^\circ$	3	*75312.00*	−0.84
		2	*75312.84*	−52.08
		1	*75364.92*	
$4p^3(^4S^\circ)9s$	$9s\ ^5S^\circ$	2	*75574.14*	
$4p^3(^4S^\circ)7f$	$7f\ ^5F$	1 to 5	75587.25	
$4p^3(^4S^\circ)7f$	$7f\ ^3F$	2 to 4	75588.92	
$4p^3(^4S^\circ)9s$	$9s\ ^3S^\circ$	1	*75638.12*	
$4p^3(^2D^\circ)4d$	$4d'\ 3^\circ$	2	*75973.6*	
$4p^3(^4S^\circ)9p$	$9p\ ^5P$	1	76013.93	2.71
		2	76016.64	4.88
		3	76021.52	
$4p^3(^4S^\circ)9p$	$9p\ ^3P$	0		
		1	76104.53	8.83
		2	76113.36	
$4p^3(^4S^\circ)8d$	$8d\ ^3D^\circ$	3	*76128.78*	−19.91
		2	*76248.69*	32.41
		1	*76216.28*	
$4p^3(^4S^\circ)8d$	$8d\ ^5D^\circ$	4	*76159.61*	−1.98
		3	*76161.59*	1.14
		2	*76160.45*	−0.50
		1	*76160.95*	
		0		
$4p^3(^4S^\circ)10s$	$10s\ ^5S^\circ$	2	*76397.26*	
$4p^3(^2D^\circ)4d$	$4d'\ 4^\circ$	3	*76400.41*	
$4p^3(^4S^\circ)8f$	$8f\ ^5F$	1 to 5	76403.68	
$4p^3(^4S^\circ)8f$	$8f\ ^3F$	2 to 4	76404.89	
$4p^3(^4S^\circ)10s$	$10s\ ^3S^\circ$	1	*76435.27*	
$4p^3(^4S^\circ)9d$	$9d\ ^5D^\circ$	0		
		1	*76766.58*	3.83
		2	*76770.41*	1.33
		3	*76771.74*	−4.35
		4	*76767.39*	
$4p^3(^4S^\circ)9d$	$9d\ ^3D^\circ$	1	*76777.65*	4.20
		2	*76781.85*	1.49
		3	*76783.34*	
$4p^3(^4S^\circ)11s$	$11s\ ^5S^\circ$	2	*76929.68*	
$4p^3(^4S^\circ)9f$	$9f\ ^5F$	1 to 5	76933.25	
$4p^3(^4S^\circ)10d$	$10d\ ^5D^\circ$	0		
		1	*77184.09*	−0.30
		2	*77183.79*	−0.31
		3	*77183.48*	3.31
		4	*77186.79*	
$4p^3(^4S^\circ)10f$	$10f\ ^5F$	1 to 5	77295.98	
$4p^3(^4S^\circ)11d$	$11d\ ^5D^\circ$	0		
		1, 2	} *77471.5*	2.2
		3	*77473.70*	0.48
		4	*77474.18*	
$4p^3(^4S^\circ)11f$	$11f\ ^5F$	1 to 5	77555.41	
Se II ($^4S^\circ_{1\frac{1}{2}}$)	*Limit*	------	78658.22	

October 1950.

Se I OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2+$	Observed Terms			
$4p^4$	$4p^4\ ^1S$ $4p^4\ ^3P$ $4p^4\ ^1D$			
	$ns\ (n\geq5)$	$np\ (n\geq5)$	$nd\ (n\geq4)$	$nf\ (n\geq4)$
$4p^3(^4S^\circ)nx$	5–11$s\ ^5S^\circ$ 5–10$s\ ^3S^\circ$	5–9$p\ ^5P$ 5–9$p\ ^3P$	4–11$d\ ^5D^\circ$ 4– 9$d\ ^3D^\circ$	6–11$f\ ^5F$ 6– 8$f\ ^3F$
$4p^3(^2D^\circ)nx'$	$5s'\ ^3D^\circ$ $5s'\ ^1D^\circ$	$5p'\ ^3P$ $5p'\ ^3D$ $5p'\ ^3F$ $5p'\ ^1P$ $5p'\ ^1D$ $5p'\ ^1F$		
$4p^3(^2P^\circ)nx''$	$5s''\ ^3P^\circ$ $5s''\ ^1P^\circ$			

*For predicted terms in the spectra of the Se I isoelectronic sequence, see Vol. II, Introduction.

Se II

(As I sequence; 33 electrons) $Z=34$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3\ ^4S^\circ_{1\frac{1}{2}}$

$4p^3\ ^4S^\circ_{1\frac{1}{2}}$ ***173557*** cm^{-1} I. P. 21.5 volts

Three different term lists having a number of levels in common, have been published for Se II. Martin gives 192 classified lines in the range between 694 A and 9816 A, and discusses the other investigations in detail, noting which levels were found by Krishnamurty and Rao. His analysis is quoted in the table. The observed g-values are from van den Bosch, who suggests the following additions and corrections:

Level	Martin	K and R*	v d B*	Obs. g
98182. 1		$4d\ ^4F_{4\frac{1}{2}}$	$4d\ ^4F_{4\frac{1}{2}}$	1. 27
127984. 3	$21^\circ_{2\frac{1}{2}}$		$5p'\ ^2F^\circ_{2\frac{1}{2}}$	1. 24
131165. 4	$23^\circ_{2\frac{1}{2}}(5p'\ ^2F^\circ_{2\frac{1}{2}})$	d	$5p'\ ^2P^\circ_{1\frac{1}{2}}$	1. 26
132189. 6	$5p'\ ^2P^\circ_{1\frac{1}{2}}$		$5p''\ ^2P^\circ_{1\frac{1}{2}}$	1. 16
138365. 7	$5d\ ^4F_{1\frac{1}{2}}$?	$5d\ ^4D_{1\frac{1}{2}}$	$5d\ ^4D_{1\frac{1}{2}}$?	1. 44
140946. 0	$31_{2\frac{1}{2}}$	$5d\ ^4D_{2\frac{1}{2}}$	$5d\ ^4D_{2\frac{1}{2}}$	1. 25
142128. 7		$5d\ ^4D_{3\frac{1}{2}}$	$5d\ ^4D_{3\frac{1}{2}}$	1. 33
142302. 2	$33_{1\frac{1}{2}}$		$33_{2\frac{1}{2}}$	0. 87

*Letters refer to authors listed under references.

The corrected J-value of the level 131165 has been adopted. The other changes are noted separately because some lines acquire two designations if any two sets of terms are combined. Further study will doubtless clarify some of the present differences in this respect. An evident misprint in level "27" has also been corrected.

The limit is also from Martin. He has determined it from the 5,6$s\ ^4P$ and 5,6$s\ ^2P$ series, by using a Rydberg formula.

The doublet and quartet systems of terms are connected by observed intersystem combinations.

Se II—Continued

REFERENCES

O. Bartelt, Naturwiss. **22,** 291 (1934); Zeit. Phys. **91,** 444 (1934). (T) (C L)
S. G. Krishnamurty and K. R. Rao, Proc. Roy. Soc. London [A] **149,** 56 (1935). (I P) (T) (C L)
D. C. Martin, Phys. Rev. **48,** 938 (1935). (I P) (T) (C L)
J. C. van den Bosch, Physica **14,** No. 4, 249 (1948). (Z E)
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Se II

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2 4p^3$	$4p^3\ ^4S^\circ$	1½	*0.0*		
$4s^2 4p^3$	$4p^3\ ^2D^\circ$	1½	*13168.2*	616.2	
		2½	*13784.4*		
$4s^2 4p^3$	$4p^3\ ^2P^\circ$	0½	*23038.3*	856.5	
		1½	*23894.8*		
$4s\ 4p^4$	$4p^4\ ^4P$	2½	83876.7	−1702.8	1.57
		1½	85579.5	−858.2	1.67
		0½	86437.7		2.60
$4s^2 4p^2(^3P)5s$	$5s\ ^4P$	0½	95270.0	1483.3	2.51
		1½	96753.3	1921.1	1.68
		2½	98674.4		1.56
	1	0½	96517.4		
	2	2½	96655.3		1.30
	3	0½	98118.2		
$4s^2 4p^2(^3P)5s$	$5s\ ^2P$	0½	98896.1	2459.9	0.77
		1½	101356.0		1.37
	4	1½	99368.5		0.82
$4s\ 4p^4$	$4p^4\ ^2P$	1½	100295.1		1.14
		0½			
	5	2½	101631.5		1.12
	6	1½	104694.4		
	7	1½	104873.7		
	8	0½	105258.0		
	9	0½	105973.8		
$4s^2 4p^2(^1D)5s$	$5s'\ ^2D$	2½	108355.7	−94.1	1.15
		1½	108449.8		0.81
	10	2½	108833.9		
	11	2½	110297.4		
	12	1½	112403.4		
$4s^2 4p^2(^3P)5p$	$5p\ ^4P^\circ$	0½	*113048.7*	3727.9	1.64
		1½	*116776.6*	1621.4	1.45
		2½	*118398.0*		1.40
$4s^2 4p^2(^3P)5p$	$5p\ ^4D^\circ$	0½	*114299.0*	412.7	0.62
		1½	*114711.7*	1356.4	1.28
		2½	*116068.1*	1730.6	1.39
		3½	*117798.7*		1.38
$4s^2 4p^2(^3P)5p$	$5p\ ^2S^\circ$	0½	*117406.0*		2.49
$4s^2 4p^2(^3P)5p$	$5p\ ^2D^\circ$	1½	*117739.6*	2647.5	1.10
		2½	*120387.1*		1.31
$4s^2 4p^2(^3P)5p$	$5p\ ^4S^\circ$	1½	*119308.5*		1.78
	13	0½	119343		
	14°	1½	*121051.5*		
$4s^2 4p^2(^3P)5p$	$5p\ ^2P^\circ$	0½	*121273.2*	108.7	0.64
		1½	*121381.9*		1.27
	15	2½	121730		
	16	2½	122720		
	17	1½	123323		
	18°	2½	*126329.7*		
	19	1½	126464.7		
$4s^2 4p^2(^1D)5p$	$5p'\ ^2D^\circ$	2½	*127415.7*	−505.7	0.97
		1½	*127921.4*		0.8
	20	0½	127867.5		
	21°	2½	*127984.3*		1.24
	22	1½	129010.4		
	23°	1½	*131165.4*		1.26
$4s^2 4p^2(^1D)5p$	$5p'\ ^2P^\circ$	0½			
		1½	*132189.6*		1.16
	24	2½	133867.1		
$4s^2 4p^2(^3P)6s$	$6s\ ^4P$	0½	134042.9	1592.7	2.35
		1½	135635.6	2033.5	1.67
		2½	137669.1		1.60
	25	1½	136188.2		1.29
$4s^2 4p^2(^3P)5d$	$5d\ ^4F$	1½	138365.7?	557.4	1.44
		2½	138923.1	1088.7	1.14
		3½	140011.8	1698.3	1.27
		4½	141710.1		1.27
$4s^2 4p^2(^3P)6s$	$6s\ ^2P$	0½	138525.7	2414.2	0.90
		1½	140939.9		
	26	2½	138535.9		
	27	1½	138701.0		
	28	1½	140131.3		1.85
	29	1½	140745.8		
	30	2½	140930.1		
	31	2½	140946.0		1.25
	32	2½	142171.0		
	33	1½	142302.2		
	34	1½	142374.1		
	35	2½	143341.7		1.24
	36	2½	143919.5		
Se III ($^3P_0$)	*Limit*	-----	***173557***		

August 1950.

Se II OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms		
$4s^2\ 4p^3$	$4p^3\ ^4S^\circ$ $4p^3\ ^2P^\circ$ $4p^3\ ^2D^\circ$		
$4s\ 4p^4$	$4p^4\ ^4P$ $4p^4\ ^2P$		
	$ns\ (n\geq5)$	$np\ (n\geq5)$	$nd\ (n\geq4)$
$4s^2\ 4p^2(^3P)nx$	$5,6s\ ^4P$ $5,6s\ ^2P$	$5p\ ^4S^\circ$ $5p\ ^4P^\circ$ $5p\ ^4D^\circ$ $5p\ ^2S^\circ$ $5p\ ^2P^\circ$ $5p\ ^2D^\circ$	$5d\ ^4F$
$4s^2\ 4p^2(^1D)nx'$	$5s'\ ^2D$	$5p'\ ^2P^\circ$ $5p'\ ^2D^\circ$	

*For predicted terms in the spectra of the As I isoelectronic sequence, see Vol. II, Introduction.

Se III

(Ge I sequence; 32 electrons) $Z=34$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2\ ^3P_0$

$4p^2\ ^3P_0$ **258000** cm^{-1} I. P. 32.0 volts

The analysis is incomplete. The authors have observed the spectrum from 517 A to 6613 A and classified 218 lines. They give the limit 274924 cm^{-1}, derived from the combinations $4p^2\ ^3P-5s\ ^3P^\circ$; $5s\ ^3P^\circ-5p\ ^3P$; and $4p^2\ ^1D-5s\ ^1P^\circ$; $5s\ ^1P^\circ-5p\ ^1D$. The writer has recalculated the limit from the series $5,6s\ ^{1,3}P^\circ$; $4,5d\ ^{1,3}F^\circ$; $4,5d\ ^1D^\circ_2$; $4,5d\ ^3D^\circ_3$; $4,5d\ ^3P^\circ_{2,1}$ by using a Rydberg formula and assuming that $5,6s\ ^3P_2$; $5,6s\ ^1P^\circ_1$; $4,5d\ ^3F^\circ_{4,3,2}$ have as a limit the component $4p\ ^2P^\circ_{1½}$ in Se IV. This component is 4376 cm^{-1} above the ground state of the ion, $4p\ ^2P^\circ_{0½}=0$. Consequently, this correction has been taken into account in determining the final value of the limit quoted in the table.

Observed intersystem combinations connect the singlet and triplet systems of terms.

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J. S. Badami and K. R. Rao, Proc. Roy. Soc. London [A] **140,** 387 (1933). (I P) (T) (C L)
K. R. Rao and S. G. K. Murti, Proc. Roy. Soc. London [A] **145,** 681 (1934). (T) (C L)

Se III

Config.	Desig.	J	Level	Interval
$4s^2\,4p^2$	$4p^2\ ^3P$	0	0	1741
		1	1741	2196
		2	3937	
$4s^2\,4p^2$	$4p^2\ ^1D$	2	13032	
$4s\ 4p^3$	$4p^3\ ^3D^\circ$	1	*91091*	1632
		2	*92723*	3825
		3	*96548*	
$4s\ 4p^3$	$4p^3\ ^3P^\circ$	0	*106482*	109
		1	*106591*	−76
		2	*106515*	
$4s\ 4p^3$	$4p^3\ ^1D^\circ$	2	*112565*	
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^3F^\circ$	2	*124051. 9*	1257. 9
		3	*125309. 8*	2099. 7
		4	*127409. 5*	
$4s^2\,4p(^2P^\circ)5s$	$5s\ ^3P^\circ$	0	*126276. 9*	504. 5
		1	*126781. 4*	3609. 6
		2	*130391. 0*	
$4s^2\,4p(^2P^\circ)5s$	$5s\ ^1P^\circ$	1	*131655. 9*	
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^1P^\circ$	1	*136946. 5*	
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^1D^\circ$	2	*139203. 7*	
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^3D^\circ$	1	*140639. 7*	−1230. 0
		2	*139409. 7*	2604. 9
		3	*142014. 6*	
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^3P^\circ$	0	*142315. 8*	442. 4
		1	*142758. 2*	−52. 1
		2	*142706. 1*	
$4s^2\,4p(^2P^\circ)4d$	$4d\ ^1F^\circ$	3	*148675*	
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^1P$	1	150761. 1	
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^3D$	1	153211. 4	309. 5
		2	153520. 9	3172. 0
		3	156692. 9	
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^3P$	0	154783. 0	1577. 4
		1	156360. 4	1513. 8
		2	157874. 2	
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^3S$	1	159302. 9	
$4s^2\,4p(^2P^\circ)5p$	$5p\ ^1D$	2	161170. 2	
$4s^2\,4p(^2P^\circ)6s$	$6s\ ^3P^\circ$	0	*187168. 7*	257. 8
		1	*187426. 5*	4096. 5
		2	*191523. 0*	
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^3F^\circ$	2	*188429. 2*	1218. 7
		3	*189647. 9*	1945. 7
		4	*191593. 6*	
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^3D^\circ$	1	*190841. 2*	−821. 0
		2	*190020. 2*	3894. 8
		3	*193915. 0*	
$4s^2\,4p(^2P^\circ)6s$	$6s\ ^1P^\circ$	1	*192161. 8*	
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^1D^\circ$	2	*193304. 4*	
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^3P^\circ$	0		
		1	*194950. 5*	−223. 5
		2	*194727. 0*	
$4s^2\,4p(^2P^\circ)5d$	$5d\ ^1F^\circ$	3	*196845. 4*	
Se IV ($^2P^\circ_{0½}$)	*Limit*	------	258000	

August 1950.

Se III Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Observed Terms		
$4s^2\,4p^2$	$\{4p^2\ ^3P$; $4p^2\ ^1D$		
$4s\ 4p^3$	$\{4p^3\ ^3P^\circ$; $4p^3\ ^3D^\circ$; $4p^3\ ^1D^\circ$		
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$
$4s^2\,4p(^2P^\circ)nx$	$\{5,6s\ ^3P^\circ$; $5,6s\ ^1P^\circ$	$5p\ ^3S$ $5p\ ^3P$ $5p\ ^3D$; $5p\ ^1P$ $5p\ ^1D$	$4,5d\ ^3P^\circ$ $4,5d\ ^3D^\circ$ $4,4d\ ^3F^\circ$; $4d\ ^1P^\circ$ $4,5d\ ^1D^\circ$ $4,5d\ ^1F^\circ$

*For predicted terms in the spectra of the Ge I isoelectronic sequence, see Vol. II, Introduction.

Se IV

(Ga I sequence; 31 electrons) $Z=34$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p\ ^2P^\circ_{0\frac{1}{2}}$

$4p\ ^2P^\circ_{0\frac{1}{2}}$ **346094** cm^{-1} I. P. 42.9 volts

The analysis is by Rao and Badami who have published 35 classified lines between 635 A and 3059 A. Their limit "depends upon a choice of 70240 cm^{-1} for the term $5g\ ^2G$, which is assumed to be very nearly hydrogenic." It is entered in brackets in the table.

REFERENCE

K. R. Rao and J. S. Badami, Proc. Roy. Soc. London [A] **131,** 159 (1931). (I P) (T) (C L)

Se IV

Config.	Desig.	J	Level	Interval
$4s^2(^1S)4p$	$4p\ ^2P^\circ$	0½ 1½	*0* *4376*	4376
$4s\ 4p^2$	$4p^2\ ^2D$	1½ 2½	104211 104706	495
$4s\ 4p^2$	$4p^2\ ^2S$	0½	128787	
$4s\ 4p^2$	$4p^2\ ^2P$	0½ 1½	136134 138354	2220
$4s^2\ (^1S)4d$	$4d\ ^2D$	1½ 2½	153217 153606	389
$4s^2(^1S)5s$	$5s\ ^2S$	0½	157241	
$4s^2(^1S)5p$	$5p\ ^2P^\circ$	0½ 1½	*189913* *191111*	1198

Se IV

Config.	Desig.	J	Level	Interval
$4s^2(^1S)4f$	$4f\ ^2F^\circ$	3½ 2½	*229684* *229714*	−30
$4s^2(^1S)5d$	$5d\ ^2D$	1½ 2½	237747 237899	152
$4s^2(^1S)6s$	$6s\ ^2S$	0½	240745	
$4s^2(^1S)5g$	$5g\ ^2G$	3½, 4½	275854	
$4s^2(^1S)7s$	$7s\ ^2S$	0½	288146?	
Se V ($^1S_0$)	*Limit*		[*346094*]	

May 1950.

Se V

(Zn I sequence; 30 electrons) $Z=34$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ ^1S_0$

$4s^2\ ^1S_0$ **589781** cm^{-1} I. P. 73.1 volts

This spectrum is incompletely analyzed. Sawyer and Humphreys found the three triplet terms $4p\ ^3P^\circ$, $4d\ ^3D$, and $5s\ ^3S$, and also the combinations $4s^2\ ^1S-4p\ ^1P^\circ$ and $4p\ ^3P^\circ-4p^2\ ^3P$, from 16 lines between 505 A and 839 A. They estimated the absolute term values by an extrapolation of the Moseley diagram.

Subsequently Rao and Badami classified 6 more lines from observations extending to 1227 A. They added the singlet term $4d\ ^1D$ together with 5 intersystem combinations connecting the singlet and triplet systems of terms. Their limit is based on these observations and the absolute values of Sawyer and Humphreys.

REFERENCES

R. A. Sawyer and C. J. Humphreys, Phys. Rev. **32,** 583 (1928). (T) (C L)
K. R. Rao and J. S. Badami, Proc. Roy. Soc. London [A] **131,** 166 (1931). (I P) (T) (C L)

Se V

Config.	Desig.	J	Level	Interval
$4s^2$	$4s^2\ ^1S$	0	0	
$4s(^2S)4p$	$4p\ ^3P^\circ$	0 1 2	*89756* *91351* *94961*	1595 3610
$4s(^2S)4p$	$4p\ ^1P^\circ$	1	*131733*	
$4p^2$	$4p^2\ ^3P$	0 1 2	211789 214087 218615	2298 2528
$4s(^2S)4d$	$4d\ ^1D$	2	213194	
$4s(^2S)4d$	$4d\ ^3D$	1 2 3	257534 257748 258083	214 335
$4s(^2S)5s$	$5s\ ^3S$	1	287426	
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Se VI ($^2S_{½}$)	*Limit*	----------	589781	

March 1950.

Se VI

(Cu I sequence; 29 electrons) $Z=34$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ ^2S_{0½}$

$4s\ ^2S_{0½}$ **658994** cm^{-1} I. P. 81.7 volts

By extrapolation along the isoelectronic sequence Sawyer and Humphreys have classified seven lines between 452 A and 886 A, and determined the limit quoted here.

REFERENCE

R. A. Sawyer and C. J. Humphreys, Phys. Rev. **32**, 583 (1928). (I P) (T) (C L)

Se VI

Config.	Desig.	J	Level	Interval
$4s$	$4s\ ^2S$	0½	0	
$4p$	$4p\ ^2P^\circ$	0½ 1½	*112762* *118462*	5700
$4d$	$4d\ ^2D$	1½ 2½	282830 283509	679
$5s$	$5s\ ^2S$	0½	333594	
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Se VII ($^1S_0$)	*Limit*	-----	[658994]	

February 1950.

Se VII

(Ni I sequence; 28 electrons) $Z=34$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ {}^1S_0$

$3d^{10}\ {}^1S_0$ **1253300** cm⁻ I. P. 155 volts

Kruger and Shoupp have observed four lines between 171 A and 180 A and classified three of them as combinations of the ground term with terms from $3d^9\ 4p$.

From preliminary measurements, Edlén has confirmed these results, extended the analysis, and derived provisional absolute term values from the Rydberg *nf*-series. All the values in the table except those from $3d^9\ 4p$ are from his unpublished manuscript. His unit, 10^3 cm^{-1} has here been changed to cm^{-1}.

Rao and Murti attribute some 40 lines in the interval 560 A to 860 A to Se VII and suggest tentative classifications of five of them. Further study of these assignments is needed.

REFERENCES

P. G. Kruger and W. E. Shoupp, Phys. Rev. **46**, 124 (1934). (I P) (T) (C L)
K. R. Rao and S. G. K. Murti, Proc. Roy. Soc. London [A] **145**, 696 (1934).
B. Edlén, letter (July 1950). (I P) (T)

Se VII

Config.	Desig.	J	Level
$3d^{10}$	$3d^{10}\ ^1S$	0	0
$3d^9(^2D)4p$	$4p\ ^3P°$	2 1 0	 *565700*
$3d^9(^2D)4p$	$4p\ ^1P°$	1	*578300*
$3d^9(^2D)4p$	$4p\ ^3D°$	3 2 1	 *581500*
$3d^9(^2D)5p$	$5p\ ^1P°$	1	*889200*
$3d^9(^2D)5p$	$5p\ ^3D°$	3 2 1	 *894100*
$3d^9(^2D)4f$	$4f\ ^3P°$	2 1 0	 *904500*
$3d^9(^2D)4f$	$4f\ ^1P°$	1	*909100*
$3d^9(^2D)4f$	$4f\ ^3D°$	3 2 1	 *917300*

Se VII

Config.	Desig.	J	Level
$3d^9(^2D)5f$	$5f\ ^1P°$	1	*1033500*
$3d^9(^2D)5f$	$5f\ ^3D°$	3 2 1	 *1040900*
$3d^9(^2D)6f$	$6f\ ^1P°$	1	*1101000*
$3d^9(^2D)6f$	$6f\ ^3D°$	3 2 1	 *1108000*
$3d^9(^2D)7f$	$7f\ ^1P°$	1	*1141700*
$3d^9(^2D)7f$	$7f\ ^3D°$	3 2 1	 *1148400*
$3d^9(^2D)8f$	$8f\ ^1P°$	1	*1167800*
$3d^9(^2D)8f$	$8f\ ^3D°$	3 2 1	 *1174700*
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Se VIII ($^2D_{2½}$)	*Limit*	--------	**1253300**

August 1950.

BROMINE

Br I

35 electrons $Z=35$

Ground States $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$

$4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$ ***95550*** cm^{-1} I. P. 11.84 volts

This spectrum has been analyzed by Kiess and de Bruin, who have observed more than 300 lines between 3735 A and 9320 A. By utilizing the ultraviolet observations by Turner in the interval 1232 A to 1633 A, they have classified a total of 208 lines as combinations among terms of the doublet and quartet systems. The terms of these two systems are connected by observed intersystem combinations.

They have determined the limit from a Rydberg formula representing 11 sets of terms of the *ns*, *np*, and *nd* configurations. This limit depends on series of two members each.

Two changes have been made in the published analysis. Revised tables have recently been prepared, which give the maximum binding energies of electrons in the first and second spectra of the elements H through Nb. From an examination of these data Russell has pointed out that the known *nd* terms are from 6*d* and 7*d*, and that the terms from 4*d* and 5*d* are not yet known because the observed lines lie beyond the range of the present observations.

In compiling the table the writer has assumed that the ^1S limit in Br II is higher than the ^1D limit, although the $5s\ {}^2S$ and $5s\ {}^2D$ terms of Br I from these respective limits are in the reverse order. Further analysis of Br II is required to settle this question; the term $4p^4\ {}^1S$ in Br II has not been found.

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L. A. Turner, Phys. Rev. **27**, 400 (1926).

C. C. Kiess, and T. L. de Bruin, Bur. Std. J. Research **4**, 667, RP 172 (1930). (I P) (T) (C L) (G D)

P. Lacroute, Ann. de Phys. [11] **3**, 59 [1934]. (Z E).

J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

Br I

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\ 4p^5$	$4p^5\ {}^2P^{\circ}$	1½	*0*	−3685	
		0½	*3685*		
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^4P$	2½	63429. 82	−1470. 68	1. 60
		1½	64900. 50	−1976. 66	1. 50
		0½	66877. 16		2. 60
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^2P$	1½	67176. 87	−1786. 65	1. 49
		0½	68963. 52		0. 75:
$4s^2\ 4p^4(^3P)5p$	$5p\ {}^4P^{\circ}$	2½	*74665. 67*	−336. 85	
		1½	*75002. 52*	−804. 81	
		0½	*75807. 33*		
$4s^2\ 4p^4(^3P)5p$	$5p\ {}^4D^{\circ}$	3½	*75514. 82*	−175. 62	
		2½	*75690. 44*	−1046. 01	
		1½	*76736. 45*	−1332. 84	
		0½	*78069. 29*		
$4s^2\ 4p^4(^1S)5s$	$5s''\ {}^2S$	0½	75901. 89		

Br I

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\ 4p^4(^1D)5s$	$5s'\ {}^2D$	1½	77305. 93	18. 18	
		2½	77324. 11		
$4s^2\ 4p^4(^3P)5p$	$5p\ {}^2D^{\circ}$	2½	*78504. 88*	−1184. 28	
		1½	*79689. 16*		
$4s^2\ 4p^4(^3P)5p$	$5p\ {}^4S^{\circ}$	1½	*78669. 92*		
$4s^2\ 4p^4(^3P)5p$	$5p\ {}^2P^{\circ}$	0½	*78858. 98*	312. 66	
		1½	*79171. 64*		
$4s^2\ 4p^4(^3P)5p$	$5p\ {}^2S^{\circ}$	0½	*79861. 30*		
$4s^2\ 4p^4(^3P)6p$	$6p\ {}^4P^{\circ}$	2½	*85520. 14*	−59. 46	1. 46
		1½	*85579. 60*	−212. 96	1. 54
		0½	*85792. 56*		
$4s^2\ 4p^4(^3P)6p$	$6p\ {}^4D^{\circ}$	3½	*85756. 22*	−57. 60	1. 43
		2½	*85813. 82*	−123. 40	1. 23
		1½	*85937. 22*	−492. 66	1. 62
		0½	*86429. 88*		2. 26

Br I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\,4p^4(^3P)6p$	$6p\ ^2P^\circ$	1½ 0½	87252.57 87492.36	−239.79	1.29 1.06
$4s^2\,4p^4(^3P)7s$	$7s\ ^2P$	1½ 0½	87748.30 90102.93	−2354.63	
$4s^2\,4p^4(^3P)7s$	$7s\ ^4P$	2½ 1½ 0½	88128.33 88268.77 90285.62	−140.44 −2016.85	
$4s^2\,4p^4(^1D)5p$	$5p'\ ^2P^\circ$	1½ 0½	88476.73 88552.92	−76.19	
$4s^2\,4p^4(^1D)5p$	$5p'\ ^2F^\circ$	3½ 2½	88658.93 88674.92	−15.99	
$4s^2\,4p^4(^3P)6p$	$6p\ ^2D^\circ$	1½ 2½	88841.29 89025.05	183.76	
$4s^2\,4p^4(^3P)6p$	$6p\ ^4S^\circ$	1½	88947.12		1.36
$4s^2\,4p^4(^3P)6p$	$6p\ ^2S^\circ$	0½	89140.50		0.47
$4s^2\,4p^4(^3P)7p$	$7p\ ^4P^\circ$	2½ 1½ 0½	89541.96 89779.48 89941.14	−237.52 −161.66	1.40: 1.56:
$4s^2\,4p^4(^3P)6d$	$6d\ ^4D$	0½ 1½ 2½ 3½	89722.68 89861.13 89941.29 89854.02	138.45 80.16 −87.27	
$4s^2\,4p^4(^1S)5p$	$5p''\ ^2P^\circ$	0½ 1½	89758.04 89899.16	141.12	
$4s^2\,4p^4(^1D)5p$	$5p'\ ^2D^\circ$	2½ 1½	89786.97 89854.34	−67.37	

Br I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\,4p^4(^3P)6d$	$6d\ ^4P$	0½ 1½ 2½	90186.50 90559.12 90782.20	372.62 223.08	
$4s^2\,4p^4(^3P)6d$	$6d\ ^4F$	4½ 3½ 2½ 1½	90238.19 90261.16 90348.33 90421.50	−22.97 −87.17 −73.17	
$4s^2\,4p^4(^3P)6d$	$6d\ ^2F$	2½ 3½	91432.00 91462.44	30.44	
$4s^2\,4p^4(^3P)6d$	$6d\ ^2D$	2½ 1½	91646.58 91811.64	−165.06	
$4s^2\,4p^4(^3P)7d$	$7d\ ^4D$	0½ 1½ 2½ 3½	91733.24 91793.40 91803.62 91748.84	60.16 10.22 −54.78	
$4s^2\,4p^4(^3P)6d$	$6d\ ^2P$	1½ 0½	 91785.35		
$4s^2\,4p^4(^3P)7d$	$7d\ ^4F$	4½ 3½ 2½ 1½	91844.52 91874.41 91949.83	−29.89 −75.42	
$4s^2\,4p^4(^3P)7d$	$7d\ ^4P$	2½ 1½ 0½	92722.87 92746.84 92736.30	−23.97 10.54	
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Br II ($^3P_2$)	*Limit*	-----	**95550**		

January 1950.

Br I Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Observed Terms		
$4s^2\,4p^5$	$4p^5\ ^2P^\circ$		
	$ns\ (n\geq5)$	$np\ (n\geq5)$	$nd\ (n\geq4)$
$4s^2\,4p^4(^3P)nx$	$5,7s\ ^4P$ $5,7s\ ^2P$	$5,6p\ ^4S^\circ$ $5,6,7p\ ^4P^\circ$ $5,6p\ ^4D^\circ$ $5,6p\ ^2S^\circ$ $5,6p\ ^2P^\circ$ $5,6p\ ^2D^\circ$	$6,7d\ ^4P$ $6,7d\ ^4D$ $6,7d\ ^4F$ $6d\ ^2P$ $6d\ ^2D$ $6d\ ^2F$
$4s^2\,4p^4(^1D)nx'$	$5s'\ ^2D$	$5p'\ ^2P^\circ$ $5p'\ ^2D^\circ$ $5p'\ ^2F^\circ$	
$4s^2\,4p^4(^1S)nx''$	$5s''\ ^2S$	$5p''\ ^2P^\circ$	

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Br II

(Se I sequence; 34 electrons) $Z=35$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^4\ ^3P_2$

$4p^4\ ^3P_2$ **174119** cm^{-1} I. P. 21.6 volts

This spectrum would well repay further observation; the analysis is far from complete. L. Bloch, E. Bloch, and P. Lacroute have given absolute values for 23 terms from the two limits $^4S°$ and $^2D°$ in Br III. The limit quoted here is from their paper, which gives no details about its derivation. The writer derives the limit 175870 (I P 21.8) from the $ns\ ^5S°$ and $ns\ ^3S°$ series ($n=5,6$) by using a Rydberg formula. This value is probably too high.

R. Ramanadham and K. R. Rao have extended the earlier analysis and revised the $4d\ ^3D°$, $5d\ ^3D°$, and $5s'\ ^1D°$ terms. In general their terms have been used in preparing the table; although the writer has made adjustments in the values of the $6s\ ^5S°$, $6s\ ^3S°$, $5d\ ^5D°$, and $5d\ ^3D°$ terms by utilizing unpublished wave lengths by Kiess. The level they list as $6s'\ ^3D_2^°$ has been corrected and entered in the table as $2_2^°$. The two levels listed as $4d\ ^3D_{2,1}^°$ by the Blochs and Lacroute, and rejected by Ramanadham and Rao, are included in the table as $4p^5\ ^3P°$. This designation is tentatively suggested by the writer.

The observed g-values are from the 1934 paper except for the following, which have been determined by the writer from Lacroute's observed Zeeman patterns:

$4p^5\ ^3P°$, $5p'\ ^3D_{2,3}$, $5p'\ ^3F_4$, $5d'\ ^1D°$, $5d'\ ^1P°$, $5d'\ ^1G°$, $6s'\ ^1D°$, $5d'\ ^3F_3^°$, $5d'\ ^3G°$, $5d'\ ^3P°$, $5d'\ ^3S°$, $5d'\ ^1F°$.

Approximately 260 lines are classified in the interval between 711 A and 6352 A. Observed intersystem combinations connect the terms of all multiplicities.

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Br II

Config.	Desig.	J	Level	Interval	Obs. g
$4p^4$	$4p^4\ ^3P$	2	0	−3139	
		1	3139	−701	
		0	3840		
$4p^4$	$4p^4\ ^1D$	2	11409		
$4p^3(^4S°)5s$	$5s\ ^5S°$	2	*93927.48*		2.02
$4s\ 4p^5$	$4p^5\ ^3P°$	2	*96439.39*	−2367.96	1.53
		1	*98807.35*		1.62
		0			
$4p^3(^4S°)5s$	$5s\ ^3S°$	1	*98476.38*		1.99
$4p^3(^2D°)5s$	$5s'\ ^3D°$	1	*109428.2*	154.3	0.55
		2	*109682.5*	695.7	1.14
		3	*110378.2*		1.29

Br II

Config.	Desig.	J	Level	Interval	Obs. g
$4p^3(^4S°)4d$	$4d\ ^3D°$	1	*112395.86*	−865.34	0.52
		2	*111530.52*	930.03	1.10
		3	*112460.55*		1.29
$4p^3(^2D°)5s$	$5s'\ ^1D°$	2	*112939.46*		1.06
$4p^3(^4S°)5p$	$5p\ ^5P$	1	114682.76	135.36	2.51
		2	114818.12	358.05	1.83
		3	115176.17		1.69
$4p^3(^2P°)5s$	$5s''\ ^1P°$	1	*116786.0*		
$4p^3(^4S°)5p$	$5p\ ^3P$	2	117767.56	206.06	1.51
		1	117561.50	−272.84	1.49
		0	117834.34		0/0

843210°—52——13

Br II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4p^3(^2P^\circ)5s$	$5s''\ ^3P^\circ$	0	*121154. 0*	404. 0	
		1	*121558. 0*	1071. 0	
		2	*122629. 0*		
$4p^3(^2D^\circ)5p$	$5p'\ ^3D$	1	128676. 26	1289. 60	0. 67
		2	129965. 86	688. 02	1. 19
		3	130653. 88		1. 31
$4p^3(^2D^\circ)5p$	$5p'\ ^3F$	2	130609. 88	698. 87	0. 86
		3	131308. 75	437. 0	1. 18
		4	131745. 7		1. 31
$4p^3(^2D^\circ)5p$	$5p'\ ^1P$	1	130823. 82		1. 08
$4p^3(^2D^\circ)5p$	$5p'\ ^1F$	3	131688. 75		1. 06
$4p^3(^2D^\circ)5p$	$5p'\ ^3P$	2	133278. 13	−323. 01	1. 42
		1	133601. 14	26. 51	1. 48
		0	133574. 63		0/0
$4p^3(^4S^\circ)6s$	$6s\ ^5S^\circ$	2	*135794. 2*		2. 02
$4p^3(^2D^\circ)5p$	$5p'\ ^1D$	2	136607. 73		1. 01
$4p^3(^4S^\circ)6s$	$6s\ ^3S^\circ$	1	*137608. 1*		
	1°	1	*138126. 9*		
$4p^3(^4S^\circ)5d$	$5d\ ^3D^\circ$	3	*139257. 5*	−866. 1	
		2	*140123. 6*	673. 4	1. 50
		1	*139450. 2*		
$4p^3(^4S^\circ)5d$	$5d\ ^5D^\circ$	0	*140223. 09*	−0. 43	0/0
		1	*140222. 66*	283. 97	1. 49
		2	*140506. 63*	−212. 44	1. 51
		3	*140294. 19*	−2. 25	1. 50
		4	*140291. 94*		1. 51

Br II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4p^3(^2D^\circ)5d$	$5d'\ ^3D^\circ$	1	*151357. 8*	144. 5	1. 30
		2	*151502. 27*	878. 31	1. 28
		3	*152380. 58*		
	2°	2	*151459. 30*		
$4p^3(^2D^\circ)5d$	$5d'\ ^1D^\circ$	2	*152832. 3*		1. 06
$4p^3(^2D^\circ)5d$	$5d'\ ^1P^\circ$	1	*154088. 7*		1. 04
$4p^3(^2D^\circ)5d$	$5d'\ ^1G^\circ$	4	*154984. 6*		1. 20
$4p^3(^2D^\circ)6s$	$6s'\ ^1D^\circ$	2	*155001. 5*		1. 07
$4p^3(^2D^\circ)5d$	$5d'\ ^3F^\circ$	2	*155591. 61*	444. 7	0. 71
		3	*156036. 3*	648. 1	1. 11
		4	*156684. 39*		1. 20
$4p^3(^2D^\circ)6s$	$6s'\ ^3D^\circ$	1			
		2			
		3	*156025. 0*		
$4p^3(^2D^\circ)5d$	$5d'\ ^3G^\circ$	3	*156116. 1*	36. 2	0. 88
		4	*156152. 3*	123. 3	1. 13
		5	*156275. 6*		1. 23
$4p^3(^2D^\circ)5d$	$5d'\ ^3P^\circ$	2	*158234. 3*	600. 6	1. 52
		1	*157633. 7*	−1624. 2	1. 40
		0	*159257. 9*		
$4p^3(^2D^\circ)5d$	$5d'\ ^3S^\circ$	1	*157725. 9*		1. 64
$4p^3(^2D^\circ)5d$	$5d'\ ^1F^\circ$	3	*160887. 7*		1. 07
Br III $(^4S^\circ_{1\frac{1}{2}})$	*Limit*	-----	174119		

October 1950.

Br II Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms		
$4s^2\ 4p^4$	$4p^4\ ^3P$ $4p^4\ ^1D$		
$4s\ 4p^5$	$4p^5\ ^3P^\circ$		
	$ns(n\geq5)$	$np(n\geq5)$	$nd(n\geq4)$
$4s^2\ 4p^3(^4S^\circ)nx$	5, 6s $^5S^\circ$ 5, 6s $^3S^\circ$	5p ^5P 5p ^3P	5d $^5D^\circ$ 4,5d $^3D^\circ$
$4s^2\ 4p^3(^2D^\circ)nx'$	5, 6s' $^3D^\circ$ 5, 6s' $^1D^\circ$	5p' ^3P 5p' ^3D 5p' ^3F 5p' ^1P 5p' ^1D 5p' ^1F	5d' $^3S^\circ$ 5d' $^3P^\circ$ 5d' $^3D^\circ$ 5d' $^3F^\circ$ 5d' $^3G^\circ$ 5d' $^1P^\circ$ 5d' $^1D^\circ$ 5d' $^1F^\circ$ 5d' $^1G^\circ$
$4s^2\ 4p^3(^2P^\circ)nx''$	5s'' $^3P^\circ$ 5s'' $^1P^\circ$		

*For predicted terms in the spectra of the Se I isoelectronic sequence, see Vol. II, Introduction.

Br III

(As I sequence; 33 electrons) Z=35

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^3\;{}^4S^{\circ}_{1\frac{1}{2}}$

$4p^3\;{}^4S^{\circ}_{1\frac{1}{2}}$ ***289529*** cm^{-1} I. P. 35.9 volts

The analysis is from K. R. Rao and Krishnamurty, who revised the early work of Deb, and published 128 classified lines between 665 A and 4519 A. Rao has since (1944) reported that "a further investigation of the spectrum has led to the identification of many intercombination lines . . ." He states that the interval between $4p^3\;{}^4S^{\circ}_{1\frac{1}{2}}$ and $4p^3\;{}^2D^{\circ}_{1\frac{1}{2}}$ is 15042 cm^{-1}. This correction has been added to the doublet terms in the 1937 paper, starting with $4p^3\;{}^2D^{\circ}_{1\frac{1}{2}}$ as zero. The six miscellaneous levels of the odd set, labeled *a*, *b*, . . . *f* by the authors, are here called 1°, 2°, . . . , 6°.

The limit is from the two series terms 5, 6s ${}^4P$.

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Br III

Config.	Desig.	J	Level	Interval
$4s^2\,4p^3$	$4p^3\;{}^4S^{\circ}$	1½	*0.0*	
$4s^2\,4p^3$	$4p^3\;{}^2D^{\circ}$	1½ 2½	*15042.0* *16301.0*	1259.0
$4s^2\,4p^3$	$4p^3\;{}^2P^{\circ}$	0½ 1½	*26915.0* *28579.0*	1664.0
$4s^2\,4p^2(?)4d$	4*d* 1	1½	137483.2	
$4s^2\,4p^2(?)4d$	4*d* 2	1½, 2½	137531.1	
$4s^2\,4p^2(?)4d$	4*d* 3	1½	139792.0	
$4s^2\,4p^2(?)4d$	4*d* 4	2½	141996.6	
$4s^2\,4p^2(?)4d$	4*d* 5	0½, 1½	143994.9	
$4s^2\,4p^2(?)4d$	4*d* 6	1½	145174.6	
$4s^2\,4p^2({}^3P)5s$	$5s\;{}^4P$	0½ 1½ 2½	145416.9 147670.4 150259.8	2253.5 2589.4
$4s^2\,4p^2(?)4d$	4*d* 7	1½	147557.5	
$4s^2\,4p^2({}^3P)5s$	$5s\;{}^2P$	0½ 1½	149199.5 152109.8	2910.3
$4s^2\,4p^2(?)4d$	4*d* 8	2½	150917.8	
$4s^2\,4p^2(?)4d$	4*d* 9	1½	151063.2	
$4s^2\,4p^2({}^1D)5s$	$5s'\;{}^2D$	2½ 1½	157746.7 158512.4	−765.7
$4s^2\,4p^2({}^3P)5p$	$5p\;{}^4D^{\circ}$	0½ 1½ 2½ 3½	*173181.8* *173840.0* *175910.4* *178322.5*	658.2 2070.4 2412.1
$4s^2\,4p^2({}^3P)5p$	$5p\;{}^4P^{\circ}$	0½ 1½ 2½	*176670.6* *178130.4* *180253.8*	1459.8 2123.4

Br III

Config.	Desig.	J	Level	Interval
$4s^2\,4p^2({}^3P)5p$	$5p\;{}^2D^{\circ}$	1½ 2½	*180695.7* *184178.9*	3483.2
$4s^2\,4p^2({}^3P)5p$	$5p\;{}^4S^{\circ}$	1½	*182017.8*	
$4s^2\,4p^2({}^3P)5p$	$5p\;{}^2S^{\circ}$	0½	*182871.5*	
$4s^2\,4p^2(?)5p$	5*p* 1°		*184627.4*	
$4s^2\,4p^2(?)5p$	5*p* 2°		*185422.2*	
$4s^2\,4p^2({}^3P)5p$	$5p\;{}^2P^{\circ}$	0½ 1½	*185432.4*	
$4s^2\,4p^2(?)5p$	5*p* 3°		*187768.1*	
$4s^2\,4p^2(?)5p$	5*p* 4°		*188043.1*	
$4s^2\,4p^2(?)5p$	5*p* 5°		*191903.3*	
$4s^2\,4p^2(?)5p$	5*p* 6°		*192109.7*	
$4s^2\,4p^2(?)5d$	5*d* 10	2½	209006.1	
$4s^2\,4p^2({}^3P)6s$	$6s\;{}^4P$	0½ 1½ 2½	210256.5 213015.3 215924.1	2758.8 2908.8
$4s^2\,4p^2(?)5d$	5*d* 11	1½	212451.6	
$4s^2\,4p^2(?)5d$	5*d* 12	1½	212586.2	
$4s^2\,4p^2(?)5d$	5*d* 13	1½	214882.6	
$4s^2\,4p^2(?)5d$	5*d* 14	2½	215470.3	
$4s^2\,4p^2(?)5d$	5*d* 15	1½, 2½	219987.2	
$4s^2\,4p^2(?)5d$	5*d* 16	1½	222868.3	
Br IV (${}^3P_0$)	***Limit***	--------	***289529***	

August 1950.

Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms				
$4s^2\ 4p^3$	{$4p^3\ ^4S°$ $4p^3\ ^2P°$ $4p^3\ ^2D°$				
	$ns\ (n \geq 5)$		$np\ (n \geq 5)$		
$4s^2\ 4p^2(^3P)nx$	{ $5,6s\ ^4P$ $5s\ ^2P$		$5p\ ^4S°$ $5p\ ^2S°$	$5p\ ^4P°$ $5p\ ^2P°$	$5p\ ^4D°$ $5p\ ^2D°$
$4s^2\ 4p^2(^1D)nx'$		$5s'\ ^2D$			

*For predicted terms in the spectra of the As I isoelectronic sequence, see Vol. II, Introduction.

Br IV

(Ge I sequence; 32 electrons) $Z=35$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2\ ^3P_0$

$4p^2\ ^3P_0$ cm^{-1} I. P. volts

This spectrum seriously needs further investigation. The authors have revised Deb's early work and published 47 classified lines in the interval 538 A to 3041 A. From combinations of $5s\ ^{1,3}P$ with terms of the $4p^2$ and $5p$ configurations, they derive absolute term values with the limit equal to 404890 cm^{-1}, giving an ionization potential of about 50 volts. No regular series have been observed and this estimate requires further confirmation.

Observed intersystem combinations connect the singlet and triplet systems of terms.

REFERENCE

A. S. Rao and S. G. Krishnamurty, Proc. Phys. Soc. London **46**, 531 (1934). (I P) (T) (C L)

Br IV

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^2$	$4p^2\ ^3P$	0 1 2	0 3247 6237	3247 2990
$4s^2\ 4p^2$	$4p^2\ ^1D$	2	18115	
	$a°$	0, 1	*139179*	
$4s\ 4p^3$	$4p^3\ ^3D°$	1 2 3	*153897* *161950* *172558*	8053 10608
$4s\ 4p^3$	$4p^3\ ^3P°$	2 1 0	*167568* *167987* *168335*	−419 −348
$4s^2\ 4p(^2P°)4d$	$4d\ ^3D°$	1 2 3	*168910* *170025* *172881*	1115 2856

Br IV

Config.	Desig.	J	Level	Interval
$4s^2\ 4p(^2P°)4d$	$4d\ ^3P°$	2 1 0	*176686* *180578* *178953*	*−1892* 1625
	$b°$	1, 2	*177993*	
$4s^2\ 4p(^2P°)5s$	$5s\ ^3P°$	0 1 2	*180619* *181900* *186588*	1281 4688
	$c°$	1, 2	*182479*	
$4s^2\ 4p(^2P°)5s$	$5s\ ^1P°$	1	*189034*	
$4s^2\ 4p(^2P°)5p$	$5p\ ^3P$	0 1 2	216786 219463 222030	2677 2567
$4s^2\ 4p(^2P°)5p$	$5p\ ^1D$	2	227763	

August 1950.

Br IV Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Observed Terms		
$4s^2\,4p^2$	$\{4p^2\ ^3P$ $4p^2\ ^1D$		
$4s\ 4p^3$	$4p^3\ ^3P^{\circ}$ $4p^3\ ^3D^{\circ}$		
	$ns(n \geq 5)$	$np(n \geq 5)$	$nd(n \geq 4)$
$4s^2\,4p(^2P^{\circ})nx$	$\{5s\ ^3P^{\circ}$ $5s\ ^1P^{\circ}$	$5p\ ^3P$ $5p\ ^1D$	$4d\ ^3P^{\circ}$ $4d\ ^3D^{\circ}$

*For predicted terms in the spectra of the Ge I isoelectronic sequence, see Vol. II, Introduction.

Br V

(Ga I sequence; 31 electrons) $Z=35$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p\ ^2P^{\circ}_{0}$

$4p\ ^2P_{0½}$ cm^{-1} I. P. volts

This spectrum needs investigation. From a study of isoelectronic sequence data, A. S. Rao and K. R. Rao have reported five terms and 12 classified lines in the range between 468 A and 855 A. Their term values are quoted in the table. The term $4p^2\ ^2D$ has been added by the writer with the value derived from its combination with $4p\ ^2P^{\circ}$, which they give.

REFERENCE

A. S. Rao and K. R. Rao, Proc. Phys. Soc. London **46**, 164 (1934). (T) (C L)

Br V

Config.	Desig.	*J*	Level	Interval
$4s^2(^1S)4p$	$4p\ ^2P^{\circ}$	0½ 1½	*0* *6090*	6090
$4s\ 4p^2$	$4p^2\ ^2D$	1½ 2½	122941 123628	687
$4s\ 4p^2$	$4p^2\ ^2P$	0½ 1½	158158 161011	2853
$4s^2(^1S)4d$	$4d\ ^2D$	1½ 2½	187970 188592	622
$4s^2(^1S)5s$	$5s\ ^2S$	0½	213510	

May 1950.

Br VI

(Zn I sequence; 30 electrons) $Z=35$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ {}^1S_0$

$4s^2\ {}^1S_0$ cm^{-1} I. P. volts

Little is known about this spectrum. Rao and Rao have classified 14 lines between 499 A and 939 A. They list one dubious intersystem combination connecting the singlet and triplet terms. The singlet term $4p\ {}^1P_1^{\circ}$ needs further confirmation since it is based upon only one combination.

REFERENCE

A. S. Rao and K. R. Rao, Proc. Phys. Soc. London **46**, 166 (1934). (T) (C L)

Br VI

Config.	Desig.	J	Level	Interval
$4s^2$	$4s^2\ {}^1S$	0	0	
$4s(^2S)4p$	$4p\ {}^3P^{\circ}$	0 1 2	*104316* *106431* *111336*	2115 4905
$4s(^2S)4p$	$4p\ {}^1P^{\circ}$	1	*151274*	
$4p^2$	$4p^2\ {}^3P$	0 1 2	244136 247406 253892	3270 6486
$4s(^2S)4d$	$4d\ {}^3D$	1 2 3	304648 304967 305451	319 484

March 1950.

Br VII

(Cu I sequence; 29 electrons) $Z=35$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ {}^2S_{0½}$

$4s\ {}^2S_{0½}$ cm^{-1} I. P. volts

This spectrum is incompletely known. In 1931 Mack reported that the lines of the principal doublet were very intense on his plates. Subsequently Rao and Rao classified five lines between 502 A and 779 A. The terms given in the table are from their paper.

REFERENCES

J. E. Mack, Phys. Rev. **38,** 194 (L) (1931).
A. S. Rao and K. R. Rao, Proc. Phys. Soc. London **46,** 167 (1934). (T) (C L)

Br VII

Config.	Desig.	*J*	Level	Interval
4*s*	4*s* ²S	0½	0	
4*p*	4*p* ²P°	0½ 1½	*128274* *135854*	7580
4*d*	4*d* ²D	1½ 2½	327205 328066	861

March 1950.

Br VIII

(Ni I sequence; 28 electrons) $Z=35$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ {}^1S_0$

$3d^{10}\ {}^1S_0$ **1554700** cm^{-1} I. P. 193 volts

Kruger and Shoupp have observed two lines near 139 A, and classified them as combinations of the ground term with terms from $3d^9\ 4p$.

From preliminary measurements Edlén has confirmed these results, extended the analysis, and derived provisional absolute term values from the Rydberg *nf*-series. All of the values in the table except those from $3d^9\ 4p$ are from his unpublished manuscript. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

P. G. Kruger and W. E. Shoupp, Phys. Rev. **46,** 124 (1934). (I P) (T) (C L)
B. Edlén, letter (July 1950). (I P) (T)

Br VIII

Config.	Desig.	J	Level
$3d^{19}$	$3d^{10}\ ^1S$	0	0
$3d^9(^2D)4p$	$4p\ ^3P°$	2 1 0	*701900*
$3d^9(^2D)4p$	$4p\ ^1P°$	1	*715300*
$3d^9(^2D)4p$	$4p\ ^3D°$	3 2 1	*719800*
$3d^9(^2D)4f$	$4f\ ^3P°$	2 1 0	*1098300*
$3d^9(^2D)4f$	$4f\ ^1P°$	1	*1104500*
$3d^9(^2D)4f$	$4f\ ^3D°$	3 2 1	*1115900*
$3d^9(^2D)5f$	$5f\ ^1P°$	1	*1266900*
$3d^9(^2D)5f$	$5f\ ^3D°$	3 2 1	*1276700*
$3d^9(^2D)6f$	$6f\ ^1P°$	1	*1355400*
$3d^9(^2D)6f$	$6f\ ^3D°$	3 2 1	*1364100*
Br IX ($^2D_{2½}$)	***Limit***	----------	**1554700**

August 1950.

Br IX

(Co I sequence; 27 electrons) $Z=35$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ ^2D_{2½}$

$3d^9\ ^2D_{2½}$ cm⁻¹ I. P. volts

Edlén has observed three lines due to the transition $3p^6\ 3d^9\ ^2D - 3p^5\ 3d^{10}\ ^2P°$. From preliminary unpublished measurements he has furnished the provisional term values quoted in the table. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCE

B. Edlén, letter (July 1950). (T)

Br IX

Config.	Desig.	J	Level	Interval
$3p^6\ 3d^9$	$3d^9\ ^2D$	2½ 1½	0 8600	−8600
$3p^5\ 3d^{10}$	$3d^{10}\ ^2P°$	1½ 0½	*912500* *962300*	−49800

July 1950.

KRYPTON

Kr I

36 electrons Z=36

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ {}^1S_0$

$4p^6\ {}^1S_0$ **112915.2** cm^{-1} I. P. 13.996 volts

The Kr I spectrum has now been observed from 850A to 22000A. The observations in the infrared beyond the photographic limit are listed in the 1947 and 1949 references below, by Humphreys and Plyler, and Sittner and Peck, respectively.

The present list of energy levels has been compiled from an unpublished manuscript kindly furnished by Edlén, who has made a careful study of the spectrum and interpreted it with the aid of present atomic theory. Many of the levels are from the papers published at the National Bureau of Standards, which, in turn, contain revisions and extensions of the earlier work on Kr I. Three place entries are from interferometer measurements. Edlén's predicted value for one level of the $6f[4\frac{1}{2}]$ pair is entered in brackets in the table.

The observed g-values are from the 1940 and 1943 references by J. B. Green and others. Those for the $4f[1\frac{1}{2}]_1$, and $5f[1\frac{1}{2}]_2$ have been added by the writer from Table 1 in the 1940 paper. Pogány has also published a shorter list of g-values of Kr I.

White has discussed the effect of autoionization on the spectra of the inert gases, as an explanation of the lack of higher series members having the higher limit $({}^2P^\circ_{0\frac{1}{2}})$. Beutler has observed a number of these lines. The levels $ns'[0\frac{1}{2}]^\circ_1$, ($n$=8 to 12) and $nd'[1\frac{1}{2}]^\circ_1$, ($n$=6 to 14) have been determined by the writer from Beutler's observations of absorption series in the region 850 A to 900 A, and added to Edlén's list.

Edlén has determined the revised series limits quoted here. Boyce's value, 112915.7, has been used for the compilation of the energy levels. This value is 1.53 cm^{-1} higher than the earlier value adopted in the 1931 paper by Meggers, de Bruin, and Humphreys.

The Paschen notation is entered in column one of the table in the same form as for Ne I and A I. The letters X, Z, U, T, Y, and W, adopted when configurations involving f-electrons were found, are also entered in this column.

Edlén suggested that a pair-coupling notation be adopted for Ne I-like spectra to take into account the departure from LS-coupling. According to Shortley, LS-designations can be significantly assigned in only a few cases. The writer suggests them provisionally for the following groups of levels:

Paschen	Desig.	Paschen	Desig.	Paschen	Desig.	Paschen	Desig.	Paschen	Desig.
$(n-4)s_5$	$ns\ {}^3P^\circ_2$	$2p_{10}$	$5p\ {}^3S_1$	$2p_5$	$5p\ {}^3P_0$	$4d_6$	$5d\ {}^3P^\circ_0$	$4d''_1$	$5d\ {}^3F^\circ_2$
$(n-4)s_4$	$ns\ {}^3P^\circ_1$	$2p_9$	$5p\ {}^3D_3$	$2p_4$	$5p\ {}^1P_1$	$4d_5$	$5d\ {}^3P^\circ_1$	$4d'_1$	$5d\ {}^1F^\circ_3$
$(n-4)s_3$	$ns\ {}^3P^\circ_0$	$2p_8$	$5p\ {}^3D_2$	$2p_3$	$5p\ {}^3P_1$	$4, 5d'_4$	$5, 6d\ {}^3F^\circ_4$	$4s''''_1$	$5d\ {}^1D^\circ_2$
$(n-4)s_2$	$ns\ {}^1P^\circ_1$	$2p_7$	$5p\ {}^3D_1$?	$2p_2$	$5p\ {}^3P_2$	$4, 5d_4$	$5, 6d\ {}^3F^\circ_3$	$4s'''_1$	$5d\ {}^3D^\circ_3$
		$2p_6$	$5p\ {}^1D_2$?	$2p_1$	$5p\ {}^1S_0$	$4d_3$	$5d\ {}^3P^\circ_2$	$4s''_1$	$5d\ {}^3D^\circ_2$
						$4d_2$	$5d\ {}^1P^\circ_1$	$4s'_1$	$5d\ {}^3D^\circ_1$

Consequently, the jl-coupling notation in the general form suggested by Racah is here introduced, as for Ne I and A I. The present arrangement has been suggested by Shortley, who has made a detailed study of the theoretical arrangement of the "pairs", to be used as a guide in preparing the present table.

Twenty lines of Kr I between 4273 A and 6456 A were recommended by the International Astronomical Union (1935) as secondary standards of wavelength. All but two are regarded as accurate to eight figures. This Union (1935) listed, also, 25 lines between 3424 A and 3845 A measured to four decimal places. Further observations are required before these can be adopted as secondary standards.

Kr I—Continued

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C. J. Humphreys, J. Research Nat. Bur. Std. **20**, 29, RP1061 (1938). (T) (C L)
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Kr I

Authors	Config.	Desig.	J	Level	Obs. g
$1p_0$	$4p^6$	$4p^6$ ^1S	0	0.0	
$1s_5$	$4p^5(^2P^\circ_{1\frac{1}{2}})5s$	$5s$ [1½]°	2	*79972.535*	1.502
$1s_4$			1	*80917.561*	1.242
$1s_3$	$4p^5(^2P^\circ_{0\frac{1}{2}})5s$	$5s'$ [0½]°	0	*85192.414*	
$1s_2$			1	*85847.501*	1.259
$2p_{10}$	$4p^5(^2P^\circ_{1\frac{1}{2}})5p$	$5p$ [0½]	1	91169.313	1.898
$2p_9$	"	$5p$ [2½]	3	92295.199	1.336
$2p_8$			2	92308.177	1.099
$2p_7$	"	$5p$ [1½]	1	92965.194	1.004
$2p_6$			2	93124.140	1.388
$2p_5$	"	$5p$ [0½]	0	94093.662	
$2p_4$	$4p^5(^2P^\circ_{0\frac{1}{2}})5p$	$5p'$ [1½]	1	97596.718	0.647
$2p_2$			2	97945.970	1.181
$2p_3$	"	$5p'$ [0½]	1	97919.951	1.452
$2p_1$			0	98855.871	
$3d_6$	$4p^5(^2P^\circ_{1\frac{1}{2}})4d$	$4d$ [0½]°	0	*96772.31*	
$3d_5$			1	*97086.00*	
$3d_4'$	"	$4d$ [3½]°	4	*97798.15*	
$3d_4$			3	*98227.08*	
$3d_3$	"	$4d$ [1½]°	2	*97688.58*	
$3d_2$			1	*99647.02*	

Kr I

Authors	Config.	Desig.	J	Level	Obs. g
$3d_1''$	$4p^5(^2P^\circ_{1\frac{1}{2}})4d$	$4d$ [2½]°	2	*98868.22*	
$3d_1'$			3	*99080.19*	
$3s_1''''$	$4p^5(^2P^\circ_{0\frac{1}{2}})4d$	$4d'$ [2½]°	2	*103443.46*	
$3s_1'''$			3	*103702.239*	
$3s_1''$	"	$4d'$ [1½]°	2	*103267.12*	
$3s_1'$			1	*104888.114*	1.018
$2s_5$	$4p^5(^2P^\circ_{1\frac{1}{2}})6s$	$6s$ [1½]°	2	*99627.67*	
$2s_4$			1	*99894.83*	
$2s_3$	$4p^5(^2P^\circ_{0\frac{1}{2}})6s$	$6s'$ [0½]°	0	*105092.14*	
$2s_2$			1	*105147.13*	
$3p_{10}$	$4p^5(^2P^\circ_{1\frac{1}{2}})6p$	$6p$ [0½]	1	102888.002	1.834
$3p_9$	"	$6p$ [2½]	3	103116.449	1.333
$3p_8$			2	103121.953	1.107
$3p_7$	"	$6p$ [1½]	1	103314.284	1.034
$3p_6$			2	103363.425	1.403
$3p_5$	"	$6p$ [0½]	0	103762.446	
$3p_4$	$4p^5(^2P^\circ_{0\frac{1}{2}})6p$	$6p'$ [1½]	1	108439.074	0.648
$3p_2$			2	108568.583	1.158
$3p_3$	"	$6p'$ [0½]	1	108514.999	1.401
$3p_1$			0	108822.382	
$4d_6$	$4p^5(^2P^\circ_{1\frac{1}{2}})5d$	$5d$ [0½]°	0	*104074.276*	
$4d_5$			1	*103802.598*	1.098

Kr I—Continued

Authors	Config.	Desig.	J	Level	Obs. g
$4d'_4$	$4p^5(^2P^\circ_{1\frac{1}{2}})5d$	5d [3½]°	4	*104631. 37*	
$4d_4$			3	*104917. 282*	1. 050
$4d_3$	"	5d [1½]°	2	*105008. 054*	1. 295
$4d_2$			1	*105649. 25*	0. 935
$4d_1''$	"	5d [2½]°	2	*105164. 302*	1. 006
$4d_1'$			3	*105209. 278*	1. 243
$4s_1''''$	$4p^5(^2P^\circ_{0\frac{1}{2}})5d$	5d' [2½]°	2	*110122. 88*	0. 899
$4s_1'''$			3	*110238. 22*	1. 140
$4s_1''$	"	5d' [1½]°	2	*110104. 05*	1. 169
$4s_1'$			1	*110734. 07*	
$3s_5$	$4p^5(^2P^\circ_{1\frac{1}{2}})7s$	7s [1½]°	2	*105648. 254*	1. 496
$3s_4$			1	*105771. 50*	1. 097
	$4p^5(^2P^\circ_{0\frac{1}{2}})7s$	7s' [0½]°	0		
$3s_2$			1	*111003. 79*	1. 208
4X	$4p^5(^2P^\circ_{1\frac{1}{2}})4f$	4f [1½]	1	105965. 258	0. 52
4Z			2	105966. 379	
4U	"	4f [4½]	5	105989. 60	
4T	"	4f [2½]	3	106021. 657	
4Y			2	106022. 425	
4W	"	4f [3½]	3, 4	106048. 19	
	$4p^5(^2P^\circ_{0\frac{1}{2}})4f$	4f' [3½]	4	111378. 7	
			3	111379. 21	
	"	4f' [2½]	3	111381. 10	
			2	111381. 98	
$4p_{10}$	$4p^5(^2P^\circ_{1\frac{1}{2}})7p$	7p [0½]	1	107006. 184	1. 795
$4p_9$	"	7p [2½]	3	107141. 983	
$4p_8$			2	107141. 611	
$4p_7$	"	7p [1½]	1	107222. 145	1. 041
$4p_6$			2	107247. 499	1. 403
$4p_5$		7p [0½]	0	107411. 191	
$5d_6$	$4p^5(^2P^\circ_{1\frac{1}{2}})6d$	6d [0½]°	0	*107604. 43*	
$5d_5$			1	*107676. 953*	1. 348
$5d'_4$	"	6d [3½]°	4	*107779. 701*	1. 231
$5d_4$			3	*107877. 712*	1. 073
$5d_3$	"	6d [1½]°	2	*107797. 681*	1. 318
$5d_2$			1	*108259. 59*	0. 823
$5d_1''$	"	6d [2½]°	2	*107993. 585*	0. 965
$5d_1'$			3	*108047. 121*	1. 254
	$4p^5(^2P^\circ_{0\frac{1}{2}})6d$	6d' [1½]°	2		
$5s_1'$			1	*113500*	
$4s_5$	$4p^5(^2P^\circ_{1\frac{1}{2}})8s$	8s [1½]°	2	*108325. 81*	1. 506
$4s_4$			1	*108373. 87*	1. 171
$4s_3$	$4p^5(^2P^\circ_{0\frac{1}{2}})8s$	8s' [0½]°	0		
$4s_2$			1	*113711*	
5X	$4p^5(^2P^\circ_{1\frac{1}{2}})5f$	5f [1½]	1	108481. 562	0. 61
5Z			2	108471. 937	1. 09

Kr I—Continued

Authors	Config.	Desig.	J	Level	Obs. g
5U	$4p^5(^2P^\circ_{1\frac{1}{2}})5f$	5f [4½]	5	108487. 73	
			4	108487. 88	
5T	"	5f [2½]	3	108504. 045	
5Y			2	108504. 62	
5W	"	5f [3½]	3, 4	108517. 77	
$5p_{10}$	$4p^5(^2P^\circ_{1\frac{1}{2}})8p$	8p [0½]	1	109083. 580	1. 795
$5p_9$	"	8p [2½]	3	109104. 106	
$5p_8$			2	109106. 58	
$5p_7$	"	8p [1½]	1	109150. 501	1. 014
$5p_6$			2	109161. 762	1. 411
$5p_5$	"	8p [0½]	0	109296. 997	
$6d_6$	$4p^5(^2P^\circ_{1\frac{1}{2}})7d$	7d [0½]°	0	*109331. 75*	
$6d_5$			1	*109343. 75*	1. 355
$6d'_4$	"	7d [3½]°	4	*109434. 716*	1. 228
$6d_4$			3	*109472. 27*	1. 094
$6d_3$	"	7d [1½]°	2	*109376. 14*	1. 315
$6d_2$			1	*109689. 56*	0. 797
$6d_1''$	"	7d [2½]°	2	*109528. 36*	0. 954
$6d_1'$			3	*109579. 82*	1. 231
	$4p^5(^2P^\circ_{0\frac{1}{2}})7d$	7d' [1½]°	2		
$6s_1'$			1	*115010*	
$5s_5$	$4p^5(^2P^\circ_{1\frac{1}{2}})9s$	9s [1½]°	2	*109752. 74*	1. 495
$5s_4$			1	*109780. 11*	1. 174
	$4p^5(^2P^\circ_{0\frac{1}{2}})9s$	9s' [0½]°	0		
$5s_2$			1	*115128*	
6X	$4p^5(^2P^\circ_{1\frac{1}{2}})6f$	6f [1½]	1	109836. 94	
6Z			2	109837. 56	
	"	6f [4½]	5	[109843. 8]	
6U			4	109843. 91	
6T	"	6f [2½]	3	109853. 01	
6Y			2	109853. 55	
6W	"	6f [3½]	3, 4	109861. 12	
$6p_{10}$	$4p^5(^2P^\circ_{1\frac{1}{2}})9p$	9p [0½]	1	110180. 87	
$6p_9$	"	9p [2½]	3	110210. 35	
$6p_8$			2	110210. 64	
$6p_7$	"	9p [1½]	1	110235. 64	
$6p_6$			2	110243. 62	
$6p_5$	"	9p [0½]	0	110308. 93	
$7d_6$	$4p^5(^2P^\circ_{1\frac{1}{2}})8d$	8d [0½]°	0	*110336. 47*	
$7d_5$			1	*110291. 15*	1. 294
$7d'_4$	"	8d [3½]°	4	*110404. 42*	1. 236
$7d_4$			3	*110471. 70*	1. 037
$7d_3$	"	8d [1½]°	2	*110513. 57*	
$7d_2$			1	*110514. 84*	

Kr I—Continued

Authors	Config.	Desig.	J	Level	Obs. g
$7d_1''$	$4p^5(^2P^\circ_{1½})8d$	$8d$ [2½]°	2	*110497.47*	1.005
$7d_1'$			3	*110508.89*	1.227
	$4p^5(^2P^\circ_{0½})8d$	$8d'$ [1½]°	2		
$7s_1'$			1	*115910*	
$6s_5$	$4p^5(^2P^\circ_{1½})10s$	$10s$ [1½]°	2	*110609.13*	
$6s_4$			1	*110619.78*	1.161
	$4p^5(^2P^\circ_{0½})10s$	$10s'$ [0½]°	0		
$6s_2$			1	*115961*	
7X	$4p^5(^2P^\circ_{1½})7f$	$7f$ [1½]	1	110656.24	
7Z			2	110656.80	
7U	"	$7f$ [4½]	4, 5	110660.69	
7T	"	$7f$ [2½]	3	110666.24	
7Y			2	110666.54	
7W	"	$7f$ [3½]	3, 4	110671.46	
$7p_{10}$	$4p^5(^2P^\circ_{1½})10p$	$10p$ [0½]	1	110873.22	
	"	$10p$ [1½]	1		
$7p_6$			2	110916.86	
$7p_5$	"	$10p$ [0½]	0	110957.03	
$8d_6$	$4p^5(^2P^\circ_{1½})9d$	$9d$ [0½]°	0	*110934.16*	
$8d_4'$	"	$9d$ [3½]°	4	*111019.65*	
$8d_4$			3	*111047.90*	
$8d_3$	"	$9d$ [1½]°	2	*111047.86*	
$8d_2$			1	*111143*	
$8d_1''$	"	$9d$ [2½]°	2	*111072.24*	
$8d_1'$			3	*111079.85*	
	$4p^5(^2P^\circ_{0½})9d$	$9d'$ [1½]°	2		
$8s_1'$			1	*116480*	
$7s_5$	$4p^5(^2P^\circ_{1½})11s$	$11s$ [1½]°	2	*111155.19*	
$7s_4$			1	*111171.62*	
	$4p^5(^2P^\circ_{0½})11s$	$11s'$ [0½]°	0		
$7s_2$			1	*116527*	
8X	$4p^5(^2P^\circ_{1½})8f$	$8f$ [1½]	1	111187.33	
			2		
8U	"	$8f$ [4½]	4, 5	111190.29	
8T	"	$8f$ [2½]	3	111193.45	
8Y			2	111193.78	
$8p_5$	$4p^5(^2P^\circ_{1½})11p$	$11p$ [0½]	0	111391.1	
$9d_6$	$4p^5(^2P^\circ_{1½})10d$	$10d$ [0½]°	0	*111413.23*	
$9d_5$			1	*111429.36*	
$9d_4'$	"	$10d$ [3½]°	4	*111433.88*	
$9d_4$			3	*111451.22*	

Kr I—Continued

Authors	Config.	Desig.	J	Level	Obs. g
$9d_3$	$4p^5(^2P^\circ_{1½})10d$	$10d$ [1½]°	2	*111446.18*	
			1		
$9d_1''$	"	$10d$ [2½]°	2	*111468.14*	
$9d_1'$			3	*111474.87*	
	$4p^5(^2P^\circ_{0½})10d$	$10d'$ [1½]°	2		
$9s_1'$			1	*116870*	
$8s_5$	$4p^5(^2P^\circ_{1½})12s$	$12s$ [1½]°	2	*111528.62*	
$8s_4$			1	*111537.42*	
	$4p^5(^2P^\circ_{0½})12s$	$12s'$ [0½]°	0		
$8s_2$			1	*116904*	
9X	$4p^5(^2P^\circ_{1½})9f$	$9f$ [1½]	1	111551.3	
			2		
9U	"	$9f$ [4½]	5	111553.16	
			4		
9T	"	$9f$ [2½]	3	111556.56	
$10d_6$	$4p^5(^2P^\circ_{1½})11d$	$11d$ [0½]°	0	*111709.11*	
$10d_5$			1	*111718.95*	
$10d_4'$	"	$11d$ [3½]°	4	*111726.00*	
$10d_4$			3	*111737.65*	
$10d_3$	"	$11d$ [1½]°	2	*111731.93*	
			1		
	"	$11d$ [2½]°	2		
$10d_1'$			3	*111755.14*	
	$4p^5(^2P^\circ_{0½})11d$	$11d'$ [1½]°	2		
$10s_1'$			1	*117145*	
10X	$4p^5(^2P^\circ_{1½})10f$	$10f$ [1½]	1	111810.4	
			2		
10U	"	$10f$ [4½]	5	111812.3	
			4		
10T	"	$10f$ [2½]	3	111814.2	
			2		
$11d_4'$	$4p^5(^2P^\circ_{1½})12d$	$12d$ [3½]°	4	*111939.50*	
$11d_4$			3	*111947.70*	
	$4p^5(^2P^\circ_{0½})12d$	$12d'$ [1½]°	2		
$11s_1'$			1	*117345*	
$12d_4'$	$4p^5(^2P^\circ_{1½})13d$	$13d$ [3½]°	4	*112100.54*	
			3		
	$4p^5(^2P^\circ_{0½})13d$	$13d'$ [1½]°	2		
$12s_1'$			1	*117497*	
	Kr II $(^2P^\circ_{1½})$	***Limit***	-----	**112915.2**	
	$4p^5(^2P^\circ_{0½})14d$	$14d'$ [1½]°	2		
$13s_1'$			1	*117625*	
	Kr II $(^2P^\circ_{0½})$	*Limit*	-----	118284.7	

June 1951.

Kr I Observed Levels*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2+$	Observed Terms			
$4p^6$	$4p^6\ ^1S$			
	ns ($n\geq5$)	*np* ($n\geq5$)	*nd* ($n\geq4$)	
$4p^5(^2P^\circ)nx$	5–12*s* $^3P^\circ$ 5–12*s* $^1P^\circ$	5*p* ^3S 5*p* ^3P 5*p* ^3D 5*p* ^1S 5*p* ^1P 5*p* ^1D	5*d* $^3P^\circ$ 5*d* $^3D^\circ$ 5, 6*d* $^3F^\circ$ 5*d* $^1P^\circ$ 5*d* $^1D^\circ$ 5, 6*d* $^1F^\circ$	
jl-Coupling Notation				
	Observed Pairs			
	ns ($n\geq5$)	*np* ($n\geq5$)	*nd* ($n\geq4$)	*nf* ($n\geq4$)
$4p^6(^2P^\circ_{1\frac{1}{2}})nx$	5–12*s* [1½]°	5–11*p* [0½] 5– 9*p* [2½] 5–10*p* [1½]	4–11*d* [0½]° 4–13*d* [3½]° 4–11*d* [1½]° 4–11*d* [2½]°	4–10*f* [1½] 4–10*f* [4½] 4–10*f* [2½] 4– 7*f* [3½]
$4p^5(^2P^\circ_{0\frac{1}{2}})nx'$	5–12*s'* [0½]°	5– 6*p'* [1½] 5– 6*p'* [0½]	4– 5*d'* [2½]° 4–14*d'* [1½]°	4*f'* [3½] 4*f'* [2½]

*For predicted levels in the spectra of the Kr I isoelectronic sequence, see Introduction.

Kr II

(Br I sequence; 35 electrons) $Z=36$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5\ ^2P^\circ_{1\frac{1}{2}}$

$4p^5\ ^2P^\circ_{1\frac{1}{2}}$ ***198182.00*** cm^{-1} I. P. 24.56 volts

A detailed analysis of this spectrum has been published by de Bruin, Humphreys, and Meggers, who have observed 1050 lines between 2080 A and 10659 A. Of these, 750, or 71 percent, are classified. In the extreme ultraviolet, Boyce has extended the work of Abbink and Dorgelo to include 82 classified lines between 559 A and 964 A, of which 31 are newly classified. No new terms are added from this ultraviolet work.

The doublet and quartet systems of terms are connected by observed intersystem combinations.

The limit is derived by applying the Rydberg series formula to the first two members of the *ns* $^4P_{2\frac{1}{2}}$ series ($n=5,6$).

Most of the observed *g*-values are from the 1931 paper listed below. A few additional values, based on unpublished observations furnished by Bakker, Zeeman, and de Bruin are also included in the 1933 paper containing the analysis of Kr II.

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C. J. Bakker and T. L. de Bruin, Zeit. Phys. **69**, 36 (1931). (Z E)

T. L. de Bruin, C. J. Humphreys, and W. F. Meggers, Bur. Std. J. Research **11**, 409, RP 599 (1933). (I P) (T) (C L) (Z E)

J. C. Boyce, Phys. Rev. **47**, 718 (1935). (C L)

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2 4p^5$	$4p^5\ ^2P^\circ$	1½ 0½	*0.00* *5371.00*	−5371.00	
$4s\ 4p^6$	$4p^6\ ^2S$	0½	109002.06		
$4s^2 4p^4(^3P)5s$	$5s\ ^4P$	2½ 1½ 0½	112830.00 115093.71 117604.73	−2263.71 −2511.02	1.60 1.54 2.64
$4s^2 4p^4(^3P)5s$	$5s\ ^2P$	1½ 0½	118476.07 121003.87	−2527.80	1.52 0.70
$4s^2 4p^4(^3P)4d$	$4d\ ^4D$	3½ 2½ 1½ 0½	120211.59 120428.65 121002.10 121781.28	−217.06 −573.45 −779.18	 0.00
$4s^2 4p^4(^3P)4d$	$4d\ ^4F$	4½ 3½ 2½ 1½	126002.57 127931.20 129698.98 129743.56	−1928.63 −1767.78 −44.58	
$4s^2 4p^4(^1D)5s$	$5s'\ ^2D$	1½ 2½	127599.19 127863.23	264.04	0.80 1.20
$4s^2 4p^4(^3P)4d$	$4d\ ^4P$	0½ 1½ 2½	130514.59 130895.28 131377.24	380.69 481.96	
$4s^2 4p^4(^3P)4d$	$4d\ ^2F$	3½ 2½	131633.86 137099.98	−5466.12	
$4s^2 4p^4(^3P)4d$	$4d\ ^2D$	1½ 2½	132967.28 134568.82	1601.54	
	1	2½	132972.50		
$4s^2 4p^4(^3P)5p$	$5p\ ^4P^\circ$	2½ 1½ 0½	*133925.65* *134288.44* *135783.03*	−362.79 −1494.59	1.58 1.67 1.98
$4s^2 4p^4(^3P)4d$	$4d\ ^2P$	0½ 1½	— 134623.17		
$4s^2 4p^4(^3P)5p$	$5p\ ^4D^\circ$	3½ 2½ 1½ 0½	*135783.18* *136071.00* *138381.35* *140163.25*	−287.82 −2310.35 −1781.90	1.43 1.23 1.26 0.00
	2	1½	138495.02		
$4s^2 4p^4(^3P)5p$	$5p\ ^2P^\circ$	0½ 1½	*139103.36* *140137.15*	1033.79	1.78 1.26
$4s^2 4p^4(^3P)5p$	$5p\ ^2D^\circ$	2½ 1½	*140118.99* *141995.68*	−1876.69	1.34 1.33
$4s^2 4p^4(^3P)5p$	$5p\ ^4S^\circ$	1½	*141722.72*		1.54
$4s^2 4p^4(^3P)5p$	$5p\ ^2S^\circ$	0½	*142363.55*		1.50
$4s^2 4p^4(^1S)5s$	$5s''\ ^2S$	0½	145813.61		2.00
$4s^2 4p^4(^1D)4d$	$4d'\ ^2G$	4½ 3½	— 146892.32?		
$4s^2 4p^4(^1D)5p$	$5p'\ ^2F^\circ$	2½ 3½	*149173.42* *149704.55*	531.13	0.86 1.14
$4s^2 4p^4(^1D)4d$	$4d'\ ^2D$	2½ 1½	149515.90 150179.87	−663.97	

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2 4p^4(^1D)4d$	$4d'\ ^2F$	3½ 2½	149860.27? 150814.24?	−953.97	
$4s^2 4p^4(^1D)5p$	$5p'\ ^2P^\circ$	1½ 0½	*150203.48* *152240.97*	−2037.49	1.33 0.70
$4s^2 4p^4(^1D)4d$	$4d'\ ^2P$	1½ 0½	151828.00 152186.70	−358.70	
$4s^2 4p^4(^1D)5p$	$5p'\ ^2D^\circ$	1½ 2½	*152191.86* *152316.20*	124.34	0.80 1.20
$4s^2 4p^4(^3P)6s$	$6s\ ^4P$	2½ 1½ 0½	157079.07 157885.41 161877.37	−806.34 −3991.96	1.60 1.39 2.34
$4s^2 4p^4(^3P)5d$	$5d\ ^4P$	0½ 1½ 2½	160796.68 161409.29 161013.56	612.61 −395.73	2.07 2.47
$4s^2 4p^4(^3P)5d$	$5d\ ^4D$	3½ 2½ 1½ 0½	161285.31 161451.83 161801.92 163033.48	−166.52 −350.09 −1231.56	1.40 1.37 0.88
$4s^2 4p^4(^3P)6s$	$6s\ ^2P$	1½ 0½	162059.03 162566.16	−507.13	1.33 0.92
$4s^2 4p^4(^3P)5d$	$5d\ ^4F$	4½ 3½ 2½ 1½	162208.84 162531.91 165077.35 167047.13	−323.07 −2545.44 −1969.78	1.33 1.17 1.12 0.52
$4s^2 4p^4(^1S)6s$	$6s''\ ^2S$	0½	164439.16?		1.94
$4s^2 4p^4(^3P)5d$	$5d\ ^2P$	1½ 0½	165141.91 166953.31	−1811.40	1.40 0.51
$4s^2 4p^4(^3P)5d$	$5d\ ^2F$	3½ 2½	165397.72 167518.91	−2121.19	1.24 1.04
	1°	1½	*166155.50?*		
	3	2½	167001.45		
$4s^2 4p^4(^3P)5d$	$5d\ ^2D$	1½ 2½	167913.11 169704.85	1791.74	1.18 1.15
$4s^2 4p^4(^3P)5f$	$5f\ ^4F^\circ$	4½ 3½ 2½ 1½	*168085.49* *168118.00* *168183.20* *168385.12*	−32.51 −65.20 −201.92	
$4s^2 4p^4(^3P)5f$	$5f\ ^2F^\circ$	3½ 2½	*168260.43* *168462.53*	−202.10	
$4s^2 4p^4(^1S)5p$	$5p''\ ^2P^\circ$	0½ 1½	*168262.90* *168939.35*	676.45	1.24 0.90
	2°	3½	*168490.67*		
$4s^2 4p^4(^3P)5f$	$5f\ ^2D^\circ$	2½ 1½	— *168630.36*		1.02
$4s^2 4p^4(^3P)5f$	$5f\ ^4D^\circ$	3½ 2½ 1½ 0½	 *168718.90* 		
$4s^2 4p^4(^1D)6s$	$6s'\ ^2D$	2½ 1½	}170571.12		1.00

Kr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
	3°	$1\frac{1}{2}$	*170887.53*		
	4°	$2\frac{1}{2}$	*171295.70*		
	5°	$2\frac{1}{2}$	*171386.32*		
	6°	$3\frac{1}{2}$	*171560.00*		
$4s^2\,4p^4(^1S)4d$	$4d''\ ^2D$	$2\frac{1}{2}$	171970.61	−81.28	1.20
		$1\frac{1}{2}$	172051.89		0.80
$4s^2\,4p^4(^1D)5f$	$5f'\ ^2D^\circ$	$1\frac{1}{2}$	*172714.72*	58.65	
		$2\frac{1}{2}$	*172773.37*		
	7°	$2\frac{1}{2}$	*172734.15*		
$4s^2\,4p^4(^1D)5f$	$5f'\ ^2F^\circ$	$3\frac{1}{2}$	*173131.03*	−25.39	
		$2\frac{1}{2}$	*173156.42*		
$4s^2\,4p^4(^3P)7s$	$7s\ ^4P$	$2\frac{1}{2}$	173309.68	−330.34	
		$1\frac{1}{2}$	173640.02	−4414.77	
		$0\frac{1}{2}$	178054.79		
$4s^2\,4p^4(^1D)5f$	$5f'\ ^2P^\circ$	$1\frac{1}{2}$	*173687.88*	−815.12	
		$0\frac{1}{2}$	*174503.00*		
$4s^2\,4p^4(^1D)5d$	$5d'\ ^2G$	$3\frac{1}{2}$	175891.74	701.23	0.89
		$4\frac{1}{2}$	176592.97		1.11
$4s^2\,4p^4(^1D)5d$	$5d'\ ^2D$	$1\frac{1}{2}$	176110.96	2209.67	
		$2\frac{1}{2}$	178320.63		1.20

Kr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4s^2\,4p^4(^1D)5d$	$5d'\ ^2P$	$1\frac{1}{2}$	177683.83	−1103.80	1.18
		$0\frac{1}{2}$	178787.63		
$4s^2\,4p^4(^1D)5d$	$5d'\ ^2F$	$2\frac{1}{2}$	177710.28	198.72	0.89
		$3\frac{1}{2}$	177909.00		1.14
$4s^2\,4p^4(^3P)7s$	$7s\ ^2P$	$1\frac{1}{2}$	177956.88	−550.57	
		$0\frac{1}{2}$	178507.45		
$4s^2\,4p^4(^3P)5g$	$5g\ ^4G$	$5\frac{1}{2}$	178842.39	31.09	
		$4\frac{1}{2}$	178811.30	−4.21	
		$3\frac{1}{2}$	178815.51	−45.37	
		$2\frac{1}{2}$	178860.88		
	8°	$1\frac{1}{2}$	*182464.85*		
	9°	$0\frac{1}{2}$?	*182479.27*		
	10°	$1\frac{1}{2}$	*182811.90*		
	11°	$2\frac{1}{2}$	*182841.19*		
	12°	$1\frac{1}{2}$	*182965.59*		
	13°	$2\frac{1}{2}$	*183308.55*		
Kr III ($^3P_2$)	*Limit*	-----	***198182.00***		

January 1951.

Kr II Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Observed Terms		
$4s^2\,4p^5$	$4p^5\ ^2P^\circ$		
$4s\ 4p^6$	$4p^6\ ^2S$		
	$ns\ (n\geq 5)$	$np\ (n\geq 5)$	
$4s^2\,4p^4(^3P)nx$	{5,6,7s ^4P {5,6,7s ^2P	$5p\ ^4S^\circ$ $5p\ ^4P^\circ$ $5p\ ^4D^\circ$ $5p\ ^2S^\circ$ $5p\ ^2P^\circ$ $5p\ ^2D^\circ$	
$4s^2\,4p^4(^1D)nx'$	5, 6s' ^2D	$5p'\ ^2P^\circ$ $5p'\ ^2D^\circ$ $5p'\ ^2F^\circ$	
$4s^2\,4p^4(^1S)nx''$	5, 6s'' ^2S	$5p''\ ^2P^\circ$	
	$nd\ (n\geq 4)$	$nf\ (n\geq 4)$	$ng\ (n\geq 5)$
$4s^2\,4p^4(^3P)nx$	{4, 5d ^4P 4,5d ^4D 4,5d ^4F {4, 5d ^2P 4,5d ^2D 4,5d ^2F	$5f\ ^4D^\circ$ $5f\ ^4F^\circ$ $5f\ ^2D^\circ$ $5f\ ^2F^\circ$	$5g\ ^4G$
$4s^2\,4p^4(^1D)nx'$	4, 5d' ^2P 4,5d' ^2D 4,5d' ^2F 4,5d' ^2G	$5f'\ ^2P^\circ$ $5f'\ ^2D^\circ$ $5f'\ ^2F^\circ$	
$4s^2\,4p^4(^1S)nx''$	$4d''\ ^2D$		

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Kr III

(Se I sequence; 34 electrons) $Z=36$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^4\ {}^3P_2$

$4p^4\ {}^3P_2$ **298020** cm^{-1} I. P. 36.9 volts

The analysis is from Humphreys, who has discussed the earlier work on this spectrum. He lists 369 classified lines in the interval between 2116 A and 7353 A. In addition, Boyce has classified 138 lines between 516 A and 1923 A. Observed intersystem combinations connect the terms of all multiplicities.

The limit is based on the *nd* $^5D^\circ_3$, *nd* $^3D^\circ_3$ ($n=4,5$), and *ns* $^3S^\circ_1$ ($n=5,6$) series.

The Zeeman effect for two lines, 3507.42 A and 3564.23 A has been observed by Bakker and de Bruin. The resulting *g*-values are:

Desig.	Obs. *g*
$5s\ {}^3S^\circ_1$	1. 99
$5p\ {}^3P_2$	1. 50
$5p\ {}^3P_1$	1. 55

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Kr III

Config.	Desig.	*J*	Level	Interval
$4s^2\ 4p^4$	$4p^4\ {}^3P$	2 1 0	0 4548 5313	−4548 −765
$4s^2\ 4p^4$	$4p^4\ {}^1D$	2	14644	
$4s^2\ 4p^4$	$4p^4\ {}^1S$	0	33079	
$4s\ 4p^5$	$4p^5\ {}^3P^\circ$	2 1 0	*115932* *119381* *121544*	−3449 −2163
$4s^2\ 4p^3(^4S^\circ)4d$	$4d\ {}^5D^\circ$	0 1 2 3 4	*138447. 68* *138472. 12* *138481. 92* *138493. 78* *138650. 27*	24. 44 9. 80 11. 86 156. 49
$4s\ 4p^6$	$4p^5\ {}^1P^\circ$	1	*141876*	
$4s^2\ 4p^3(^4S^\circ)5s$	$5s\ {}^5S^\circ$	2	*145720. 00*	
$4s^3\ 4p^3(^4S^\circ)4d$	$4d\ {}^3D^\circ$	3 2 1	*148736. 44* *147805. 70* *149072. 99*	930. 74 −1267. 29
$4s^2\ 4p^3(^4S^\circ)5s$	$5s\ {}^3S^\circ$	1	*151581. 26*	
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^3F^\circ$	2 3 4	*153564. 18* *154701. 05* *156082. 96*	1136. 87 1381. 91
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^3G^\circ$	3 4 5	*159997. 52* *160415. 88* *161109. 55*	418. 36 693. 67
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^1G^\circ$	4	*162842. 07*	
$4s^2\ 4p^3(^2D^\circ)5s$	$5s'\ {}^3D^\circ$	1 2 3	*163270. 01* *163636. 83* *165054. 55*	366. 82 1417. 72

Kr III

Config.	Desig.	*J*	Level	Interval
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^1D^\circ$	2	*165464. 45*	
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^3D^\circ$	1 2 3	*170203. 38* *172466. 51* *174452. 05*	2263. 13 1985. 54
$4s^2\ 4p^3(^2D^\circ)5s$	$5s'\ {}^1D^\circ$	2	*170900. 02*	
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^1P^\circ$?	1	*171996. 91*	
$4s^2\ 4p^3(^2D^\circ)4d$	$4d'\ {}^3S^\circ$?	1	*172984. 33*	
$4s^2\ 4p^3(^2P^\circ)4d$	$4d''\ {}^3F^\circ$	4 3 2	*175043. 98* *174831. 66* *175212. 28*	212. 32 −380. 62
$4s^2\ 4p^3(^4S^\circ)5p$	$5p\ {}^5P$	1 2 3	175545. 05 175779. 74 176521. 18	234. 69 741. 44
$4s^2\ 4p^3(^2P^\circ)4d$	$4d''\ {}^3D^\circ$	1 2 3	*182266. 00* *176791. 83* *184892. 85*	−5474. 17 8101. 02
$4s^2\ 4p^3(^2P^\circ)5s$	$5s''\ {}^3P^\circ$	0 1 2	*178244. 46* *178260. 12* *180248. 10*	15. 66 1987. 98
$4s^2\ 4p^3(^4S^\circ)5p$	$5p\ {}^3P$	0 1 2	 179629. 83 180084. 12	454. 29
$4s^2\ 4p^3(^2P^\circ)5s$	$5s''\ {}^1P^\circ$	1	*181264. 53*	
$4s^2\ 4p^3(^2P^\circ)4d$	$4d''\ {}^1F^\circ$	3	*182968. 27*	
$4s^2\ 4p^3(^2P^\circ)4d$	$4d''\ {}^1P^\circ$	1	*188234. 28*	

Kr III—Continued

Config.	Desig.	J	Level	Interval
$4s^2 4p^3(^2P^\circ)4d$	$4d''\ ^1D^\circ$	2	*188570. 30*	
$4s^2 4p^3(^2P^\circ)4d$	$4d''\ ^3P^\circ$	0 1 2	 *190227. 24* *193652. 80*	 3425. 56
$4s^2 4p^3(^2D^\circ)5p$	$5p'\ ^3D$	1 2 3	190724. 64 192702. 93 193826. 24	1978. 29 1123. 31
$4s^2 4p^3(^2D^\circ)5p$	$5p'\ ^3F$	2 3 4	193856. 49 194963. 87 195675. 44	1107. 38 711. 57
$4s^2 4p^3(^2D^\circ)5p$	$5p'\ ^1P$	1	194121. 20	
$4s^2 4p^3(^2D^\circ)5p$	$5p'\ ^1F$	3	195478. 99	
$4s^2 4p^3(^2D^\circ)5p$	$5p'\ ^3P$	2 1 0	198108. 88 198825. 49 198790. 11	−716. 61 35. 38
$4s^2 4p^3(^2D^\circ)5p$	$5p'\ ^1D$	2	202897. 08	
$4s^2 4p^3(^2P^\circ)5p$	$5p''\ ^3D$	1 2 3	207248. 18 208511. 04 209869. 57	1262. 86 1358. 53
$4s^2 4p^3(^2D^\circ)5p$	$5p''\ ^3S$	1	208610. 74	
$4s^2 4p^3(^2P^\circ)5p$	$5p''\ ^1P$	1	209285. 43	
$4s^2 4p^3(^2P^\circ)5p$	$5p''\ ^3P$	0 1 2	209787. 45 212264. 81 213058. 56	2477. 36 793. 75
$4s^2 4p^3(^2P^\circ)5p$	$5p''\ ^1D$	2	212124. 52	
$4s^2 4p^3(^4S^\circ)6s$	$6s\ ^5S^\circ$	2	*215522. 57*	
$4s^2 4p^3(^4S^\circ)5d$	$5d\ ^5D^\circ$	0 1 2 3 4	*216501. 29* *216515. 30* *216529. 32* *216545. 64* *216605. 16*	14. 01 14. 02 16. 32 59. 52
$4s^2 4p^3(^4S^\circ)5d$	$5d\ ^3D^\circ$	1 2 3	*219295. 44* *217376. 66* *220759. 93*	−1918. 78 3383. 27
$4s^2 4p^3(^4S^\circ)6s$	$6s\ ^3S^\circ$	1	*221843. 40*	
$4s^2 4p^3(^2D^\circ)6s$	$6s'\ ^3D^\circ$	1 2 3	 *233111. 63* *234567. 20*	 1455. 57
$4s^2 4p^3(^2D^\circ)5d$	$5d'\ ^1D^\circ?$	2	*233347. 38*	
$4s^2 4p^3(^2D^\circ)5d$	$5d'\ ^1G^\circ$	4	*235357. 36*	
$4s^2 4p^3(^2D^\circ)6s$	$6s'\ ^1D^\circ?$	2	*236183. 67*	
$4s^2 4p^3(^2D^\circ)5d$	$5d'\ 1^\circ$	1	*237971. 13*	
$4s^2 4p^3(^2D^\circ)5d$	$5d'\ 2^\circ$	2	*238608. 32*	
$4s^2 4p^3(^2P^\circ)6s$	$6s''\ ^3P^\circ$	0 1 2	 *249167. 98* *250911. 83*	 1743. 85
$4s^2 4p^3(^2P^\circ)6s$	$6s''\ ^1P^\circ$	1	*252461. 12*	
Kr IV ($^4S^\circ_{1\frac{1}{2}}$)	***Limit***	--------	**298020**	

November 1950.

Kr III Observed Terms*

Config. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}+$	Observed Terms		
$4s^2 4p^4$	$4p^4\ ^1S$ $4p^4\ ^3P$ $4p^4\ ^1D$		
$4s\ 4p^5$	$4p^5\ ^3P^\circ$ $4p^5\ ^1P^\circ$		
	ns ($n \geq 5$)	np ($n \geq 5$)	nd ($n \geq 4$)
$4s^2 4p^3(^4S^\circ)nx$	$5,6s\ ^5S^\circ$ $5,6s\ ^3S^\circ$	$5p\ ^5P$ $5p\ ^3P$	$4,5d\ ^5D^\circ$ $4,5d\ ^3D^\circ$
$4s^2 4p^3(^2D^\circ)nx'$	$5,6s'\ ^3D^\circ$ $5,6s'\ ^1D^\circ$	$5p'\ ^3P$ $5p'\ ^3D$ $5p'\ ^3F$ $5p'\ ^1P$ $5p'\ ^1D$ $5p'\ ^1F$	$4d'\ ^3S^\circ?$ $4d'\ ^1P^\circ?$ $4d'\ ^3D^\circ$ $4d'\ ^3F^\circ$ $4d'\ ^3G^\circ$ $4,5d'\ ^1D^\circ$ $4,5d'\ ^1G^\circ$
$4s^2 4p^3(^2P^\circ)nx''$	$5,6s''\ ^3P^\circ$ $5,6s''\ ^1P^\circ$	$5p''\ ^3S$ $5p''\ ^3P$ $5p''\ ^3D$ $5p''\ ^1P$ $5p''\ ^1D$	$4d''\ ^3P^\circ$ $4d''\ ^3D^\circ$ $4d''\ ^3F^\circ$ $4d''\ ^1P^\circ$ $4d''\ ^1D^\circ$ $4d''\ ^1F^\circ$

*For predicted terms in the spectra of the Se I isoelectronic sequence, see Vol. II, Introduction.

Kr IV

(As I sequence; 33 electrons) $Z=36$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3\ {}^4S^\circ_{1\frac{1}{2}}$

$4p^3\ {}^4S^\circ_{1\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been satisfactorily analyzed. Boyce has observed the three ultimate lines, 805 A to 842 A, having the transition $4p^3\ {}^4S^\circ - 4p^4\ {}^4P$. These observations have been used to calculate the recorded value of $4p^4\ {}^4P$.

Rao and Krishnamurty have reported 61 additional lines in the interval from 2237 A to 3934 A, as combinations among four terms and a number of miscellaneous levels. Their terms start with $5s\ {}^4P_{0\frac{1}{2}}=0$. By comparison with As I and Se II the writer has estimated that this level is approximately 166100 cm^{-1} above the ground state zero. This value, entered in brackets in the table, has been added to all levels taken from the 1939 reference, x denoting that they are not connected with the rest by observed combinations. The writer has also assigned numbers to the miscellaneous levels. The levels here designated as 1, 2, and 3 have been corrected to fit the observed combinations, because they are incorrectly tabulated in the published paper.

All but the two lowest terms in the table need confirmation.

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Kr IV

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^3$	$4p^3\ {}^4S^\circ$	1½	0.0	
$4s\ 4p^4$	$4p^4\ {}^4P$	2½	118760	−3666
		1½	122426	−1682
		0½	124108	
$4s^2\ 4p^2(^3P)5s$	$5s\ {}^4P$	0½	[166100] +x	3100
		1½	169200 +x	3223
		2½	172423 +x	
$4s^2\ 4p^2(^3P)4d$	1	1½, 2½	164416 +x	
$4s^2\ 4p^2(^3P)4d$	2	1½, 2½	165881 +x	
$4s^2\ 4p^2(^3P)4d$	3	1½, 2½	166062 +x	
$4s^2\ 4p^2(^3P)4d$	4	2½	167708 +x	
$4s^2\ 4p^2(^3P)4d$	5	2½, 3½	168025 +x	
$4s^2\ 4p^2(^3P)4d$	6	2½, 3½	168159 +x	
$4s^2\ 4p^2(^3P)4d$	7	1½, 2½	170862 +x	
$4s^2\ 4p^2(^3P)4d$	8	2½	171482 +x	

Kr IV

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^2(^3P)4d$	9	0½, 1½	172999 +x	
$4s^2\ 4p^2(^3P)4d$	10	1½, 2½	173552 +x	
$4s^2\ 4p^2(^3P)4d$	11	1½, 2½	177800 +x	
$4s^2\ 4p^2(^3P)4d$	12	1½	182553.5+x	
$4s^2\ 4p^2(^3P)5p$	$5p\ {}^4D^\circ$	0½	*202711.8+x*	1529.1
		1½	*204240.9+x*	3183.6
		2½	*207424.5+x*	3308
		3½	*210732 +x*	
$4s^2\ 4p^2(^3P)5p$	$5p\ {}^4P^\circ$	0½	*207962 +x*	488
		1½	*208450 +x*	348
		2½	*208798.5+x*	
$4s^2\ 4p^2(^3P)5p$	$5p\ {}^4S^\circ$	1½	*208881 +x*	
$4s^2\ 4p^2(^3P)5p$	1°	1½, 2½	*210126.9+x*	
$4s^2\ 4p^2(^3P)5p$	2°	1½, 2½	*210563.4+x*	
$4s^2\ 4p^2(^3P)5p$	3°	1½, 2½	*212831.3+x*	

October 1950.

Kr IX

(Ni I sequence; 28 electrons) $Z=36$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ ^1S_0$

$3d^{10}\ ^1S_0$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Paul has observed three lines as follows:

I A	Int.	Wave No.
114. 948	75	869958
115. 741	100	863998
117. 710	20	849546

By analogy with the related isoelectronic spectra Se VII to Y XII, he has classified these lines as combinations of the ground term with terms from the $3d^9\ 4p$ configuration, as given in the table. He has examined this spectrum and furnished these results especially for inclusion here.

REFERENCE

F. W. Paul (letter, November 1950). (T) (C L)

Kr IX

Config.	Desig.	J	Level
$3d^{10}$	$3d^{10}\ ^1S$	0	0
$3d^9(^2D)4p$	$4p\ ^3P°$	2	
		1	*849546*
		0	
$3d^9(^2D)4p$	$4p\ ^1P°$	1	*863998*
$3d^9(^2D)4p$	$4p\ ^3D°$	3	
		2	
		1	*869958*

November 1950.

RUBIDIUM

Rb I

37 electrons $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s\ {}^2S_{0\frac{1}{2}}$

$5s\ {}^2S_{0\frac{1}{2}}$ Rb^{85} **33691.02±0.03** cm^{-1} I. P. 4.176 volts

$5s\ {}^2S_{0\frac{1}{2}}$ Rb^{87} **33691.10±0.03** cm^{-1} I. P. 4.176 volts

The well known series of Rb I reported in the classical publications of Paschen-Götze and Fowler have recently been extended. Kratz has observed in absorption the principal series ($np\ {}^2P°$) to $n=77$.

Mack has furnished in advance of publication his observations of forbidden absorption lines, all of which are combinations of the ground term, $5s\ {}^2S$, with higher series members $nd\ {}^2D$ and $ns\ {}^2S$. The series called $nf\ {}^2F°$ in the table is labeled by Mack $n\ {}^2Q$ to indicate that the terms are $nf\ {}^2F°$, $ng\ {}^2G$, $nh\ {}^2H°$, etc.

Ramb has observed with the interferometer 33 lines between 5169.651 A and 10075.711 A. The inverted terms of the Bergmann series have been discussed in detail by Meissner and Masaki. From these and other papers Mack has prepared the list of terms as far as $12s\ {}^2S$, and furnished his manuscript for inclusion here. He notes that the values of the terms $6s\ {}^2S$, $4d\ {}^2D$, 4 to $8f\ {}^2F°$, 5, $6g\ {}^2G$, and $6h\ {}^2H°$ need further adjustment from more accurate wave lengths. He suggests, also, the following improved values of intervals:

Term	Interval	Term	Interval
$5p\ {}^2P°$	237. 598	$7d\ {}^2D$	1. 507
$5d\ {}^2D$	2. 960	$8d\ {}^2D$	1. 013
$6d\ {}^2D$	2. 262	$9d\ {}^2D$	0. 697

Brackets denote that the tabular entries have been derived from series calculations.

Kratz derives the limit 33690.96 ±0.03 cm^{-1}, from the long $np\ {}^2P°$ series, and calculates the limit of the lowest hyperfine structure sublevel as 33691.02 ±0.03. Mack confirms this calculation for Rb^{85} and adds the value quoted above for Rb^{87}.

Beutler has observed in absorption 39 lines between 594.61 A and 809.72 A, and classified all but 3 as transitions from the ground term to levels above the ionization limit. His rounded-off wave numbers have been entered in the table. These levels have as limits, two higher terms ${}^3P°$ and ${}^1P°$ in Rb II. The miscellaneous levels have been assigned numbers by the writer. The double entries of J for these levels (unlike those for unresolved terms) indicate that the existing data are insufficient to distinguish which value of J is correct.

The Quadratic Zeeman Effect in the principal series of Rb I is discussed by Harting and Klinkenberg.

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Rb I

Config.	Desig.	J	Level	Interval
$4p^6(^1S)5s$	$5s\ ^2S$	0½	0.00	
$4p^6(^1S)5p$	$5p\ ^2P^\circ$	0½ 1½	*12578.96* *12816.56*	237.60
$4p^6(^1S)4d$	$4d\ ^2D$	2½ 1½	19355.01 19355.45	−0.44
$4p^6(^1S)6s$	$6s\ ^2S$	0½	20133.6	
$4p^6(^1S)6p$	$6p\ ^2P^\circ$	0½ 1½	*23715.19* *23792.69*	77.50
$4p^6(^1S)5d$	$5d\ ^2D$	1½ 2½	25700.56 25703.52	2.96
$4p^6(^1S)7s$	$7s\ ^2S$	0½	26311.46	
$4p^6(^1S)4f$	$4f\ ^2F^\circ$	2½, 3½	*26791.98*	
$4p^6(^1S)7p$	$7p\ ^2P^\circ$	0½ 1½	*27835.05* *27870.14*	35.09
$4p^6(^1S)6d$	$6d\ ^2D$	1½ 2½	28687.15 28689.41	2.26
$4p^6(^1S)8s$	$8s\ ^2S$	0½	29046.84	
$4p^6(^1S)5f$	$5f\ ^2F^\circ$	3½ 2½	*29277.58* *29277.59*	−0.01
$4p^6(^1S)5g$	$5g\ ^2G$	3½, 4½	29297.6	
$4p^6(^1S)8p$	$8p\ ^2P^\circ$	0½ 1½	*29834.96* *29853.82*	18.86
$4p^6(^1S)7d$	$7d\ ^2D$	1½ 2½	30280.18 30281.69	1.51
$4p^6(^1S)9s$	$9s\ ^2S$	0½	30499.06	
$4p^6(^1S)6f$	$6f\ ^2F^\circ$	3½ 2½	*30627.77* *30627.78*	−0.01
$4p^6(^1S)6g$	$6g\ ^2G$	3½, 4½	30636.9	
$4p^6(^1S)6h$	$6h\ ^2H^\circ$	4½, 5½	*30643.5*	
$4p^6(^1S)9p$	$9p\ ^2P^\circ$	0½ 1½	*30958.94* *30970.22*	11.28
$4p^6(^1S)8d$	$8d\ ^2D$	1½ 2½	31221.47 31222.48	1.01
$4p^6(^1S)10s$	$10s\ ^2S$	0½	31362.36	
$4p^6(^1S)7f$	$7f\ ^2F^\circ$	3½ 2½	*31441.52* *31441.53*	−0.01
$4p^6(^1S)10p$	$10p\ ^2P^\circ$	0½ 1½	*31653.88* *31661.19*	7.31
$4p^6(^1S)9d$	$9d\ ^2D$	1½ 2½	31821.88 31822.58	0.70
$4p^6(^1S)11s$	$11s\ ^2S$	0½	31917.25	
$4p^6(^1S)8f$	$8f\ ^2F^\circ$	2½, 3½	*31969.43*	
$4p^6(^1S)11p$	$11p\ ^2P^\circ$	0½ 1½	*32113.58* *32118.55*	4.97
$4p^6(^1S)10d$	$10d\ ^2D$	1½ 2½	[32227.68] 32228.16	[0.48]
$4p^6(^1S)12s$	$12s\ ^2S$	0½	[32295.04]	
$4p^6(^1S)12p$	$12p\ ^2P^\circ$	0½ 1½	*32433.50* *32437.04*	3.54
$4p^6(^1S)11d$	$11d\ ^2D$	1½ 2½	32514.63 32514.93	0.30
$4p^6(^1S)13p$	$13p\ ^2P^\circ$	0½ 1½	*32665.03* *32667.63*	2.60
$4p^6(^1S)12d$	$12d\ ^2D$	1½ 2½	32724.68 32724.93	0.25
$4p^6(^1S)14p$	$14p\ ^2P^\circ$	0½ 1½	*32838.02* *32840.02*	2.00
$4p^6(^1S)13d$	$13d\ ^2D$	1½ 2½	32883.21 32883.41	0.20
$4p^6(^1S)15p$	$15p\ ^2P^\circ$	0½ 1½	*32970.66* *32972.19*	1.53
$4p^6(^1S)14d$	$14d\ ^2D$	1½, 2½	33005.84	
$4p^6(^1S)16p$	$16p\ ^2P^\circ$	0½ 1½	*33074.59* *33075.83*	1.24
$4p^6(^1S)15d$	$15d\ ^2D$	1½, 2½	33102.39	
$4p^6(^1S)17p$	$17p\ ^2P^\circ$	0½ 1½	*33157.54* *33158.54*	1.00
$4p^6(^1S)16d$	$16d\ ^2D$	1½, 2½	33180.03	
$4p^6(^1S)18p$	$18p\ ^2P^\circ$	0½ 1½	*33224.83* *33225.67*	0.84
$4p^6(^1S)17d$	$17d\ ^2D$	1½, 2½	33244.23	
$4p^6(^1S)19p$	$19p\ ^2P^\circ$	0½ 1½	*33280.13* *33280.81*	0.68
$4p^6(^1S)18d$	$18d\ ^2D$	1½, 2½	33295.28	
$4p^6(^1S)20p$	$20p\ ^2P^\circ$	0½ 1½	*33326.13* *33326.70*	0.57
$4p^6(^1S)19d$	$19d\ ^2D$	1½, 2½	33338.80	
$4p^6(^1S)21p$	$21p\ ^2P^\circ$	0½ 1½	*33364.81* *33365.29*	0.48
$4p^6(^1S)20d$	$20d\ ^2D$	1½, 2½	33375.4	
$4p^6(^1S)22p$	$22p\ ^2P^\circ$	0½ 1½	*33397.66* *33398.09*	0.43
$4p^6(^1S)21d$	$21d\ ^2D$	1½, 2½	33406.86	
$4p^6(^1S)23p$	$23p\ ^2P^\circ$	0½ 1½	*33425.76* *33426.15*	0.39
$4p^6(^1S)22d$	$22d\ ^2D$	1½, 2½	33433.88	
$4p^6(^1S)24p$	$24p\ ^2P^\circ$	0½ 1½	*33450.03* *33450.38*	0.35
$4p^6(^1S)23d$	$23d\ ^2D$	1½, 2½	33457.06	
$4p^6(^1S)25p$	$25p\ ^2P^\circ$	0½ 1½	*33471.11* *33471.43*	0.32
$4p^6(^1S)24d$	$24d\ ^2D$	1½, 2½	33477.0	
$4p^6(^1S)26p$	$26p\ ^2P^\circ$	0½ 1½	*33489.53* *33489.79*	0.26
$4p^6(^1S)25d$	$25d\ ^2D$	1½, 2½	33494.8	
$4p^6(^1S)27p$	$27p\ ^2P^\circ$	0½, 1½	*33505.92*	
$4p^6(^1S)26d$	$26d\ ^2D$	1½, 2½	33510.1	
$4p^6(^1S)28p$	$28p\ ^2P^\circ$	0½, 1½	*33520.22*	

Rb I—Continued

Config.	Desig.	J	Level	Interval
$4p^6(^1S)27d$	$27d\ ^2D$	1½, 2½	33524.01	
$4p^6(^1S)29p$	$29p\ ^2P^\circ$	0½, 1½	*33532.91*	
$4p^6(^1S)28d$	$28d\ ^2D$	1½, 2½	33535.9	
$4p^6(^1S)30p$	$30p\ ^2P^\circ$	0½, 1½	*33544.26*	
$4p^6(^1S)29d$	$29d\ ^2D$	1½, 2½	33547.3	
$4p^6(^1S)31p$	$31p\ ^2P^\circ$	0½, 1½	*33554.47*	
$4p^6(^1S)30d$	$30d\ ^2D$	1½, 2½	33557.02	
$4p^6(^1S)32s$	$32s\ ^2S$	0½	33559.2	
$4p^6(^1S)29f$	$29f\ ^2F^\circ$	2½, etc.	*33559.9*	
$4p^6(^1S)32p$	$32p\ ^2P^\circ$	0½, 1½	*33563.57*	
$4p^6(^1S)31d$	$31d\ ^2D$	1½, 2½	33565.95	
$4p^6(^1S)33s$	$33s\ ^2S$	0½	33567.7	
$4p^6(^1S)30f$	$30f\ ^2F^\circ$	2½, etc.	*33568.5*	
$4p^6(^1S)33p$	$33p\ ^2P^\circ$	0½, 1½	*33571.85*	
$4p^6(^1S)32d$	$32d\ ^2D$	1½, 2½	33574.06	
$4p^6(^1S)34s$	$34s\ ^2S$	0½	[33575.6]	
$4p^6(^1S)31f$	$31f\ ^2F^\circ$	2½, etc.	[*33576.7*]	
$4p^6(^1S)34p$	$34p\ ^2P^\circ$	0½, 1½	*33579.34*	
$4p^6(^1S)33d$	$33d\ ^2D$	1½, 2½	33581.21	
$4p^6(^1S)35s$	$35s\ ^2S$	0½	33582.7	
$4p^6(^1S)32f$	$32f\ ^2F^\circ$	2½, etc.	*33583.8*	
$4p^6(^1S)35p$	$35p\ ^2P^\circ$	0½, 1½	*33586.11*	
$4p^6(^1S)34d$	$34d\ ^2D$	1½, 2½	33587.87	
$4p^6(^1S)36s$	$36s\ ^2S$	0½	33589.09	
$4p^6(^1S)33f$	$33f\ ^2F^\circ$	2½, etc.	*33589.93*	
$4p^6(^1S)36p$	$36p\ ^2P^\circ$	0½, 1½	*33592.31*	
$4p^6(^1S)35d$	$35d\ ^2D$	1½, 2½	33593.83	
$4p^6(^1S)37s$	$37s\ ^2S$	0½	33595.02	
$4p^6(^1S)34f$	$34f\ ^2F^\circ$	2½, etc.	*33595.9*	
$4p^6(^1S)37p$	$37p\ ^2P^\circ$	0½, 1½	*33597.96*	
$4p^6(^1S)36d$	$36d\ ^2D$	1½, 2½	33599.42	
$4p^6(^1S)38s$	$38s\ ^2S$	0½	33600.57	
$4p^6(^1S)35f$	$35f\ ^2F^\circ$	2½, etc.	*33601.44*	
$4p^6(^1S)38p$	$38p\ ^2P^\circ$	0½, 1½	*33603.14*	
$4p^6(^1S)37d$	$37d\ ^2D$	1½, 2½	33604.43	
$4p^6(^1S)39s$	$39s\ ^2S$	0½	33605.26	
$4p^6(^1S)36f$	$36f\ ^2F^\circ$	2½, etc.	*33605.97*	
$4p^6(^1S)39p$	$39p\ ^2P^\circ$	0½, 1½	*33607.96*	
$4p^6(^1S)38d$	$38d\ ^2D$	1½, 2½	33609.08	
$4p^6(^1S)40s$	$40s\ ^2S$	0½	33610.09	
$4p^6(^1S)37f$	$37f\ ^2F^\circ$	2½, etc.	*33610.41*	

Rb I—Continued

Config.	Desig.	J	Level	Interval
$4p^6(^1S)40p$	$40p\ ^2P^\circ$	0½, 1½	*33612.34*	
$4p^6(^1S)39d$	$39d\ ^2D$	1½, 2½	33613.38	
$4p^6(^1S)41s$	$41s\ ^2S$	0½	33614.23	
$4p^6(^1S)38f$	$38f\ ^2F^\circ$	2½, etc.	*33614.55*	
$4p^6(^1S)41p$	$41p\ ^2P^\circ$	0½, 1½	*33616.38*	
$4p^6(^1S)40d$	$40d\ ^2D$	1½, 2½	33617.34	
$4p^6(^1S)42s$	$42s\ ^2S$	0½	33618.26	
$4p^6(^1S)39f$	$39f\ ^2F^\circ$	2½, etc.	*33619.5*	
$4p^6(^1S)42p$	$42p\ ^2P^\circ$	0½, 1½	*33620.15*	
$4p^6(^1S)41d$	$41d\ ^2D$	1½, 2½	33621.00	
$4p^6(^1S)43s$	$43s\ ^2S$	0½	33621.62	
$4p^6(^1S)40f$	$40f\ ^2F^\circ$	2½, etc.	*33622.05*	
$4p^6(^1S)43p$	$43p\ ^2P^\circ$	0½, 1½	*33623.61*	
$4p^6(^1S)42d$	$42d\ ^2D$	1½, 2½	33624.41	
$4p^6(^1S)44s$	$44s\ ^2S$	0½	33625.08	
$4p^6(^1S)41f$	$41f\ ^2F^\circ$	2½, etc.	*33625.56*	
$4p^6(^1S)44p$	$44p\ ^2P^\circ$	0½, 1½	*33626.83*	
$4p^6(^1S)43d$	$43d\ ^2D$	1½, 2½	33627.55	
$4p^6(^1S)45s$	$45s\ ^2S$	0½	33628.23	
$4p^6(^1S)42f$	$42f\ ^2F^\circ$	2½, etc.	*33628.76*	
$4p^6(^1S)45p$	$45p\ ^2P^\circ$	0½, 1½	*33629.80*	
$4p^6(^1S)44d$	$44d\ ^2D$	1½, 2½	33630.51	
$4p^6(^1S)46s$	$46s\ ^2S$	0½	33631.13	
$4p^6(^1S)43f$	$43f\ ^2F^\circ$	2½, etc.	[*33631.6*]	
$4p^6(^1S)46p$	$46p\ ^2P^\circ$	0½, 1½	*33632.60*	
$4p^6(^1S)45d$	$45d\ ^2D$	1½, 2½	33633.23	
$4p^6(^1S)47s$	$47s\ ^2S$	0½	33633.93	
$4p^6(^1S)44f$	$44f\ ^2F^\circ$	2½, etc.	[*33634.28*]	
$4p^6(^1S)47p$	$47p\ ^2P^\circ$	0½, 1½	*33635.21*	
$4p^6(^1S)46d$	$46d\ ^2D$	1½, 2½	33635.83	
$4p^6(^1S)48s$	$48s\ ^2S$	0½	33636.33	
$4p^6(^1S)45f$	$45f\ ^2F^\circ$	2½, etc.	*33636.86*	
$4p^6(^1S)48p$	$48p\ ^2P^\circ$	0½, 1½	*33637.63*	
$4p^6(^1S)47d$	$47d\ ^2D$	1½, 2½	33638.17	
$4p^6(^1S)49s$	$49s\ ^2S$	0½	33638.80	
$4p^6(^1S)46f$	$46f\ ^2F^\circ$	2½, etc.	[*33639.10*]	
$4p^6(^1S)49p$	$49p\ ^2P^\circ$	0½, 1½	*33639.89*	
$4p^6(^1S)48d$	$48d\ ^2D$	1½, 2½	33640.46	
$4p^6(^1S)50s$	$50s\ ^2S$	0½	33640.95	
$4p^6(^1S)47f$	$47f\ ^2F^\circ$	2½, etc.	*33641.32*	
$4p^6(^1S)50p$	$50p\ ^2P^\circ$	0½, 1½	*33642.01*	

Rb I—Continued

Config.	Desig.	J	Level	Interval
$4p^6(^1S)49d$	$49d\ ^2D$	1½, 2½	33642.7	
$4p^6(^1S)51s$	$51s\ ^2S$	0½	33643.98	
$4p^6(^1S)51p$	$51p\ ^2P^\circ$	0½, 1½	*33644.02*	
$4p^6(^1S)50d$	$50d\ ^2D$	1½, 2½	33644.5	
$4p^6(^1S)52s$	$52s\ ^2S$	0½	33644.95	
$4p^6(^1S)52p$	$52p\ ^2P^\circ$	0½, 1½	*33645.96*	
$4p^6(^1S)51d$	$51d\ ^2D$	1½, 2½	33646.54	
$4p^6(^1S)53s$	$53s\ ^2S$	0½	33646.84?	
$4p^6(^1S)53p$	$53p\ ^2P^\circ$	0½, 1½	*33647.72*	
$4p^6(^1S)52d$	$52d\ ^2D$	1½, 2½	33648.29	
$4p^6(^1S)54p$	$54p\ ^2P^\circ$	0½, 1½	*33649.33*	
$4p^6(^1S)53d$	$53d\ ^2D$	1½, 2½	33650.03	
$4p^6(^1S)55p$	$55p\ ^2P^\circ$	0½, 1½	*33650.95*	
$4p^6(^1S)54d$	$54d\ ^2D$	1½, 2½	33651.36	
$4p^6(^1S)56p$	$56p\ ^2P^\circ$	0½, 1½	*33652.41*	
$4p^6(^1S)57p$	$57p\ ^2P^\circ$	0½, 1½	*33653.80*	
$4p^6(^1S)58p$	$58p\ ^2P^\circ$	0½, 1½	*33655.11*	
$4p^6(^1S)59p$	$59p\ ^2P^\circ$	0½, 1½	*33656.39*	
$4p^6(^1S)60p$	$60p\ ^2P^\circ$	0½, 1½	*33657.55*	
$4p^6(^1S)61p$	$61p\ ^2P^\circ$	0½, 1½	*33658.69*	
$4p^6(^1S)62p$	$62p\ ^2P^\circ$	0½, 1½	*33659.80*	
$4p^6(^1S)63p$	$63p\ ^2P^\circ$	0½, 1½	*33660.82*	
$4p^6(^1S)64p$	$64p\ ^2P^\circ$	0½, 1½	*33661.81*	
$4p^6(^1S)65p$	$65p\ ^2P^\circ$	0½, 1½	*33662.73*	
$4p^6(^1S)66p$	$66p\ ^2P^\circ$	0½, 1½	*33663.63*	
$4p^6(^1S)67p$	$67p\ ^2P^\circ$	0½, 1½	*33664.48*	
$4p^6(^1S)68p$	$68p\ ^2P^\circ$	0½, 1½	*33665.28*	
$4p^6(^1S)69p$	$69p\ ^2P^\circ$	0½, 1½	*33666.04*	
$4p^6(^1S)70p$	$70p\ ^2P^\circ$	0½, 1½	*33666.78*	
$4p^6(^1S)71p$	$71p\ ^2P^\circ$	0½, 1½	*33667.49*	
$4p^6(^1S)72p$	$72p\ ^2P^\circ$	0½, 1½	*33668.11*	
$4p^6(^1S)73p$	$73p\ ^2P^\circ$	0½, 1½	*33668.79*	
$4p^6(^1S)74p$	$74p\ ^2P^\circ$	0½, 1½	*33669.36*	
$4p^6(^1S)75p$	$75p\ ^2P^\circ$	0½, 1½	*33670.01*	
$4p^6(^1S)76p$	$76p\ ^2P^\circ$	0½, 1½	*33670.61*	
$4p^6(^1S)77p$	$77p\ ^2P^\circ$	0½, 1½	*33671.07*	
Rb II $(^1S_0)$	**Limit**	-------	**33691.02**	
$4p^5(^3P^\circ_2)5s^2$	$5s^2\ ^2P^\circ$	1½	*123500*	−6820
$4p^5(^1P^\circ_1)5s^2$		0½	*130320*	
$4p^5\ 5s(^3P^\circ_2)4d$	$4d$ 1°	0½, 1½	*138780*	

Rb I—Continued

Config.	Desig.	J	Level	Interval
$4p^5\ 5s(^3P^\circ_1)4d$	$4d$ 2°	0½, 1½	*139910*	
$4p^5\ 5s(^3P^\circ_2)4d$	$4d$ 3°	0½, 1½	*145540*	
$4p^5\ 5s(^3P^\circ_2)4d$	$4d$ 4°	0½, 1½	*146050*	
$4p^5\ 5s(^3P^\circ_1)4d$	$4d$ 5°	0½, 1½	*146780*	
$4p^5\ 5s(^3P^\circ_2)4d$	$4d$ 6°	0½, 1½	*147330*	
$4p^5\ 5s(^3P^\circ_0)4d$	$4d$ 7°	0½, 1½	*147580*	
$4p^5\ 5s(^3P^\circ_1)4d$	$4d$ 8°	0½, 1½	*148910*	
$4p^5\ 5s(^3P^\circ_2)6s$	$6s\ ^2P^\circ$	1½	*151760*	−1220
$4p^5\ 5s(^3P^\circ_1)6s$		0½?	*152980*	
$4p^5\ 5s(^3P^\circ)6s$	$6s\ ^4P^\circ$	2½		
$4p^5\ 5s(^3P^\circ_1)6s$		1½?	*152380*	−6140
$4p^5\ 5s(^3P^\circ_0)6s$		0½?	*158520*	
$4p^5\ 5s(^1P^\circ_1)4d$	$4d'$ 9°	0½, 1½	*152690*	
$4p^5\ 5s(^1P^\circ_1)4d$	$4d'$ 10°	0½, 1½	*154040*	
$4p^5\ 5s(^3P^\circ_2)5d$	$5d$ 11°	0½, 1½	*154260*	
$4p^5\ 5s(^1P^\circ_1)4d?$	$4d'$ 12°	0½, 1½	*154950*	
$4p^5\ 5s(^3P^\circ_1)5d$	$5d$ 13°	0½, 1½	*156310*	
$4p^5\ 5s(^3P^\circ_2)5d$	$5d$ 14°	0½, 1½	*156980*	
$4p^5\ 5s(^3P^\circ_2)5d$	$5d$ 15°	0½, 1½	*157380*	
$4p^5\ 5s(^3P^\circ_1)5d$	$5d$ 16°	0½, 1½	*157750*	
$4p^5\ 5s(^3P^\circ_1)5d$	$5d$ 17°	0½, 1½	*159070*	
$4p^5\ 5s(^1P^\circ_1)6s$	$6s'\ ^2P^\circ$	0½	*159210*	1780
		1½	*160990*	
$4p^5\ 5s(^3P^\circ_2)7s$	$7s\ ^2P^\circ$	1½	*159210*	
		0½		
$4p^5\ 5s(^3P^\circ)7s$	$7s\ ^4P^\circ$	2½		
$4p^5\ 5s(^3P^\circ_1)7s?$		1½?	*160060*	−6770
$4p^5\ 5s(^3P^\circ_0)7s?$		0½?	*166830*	
$4p^5\ 5s(^3P^\circ_2)6d$	$6d$ 18°	0½, 1½	*161210*	
$4p^5\ 5s(^3P^\circ_2)6d$	$6d$ 19°	0½, 1½	*161450*	
$4p^5\ 5s(^3P^\circ_1)6d$	$6d$ 20°	0½, 1½	*162820*	
$4p^5\ 5s(^3P^\circ_2)7d$	$7d$ 21°	0½, 1½	*162820*	
$4p^5\ 5s(^3P^\circ_0)5d$	$5d$ 22°	0½, 1½	*163380*	
$4p^5\ 5s(^3P^\circ)8s$	$8s\ ^4P^\circ$	2½		
$4p^5\ 5s(^3P^\circ_1)8s$		1½?	*163500*	
		0½		
$4p^5\ 5s(^1P^\circ_1)5d$	$5d'$ 23°	0½, 1½	*164700*	
$4p^5\ 5s(^1P^\circ_1)5d$	$5d'$ 24°	0½, 1½	*165080*	
$4p^5\ 5s(^1P^\circ_1)5d$	$5d'$ 25°	0½, 1½	*166060*	
$4p^5\ 5s(^1P^\circ_1)7s$	$7s'\ ^2P^\circ$	0½?	*168180*	
		1½		
Rb II $(5s\ ^3P^\circ_2)$	*Limit*	---------	*167040*	
Rb II $(5s\ ^3P^\circ_1)$	*Limit*	---------	*168570*	
Rb II $(5s\ ^3P^\circ_0)$	*Limit*	---------	*175570*	
Rb II $(5s\ ^1P^\circ_1)$	*Limit*	---------	*177160*	

June 1951.

Rb II

(Kr I sequence; 36 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ ^1S_0$

$4p^6\ ^1S_0$ **221852 cm^{-1}** I. P. 27.5 volts

Laporte, Miller, and Sawyer have published a list of 102 classified lines extending from 697.04 A to 7698.57 A. They have utilized earlier data by Reinheimmer and Otsuka together with their own additional observations. Their limit is from the $ns\ ^3P^{\circ}_{2,1}$ series (n=5,6) fitted to a Rydberg formula. The higher limit given in the table has been obtained by adding to their ionization limit the interval of the ground term of Rb III.

The author's notation is entered in column one of the table. The writer has provisionally assigned to the miscellaneous levels the pair-coupling notation, used in these volumes for spectra of the inert gases. These assignments require further confirmation.

REFERENCES

O. Laporte, G. R. Miller, and R. A. Sawyer, Phys. Rev. **38**, 843 (1931). (I P) (T) (C L)
J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

Rb II

Authors	Config.	Desig.	J	Level
$4p^6\ ^1S_0$	$4p^6$	$4p^6\ ^1S$	0	0. 00
$4d\ 1^{\circ}_{1}$	$4p^5(^2P^{\circ}_{1\frac{1}{2}})4d$	$4d$ [0½]°	1	*126453. 53*
$4d\ 4^{\circ}_{0}$			0	*138799. 56*
$4d\ 2^{\circ}_{2}$	"	$4d$ [1½]°	2	*128693 70*
$4d\ 5^{\circ}_{1}$			1	*140615. 18*
$4d\ 3^{\circ}_{2}$	"	$4d$ [2½]°	2	*136665. 21*
			3	
$4d\ 6^{\circ}_{1,2}$	$4p^5(^2P^{\circ}_{0\frac{1}{2}})4d$	$4d'$ [2½]°	2	*143027. 39*
			3	
$4d\ 7^{\circ}_{2}$	"	$4d'$ [1½]°	2	*143960. 94*
$4d\ 8^{\circ}_{1,2}$			1	*145630. 06*
$5s\ ^3P^{\circ}_{2}$	$4p^5(^2P^{\circ}_{1\frac{1}{2}})5s$	$5s$ [1½]°	2	*133347. 29*
$5s\ ^3P^{\circ}_{1}$			1	*134875. 14*
$5s\ ^3P^{\circ}_{0}$	$4p^5(^2P^{\circ}_{0\frac{1}{2}})5s$	$5s'$ [0½]°	0	*141879. 24*
$5s\ ^1P^{\circ}_{1}$			1	*143467. 00*
$5p\ 1_1$	$4p^5(^2P^{\circ}_{1\frac{1}{2}})5p$	$5p$ [0½]	1	154279. 25
$5p\ 2_2$	"	$5p$ [2½]	2	156742. 20
$5p\ 3_3$			3	156900. 72
$5p\ 4_1$	"	$5p$ [1½]	1	158156. 66
$5p\ 5_2$			2	158717. 04
$5p\ 6_0$	"	$5p$ [0½]	0	161205. 13
$5p\ 7_1$	$4p^5(^2P^{\circ}_{0\frac{1}{2}})5p$	$5p'$ [1½]	1	163929. 47
$5p\ 8_2$			2	164972. 81
$5p\ 9_1$	"	$5p'$ [0½]	1	165094. 55
$5p\ 10_0$			0	167637. 30
$6s\ ^3P^{\circ}_{2}$	$4p^5(^2P^{\circ}_{1\frac{1}{2}})6s$	$6s$ [1½]°	2	*179740. 11*
$6s\ ^3P^{\circ}_{1}$			1	*180173. 33*
	$4p^5(^2P^{\circ}_{0\frac{1}{2}})6s$	$6s'$ [0½]°	0	
$6s\ ^1P^{\circ}_{1}$			1	*188622. 28*
$5d\ 1^{\circ}_{1}$	$4p^5(^2P^{\circ}_{1\frac{1}{2}})5d$	$5d$ [0½]°	1	*184205. 27*
			0	
$5d\ 3^{\circ}_{3}$	"	$5d$ [3½]°	3	*185131. 62*
			4	
$5d\ 2^{\circ}_{2}$	"	$5d$ [1½]°	2	*184841. 65*
$5d\ 6^{\circ}_{1}$			1	*187340. 37*
$5d\ 4^{\circ}_{2}$	"	$5d$ [2½]°	2	*185622. 53*
$5d\ 5^{\circ}_{3}$			3	*186010. 87*
$5d\ 7^{\circ}_{1}$	$4p^5(^2P^{\circ}_{0\frac{1}{2}})5d$	$5d'$ [1½]°	1	*189006. 27*
$5d\ 8^{\circ}_{1,2}$			2	*192380. 15*
	Rb III ($^2P^{\circ}_{1\frac{1}{2}}$)	***Limit***	-------	**221852**
	Rb III ($^2P^{\circ}_{0\frac{1}{2}}$)	*Limit*	-------	229232

May 1951.

Rb II Observed Levels*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2+$	Observed Terms		
$4p^6$	$4p^6\ {}^1S$		
	ns $(n\geq5)$		
$4p^5(^2P^\circ)nx$	$\{$ 5, 6s $^3P^\circ$ 5, 6s $^1P^\circ$		
jl-Coupling Notation			
	Observed Pairs		
	ns $(n\geq5)$	np $(n\geq5)$	nd $(n\geq4)$
$4p^5(^2P^\circ_{1\frac{1}{2}})nx$	5, 6s [1½]°	5p [0½] 5p [2½] 5p [1½]	4,5d [0½]° 5d [3½]° 4,5d [1½]° 4,5d [2½]°
$4p^5(^2P^\circ_{0\frac{1}{2}})nx'$	5, 6s' [0½]°	5p' [1½] 5p' [0½]	4d' [2½]° 4,5d' [1½]°

*For predicted levels in the spectra of the Kr I isoelectronic sequence, see Introduction.

Rb III

(Br I sequence; 35 electrons) $Z=37$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^5\ {}^2P^\circ_{1\frac{1}{2}}$

$4p^5\ {}^2P^\circ_{1\frac{1}{2}}$ ***320000*** cm^{-1} I. P. 40 volts

The analysis is incomplete. Tomboulian has classified 30 lines of Rb III in the region between 482 A and 815 A as due to transitions from the ground term to 11 higher terms.

He has estimated the value of the limit by extrapolation of isoelectronic sequence data.

REFERENCE

D. H. Tomboulian, Phys. Rev. **54**, 350 (1938). (I P) (T) (C L)

Rb III

Config.	Desig.	J	Level	Interval
$4s^2\,4p^5$	$4p^5\ {}^2P^\circ$	1½	*0*	−7380
		0½	*7380*	
$4s\,4p^6$	$4p^6\ {}^2S$	0½	130036	
$4s^2\,4p^4(^3P)4d$	$4d\ {}^4D$	3½		
		2½		
		1½	152353	−2050
		0½	154403	
$4s^2\,4p^4(^3P)5s$	$5s\ {}^4P$	2½		
		1½	164507	−3578
		0½	168085	
$4s^2\,4p^4(^3P)4d$	$4d\ {}^4P$	0½	170423	424
		1½	170847	
		2½		
$4s^2\,4p^4(^3P)5s$	$5s\ {}^2P$	1½	172045	−3351
		0½	175396	

Rb III

Config.	Desig.	J	Level	Interval
$4s^2\,4p^4(^3P)4d$	$4d\ {}^2D$	1½	173475	
		2½		
$4s^2\,4p^4(^3P)4d$	$4d\ {}^2P$	0½		
		1½	177044	
$4s^2\,4p^4(^1D)5s$	$5s'\ {}^2D$	1½	182963	
		2½		
$4s^24p^4(^1D)4d$	$4d'\ {}^2D$	2½		
		1½	200883	
$4s^2\,4p^4(^1D)4d$	$4d'\ {}^2P$	1½	204104	
		0½		
$4s^2\,4p^4(^1S)5s$	$5s''\ {}^2S$	0½	207277	
Rb IV $(^3P_2)$	*Limit*	------	[*320000*]	

January 1951.

Rb III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms		
$4s^2\ 4p^5$		$4p^5\ ^2P^\circ$	
$4s\ 4p^6$	$4p^6\ ^2S$		
		$ns\ (n\geq 5)$	$nd\ (n\geq 4)$
$4s^2\ 4p^4(^3P)nx$		$5s\ ^4P$ $5s\ ^2P$	$4d\ ^4P$ $4d\ ^4D$ $4d\ ^2P$ $4d\ ^2D$
$4s^2\ 4p^4(^1D)nx'$		$5s'\ ^2D$	$4d'\ ^2P$ $4d'\ ^2D$
$4s^2\ 4p^4(^1S)nx''$	$5s''\ ^2S$		

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Rb IX

(Cu I sequence; 29 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s\ ^2S_{0\frac{1}{2}}$

$4s\ ^2S_{0\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Mack has observed the principal doublet, as follows:

I A	Wave No.	Desig.
583. 37	171417	$4s\ ^2S_{0\frac{1}{2}}-4p\ ^2P^\circ_{1\frac{1}{2}}$
628. 62	159078	$4s\ ^2S_{0\frac{1}{2}}-4p\ ^2P^\circ_{0\frac{1}{2}}$

REFERENCE

J. E. Mack, Phys. Rev. **38,** 193 (L) (1931). (I P) (T) (C L)

March 1950.

Rb X

(Ni I sequence; 28 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ ^1S_0$

$3d^{10}\ ^1S_0$ **2235100** cm^{-1} I. P. 277 volts

Edlén has observed lines from the $3d^{10}-3d^9np(n=4,5)$ and $3d^{10}-3d^9nf\ (n=4\text{–}6)$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, some lines from each group are indicated on the photograph of vacuum spark spectra of Rb observed between 50 A and 100 A.

From preliminary unpublished measurements he has derived provisional absolute term values from the Rydberg nf-series. The terms in the table are from his manuscript. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica **13,** No. 9, 547 (1947).
B. Edlén, letter (July 1950). (I P) (T)

Rb X

Config.	Desig.	*J*	Level
$3d^{10}$	$3d^{10}\ ^1S$	0	0
$3d^9(^2D)4p$	$4p\ ^1P^\circ$	1	*1023400*
$3d^9(^2D)4p$	$4p\ ^3D^\circ$	3	
		2	
		1	*1031100*
$3d^9(^2D)4f$	$4f\ ^3P^\circ$	2	
		1	*1517200*
		0	
$3d^9(^2D)4f$	$4f\ ^1P^\circ$	1	*1527700*
$3d^9(^2D)4f$	$4f\ ^3D^\circ$	3	
		2	
		1	*1548000*
$3d^9(^2D)5p$	$5p\ ^1P^\circ$	1	*1559600*
$3d^9(^2D)5p$	$5p\ ^3D^\circ$	3	
		2	
		1	*1568400*
$3d^9(^2D)5f$	$5f\ ^1P^\circ$	1	*1783800*
$3d^9(^2D)5f$	$5f\ ^3D^\circ$	3	
		2	
		1	*1799200*
$3d^9(^2D)6f$	$6f\ ^1P^\circ$	1	*1922300*
$3d^9(^2D)6f$	$4f\ ^3D^\circ$	3	
		2	
		1	*1935400*
Rb XI ($^2D_{2\frac{1}{2}}$)	*Limit*	--------	**2235100**

August 1950.

Rb XI

(Co I sequence; 27 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ ^2D_{2\frac{1}{2}}$

$3d^9\ ^2D_{2\frac{1}{2}}$ cm^{-1} I. P. volts

Edlén has observed three lines due to the transition $3p^6\ 3d^9\ ^2D-3p^5\ 3d^{10}\ ^2P^\circ$. From preliminary unpublished measurements he has furnished the provisional term values quoted in the table. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of the vacuum spark spectra of Rb observed between 50 A and 100 A. Another group of lines from $3d^9-3d^8\ 4p$ is also indicated in the figure.

Edlén's unit, $10^3\ cm^{-1}$, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica, **13,** No. 9, 547 (1947).
B. Edlén, letter (July 1950). (T)

Rb XI

Config.	Desig.	*J*	Level	Interval
$3p^6\ 3d^9$	$3d^9\ ^2D$	$2\frac{1}{2}$	0	−12300
		$1\frac{1}{2}$	12300	
$3p^5\ 3d^{10}$	$3d^{10}\ ^2P^\circ$	$1\frac{1}{2}$	*1028700*	−72700
		$0\frac{1}{2}$	*1101400*	

July 1950.

Rb XII

(Fe I sequence; 26 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ {}^3F_4$

$3d^8\ {}^3F_4$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^8-3d^7\ 4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of vacuum spark spectra of Rb observed between 50 A and 100 A.

The writer has assumed the ground state indicated above, by analogy with Ni III.

REFERENCE

B. Edlén, Physica **13**, No. 9, 547 (1947).

February 1950.

Rb XIII

(Mn I sequence; 25 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ {}^4F_{4\frac{1}{2}}$

$3d^7\ {}^4F_{4\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^7-3d^6\ 4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of vacuum spark spectra of Rb observed between 50 A and 100 A.

The writer has assumed the ground state indicated above, by analogy with Co III.

REFERENCE

B. Edlén, Physica **13**, No. 9, 547 (1947).

February 1950.

Rb XIV

(Cr I sequence; 24 electrons) $Z=37$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ {}^5D_4$

$3d^6\ {}^5D_4$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^6-3d^5\ 4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms the lines are indicated on the photograph of vacuum spark spectra of Rb observed between 50 A and 100 A.

The writer has assumed the ground state indicated above, by analogy with Fe III.

REFERENCE

B. Edlén, Physica **13**, No. 9, 547 (1947).

February 1950.

STRONTIUM

Sr I

38 electrons $Z=38$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,5s^2\;{}^1S_0$

$5s^2\;{}^1S_0$ **45925.6** cm^{-1} I. P. 5.692 volts

The Sr I spectrum, like Ca I, has played an important part in the development of a satisfactory theory for atomic spectra. In addition to the "regular" series, terms involving two excited electrons were found in Sr I as well as in Ca I, and were first discussed in the classical paper by Russell and Saunders in 1925. White discusses these terms further in his paper on "Auto-Ionization in the Alkaline Earth Metals and the Inert Gases."

The regular series terms, i. e., those having the limit ${}^2S$ in Sr II, have been taken from the paper by Saunders, except for $5d\;{}^1D_2$. Other terms are from the papers by Russell and Saunders and by Meggers. The writer has also had at her disposal Russell's unpublished line list and multiplet arrays.

Sullivan has observed 102 Sr I lines with the interferometer. From these observations he has improved a number of the term values. All of the three-place entries in the table, except that of $6p\;{}^3P^\circ_0$; and the two-place values for the terms 6, 7, $10p\;{}^1P^\circ$; 4, $5f\;{}^1F^\circ$; 7, $8d\;{}^3D$; and $4d^2\;{}^3P$, are from his paper. The rest have been adjusted to these by the writer with the aid of the best available line list. The resolution of the terms 6, $7f\;{}^3F^\circ$ is dubious, owing to the inaccuracy of the existing wavelengths.

Although long series are well known, and all of the terms are well connected by observed intersystem combinations, a number of Sr I lines remain unclassified, and many of the observed lines should be remeasured. Humphreys has recently remeasured two lines, 20764.19 A and 20778.14 A, which are designated as $6s\;{}^3S_1-6p\;{}^3P^\circ_0$ and $5d\;{}^1D_2-4f\;{}^1F^\circ_3$, respectively. He expects to extend the analysis from further observations in the far infrared. A monograph containing a homogeneous list of lines and term values is seriously needed as soon as his work is completed.

REFERENCES

F. Paschen und R. Götze, *Seriengesetze der Linienspektren*, p. 83 (Julius Springer, Berlin, 1922). (T) (C L)
A. Fowler, *Report on Series in Line Spectra*, p. 128 (Fleetway Press, London, 1922). (T) (C L)
F. A. Saunders, Astroph. J. **56,** 73 (1922). (I P) (T) (C L)
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H. E. White, Phys. Rev. **38,** 2016 (1931)
W. F. Meggers, Bur. Std. J. Research **10,** 679, RP558 (1933). (I P) (T) (C L)
F. J. Sullivan, Univ. Pittsburgh Bull. **35,** No. 1, 1 (1938). (T) (C L)
J. F. Mack, Rev. Mod. Phys. **22,** No. 1, 64 (1950). (Summary hfs)
C. J. Humphreys, unpublished material (April 1951). (C L)

Sr I

Config.	Desig.	J	Level	Interval
$5s^2$	$5s^2\ ^1S$	0	0.000	
$5s(^2S)5p$	$5p\ ^3P^\circ$	0	*14317.520*	186.831
		1	*14504.351*	394.212
		2	*14898.563*	
$5s(^2S)4d$	$4d\ ^3D$	1	18159.056	59.739
		2	18218.795	100.472
		3	18319.267	
$5s(^2S)4d$	$4d\ ^1D$	2	20149.700	
$5s(^2S)5p$	$5p\ ^1P^\circ$	1	*21698.482*	
$5s(^2S)6s$	$6s\ ^3S$	1	29038.795	
$5s(^2S)6s$	$6s\ ^1S$	0	30591.8	
$4d(^2D)5p$	$5p'\ ^3F^\circ$	2	*33266.872*	322.852
		3	*33589.724*	329.606
		4	*33919.330*	
$4d(^2D)5p$	$5p'\ ^1D^\circ$	2	*33826.927*	
$5s(^2S)6p$	$6p\ ^3P^\circ$	0	*33853.516*	14.817
		1	*33868.333*	104.748
		2	*33973.081*	
$5s(^2S)6p$	$6p\ ^1P^\circ$	1	*34098.44*	
$5s(^2S)5d$	$5d\ ^1D$	2	34727.483	
$5s(^2S)5d$	$5d\ ^3D$	1	35006.943	15.072
		2	35022.015	23.040
		3	35045.055	
$5p^2$	$5p^2\ ^3P$	0	35193.47	206.67
		1	35400.138	274.530
		2	35674.668	
$4d(^2D)5p$	$5p'\ ^3D^\circ$	1	*36264.181*	117.588
		2	*36381.769*	177.745
		3	*36559.514*	
$5p^2$	$5p^2\ ^1D$	2	36960.881	
$5p^2$	$5p^2\ ^1S$	0	37160.278	
$4d(^2D)5p$	$5p'\ ^3P^\circ$	0	*37292.106*	10.654
		1	*37302.760*	33.856
		2	*37336.616*	
$5s(^2S)7s$	$7s\ ^3S$	1	37424.713	
$4d(^2D)5p$	$5p'\ ^1F^\circ$	3	*38008.0*	
$5s(^2S)7s$	$7s\ ^1S$	0	38444.054	
$5s(^2S)4f$	$4f\ ^3F^\circ$	2	*38750.454*	1.986
		3	*38752.440*	2.759
		4	*38755.199*	
$5s(^2S)7p$	$7p\ ^1P^\circ$	1	*38906.90*	
$5s(^2S)7p$	$7p\ ^3P^\circ$	0	*39411.703*	14.768
		1	*39426.471*	30.938
		2	*39457.409*	
$5s(^2S)4f$	$4f\ ^1F^\circ$	3	*39539.04*	
$5s(^2S)6d$	$6d\ ^3D$	1	39685.903	4.946
		2	39690.849	12.305
		3	39703.154	
$5s(^2S)6d$	$6d\ ^1D$	2	39733.114	
$5s(^2S)8s$	$8s\ ^3S$	1	40761.440	
$5s(^2S)8s$	$8s\ ^1S$	0	41052.5	

Sr I

Config.	Desig.	J	Level	Interval
$5s(^2S)8p$	$8p\ ^1P^\circ$	1	*41172.15*	
$5s(^2S)5f$	$5f\ ^3F^\circ$	2	*41364.614*	0.918
		3	*41365.532*	1.163
		4	*41366.695*	
$5s(^2S)5f$	$5f\ ^1F^\circ$	3	*41518.91*	
$5s(^2S)7d$	$7d\ ^1D$	2	41831.7	
$5s(^2S)7d$	$7d\ ^3D$	1	41864.40	4.92
		2	41869.32	5.58
		3	41874.90	
$5s(^2S)9s$	$9s\ ^3S$	1	42451.2	
$5s(^2S)9p$	$9p\ ^1P^\circ$	1	*42462.36*	
$5s(^2S)9s$	$9s\ ^1S$	0	42596.0	
$5s(^2S)6f$	$6f\ ^3F^\circ$	2	*42776.2?*	0.4?
		3	*42776.6?*	1.6?
		4	*42778.155*	
$5s(^2S)6f$	$6f\ ^1F^\circ$	3	*42839.4*	
$5s(^2S)8d$	$8d\ ^1D$	2	43020.9	
$5s(^2S)8d$	$8d\ ^3D$	1	43066.7	3.6
		2	43070.31	4.46
		3	43074.77	
$5s(^2S)10p$	$10p\ ^1P^\circ$	1	*43327.94*	
$5s(^2S)10s$	$10s\ ^3S$	1	43427.6	
$5s(^2S)10s$	$10s\ ^1S$	0	43512.6	
$5s(^2S)7f$	$7f\ ^3F^\circ$	2, 3	*43624.0*	0.5?
		4	*43624.513*	
$5s(^2S)7f$	$7f\ ^1F^\circ$	3	*43656.1*	
$5s(^2S)9d$	$9d\ ^1D$	2	43780.6	
$5s(^2S)9d$	$9d\ ^3D$	1, 2	43807.8	4.8
		3	43812.6	
$5s(^2S)11p$	$11p\ ^1P^\circ$	1	*43938.26*	
$5s(^2S)11s$	$11s\ ^3S$	1	44043.4	
$5s(^2S)11s$	$11s\ ^1S$	0	44097.1	
$5s(^2S)8f$	$8f\ ^3F^\circ$	2, 3, 4	*44171.8*	
$5s(^2S)8f$	$8f\ ^1F^\circ$	3	*44190.1*	
$5s(^2S)10d$	$10d\ ^3D$	1	44283.8	3.3?
		2	44287.1	12.6
		3	44299.7	
$5s(^2S)12p$	$12p\ ^1P^\circ$	1	*44365.9*	
$5s(^2S)12s$	$12s\ ^3S$	1	44457.3	
$4d^2$	$4d^2\ ^3P$	0	44525.88	70.09
		1	44595.97	133.70
		2	44729.67	
$5s(^2S)9f$	$9f\ ^3F^\circ$	2, 3, 4	*44544.6*	
$5s(^2S)9f$	$9f\ ^1F^\circ$	3	*44556.1*	
$5s(^2S)11d$	$11d\ ^3D$	1		
		2	44618.4	6.7
		3	44625.1	
$5s(^2S)13p$	$13p\ ^1P^\circ$	1	*44675.1*	

Sr I—Continued

Config.	Desig.	J	Level	Interval
$5s(^2S)10f$	$10f\ ^3F^\circ$	2, 3, 4	*44809.8*	
$5s(^2S)10f$	$10f\ ^1F^\circ$	3	*44819.1*	
$5s(^2S)12d$	$12d\ ^3D$	1		
		2	44860.0	4.9
		3	44864.9	
$5s(^2S)14p$	$14p\ ^1P^\circ$	1	*44903.5*	
$5s(^2S)11f$	$11f\ ^3F^\circ$	2, 3, 4	*45005.6*	
$5s(^2S)11f$	$11f\ ^1F^\circ$	3	*45012.0*	
$5s(^2S)13d$	$13d\ ^3D$	1, 2, 3	45043.9	
$5s(^2S)12f$	$12f\ ^3F^\circ$	2, 3, 4	*45155.6*	

Sr I—Continued

Config.	Desig.	J	Level	Interval
$5s(^2S)12f$	$12f\ ^1F^\circ$	3	*45160.4*	
$5s(^2S)13f$	$13f\ ^3F^\circ$	2, 3, 4	*45274.1*	
$5s(^2S)13f$	$13f\ ^1F^\circ$	3	*45277.9*	
$5s(^2S)15d$	$15d\ ^3D$	1, 2, 3	45287.4	
$5s(^2S)16d$	$16d\ ^3D$	1, 2, 3	45372.6	
Sr II $(^2S_{0½})$	*Limit*	-------	**45925.6**	
$4d(^2D)6p$	$6p'\ ^3F^\circ$	2	*49409.9*	
		3	*49558.3*	148.4
		4	*49665.8*	107.5

April 1951.

Sr I Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Observed Terms			
$5s^2$	$5s^2\ ^1S$			
$4d^2$	$4d^2\ ^3P$			
$5p^2$	$5p^2\ ^3P$; $5p^2\ ^1S$; $5p^2\ ^1D$			
	$ns\ (n\geq5)$	$np\ (n\geq5)$	$nd\ (n\geq4)$	$nf\ (n\geq4)$
$5s(^2S)nx$	6–12$s\ ^3S$ 6–11$s\ ^1S$	5– 7$p\ ^3P^\circ$ 5–14$p\ ^1P^\circ$	4–13, 15, 16$d\ ^3D$ 4–9$d\ ^1D$	4–13$f\ ^3F^\circ$ 4–13$f\ ^1F^\circ$
$4d(^2D)nx'$		$5p'\ ^3P^\circ$ $5p'\ ^3D^\circ$ 5, $6p'\ ^3F^\circ$ $5p'\ ^1D^\circ$ $5p'\ ^1F^\circ$		

*For predicted terms in the spectra of the Sr I isoelectronic sequence, see Vol. II, Introduction.

Sr II

(Rb I sequence; 37 electrons) $Z=38$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s\ ^2S_{0½}$

$5s\ ^2S_{0½}$ **88964.0** cm^{-1} I. P. 11.027 volts

The analysis is from the paper by Saunders, Schneider, and Buckingham, who list 93 classified lines between 1482 A and 13124 A, including the infrared observations by Meggers and by Randall, in addition to their own observations. Sullivan has observed 14 of these lines with the interferometer, and derived improved term values for the six terms given to two decimal places in the table. Brackets denote calculated values.

REFERENCES

W. F. Meggers, Bur. Std. J. Research **10**, 679, RP 558 (1933). (C L)

F. A. Saunders, E. G. Schneider, and E. Buckingham, Proc. Nat. Acad. Sci. **20**, 291 (1934). (I P) (T) (C L)

H. Westmeyer, Zeit. Phys. **94**, 590 (1935). (hfs)

F. J. Sullivan, Univ. Pittsburgh Bull. **35**, No. 1, 1 (1938). (T) (C L)

J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

Sr II

Config.	Desig.	J	Level	Interval
$4p^6(^1S)5s$	$5s\ ^2S$	0½	0.00	
$4p^6(^1S)4d$	$4d\ ^2D$	1½ 2½	14555.90 14836.24	280.34
$4p^6(^1S)5p$	$5p\ ^2P^\circ$	0½ 1½	*23715.19* *24516.65*	801.46
$4p^6(^1S)6s$	$6s\ ^2S$	0½	47736.53	
$4p^6(^1S)5d$	$5d\ ^2D$	1½ 2½	53286.31 53372.97	86.66
$4p^6(^1S)6p$	$6p\ ^2P^\circ$	0½ 1½	*55769.7* *56057.9*	288.2
$4p^6(^1S)4f$	$4f\ ^2F^\circ$	{ 2½ 3½ }	*60991.7*	
$4p^6(^1S)7s$	$7s\ ^2S$	0½	64964.10	
$4p^6(^1S)6d$	$6d\ ^2D$	1½ 2½	67522.87 67563.15	40.28
$4p^6(^1S)7p$	$7p\ ^2P^\circ$	0½ 1½	*68645.2* *68793.6*	148.4
$4p^6(^1S)5f$	$5f\ ^2F^\circ$	{ 2½ 3½ }	*71065.8*	
$4p^6(^1S)4g$	$4g\ ^2G$	{ 3½ 4½ }	71357.8	
$4p^6(^1S)8s$	$8s\ ^2S$	0½	73237.1	
$4p^6(^1S)7d$	$7d\ ^2D$	1½ 2½	74621.3 74643.1	21.8
$4p^6(^1S)8p$	$8p\ ^2P^\circ$	0½ 1½	 *75311.8*	
$4p^6(^1S)6f$	$6f\ ^2F^\circ$	{ 2½ 3½ }	*76553.4*	
$4p^6(^1S)5g$	$5g\ ^2G$	{ 3½ 4½ }	76737.7	
$4p^6(^1S)9s$	$9s\ ^2S$	0½	77857.6	
$4p^6(^1S)8d$	$8d\ ^2D$	1½ 2½	78688.8 78702.4	13.6
$4p^6(^1S)7f$	$7f\ ^2F^\circ$	{ 2½ 3½ }	*79861.3*	
$4p^6(^1S)6g$	$6g\ ^2G$	{ 3½ 4½ }	79984.3	

Sr II

Config.	Desig.	J	Level	Interval
$4p^6(^1S)10s$	$10s\ ^2S$	0½	80701.8	
$4p^6(^1S)9d$	$9d\ ^2D$	1½ 2½	81240.2 [81249.0]	[8.8]
$4p^6(^1S)8f$	$8f\ ^2F^\circ$	{ 2½ 3½ }	*82005.9*	
$4p^6(^1S)7g$	$7g\ ^2G$	{ 3½ 4½ }	82090.4	
$4p^6(^1S)11s$	$11s\ ^2S$	0½	82576.1	
$4p^6(^1S)10d$	$10d\ ^2D$	2½ 1½	82951.5 82953.9	−2.4
$4p^6(^1S)9f$	$9f\ ^2F^\circ$	{ 2½ 3½ }	*83472.7*	
$4p^6(^1S)8g$	$8g\ ^2G$	{ 3½ 4½ }	[83533.8]	
$4p^6(^1S)12s$	$12s\ ^2S$	0½	83879.9	
$4p^6(^1S)11d$	$11d\ ^2D$	1½ 2½	84142.0 84146.9	4.9
$4p^6(^1S)10f$	$10f\ ^2F^\circ$	{ 2½ 3½ }	*84521.0*	
$4p^6(^1S)9g$	$9g\ ^2G$	{ 3½ 4½ }	84567.0	
$4p^6(^1S)13s$	$13s\ ^2S$	0½	84819.1	
$4p^6(^1S)12d$	$12d\ ^2D$	{ 1½ 2½ }	85015.5	
$4p^6(^1S)11f$	$11f\ ^2F^\circ$	{ 2½ 3½ }	*85294.8*	
$4p^6(^1S)10g$	$10g\ ^2G$	{ 3½ 4½ }	85330.3	
$4p^6(^1S)13d$	$13d\ ^2D$	{ 1½ 2½ }	85668.8	
$4p^6(^1S)12f$	$12f\ ^2F^\circ$	{ 2½ 3½ }	*85883.9*	
$4p^6(^1S)14d$	$14d\ ^2D$	{ 1½ 2½ }	86174.6	
Sr III ($^1S_0$)	*Limit*	------	88964.0	

March 1951.

Sr IV

(Br I sequence; 35 electrons) $Z=38$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$

$4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$ ***460000*** cm^{-1} I. P. 57 volts

The analysis is incomplete. Tomboulian has classified 29 lines of Sr IV in the region between 367 A and 710 A as due to transitions from the ground term to 11 higher terms.

He has estimated the value of the limit by extrapolation of isoelectronic sequence data.

REFERENCE

D. H. Tomboulian, Phys. Rev. **54**, 350 (1938). (I P) (T) (C L)

Sr IV

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^5$	$4p^5\ {}^2P^{\circ}$	1½	*0*	−9731
		0½	*9731*	
$4s\ 4p^6$	$4p^6\ {}^2S$	0½	150505	
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4D$	3½		
		2½		
		1½	183305	−2760
		0½	186065	
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4P$	0½	209214	315
		1½	209529	
		2½		
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2D$	1½	214345	
		2½		
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2P$	0½		
		1½	218939	

Sr IV

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^4P$	2½		
		1½	221149	−4704
		0½	225853	
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^2P$	1½	232970	−5233
		0½	238203	
$4s^2\ 4p^4(^1D)5s$	$5s'\ {}^2D$	1½	247616	
		2½		
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2D$	2½		
		1½	249646	
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2P$	1½	253233	
		0½		
$4s^2\ 4p^4(^1S)5s$	$5s''\ {}^2S$	0½	271774	
Sr V $(^3P_2)$	*Limit*	--------	***460000***	

February 1951.

Sr IV Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms	
$4s^2\ 4p^5$	$4p^5\ {}^2P^{\circ}$	
$4s\ 4p^6$	$4p^6\ {}^2S$	
	$ns\ (n \geq 5)$	$nd\ (n \geq 4)$
$4s^2\ 4p^4(^3P)nx$	$5s\ {}^4P$ $5s\ {}^2P$	$4d\ {}^4P$ $4d\ {}^4D$ $4d\ {}^2P$ $4d\ {}^2D$
$4s^2\ 4p^4(^1D)nx'$	$5s'\ {}^2D$	$4d'\ {}^2P$ $4d'\ {}^2D$
$4s^2\ 4p^4(^1S)nx''$	$5s''\ {}^2S$	

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Sr XI

(Ni I sequence; 28 electrons) $Z=38$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ ^1S_0$

$3d^{10}\ ^1S_0$ **2613800** cm^{-1} I. P. 324 volts

Edlén has observed lines from the $3d^{10}-3d^9\ np$ (n=4,5) and $3d^{10}-3d^9\ nf$ (n=4–6) configurations. In figure 2 of his paper on the spectra of highly ionized atoms, some lines from each group are indicated on the photograph of vacuum spark spectra of Sr observed between 50 A and 100 A.

From preliminary unpublished measurements he has derived provisional absolute term values from the Rydberg nf-series. The terms in the table are from his manuscript. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica **13**, No. 9, 547 (1947).
B. Edlén, letter (July 1950). (I P) (T)

Sr XI **Sr XI**

Config.	Desig.	J	Level	Config.	Desig.	J	Level
$3d^{10}$	$3d^{10}\ ^1S$	0	0	$3d^9(^2D)5p$	$5p\ ^3D°$	3	
						2	
$3d^9(^2D)4p$	$4p\ ^1P°$	1	*1193900*			1	*1824800*
$3d^9(^2D)4p$	$4p\ ^3D°$	3		$3d^9(^2D)5f$	$5f\ ^1P°$	1	*2067000*
		2					
		1	*1203500*	$3d^9(^2D)5f$	$5f\ ^3D°$	3	
						2	
$3d^9(^2D)4f$	$4f\ ^3P°$	2				1	*2086400*
		1	*1743100*				
		0		$3d^9(^2D)6f$	$6f\ ^1P°$	1	*2236600*
$3d^9(^2D)4f$	$4f\ ^1P°$	1	*1755900*	$3d^9(^2D)6f$	$6f\ ^3D°$	3	
						2	
$3d^9(^2D)4f$	$4f\ ^3D°$	3				1	*2251700*
		2					
		1	*1781900*				
$3d^9(^2D)5p$	$5p\ ^1P°$	1	*1814900*	Sr XII ($^2D_{2\frac{1}{2}}$)	*Limit*	--------	**2613800**

August 1950.

Sr XII

(Co I sequence; 27 electrons) $Z=38$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ ^2D_{2\frac{1}{2}}$

$3d^9\ ^2D_{2\frac{1}{2}}$ cm^{-1} I. P. volts

Edlén has observed three lines due to the transition $3p^6\ 3d^9\ ^2D-3p^5\ 3d^{10}\ ^2P°$. From preliminary unpublished measurements he has furnished the provisional term values quoted in the table. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of the vacuum spark spectra of Sr observed between 50 A and 100 A. Another group of lines from $3d^9-3d^8\ 4p$ is also indicated in the figure.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica **13**, No. 9, 547 (1947).
B. Edlén, letter (July 1950). (T)

Sr XII

Config.	Desig.	J	Level	Interval
$3p^6\ 3d^9$	$3d^9\ {}^2D$	$2\frac{1}{2}$ $1\frac{1}{2}$	0 14500	−14500
$3p^5\ 3d^{10}$	$3d^{10}\ {}^2P^\circ$	$1\frac{1}{2}$ $0\frac{1}{2}$	*1086400* *1171800*	−85400

July 1950.

Sr XIII

(Fe I sequence; 26 electrons) $Z=38$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ {}^3F_4$

$3d^8\ {}^3F_4$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^8-3d^7\ 4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of vacuum spark spectra of Sr observed between 50 A and 100 A.

The writer has assumed the ground state indicated above, by analogy with Ni III.

REFERENCE

B. Edlén, Physica **13,** No. 9, 547 (1947).

February 1950.

Sr XIV

(Mn I sequence; 25 electrons) $Z=38$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ {}^4F_{4\frac{1}{2}}$

$3d^7\ {}^4F_{4\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^7-3d^6\ 4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of vacuum spark spectra of Sr observed between 50 A and 100 A.

The writer has assumed the ground state indicated above, by analogy with Co III.

REFERENCE

B. Edlén, Physica **13,** No. 9, 547 (1947).

February 1950.

Y I

39 electrons $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^2\ 4d\ ^2D_{1\frac{1}{2}}$

$4d\ ^2D_{1\frac{1}{2}}$ **52650 cm^{-1}** I. P. 6.5 volts

The analysis is by Meggers and Russell, who have classified 448 lines in the interval 2332.58 A to 9494.81 A, based chiefly on observations of wave length by Meggers and of Zeeman effect by Meggers and B. E. Moore. Observed intersystem combinations connect the doublet and quartet systems of terms. Their limit is from the $ns\,^2D(n=5,6)$, $ns\,^4D(n=6,7)$, $ns\,^4F(n=5,6)$, and $ns\,^4P(n=5,6)$ series represented by a Rydberg formula, with a Ritz correction applied to take into account the error in limits derived from series of only two members.

The writer has changed the notation to agree with that used in the present volumes for complex spectra. The notation of Meggers and Russell is given in the first column. In their term table the J-values for $z\,^2H$ should be interchanged. This correction has been made in column one.

McNally and Harrison have observed the Zeeman Effect of Y I at the Massachusetts Institute of Technology and derived the g-values listed in the table from their own data combined with the earlier observations. In the course of this work they have adjusted the decimals of known levels to agree with their observed wave lengths, but have added no new analysis. These revisions have been adopted in the table.

REFERENCES

W. F. Meggers and H. N. Russell, Bur. Std. J. Research **2,** 745, RP55 (1929). (I P) (T) (C L) (Z E) (G D)
J. R. McNally, Jr., and G. R. Harrison, J. Opt. Soc. Am. **35,** 584 (1945). (Z E) (T) (C L)
J. E. Mack, Rev. Mod. Phys. **22,** No. 1, 64 (1950). (Summary hfs)

Y I

Authors	Config.	Desig.	J	Level	Interval	Obs. g
$a\ ^2D_2$	$4d\ 5s^2$	$a\ ^2D$	1½	0.00		0.798
$a\ ^2D_3$			2½	530.36	530.36	1.196
$z\ ^2P_1$	$5s^2(a\ ^1S)5p$	$z\ ^2P°$	0½	*10529.20*		0.63
$z\ ^2P_2$			1½	*11359.70*	830.50	1.34
$a\ ^4F'_2$	$4d^2(a\ ^3F)5s$	$a\ ^4F$	1½	10937.35		0.402
$a\ ^4F'_3$			2½	11078.61	141.26	1.033
$a\ ^4F'_4$			3½	11277.96	199.35	1.242
$a\ ^4F'_5$			4½	11532.13	254.17	1.337
$z\ ^4F_2$	$4d\ 5s(a\ ^3D)5p$	$z\ ^4F°$	1½	*14949.00*		0.47
$z\ ^4F_3$			2½	*15245.80*	296.80	1.08
$z\ ^4F_4$			3½	*15712.40*	466.60	1.26
$z\ ^4F_5$			4½	*16234.50*	522.10	1.33
$a\ ^4P'_1$	$4d^2(a\ ^3P)5s$	$a\ ^4P$	0½	15221.81		2.61
$a\ ^4P'_2$			1½	15329.04	107.23	1.62
$a\ ^4P'_3$			2½	15476.69	147.65	1.27
$a\ ^2F'_3$	$4d^2(a\ ^3F)5s$	$a\ ^2F$	2½	15326.83		1.15
$a\ ^2F'_4$			3½	15864.35	537.52	1.17
$b\ ^2D_2$	$4d^2(b\ ^1D)5s$	$b\ ^2D$	1½	15994.11		0.86
$b\ ^2D_3$			2½	16158.9	164.8	1.22
$z\ ^2D'_3$	$4d\ 5s(a\ ^3D)5p$	$z\ ^2D°$	2½	*16066.00*		1.203
$z\ ^2D'_2$			1½	*16146.10*	−80.10	0.797

Y I

Authors	Config.	Desig.	J	Level	Interval	Obs. g
$z\ ^4D'_1$	$4d\ 5s(a\ ^3D)5p$	$z\ ^4D°$	0½	*16435.80*		0.01
$z\ ^4D'_2$			1½	*16597.30*	161.50	1.22
$z\ ^4D'_3$			2½	*16816.60*	219.30	1.38
$z\ ^4D'_4$			3½	*17116.30*	299.70	1.42
$a\ ^2G_5$	$4d^2(a\ ^1G)5s$	$a\ ^2G$	4½	18499.30		1.12
$a\ ^2G_4$			3½	18512.46	−13.16	0.90
$z\ ^4P_1$	$4d\ 5s(a\ ^3D)5p$	$z\ ^4P°$	0½	*18976.30*		
$z\ ^4P_2$			1½	*19027.50*	51.20	
$z\ ^4P_3$			2½	*19148.00*	120.50	1.49
$a\ ^2P'_1$	$4d^2(a\ ^3P)5s$	$a\ ^2P$	0½	19237.65		1.18?
$a\ ^2P'_2$			1½	19406.19	168.54	1.28?
$z\ ^2F_3$	$4d\ 5s(a\ ^3D)5p$	$z\ ^2F°$	2½	*21528.60*		0.854
$z\ ^2F_4$			3½	*21915.40*	386.80	1.148
$y\ ^2D'_2$	$4d\ 5s(a\ ^1D)5p$	$y\ ^2D°$	1½	*24131.20*		0.823
$y\ ^2D'_3$			2½	*24746.60*	615.40	1.088
$y\ ^2P_2$	$4d\ 5s(a\ ^3D)5p$	$y\ ^2P°$	1½	*24480.60*		1.302
$y\ ^2P_1$			0½	*24698.80*	−218.20	0.674
$y\ ^2F_3$	$4d\ 5s(a\ ^1D)5p$	$y\ ^2F°$	2½	*24518.80*		0.964
$y\ ^2F_4$			3½	*24899.50*	380.70	1.147

Y I—Continued

Authors	Config.	Desig.	J	Level	Interval	Obs. g
$x\ ^2P_1$	$4d\,5s(a\,^1D)5p$	$x\ ^2P^\circ$	0½	27824.50	315.10	0.667
$x\ ^2P_2$			1½	28139.60		1.324
$z\ ^4G'_3$	$4d^2(a\,^3F)5p$	$z\ ^4G^\circ$	2½	28694.00	294.90	0.56
$z\ ^4G'_4$			3½	28988.90	375.30	1.00
$z\ ^4G'_5$			4½	29364.20	456.20	1.18
$z\ ^4G'_6$			5½	29820.40		1.27
$b\ ^4F'_2$	$4d^3$	$b\ ^4F$	1½	29272.0	148.4	
$b\ ^4F'_3$			2½	29420.4	193.4	
$b\ ^4F'_4$			3½	29613.8	228.9	
$b\ ^4F'_5$			4½	29842.7		
$y\ ^4F_2$	$4d^2(a\,^3F)5p$	$y\ ^4F^\circ$	1½	31508.40	171.60	0.402
$y\ ^4F_3$			2½	31680.00	229.20	1.033
$y\ ^4F_4$			3½	31909.20	278.90	1.242
$y\ ^4F_5$			4½	32188.10		1.337
$a\ ^2S_1$	$5s^2(a\,^1S)6s$	$e\ ^2S$	0½	31671.5		2.03
$b\ ^4P'_1$	$4d^3$	$b\ ^4P$	0½	31977.5	113.5	
$b\ ^4P'_2$			1½	32091.0	275.3	
$b\ ^4P'_3$			2½	32366.3		
$a\ ^4D_1$	$4d\,5s(a\,^3D)6s$	$e\ ^4D$	0½	33148.3	89.6	0.01
$a\ ^4D_2$			1½	33237.9	173.7	1.28
$a\ ^4D_3$			2½	33411.6	341.2	1.35
$a\ ^4D_4$			3½	33752.8		1.42
$y\ ^4D'_1$	$4d^2(a\,^3F)5p$	$y\ ^4D^\circ$	0½	33215.40	49.90	−0.04
$y\ ^4D'_2$			1½	33265.30	92.30	1.20
$y\ ^4D'_3$			2½	33357.60	256.90	1.38
$y\ ^4D'_4$			3½	33614.50		1.40
$z\ ^2G'_4$	$4d^2(a\,^3F)5p$	$z\ ^2G^\circ$	3½	33432.30	356.50	0.91
$z\ ^2G'_5$			4½	33788.80		1.15
$x\ ^2F_3$	$4d^2(a\,^3F)5p$	$x\ ^2F^\circ$	2½	33608.20	421.60	0.985
$x\ ^2F_4$			3½	34029.80		1.17
$b\ ^2P'_1$	$5p^2(b\,^3P)5s?$	$e\ ^2P$	0½	33613.2	229.2	0.93
$b\ ^2P'_2$			1½	33842.4		1.36
$x\ ^2D'_2$	$4d^2(a\,^3F)5p$	$x\ ^2D^\circ$	1½	33906.80	340.90	0.826
$x\ ^2D'_3$			2½	34247.70		1.186
$c\ ^4P'_1$	$5p^2(b\,^3P)5s$	$e\ ^4P$	0½	33911.5	244.4	2.58
$c\ ^4P'_2$			1½	34155.9	365.4	1.47
$c\ ^4P'_3$			2½	34521.3		1.46
$c\ ^2D_2$	$5p^2(f\,^1D)5s?$	$e\ ^2D$	1½	34231.6	25.8	0.94?
$c\ ^2D_3$			2½	34257.4		1.34
$z\ ^2S'_1$	$4d^2(a\,^3P)5p$	$z\ ^2S^\circ$	0½	34438.20		1.70
$x\ ^4D'_1$	$4d^2(a\,^3P)5p$	$x\ ^4D^\circ$	0½	35816.70	319.00	0.18
$x\ ^4D'_2$			1½	36135.70	−74.70	1.94?
$x\ ^4D'_3$			2½	36061.00	300.30	1.34
$x\ ^4D'_4$			3½	36361.30		1.38
$d\ ^2D_2$	$4d\,5s(a\,^3D)6s$	$f\ ^2D$	1½	36420.6	10.5	0.90
$d\ ^2D_3$			2½	36431.1		1.21
$w\ ^2D'_2$	$4d^2(b\,^1D)5p$	$w\ ^2D^\circ$	1½	36452.30	166.20	0.86
$w\ ^2D'_3$			2½	36618.50		1.32
$z\ ^4S'_2$	$4d^2(a\,^3P)5p$	$z\ ^4S^\circ$	1½	36750.80		
$y\ ^4P_1$	$4d^2(a\,^3P)5p$	$y\ ^4P^\circ$	0½	37039.50	109.00	2.28
$y\ ^4P_2$			1½	37148.50	327.50	1.58
$y\ ^4P_3$			2½	37476.00		1.45
1		1	2½	37074.2		
$w\ ^2P_2$	$4d^2(b\,^1D)5p$	$w\ ^2P^\circ$	1½	37243.89	−35.41	1.32
$w\ ^2P_1$			0½	37279.30		0.60
$w\ ^2F_3$	$4d^2(b\,^1D)5p$	$w\ ^2F^\circ$	2½	37412.90	206.90	0.86
$w\ ^2F_4$			3½	37619.80		1.14

Y I—Continued

Authors	Config.	Desig.	J	Level	Interval	Obs. g
$z\ ^2H_5$	$4d^2(a\,^1G)5p$	$z\ ^2H^\circ$	4½	37588.20	379.00	0.91
$z\ ^2H_6$			5½	37967.20		1.11
$b\ ^4D_1$	$4d\,5s(a\,^3D)5d$	$f\ ^4D$	0½	38469.9	73.8	
$b\ ^4D_2$			1½	38543.7	131.7	1.22
$b\ ^4D_3$			2½	38675.4	190.2	1.08
$b\ ^4D_4$			3½	38865.6		1.34
$y\ ^2G'_4$	$4d^2(a\,^1G)5p$	$y\ ^2G^\circ$	3½	38479.00	117.70	0.89
$y\ ^2G'_5$			4½	38596.70		1.11
$a\ ^4G_3$	$4d\,5s(a\,^3D)5d$	$e\ ^4G$	2½	38635.5	126.6	0.73
$a\ ^4G_4$			3½	38762.1	187.5	1.04
$a\ ^4G_5$			4½	38949.6	273.4	1.16
$a\ ^4G_6$			5½	39223.0		1.30
$c\ ^4F'_2$	$4d\,5s(a\,^3D)5d$	$e\ ^4F$	1½	39446.3	118.8	0.57
$c\ ^4F'_3$			2½	39565.1	192.7	1.12
$c\ ^4F'_4$			3½	39757.8	205.9	1.20
$c\ ^4F'_5$			4½	39963.7		
$d\ ^4P'_1$	$4d\,5s(a\,^3D)5d$	$f\ ^4P$	0½			
$d\ ^4P'_2$			1½	40455.1	62.0	
$d\ ^4P'_3$			2½	40517.1		1.52
$v\ ^2D'_2$	$4d^2(a\,^3P)5p$	$v\ ^2D^\circ$	1½	40636.30	36.10	
$v\ ^2D'_3$			2½	40672.40		1.25
$e\ ^2D_2$	$5s^2(a\,^1S)5d$	$g\ ^2D$	1½	42655.6	414.4	
$e\ ^2D_3$			2½	43070.0		
$b\ ^2S_1$	$5p^2(^1S)5s?$	$f\ ^2S$	0½	42685.7		
$v\ ^2F_3$	$4d^2(a\,^1G)5p$	$v\ ^2F^\circ$	2½	42857.90	136.90	
$v\ ^2F_4$			3½	42994.80		
$d\ ^4F'_2$	$4d^2(a\,^3F)5d?$	$f\ ^4F$	1½	43095.7	241.9	
$d\ ^4F'_3$			2½	43337.6	366.9	
$d\ ^4F'_4$			3½	43704.5	485.8	1.26
$d\ ^4F'_5$			4½	44190.3		1.33
$c\ ^2S_1$	$5s^2(a\,^1S)7s$	$g\ ^2S$	0½	43643.6		
$e\ ^4F'_2$	$4d^2(a\,^3F)6s$	$g\ ^4F$	1½			
$e\ ^4F'_3$			2½	44052.8?	313.3	
$e\ ^4F'_4$			3½	44366.1	393.5	
$e\ ^4F'_5$			4½	44759.6		
$c\ ^4D_1$	$4d\,5s(a\,^3D)7s$	$g\ ^4D$	0½			
$c\ ^4D_2$			1½			
$c\ ^4D_3$			2½	44654.8	267	
$c\ ^4D_4$			3½	44922		
$d\ ^4D_1$	$5p^2(b\,^3P)4d$	$h\ ^4D$	0½	44660.1	88.2	
$d\ ^4D_2$			1½	44748.3	260.1	
$d\ ^4D_3$			2½	45008.4	195.6	
$d\ ^4D_4$			3½	45204.0		
$f\ ^4F'_2$	$5p^2(b\,^3P)4d$	$h\ ^4F$	1½	44742.7?	326.6?	0.73
$f\ ^4F'_3$			2½	45069.3	319.2	
$f\ ^4F'_4$			3½	45388.5	408.0	
$f\ ^4F'_5$			4½	45796.5		1.37
2		2	{0½, 1½}	44984.1		
3		3	3½	45663.5		
$c\ ^2P'_1$	$5p^2(b\,^3P)4d?$	$f\ ^2P$	0½	45947.5	46.7	
$c\ ^2P'_2$			1½	45994.2		
$e\ ^4P'_1$	$4d^2(a\,^3P)6s$	$g\ ^4P$	0½			
$e\ ^4P'_2$			1½			
$e\ ^4P'_3$			2½	50254.0		
	Y II ($^1S_0$)	*Limit*	-----	52650		

April 1951.

Y I Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Observed Terms		
$4d\ 5s^2$	$a\ ^2\mathrm{D}$		
$4d^3$	$b\ ^4\mathrm{P}$ $b\ ^4\mathrm{F}$		
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$	$nd\ (n \geq 4)$
$5s^2(a\ ^1\mathrm{S})nx$	$e,\ g\ ^2\mathrm{S}$	$z\ ^2\mathrm{P}^\circ$	$g\ ^2\mathrm{D}$
$4d\ 5s(a\ ^3\mathrm{D})nx$	$e,\ g\ ^4\mathrm{D}$ $f\ ^2\mathrm{D}$	$z\ ^4\mathrm{P}^\circ$ $z\ ^4\mathrm{D}^\circ$ $z\ ^4\mathrm{F}^\circ$ $y\ ^2\mathrm{P}^\circ$ $z\ ^2\mathrm{D}^\circ$ $z\ ^2\mathrm{F}^\circ$	$f\ ^4\mathrm{P}$ $f\ ^4\mathrm{D}$ $e\ ^4\mathrm{F}$ $e\ ^4\mathrm{G}$
$4d\ 5s(a\ ^1\mathrm{D})nx$		$x\ ^2\mathrm{P}^\circ$ $y\ ^2\mathrm{D}^\circ$ $y\ ^2\mathrm{F}^\circ$	
$4d^2(a\ ^3\mathrm{F})nx$	$a,\ g\ ^4\mathrm{F}$ $a\ ^2\mathrm{F}$	$y\ ^4\mathrm{D}^\circ$ $y\ ^4\mathrm{F}^\circ$ $z\ ^4\mathrm{G}^\circ$ $x\ ^2\mathrm{D}^\circ$ $x\ ^2\mathrm{F}^\circ$ $z\ ^2\mathrm{G}^\circ$	$f\ ^4\mathrm{F}$?
$4d^2(a\ ^3\mathrm{P})nx$	$a,\ g\ ^4\mathrm{P}$ $a\ ^2\mathrm{P}$	$z\ ^4\mathrm{S}^\circ$ $y\ ^4\mathrm{P}^\circ$ $x\ ^4\mathrm{D}^\circ$ $z\ ^2\mathrm{S}^\circ$ $v\ ^2\mathrm{D}^\circ$	
$4d^2(b\ ^1\mathrm{D})nx$	$b\ ^2\mathrm{D}$	$w\ ^2\mathrm{P}^\circ$ $w\ ^2\mathrm{D}^\circ$ $w\ ^2\mathrm{F}^\circ$	
$4d^2(a\ ^1\mathrm{G})nx$	$a\ ^2\mathrm{G}$	$v\ ^2\mathrm{F}^\circ$ $y\ ^2\mathrm{G}^\circ$ $z\ ^2\mathrm{H}^\circ$	
$5p^2(b\ ^3\mathrm{P})nx$	$e\ ^4\mathrm{P}$ $e\ ^2\mathrm{P}$?		$f\ ^2\mathrm{P}$? $h\ ^4\mathrm{D}$ $h\ ^4\mathrm{F}$
$5p^2(f\ ^1\mathrm{D})nx$	$e\ ^2\mathrm{D}$?		
$5p^2(^1\mathrm{S})nx$	$f\ ^2\mathrm{S}$?		

*For predicted terms in the spectra of the Y I isoelectronic sequence, see Vol. II, Introduction.

Y II

(Sr I sequence; 38 electrons) $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^2\ ^1S_0$

$a\ ^1S_0$ **100000** cm^{-1} I. P. 12.4 volts

The analysis is by Meggers and Russell, who greatly extended the earlier work on Y II. They have published 223 classified lines in the interval 2243.06 A to 8835.85 A, based on Meggers' observations of wavelength and Zeeman effect. Observed intersystem combinations connect the systems of terms of different multiplicity.

Their limit has been determined by applying a Rydberg formula to the *ns*-series terms $a,e\ ^{1,3}D$ and $a,f\ ^1S$, (n=5,6); and an empirical correction to compensate for the error resulting in limits from series of only two members.

Subsequently McNally and Harrison observed the Zeeman effect of Y II at the Massachusetts Institute of Technology, and determined *g*-values for all but one of the 61 known energy levels. Their work confirms in great detail the 1929 analysis. In the course of this work they have adjusted the decimals of the known levels to agree with their observations, but have added no new levels. Their revised level values and *g*-values are quoted in the table.

In 1937 Miss Ho observed the Y spectra with a hollow cathode discharge, and provisionally suggested 39 miscellaneous levels of Y II based on the additional lines observed with this source. Since these levels are not fitted into the term array of Y II, they are not included in the table, pending further confirmation of the new lines as observed with higher dispersion.

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Y II

Authors	Config.	Desig.	J	Level	Interval	Obs. g
$a\ ^1$S	$5s^2$	$a\ ^1$S	0	0. 00		0/0
$a\ ^3$D	$4d(^2D)5s$	$a\ ^3$D	1 2 3	840. 18 1045. 07 1449. 75	204. 89 404. 68	0. 495 1. 162 1. 332
$a\ ^1$D	$4d(^2D)5s$	$a\ ^1$D	2	3296. 20		1. 000
$a\ ^3$F′	$4d^2$	$a\ ^3$F	2 3 4	8003. 12 8328. 03 8743. 33	324. 91 415. 30	0. 668 1. 087 1. 256
$a\ ^3$P′	$4d^2$	$a\ ^3$P	0 1 2	13883. 44 14018. 24 14098. 08	134. 86 79. 84	0/0 1. 497 1. 41
$b\ ^1$D	$4d^2$	$b\ ^1$D	2	14832. 89		1. 10
$a\ ^1$G	$4d^2$	$a\ ^1$G	4	15682. 91		0. 999
$z\ ^3$P	$5s(^2S)5p$	$z\ ^3$P°	0 1 2	*23445. 05* *23776. 25* *24647. 14*	331. 20 870. 89	0/0 1. 489 1. 493
$z\ ^1$D′	$4d(^2D)5p$	$z\ ^1$D°	2	*26147. 27*		0. 912
$z\ ^3$F	$4d(^2D)5p$	$z\ ^3$F°	2 3 4	*27227. 00* *27532. 34* *28394. 17*	305. 34 861. 83	0. 764 1. 082 1. 254
$z\ ^1$P	$4d(^2D)5p$	$z\ ^1$P°	1	*27516. 70*		0. 910
$z\ ^3$D′	$4d(^2D)5p$	$z\ ^3$D°	1 2 3	*28595. 27* *28730. 02* *29213. 95*	134. 75 483. 93	0. 596 1. 165 1. 333
$y\ ^3$P	$4d(^2D)5p$	$y\ ^3$P°	0 1 2	*32048. 76* *32124. 07* *32283. 43*	75. 31 159. 36	0/0 1. 496 1. 494
$z\ ^1$F	$4d(^2D)5p$	$z\ ^1$F°	3	*33336. 74*		0. 997
$y\ ^1$P	$5s(^2S)5p$	$y\ ^1$P°	1	*44568. 63*		0. 998
$b\ ^3$D	$4d(^2D)6s$	$e\ ^3$D	1 2 3	54955. 2 55032. 2 55645. 2	77. 0 613. 0	0. 52 1. 12 1. 34
$c\ ^1$D	$4d(^2D)6s$	$e\ ^1$D	2	55724. 9		1. 05

Y II

Authors	Config.	Desig.	J	Level	Interval	Obs. g
$a\ ^3$S	$5s(^2S)6s$	$e\ ^3$S	1	58262. 1		1. 99
$a\ ^1$F′	$4d(^2D)5d$	$e\ ^1$F	3	58532. 8		1. 02
$c\ ^3$D	$4d(^2D)5d$	$f\ ^3$D	1 2 3	58719. 6 58946. 6 59326. 7	227. 0 380. 1	0. 58 1. 17 1. 17
$b\ ^3$P′	$5p^2$	$e\ ^3$P	0 1 2	58776. 3 59147. 4 59669. 3	371. 1 521. 9	0/0 1. 49 1. 38
$a\ ^3$G	$4d(^2D)5d$	$e\ ^3$G	3 4 5	59179. 4 59472. 1 59900. 5	292. 7 428. 4	0. 90 1. 06 1. 22
$b\ ^1$S	$4d(^2D)5d$	$e\ ^1$S	0	59616. 0?		
$a\ ^1$P′	$4d(^2D)5d$	$e\ ^1$P	1	59715. 8		0. 99
$d\ ^1$D	$4d(^2D)5d$	$f\ ^1$D	2	60535. 1		1. 09
$b\ ^3$S	$4d(^2D)5d$	$f\ ^3$S	1	61199. 6		1. 97
$b\ ^3$F′	$4d(^2D)5d$	$e\ ^3$F	2 3 4	61336. 6 61650. 8 61934. 5	314. 2 283. 7	0. 69 1. 09 1. 26
$c\ ^1$S	$5s(^2S)6s$	$f\ ^1$S	0	61367. 4		0/0
$e\ ^1$D	$5s(^2S)5d$	$g\ ^1$D	2	62495. 2		0. 99
$b\ ^1$G	$4d(^2D)5d$	$e\ ^1$G	4	63350. 3		1. 00
$c\ ^3$P′	$4d(^2D)5d$	$f\ ^3$P	0 1 2	64102. 8 64263. 2 64596. 9	160. 4 333. 7	0/0 1. 50 1. 48
$d\ ^3$D	$5s(^2S)5d$	$g\ ^3$D	1 2 3	65132. 0 65188. 9 65274. 9	56. 9 86. 0	0. 50 1. 16 1. 37
$f\ ^1$D	$5p^2$	$h\ ^1$D	2	70223. 4		0. 99
	Y III ($^2D_{1½}$)	***Limit***		**100000**		

May 1951.

Y II OBSERVED TERMS*

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Observed Terms	
$5s^2$	$a\ ^1S$	
$4d^2$	$a\ ^3P$ $a\ ^3F$ $b\ ^1D$ $a\ ^1G$	
$5p^2$	$e\ ^3P$ $h\ ^1D$	
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$
$4d(^2D)nx$	$a,\ e\ ^3D$ $a,\ e\ ^1D$	$y\ ^3P^\circ$ $z\ ^3D^\circ$ $z\ ^3F^\circ$ $z\ ^1P^\circ$ $z\ ^1D^\circ$ $z\ ^1F^\circ$
$5s(^2S)nx$	$e\ ^3S$ $f\ ^1S$	$z\ ^3P^\circ$ $y\ ^1P^\circ$
	$nd\ (n \geq 4)$	
$4d(^2D)nx$	$f\ ^3S$ $f\ ^3P$ $f\ ^3D$ $e\ ^3F$ $e\ ^3G$ $e\ ^1S$ $e\ ^1P$ $f\ ^1D$ $e\ ^1F$ $e\ ^1G$	
$5s(^2S)nx$	$g\ ^3D$ $g\ ^1D$	

*For predicted terms in the spectrum of the Sr I isoelectronic sequence, see Vol. II, Introduction.

Y III

(Rb I sequence; 37 electrons) $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d\ ^2D_{1\frac{1}{2}}$

$4d\ ^2D_{1\frac{1}{2}}$ **165289** cm^{-1} I. P. 20.5 volts

The analysis is incomplete. Twelve lines have been classified, in the interval between 989.21 A and 2945.92 A. The term values in the table are quoted from the paper by Meggers and Russell. They are based on the measurements by Meggers, except for the two ultraviolet lines 989.21 A and 996.37 A from Bowen and Millikan.

Gibbs and White published Moseley diagrams for the $5s$ and $5p$ electrons of this isoelectronic sequence. Bowen and Millikan extended these diagrams to include $4d$, $5d$, and $4f$ electrons and showed that the $4d$ electron was the most firmly bound in Y III. By comparison with Rb I and Sr II they estimated the value of the $4f\ ^2F^\circ$ term and from this derived the limit quoted here.

REFERENCES

R. C. Gibbs and H. E. White, Proc. Nat. Acad. Sci. **12,** 551 (1926). (C L)
I. S. Bowen and R. A. Millikan, Phys. Rev. **28,** 923 (1926). (I P) (T) (C L)
W. F. Meggers and H. N. Russell, Bur. Std. J. Research **2,** 735, RP55 (1929). (I P) (T) (C L)
J. R. McNally, Jr., and G. R. Harrison, J. Opt. Soc. Am. **35,** 584 (1945). (Z E)
J. E. Mack, Rev. Mod. Phys. **22,** No. 1, 64 (1950). (Summary hfs)

Y III

Config.	Desig.	J	Level	Interval	Obs. g
$4p^6(^1S)4d$	$4d\ ^2D$	1½ 2½	0. 0 724. 8	724. 8	0. 79 1. 22
$4p^6(^1S)5s$	$5s\ ^2S$	0½	7466. 2		2. 00
$4p^6(^1S)5p$	$5p\ ^2P^\circ$	0½ 1½	*41401. 2* *42954. 7*	1553. 5	0. 66 1. 33
$4p^6(^1S)6s$	$6s\ ^2S$	0½	86713. 9		
$4p^6(^1S)5d$	$5d\ ^2D$	1½ 2½	88378. 8 88577. 1	198. 3	
$4p^6(^1S)4f$	$4f\ ^2F^\circ$	{ 2½ 3½	} *101090. 0*		
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Y IV ($^1S_0$)	*Limit*	---	[165289]		

March 1951.

Y V

(Br I sequence; 35 electrons) $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5\ ^2P^\circ_{1½}$

$4p^5\ ^2P^\circ_{1½}$ ***620000*** cm^{-1} I. P. 77 volts

The analysis is incomplete. Paul and Rense have classified 41 lines between 313 A and 629 A, as due to transitions from the ground term to 13 higher terms.

They have estimated the limit by extrapolation of isoelectronic sequence data.

REFERENCE

F. W. Paul and W. A. Rense, Phys. Rev. **56**, 1110 (1939). (I P) (T) (C L)

Y V

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^5$	$4p^5\ ^2P^\circ$	1½ 0½	*0* *12068*	−12068
$4s\ 4p^6$	$4p^6\ ^2S$	0½	170936	
$4s^2\ 4p^4(^3P)4d$	$4d\ ^4D$	3½ 2½ 1½ 0½	 202902 213254 219116	−10352 −5862
$4s^2\ 4p^4(^3P)4d$	$4d\ ^4P$	0½ 1½ 2½	247473 248352 250406	879 2054
$4s^3\ 4p^4(^3P)4d$	$4d\ ^2D$	1½ 2½	253678 263524	9846
$4s^2\ 4p^4(^3P)4d$	$4d\ ^2P$	0½ 1½	258518 258567	49
$4s^2\ 4p^4(^3P)4d$	$4d\ ^2F$	3½ 2½	 274254	
$4s^2\ 4p^4(^3P)5s$	$5s\ ^4P$	2½ 1½ 0½	280932 287205 290911	−6273 −3706

Y V

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^4(^1D)4d$	$4d'\ ^2D$	2½ 1½	289836 297072	−7236
$4s^2\ 4p^4(^1D)4d$	$4d'\ ^2F$	3½ 2½	 291052	
$4s^2\ 4p^4(^3P)5s$	$5s\ ^2P$	1½ 0½	296745 306349	−9604
$4s^2\ 4p^4(^1D)4d$	$4d'\ ^2P$	0½ 1½	299567 300217	650
$4s^2\ 4p^4(^1D)5s$	$5s'\ ^2D$	2½ 1½	315430 317192	−1762
$4s^2\ 4p^4(^1S)4d$	$4d''\ ^2D$	2½ 1½	 318885	
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Y VI ($^3P_2$)	[*Limit*]	--------	[***620000***]	

February 1951.

Y v OBSERVED TERMS*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}+$	Observed Terms	
$4s^2\,4p^5$	$4p^5\ ^2P^\circ$	
$4s\,4p^6$	$4p^6\ ^2S$	
	ns ($n \geq 5$)	nd ($n \geq 4$)
$4s^2\,4p^4(^3P)nx$	$5s\ ^4P$ $5s\ ^2P$	$4d\ ^4P$ $4d\ ^4D$ $4d\ ^2P$ $4d\ ^2D$ $4d\ ^2F$
$4s^2\,4p^4(^1D)nx'$	$5s'\ ^2D$	$4d'\ ^2P$ $4d'\ ^2D$ $4d'\ ^2F$
$4s^2\,4p^4(^1S)nx''$		$4d''\ ^2D$

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Y XII

(Ni I sequence; 28 electrons) $Z=39$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\ ^1S_0$

$3d^{10}\ ^1S_0$ **3016800** cm^{-1} I. P. 374 volts

Edlén has observed three lines from the $3d^{10}-3d^9\,np$ and $3d^{10}-3d^9\,nf$ (n=4, 5) configurations. In figure 2 of his paper on the spectra of highly ionized atoms, two lines of the former group are indicated on the photograph of vacuum spark spectra of Y observed between 50 A and 100 A.

From preliminary unpublished measurements he has derived provisional absolute term values from the Rydberg *nf*-series. The terms in the table are from his manuscript. His unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica **13,** No. 9, 547 (1947).
B. Edlén, letter (July 1950). (I P (T)

Y XII

Config.	Desig.	J	Level
$3d^{10}$	$3d^{10}\ ^1S$	0	0
$3d^9(^2D)4p$	$4p\ ^1P^\circ$	1	*1374600*
$3d^9(^2D)4p$	$4p\ ^3D^\circ$	3 2 1	 *1386800*
$3d^9(^2D)4f$	$4f\ ^1P^\circ$	1	*1994800*
$3d^9(^2D)4f$	$4f\ ^3D^\circ$	3 2 1	 *2026800*
$3d^9(^2D)5p$	$5p\ ^1P^\circ$	1	*2088600*
$3d^9(^2D)5p$	$5p\ ^3D^\circ$	3 2 1	 *2099500*
$3d^9(^2D)5f$	$5f\ ^3D^\circ$	3 2 1	 *2388900*
Y XIII ($^2D_{2\frac{1}{2}}$)	*Limit*	--------	**3016800**

August 1950.

Y XIII

(Co I sequence; 27 electrons) $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ ^2D_{2\frac{1}{2}}$

$3d^9\ ^2D_{2\frac{1}{2}}$ cm^{-1} I. P. volts

Edlén has observed three lines due to the transition $3p^6\,3d^9\ ^2D - 3p^5\,3d^{10}\ ^2P^\circ$. From preliminary unpublished measurements he has furnished the provisional term values quoted in the table. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of the vacuum spark spectra of Y observed between 50 A and 100 A. Another group of lines from $3d^9 - 3d^8\,4p$ is also indicated in the figure.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica **13,** No. 9, 547 (1947).
B. Edlén, letter (July 1950). (T)

Y XIII

Config.	Desig.	J	Level	Interval
$3p^6\ 3d^9$	$3d^9\ ^2D$	2½ 1½	0 17200	−17200
$3p^5\ 3d^{10}$	$3d^{10}\ ^2P^\circ$	1½ 0½	*1143600* *1242400*	−98800

July 1950.

Y XIV

(Fe I sequence; 26 electrons) $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ ^3F_4$

$3d^8\ ^3F_4$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^8 - 3d^7\,4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of vacuum spark spectra of Y observed between 50 A and 100 A.

The writer has assumed the ground state indicated above, by analogy with Ni III.

REFERENCE

B. Edlén, Physica **13,** No. 9, 547 (1947).

February 1950.

Y XV

(Mn I sequence; 25 electrons) $Z=39$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ ^4F_{4\frac{1}{2}}$

$3d^7\ ^4F_{4\frac{1}{2}}$ cm^{-1} I. P. volts

This spectrum has not been analyzed, but Edlén has observed a group of lines due to terms from the $3d^7 - 3d^6\,4p$ configurations. In figure 2 of his paper on the spectra of highly ionized atoms, the lines are indicated on the photograph of vacuum spark spectra of Y observed between 50 A and 100 A.

The writer has assumed the ground state indicated above by analogy with Co III.

REFERENCE

B. Edlén, Physica **13,** No. 9, 547 (1947).

February 1950.

ZIRCONIUM

Zr I

40 electrons $Z=40$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^2\ 5s^2\ {}^3F_2$

$a\ {}^3F_2$ **56077** cm^{-1} I. P. 6.95 volts

The analysis is by Kiess and Mrs. Kiess, who have observed nearly 1600 lines in this spectrum between 2088.89 A and 9276.94 A, and classified approximately 80 percent of them. Meggers and Kiess have since extended the observations to 10738.94 A. Many of the terms are confirmed by the Zeeman patterns, for which the observations by B. E. Moore as well as those of the authors were utilized.

Their limit is from a Rydberg representation of the $ns\ {}^3F$ and $ns\ {}^5F$ series ($n=5,6$), the former having the configuration $4d^2\ 5s(a\ {}^4F)ns$, and the latter $4d^3(b\ {}^4F)ns$.

The singlet, triplet, and quintet systems of terms are connected by observed intersystem combinations.

Kiess has suggested that his published configuration assignment of the $c\ {}^2D$ term in Zr II be changed from $4d^3$ to $4d\ 5s^2$, and that the term $d\ {}^2D$ remain unassigned. These changes have been adopted here. Consequently, the three Zr I terms having the limit term $d\ {}^2D$ in Zr II, $q\ {}^3F°$, $o\ {}^3D°$, and $t\ {}^3P°$, do not appear in the array of observed terms following the table.

The observed g-values are those given by Sancho except for seven pairs of levels affected by g-sharing, which are taken from Table 5 of the Kiess' paper.

The detailed analysis of this complex spectrum presents another beautiful confirmation of Hund's theory of line spectra and atomic structure.

REFERENCES

C. C. Kiess and H. K. Kiess, Bur. Std. J. Research **6,** 621, RP296 (1931). (I P) (T) (C L) (Z E) (E D)
W. F. Meggers and C. C. Kiess, Bur. Std. J. Research **9,** ,324, RP473 (1932). (C L)
P. M. Sancho, Anal. Soc. Esp. de Fisica y Quimica (Madrid) **30,** 867 (1932). (Z E)
J. E. Mack, Rev. Mod. Phys. **22,** No. 1, 64 (1950). (Summary hfs)

Zr I

Config.	Desig.	J	Level	Interval	Obs. g
$4d^2\ 5s^2$	$a\ {}^3F$	2	0.00	570.41	0.66
		3	570.41	670.43	1.06
		4	1240.84		1.24
$4d^2\ 5s^2$	$a\ {}^3P$	2	4186.11	−190.17	1.25
		1	4376.28	179.43	1.48
		0	4196.85		0.00
$4d^3(b\ {}^4F)5s$	$a\ {}^5F$	1	4870.53	152.88	0.00
		2	5023.41	225.66	0.98
		3	5249.07	291.47	1.28
		4	5540.54	348.39	1.31
		5	5888.93		1.37
$4d^2\ 5s^2$	$a\ {}^1D$	2	5101.68		1.25
$4d^2\ 5s^2$	$a\ {}^1G$	4	8057.30		1.00
$4d^3(b\ {}^4P)5s$	$a\ {}^5P$	1	10885.36	131.29	2.50
		2	11016.65	241.73	1.82
		3	11258.38		1.66
$4d^3(b\ {}^4F)5s$	$b\ {}^3F$	2	11640.72	315.61	0.75
		3	11956.33	386.04	1.05
		4	12342.37		1.15

Zr I

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3(a\ {}^2G)5s$	$a\ {}^3G$	3	12503.44	257.22	0.78
		4	12760.66	12.12	1.15
		5	12772.78		1.20
$4d^2\ 5s^2$	$a\ {}^1S$	0	13141.76		
$4d^3(b\ {}^2D)5s$	$a\ {}^3D$	1	14123.01	225.77	0.61
		2	14348.78	348.25	1.17
		3	14697.03		1.35
$4d^2\ 5s(a\ {}^4F)5p$	$z\ {}^5G°$	2	*14783.54*	417.72	0.43
		3	*15201.26*	519.10	1.09
		4	*15720.36*	596.60	1.12
		5	*16316.96*	661.33	1.28
		6	*16978.29*		1.36
$4d^3(a\ {}^3H)5s$	$a\ {}^3H$	4	14791.28	197.23	0.77
		5	14988.51	131.15	1.03
		6	15119.66		1.15
$4d^3(b\ {}^2F)5s$	$c\ {}^3F$	2	15146.48	310.92	
		3	15457.40	242.46	
		4	15699.86		

Zr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3(b\ ^4P)5s$	$b\ ^3P$	0			
		1			
		2	15932.10		1.46
$4d^2\ 5s(a\ ^4F)5p$	$z\ ^3F°$	2	16296.51	547.42	0.67
		3	16843.93	712.33	1.08
		4	17556.26		1.23
$4d^2\ 5s(a\ ^4F)5p$	$z\ ^5F°$	1	16786.93	272.68	0.30
		2	17059.61	362.56	0.95
		3	17422.17	410.56	1.25
		4	17832.73	444.19	1.35
		5	18276.92		1.40
$4d^3(b\ ^2P)5s$	$c\ ^3P$	2	17142.72	82.90	
		1	17059.82	−261.70	
		0	17321.52		
$4d^3(b\ ^2D)5s$	$b\ ^1D$	2	17228.42		
$4d^2\ 5s(a\ ^4F)5p$	$z\ ^3D°$	1	17429.86	383.78	0.42
		2	17813.64	429.92	1.09
		3	18243.56		1.32
$4d^2\ 5s(a\ ^2D)5p$	$z\ ^1D°$	2	17511.78		0.96
$4d^3(a\ ^2G)5s$	$b\ ^1G$	4	17752.73		1.00
$4d^3(a\ ^2H)5s$	$a\ ^1H$	5	18738.94		1.02
$4d^2\ 5s(a\ ^4F)5p$	$z\ ^5D°$	0	18976.36	120.17	0.00
		1	19096.53	227.31	1.55
		2	19323.84	301.74	1.45
		3	19625.58	208.20	1.50
		4	19833.78		1.49
$4d^2\ 5s(a\ ^2P)5p$	$z\ ^3P°$	0	20233.97	285.23	0.00
		1	20519.20	−52.37	1.51
		2	20466.83		1.47
$4d^4$	$a\ ^5D$	0	21726.28	74.93	
		1	21801.21	142.53	
		2	21943.74	201.57	
		3	22145.31	252.69	
		4	22398.00		
$4d^2\ 5s(a\ ^4F)5p$	$z\ ^3G°$	3	21849.33	294.75	0.75
		4	22144.08	419.81	1.03
		5	22563.89		1.21
$4d^2\ 5s(a\ ^2P)5p$	$z\ ^3S°$	1	21974.18		2.01
$4d^2\ 5s(a\ ^2P)5p$	$y\ ^1D°$	2	22750.53		1.09
$4d^2\ 5s(a\ ^2D)5p$	$z\ ^1F°$	3	22862.02		0.90
$4d^2\ 5s(a\ ^4P)5p$	$y\ ^3D°$	1	23018.92	300.94	0.52
		2	23319.86	341.11	1.14
		3	23660.97		1.28
$4d^2\ 5s(a\ ^4P)5p$	$z\ ^5S°$	2	23085.06		
$4d^2\ 5s(a\ ^4P)5p$	$y\ ^5D°$	0	23122.29	124.04	
		1	23246.33	243.10	
		2	23489.43	399.60	
		3	23889.03	487.34	
		4	24376.37		1.45
$4d^3(b\ ^4F)5p$	$y\ ^3F°$	2	23597.47	−30.35	1.08
		3	23567.12	439.18	
		4	24006.30		
$4d^2\ 5s(a\ ^2F)5p$	$y\ ^1F°$	3	24387.52		1.01
$4d^2\ 5s(a\ ^4P)5p$	$z\ ^5P°$	1	25489.87	156.10	
		2	25645.97	252.19	
		3	25898.16		1.65
$4d^3(b\ ^4F)5p$	$y\ ^5G°$	2	25630.48	341.23	0.34
		3	25971.71	370.82	0.93
		4	26342.53	423.13	1.13
		5	26765.66	449.23	1.24
		6	27214.89		1.32

Zr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3(b\ ^4F)5p$	$y\ ^3G°$	3	25729.96	281.59	0.82
		4	26011.55	422.17	1.05
		5	26433.72		1.15
$4d^2\ 5s(a\ ^2D)5p$	$x\ ^3F°$	2	26061.70	382.18	0.67
		3	26443.88	494.54	1.06
		4	26938.42		1.13
$4d^2\ 5s(a\ ^2P)5p$	$x\ ^3D°$	1	26154.13	403.08	0.49
		2	26557.21	553.95	1.15
		3	27111.16		1.33
$4d^3(b\ ^2D)5p$	$x\ ^1F°$	3	26226.97		1.00
$4d^3(b\ ^4F)5p$	$w\ ^3D°$	1	26902.45	219.51	0.50
		2	27121.96	360.30	1.14
		3	27482.26		1.31
$4d^2\ 5s(a\ ^2F)5p$	$z\ ^1G°$	4	26931.35		1.13
$4d^3(b\ ^2D)5p$	$x\ ^1D°$	2	27515.38		
$4d^2\ 5s(a\ ^4P)5p$	$y\ ^3P°$	0	27600.24	−27.72	0.00
		1	27572.52	100.83	1.47
		2	27673.35		1.45
$4d^2\ 5s(a\ ^2F)5p$	$w\ ^3F°$	2	27876.16	281.26	0.70
		3	28157.42	370.94	1.03
		4	28528.36		1.15
$4d^3(a\ ^2G)5p$	$z\ ^3H°$	4	27908.28	303.54	0.78
		5	28211.82	396.80	1.00
		6	28608.62		1.18
$4d^2\ 5s(a\ ^2F)5p$	$x\ ^3G°$	3	28404.26	345.54	0.79
		4	28749.80	251.85	1.15
		5	29001.65		1.21
$4d^3(b\ ^4F)5p$	$y\ ^5F°$	1	28446.92	148.11	0.00
		2	28595.03	222.99	1.03
		3	28818.02	304.69	1.22
		4	29122.71	412.77	1.33
		5	29535.48		1.37
$4d^2\ 5s(a\ ^2D)5p$	$x\ ^3P°$	0	28632.75	77.13	0.00
		1	28709.88	199.69	1.45
		2	28909.57		1.50
$4d^2\ 5s(a\ ^2D)5p$	$v\ ^3D°$	1	28800.51	257.33	0.75
		2	29057.84	216.98	1.16
		3	29274.82		1.31
$4d^2\ 5s(a\ ^2D)5p$	$z\ ^1P°$	1	28999.46		0.75
$4d^3(b\ ^4F)5p$	$x\ ^5D°$	0	29588.07	89.07	0.00
		1	29677.14	170.35	1.48
		2	29847.49	239.84	1.54
		3	30087.33	297.17	1.48
		4	30384.50		1.46
$4d^3(a\ ^2G)5p$	$y\ ^1G°$	4	31050.48		1.01
$4d^3(b\ ^2F)5p$	$w\ ^3G°$	3	31326.81	367.71	0.75
		4	31694.52	457.64	1.04
		5	32152.16		1.20
$4d^2\ 5s(a\ ^4P)5p$	$y\ ^3S°$	1	31850.77		
$4d^2\ 5s(a\ ^2P)5p$	$y\ ^1P°$	1	32722.80		
$4d^3(b\ ^2F)5p$	$v\ ^3F°$	2	32972.30	219.56	
		3	33191.86	496.37	1.08
		4	33688.23		1.08
$4d^3(b\ ^4P)5p$	$x\ ^3S°$	1	33113.80		1.93
$4d^3(b\ ^2D)5p$	$u\ ^3F°$	2	33163.98	256.49	0.70
		3	33420.47	138.87	1.06
		4	33559.34		1.24

Zr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3(b\,^4P)5p$	$w\ ^5D^\circ$	0	33349.56	95.31	0.00
		1	33444.87	187.61	1.52
		2	33632.48	279.61	1.51
		3	33912.09	375.40	1.49
		4	34287.49		1.51
$4d^2\,5s(a\,^2F)5p$	$u\ ^3D^\circ$	1	33486.82	277.30	0.62
		2	33764.12	475.70	1.10
		3	34239.82		1.35
$4d^2\,5s(b\,^2G)5p$	$z\ ^1H^\circ$	5	33839.20		1.03
$4d^3(a\,^2H)5p$	$y\ ^3H^\circ$	4	34450.60	255.30	0.80
		5	34705.90	429.17	1.02
		6	35135.07		1.16
$4d^3(b\,^4P)5p$	$y\ ^5P^\circ$	1	34617.00	144.52	2.46
		2	34761.52	329.38	1.42
		3	35090.90		1.66
$4d\,5s^2(c\,^2D)5p$	$w\ ^1D^\circ$	2	34850.96		1.42
$4d^2\,5s(a\,^4F)6s$	$e\ ^5F$	1	35046.95	163.35	
		2	35210.30	265.77	1.26
		3	35476.07	384.76	1.23
		4	35860.83	499.37	1.35
		5	36360.20		1.40
$4d^3(b\,^4P)5p$	$w\ ^3P^\circ$	0			
		1	35205.52	250.73	
		2	35456.25		1.45
$4d^2\,5s(b\,^2G)5p$	$t\ ^3F^\circ$	2	35514.53	291.10	0.69
		3	35805.63	195.72	1.00
		4	36001.35		1.22
$4d^3(a\,^2H)5p$	$z\ ^3I^\circ$	5	35781.67	391.36	0.82
		6	36173.03	−20.18	1.02
		7	36152.85		1.13
$4d^3(b\,^4P)5p$	$y\ ^5S^\circ$	2	35990.21		2.01
$4d^3(b\,^2D)5p$	$v\ ^3P^\circ$	0	36034.54	454.56	
		1	36489.10	519.30	
		2	37008.40		1.55
$4d^3(b\,^4P)5p$	$t\ ^3D^\circ$	1	36125.16	169.71	0.45
		2	36294.87	−74.42	1.16
		3	36220.45		1.28
$4d^2\,5s(b\,^2G)5p$	$x\ ^1G^\circ$	4	36336.48		1.15
$4d\,5s^2(c\,^2D)5p$	$u\ ^3P^\circ$	0	36538.27	432.38	
		1	36970.65	479.58	
		2	37450.23		
$4d^2\,5s(b\,^2G)5p$	$x\ ^3H^\circ$	4	36608.41	−10.93	0.82
		5	36597.48	243.11	1.04
		6	36840.59		1.13
$4d\,5s^2(c\,^2D)5p$	$w\ ^1F^\circ$	3	36759.90		0.87
					0.87
$4d^3(a\,^2G)5p$	$v\ ^3G^\circ$	3	36941.65	287.89	1.02
		4	37229.54	192.82	1.18
		5	37422.36		
$4d^3(a\,^2G)5p$	$s\ ^3F^\circ$	2	37123.42	345.45	0.71
		3	37468.87	452.09	1.11
		4	37920.96		1.26
$4d^2\,5s(a\,^4F)6s$	$e\ ^3F$	2	37459.60	241.48	
		3	37701.08	400.01	1.02
		4	38101.09		1.25
$4d^3(b\,^2F)5p$	$s\ ^3D^\circ$	1	38270.81		
		2	38326.72	55.91	1.41
		3	38435.88	109.16	1.00
$4d^3(a\,^2H)5p$	$z\ ^1I^\circ$	6	38475.82		
$4d\,5s^2(c\,^2D)5p$	$r\ ^3F^\circ$	2	38566.00	315.80	
		3	38881.80	292.64	1.26
		4	39174.44		

Zr I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^2\,5s(b\,^2G)5p$	$u\ ^3G^\circ$	3	39389.29	544.85	
		4	39934.14	244.30	1.05
		5	40178.44		1.13
$4d^3(b\,^2D)5p$	$x\ ^1P^\circ$	1	39704.10		
$4d^3(b\,^2D)5p$	$r\ ^3D^\circ$	1			
		2	39766.47	579.88	
		3	40346.35		1.29
$4d^3(a\,^2G)5p$	$v\ ^1F^\circ$	3	39803.73		
$4d^3(a\,^2G)5p$	$y\ ^1H^\circ$	5	39855.22		1.02
$4d^2\,5s(a\,^4F)5d$	$e\ ^5H$	3			
		4	39936.70	700.35	
		5	40637.05	806.48	1.07
		6	41443.53	643.29	
		7	42086.82		1.36
$4d\,5s^2(d\,^2D)5p$	$t\ ^3P^\circ$	0	40536.38	437.56	
		1	40973.94	813.68	
		2	41787.62		
$4d^3(b\,^2F)5p$	$v\ ^1D^\circ$	2	40557.65		
$4d^3(b\,^4F)6s$	$f\ ^5F$	1			
		2			
		3	40653.41	196.29	
		4	40849.70	218.30	
		5	41068.00		
$4d^2\,5s(a\,^4F)5d$	$e\ ^5G$	2	40660.65	226.96	
		3	40887.61	291.69	1.09
		4	41179.30	358.93	1.07
		5	41538.23	402.63	
		6	41940.86		1.41
$4d\,5s^2(c\,^2D)5p$	$w\ ^1P^\circ$	1	40931.60		
$4d^3(a\,^2H)5p$	$w\ ^1G^\circ$	4	41319.96		0.99
$4d^3(a\,^2H)5p$	$t\ ^3G^\circ$	3	42102.56	169.85	
		4	42272.41	562.55	
		5	42834.96		
$4d\,5s^2(c\,^2D)5p$	$q\ ^3D^\circ$	1	42296.80	136.85	
		2	42433.65	365.55	
		3	42799.20		1.35
$4d^3(a\,^2H)5p$	$x\ ^1H^\circ$	5	42309.29		
$4d\,5s^2(d\,^2D)5p$	$q\ ^3F^\circ$	2	42706.00	562.24	
		3	43268.24	7.76	
		4	43276.00		
$4d^3(b\,^2P)5p$	$w\ ^3S^\circ$	1	43182.96		
$4d^3(b\,^2P)5p$	$s\ ^3P^\circ$	0			
		1	44882.30	134.83	
		2	45017.13		
$4d^3(b\,^2P)5p$	$p\ ^3D^\circ$	1	45405.30	182.32	
		2	45587.62	122.67	
		3	45710.29		
$4d^2\,5p^2$	$f\ ^5G$	2	45798.48	396.67	
		3	46195.15	446.27	
		4	46641.42	493.08	
		5	47134.50	563.79	
		6	47698.29		
$4d^3(b\,^2F)5p$	$u\ ^1F^\circ$	3	46328.16		
$4d\,5s^2(d\,^2D)5p$	$o\ ^3D^\circ$	1	47765.56	368.08	
		2	48133.64	579.80	
		3	48713.44		
$4d^2\,5s(a\,^2S)5p$	$v\ ^1P^\circ$	1	51899.40		
Zr II ($^4F_{1\frac{1}{2}}$)	*Limit*	-----	56077		

May 1951.

Zr I Observed Terms *

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6+$	Observed Terms														
$4d^2\,5s^2$	$a\,^1S$	$a\,^3P$	$a\,^1D$	$a\,^3F$	$a\,^1G$										
$4d^4$			$a\,^5D$												
$4d^2\,5p^2$					$f\,^5G$										
	ns $(n\geq5)$						np $(n\geq5)$							nd $(n\geq5)$	
$4d^2\,5s(a\,^4F)nx$				$e\,^5F$ $e\,^3F$					$z\,^5D^\circ$ $z\,^3D^\circ$	$z\,^5F^\circ$ $z\,^3F^\circ$	$z\,^5G^\circ$ $z\,^3G^\circ$			$e\,^5G$	$e\,^5H$
$4d^3(b\,^4F)nx$				$a, f\,^5F$ $b\,^3F$					$x\,^5D^\circ$ $w\,^3D^\circ$	$y\,^5F^\circ$ $y\,^3F^\circ$	$y\,^5G^\circ$ $y\,^3G^\circ$				
$4d^2\,5s(a\,^2D)nx$								$x\,^3P^\circ$ $z\,^1P^\circ$	$v\,^3D^\circ$ $z\,^1D^\circ$	$x\,^3F^\circ$ $z\,^1F^\circ$					
$4d^2\,5s(a\,^2P)nx$							$z\,^3S^\circ$	$z\,^3P^\circ$ $y\,^1P^\circ$	$x\,^3D^\circ$ $y\,^1D^\circ$						
$4d^2\,5s(a\,^2F)nx$									$u\,^3D^\circ$	$w\,^3F^\circ$ $y\,^1F^\circ$	$x\,^3G^\circ$ $z\,^1G^\circ$				
$4d^2\,5s(a\,^4P)nx$							$z\,^5S^\circ$ $y\,^3S^\circ$	$z\,^5P^\circ$ $y\,^3P^\circ$	$y\,^5D^\circ$ $y\,^3D^\circ$						
$4d^3(a\,^2G)nx$					$a\,^3G$ $b\,^1G$					$s\,^3F^\circ$ $v\,^1F^\circ$	$v\,^3G^\circ$ $y\,^1G^\circ$	$z\,^3H^\circ$ $y\,^1H^\circ$			
$4d^3(b\,^4P)nx$		$a\,^5P$ $b\,^3P$					$y\,^5S^\circ$ $x\,^3S^\circ$	$y\,^5P^\circ$ $w\,^3P^\circ$	$w\,^5D^\circ$ $t\,^3D^\circ$						
$4d^3(a\,^2H)nx$						$a\,^3H$ $a\,^1H$					$t\,^3G^\circ$ $w\,^1G^\circ$	$y\,^3H^\circ$ $x\,^1H^\circ$	$z\,^3I^\circ$ $z\,^1I^\circ$		
$4d^3(b\,^2D)nx$			$a\,^3D$ $b\,^1D$					$v\,^3P^\circ$ $x\,^1P^\circ$	$r\,^3D^\circ$ $x\,^1D^\circ$	$u\,^3F^\circ$ $x\,^1F^\circ$					
$4d^2\,5s(b\,^2G)nx$										$t\,^3F^\circ$	$u\,^3G^\circ$ $x\,^1G^\circ$	$x\,^3H^\circ$ $z\,^1H^\circ$			
$4d\,5s^2(c\,^2D)nx$								$u\,^3P^\circ$ $w\,^1P^\circ$	$q\,^3D^\circ$ $w\,^1D^\circ$	$r\,^3F^\circ$ $w\,^1F^\circ$					
$4d^3(b\,^2F)nx$				$c\,^3F$					$s\,^3D^\circ$ $v\,^1D^\circ$	$v\,^3F^\circ$ $u\,^1F^\circ$	$w\,^3G^\circ$				
$4d^3(b\,^2P)nx$		$c\,^3P$					$w\,^3S^\circ$	$s\,^3P^\circ$	$p\,^3D^\circ$						
$4d^2\,5s(a\,^2S)nx$								$v\,^1P^\circ$							

* For predicted terms in the spectra of the Zr I isoelectronic sequence, see Vol. II, Introduction.

Zr II

(Y I sequence; 39 electrons) Z=40

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^2\ 5s\ ^4F_{1\frac{1}{2}}$

$a\ ^4F_{1\frac{1}{2}}$ 113175 cm^{-1} I. P. 14.03 volts

The analysis is by Kiess and Mrs. Kiess, whose line list extends from 1743.53 to 6787.15 A, includes 735 classified lines, and gives observed and theoretical Zeeman patterns. The terms of different multiplicities are connected by observed intersystem combinations.

Their value of the limit is based on the four pairs of series terms involving 5*s* and 6*s* electrons, and is derived by using a Rydberg formula.

C. C. Kiess has recently revised the configuration assignments of $b\ ^2D$, $c\ ^2D$, and $d\ ^2D$ as given in the table. On theoretical grounds, Ufford suggests that these configurations be interchanged as follows:

Term	C. C. Kiess	Ufford
$b\ ^2D$	$4d^3$	$4d\ 5s^2$
$c\ ^2D$	$4d\ 5s^2$	$4d^3$
$d\ ^2D$	Unassigned	Unassigned

The observed *g*-values are from three sources: those for $z\ ^4F^{\circ}_{1\frac{1}{2}}$ and $y\ ^2F^{\circ}_{2\frac{1}{2}}$ are from the Kiess paper. All other three-place entries are from unpublished material by Miss Weeks furnished especially for inclusion here. These are from films of spectrograms taken with the Bitter magnet at the Massachusetts Institute of Technology. The rest are quoted from the paper by Sancho.

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Zr II

Config.	Desig.	J	Level	Interval	Obs. g
$4d^2(a\ ^3F)5s$	$a\ ^4F$	1½	0.00	314.67	0.398
		2½	314.67	448.77	1.023
		3½	763.44	559.47	1.235
		4½	1322.91		1.324
$4d^3$	$b\ ^4F$	1½	2572.21	322.84	0.413
		2½	2895.05	404.59	1.025
		3½	3299.64	458.02	1.227
		4½	3757.66		1.326
$4d^2(a\ ^1D)5s$	$a\ ^2D$	1½	4248.30	257.20	0.812
		2½	4505.50		1.172
$4d^2(a\ ^3P)5s$	$a\ ^2P$	0½	5724.38	387.32	0.690
		1½	6111.70		1.304
$4d^2(a\ ^3F)5s$	$a\ ^2F$	2½	5752.92	714.69	0.883
		3½	6467.61		1.144
$4d^2(a\ ^3P)5s$	$a\ ^4P$	0½	7512.67	223.35	2.656
		1½	7736.02	322.14	1.720
		2½	8058.16		1.585

Zr II

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3$	$a\ ^2G$	3½	7837.74	315.06	0.887
		4½	8152.80		1.107
$4d^3$	$b\ ^4P$	0½	9553.10	189.70	2.649
		1½	9742.80	225.85	1.721
		2½	9968.65		1.593
$4d^3$	$a\ ^2H$	4½	11984.46	375.20	0.910
		5½	12359.66		1.091
$4d^3$	$b\ ^2D$	1½	13428.50	734.40	0.800
		2½	14162.90		1.209
$4d^2(^1G)5s$	$b\ ^2G$	3½	14059.76	130.69	0.890
		4½	14190.45		1.103
$4d\ 5s^2$	$c\ ^2D$	1½	14298.64	434.73	0.807
		2½	14733.37		1.188
	$d\ ^2D$	1½	17614.00	782.54	
		2½	18396.54		

843210°—52——16

Zr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3$	$b\ ^2F$	3½ 2½	19433. 24 19514. 84	81. 60	1. 153 0. 855
$4d^3$	$b\ ^2P$	0½ 1½	19613. 54 20080. 30	466. 76	0. 514 1. 326
$4d^2(^1S)5s$	$a\ ^2S$	0½	25201. 57		1. 990
$4d^2(a\ ^3F)5p$	$z\ ^4G^\circ$	2½ 3½ 4½ 5½	27983. 83 28909. 04 29839. 87 30795. 74	925. 21 930. 83 955. 87	0. 664 0. 998 1. 164 1. 275
$4d^2(a\ ^3F)5p$	$z\ ^2F^\circ$	2½ 3½	29504. 97 30561. 75	1056. 78	0. 841 1. 132
$4d^2(a\ ^3F)5p$	$z\ ^4F^\circ$	1½ 2½ 3½ 4½	29777. 60 30551. 48 31249. 28 31866. 49	773. 88 697. 80 617. 21	0. 700 1. 046 1. 238 1. 321
$4d^2(a\ ^3F)5p$	$z\ ^2D^\circ$	1½ 2½	30435. 38 31160. 04	724. 66	0. 589 1. 117
$4d^2(a\ ^3F)5p$	$z\ ^4D^\circ$	0½ 1½ 2½ 3½	31981. 25 32256. 71 32614. 71 32899. 46	275. 46 358. 00 284. 75	0. 016 1. 166 1. 342 1. 408
$4d^2(a\ ^3P)5p$	$y\ ^2D^\circ$	1½ 2½	32983. 73 33419. 45	435. 72	0. 810 1. 195
$4d^2(a\ ^3F)5p$	$z\ ^2G^\circ$	3½ 4½	34485. 42 35185. 64	700. 22	0. 889 1. 109
$4d^2(a\ ^3P)5p$	$z\ ^2S^\circ$	0½	34810. 03		1. 956
$4d^2(a\ ^1D)5p$	$z\ ^2P^\circ$	1½ 0½	35914. 81 36196. 57	−281. 76	1. 340 0. 610
$4d^2(a\ ^3P)5p$	$y\ ^4D^\circ$	0½ 1½ 2½ 3½	36237. 04 36638. 50 37171. 22 38041. 49	401. 46 532. 72 870. 27	0. 144 1. 038 1. 140 1. 306
$4d\ 5s(a\ ^3D)5p$	$y\ ^4F^\circ$	1½ 2½ 3½ 4½	36451. 79 36869. 00 37429. 76 38644. 12	417. 21 560. 76 1214. 36	0. 579 1. 091 1. 266 1. 321
$4d^2(^1G)5p$	$y\ ^2F^\circ$	2½ 3½	37346. 31 37787. 59	441. 28	0. 975 1. 212
$4d^2(a\ ^3P)5p$	$z\ ^4S^\circ$	1½	37681. 75		1. 908
$4d\ 5s(a\ ^3D)5p$	$z\ ^4P^\circ$	0½ 1½ 2½	38063. 40 38133. 50 38482. 64	70. 10 349. 14	2. 448 1. 734 1. 606
$4d\ 5s(a\ ^3D)5p$	$x\ ^4D^\circ$	0½ 1½ 2½ 3½	38934. 37 39192. 35 39640. 08 40238. 55	257. 98 447. 73 598. 47	0. 055 1. 209 1. 370 1. 408
$4d^2(a\ ^3P)5p$	$y\ ^2P^\circ$	0½ 1½	40727. 26 41337. 36	610. 10	0. 677 1. 326
$4d^2(^1G)5p$	$y\ ^2G^\circ$	3½ 4½	40852. 74 40878. 25	25. 51	0. 915 1. 083
$4d^2(a\ ^1D)5p$	$x\ ^2D^\circ$	1½ 2½	41467. 72 41676. 82	209. 10	0. 821 1. 184
$4d^2(^1G)5p$	$z\ ^2H^\circ$	4½ 5½	41738. 21 42409. 93	671. 72	0. 954 1. 080

Zr II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^2(a\ ^1D)5p$	$x\ ^2F^\circ$	3½ 2½	42504. 11 42860. 72	−356. 61	1. 134 0. 887
$4d^2(a\ ^3P)5p$	$y\ ^4P^\circ$	0½ 1½ 2½	42789. 24 42893. 54 43202. 45	104. 30 308. 91	2. 632 1. 710 1. 561
$4d\ 5s(a\ ^1D)5p$	$w\ ^2D^\circ$	1½ 2½	45054. 87 45186. 05	131. 18	0. 870 1. 226
$4d^2(^1S)5p$	$x\ ^2P^\circ$	1½ 0½	45568. 21 45944. 00	−375. 79	1. 14 0. 724
$4d\ 5s(a\ ^1D)5p$	$w\ ^2F^\circ$	2½ 3½	47881. 88 48344. 91	463. 03	0. 871 1. 142
$4d\ 5s(a\ ^1D)5p$	$w\ ^2P^\circ$	0½ 1½	52585. 80 52876. 80	291. 00	0. 659 1. 318
$4d\ 5s(a\ ^3D)5p$	$v\ ^2D^\circ$	1½ 2½	55835. 53 56569. 44	733. 91	1. 16
$4d\ 5s(a\ ^3D)5p$	$v\ ^2F^\circ$	2½ 3½	57062. 00 57741. 16	679. 16	1. 24
$4d\ 5s(a\ ^3D)5p$	$v\ ^2P^\circ$	0½ 1½	60814. 50 61861. 90	1047. 40	
$4d^2(a\ ^3F)6s$	$e\ ^4F$	1½ 2½ 3½ 4½	63602. 64 63868. 45 64368. 28 64901. 71	265. 81 499. 83 533. 43	1. 11 1. 205 1. 274
$4d^2(a\ ^3F)6s$	$e\ ^2F$	2½ 3½	65872. 41 66192. 68	320. 27	1. 18
$4d^2(a\ ^1D)6s$	$e\ ^2D$	1½ 2½	66686. 25 66868. 35	182. 10	1. 14
$4d^2(^1G)6s$	$e\ ^2G$	3½ 4½	69116. 70 69283. 38	166. 68	
$4d^2(a\ ^3F)5d$	$f\ ^2F$	2½ 3½	73852. 95 74496. 80	643. 85	
$4d^2(a\ ^3F)5d$	$f\ ^4F$	1½ 2½ 3½ 4½	74611. 28 75343. 57 76009. 05 76593. 58	732. 29 665. 48 584. 53	
$4d^2(^1G)5d$	$e\ ^2I$	5½ 6½	76395. 50 76838. 70	443. 20	0. 999 1. 081
$4d^2(^1G)5d$	$e\ ^2H$	4½ 5½	77743. 00 78280. 90	537. 90	1. 073
$4d^2(a\ ^3F)5d$	$e\ ^4H$	3½ 4½ 5½ 6½	78577. 85 78847. 67 79198. 35 79280. 30	269. 82 350. 68 81. 95	
$4d^2(^1G)5d$	$f\ ^2G$	3½ 4½	79624. 60 80311. 54	686. 94	
$4d^2(a\ ^3F)5d$	$g\ ^2G$	3½ 4½	83221. 45 83547. 45	326. 00	
$4d^2(a\ ^3F)5d$	$f\ ^2H$	4½ 5½	90986. 50 91737. 40	750. 90	
Zr III ($^3F_2$)	***Limit***	-----	113175		

April 1951.

Zr II Observed Terms*

Config. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6+$	Observed Terms		
$4d\ 5s^2$	$c\ ^2D$		
$4d^3$	$b\ ^4P$, $b\ ^2P$; $b\ ^2D$; $b\ ^4F$, $b\ ^2F$; $a\ ^2G$; $a\ ^2H$		
	ns ($n \geq 5$)	*np* ($n \geq 5$)	*nd* ($n \geq 4$)
$4d^2(a\ ^3F)nx$	$a, e\ ^4F$ $a, e\ ^2F$	$z\ ^4D^\circ$ $z\ ^4F^\circ$ $z\ ^4G^\circ$ $z\ ^2D^\circ$ $z\ ^2F^\circ$ $z\ ^2G^\circ$	$f\ ^4F$ $e\ ^4H$ $f\ ^2F$ $g\ ^2G$ $f\ ^2H$
$4d^2(a\ ^1D)nx$	$a, e\ ^2D$	$z\ ^2P^\circ$ $x\ ^2D^\circ$ $x\ ^2F^\circ$	
$4d^2(a\ ^3P)nx$	$a\ ^4P$ $a\ ^2P$	$z\ ^4S^\circ$ $y\ ^4P^\circ$ $y\ ^4D^\circ$ $z\ ^2S^\circ$ $y\ ^2P^\circ$ $y\ ^2D^\circ$	
$4d^2(^1G)nx$	$b, e\ ^2G$	$y\ ^2F^\circ$ $y\ ^2G^\circ$ $z\ ^2H^\circ$	$f\ ^2G$ $e\ ^2H$ $e\ ^2I$
$4d^2(^1S)nx$	$a\ ^2S$	$x\ ^2P^\circ$	
$4d\ 5s(a\ ^3D)nx$		$z\ ^4P^\circ$ $x\ ^4D^\circ$ $y\ ^4F^\circ$ $v\ ^2P^\circ$ $v\ ^2D^\circ$ $v\ ^2F^\circ$	
$4d\ 5s(a\ ^1D)nx$		$w\ ^2P^\circ$ $w\ ^2D^\circ$ $w\ ^2F^\circ$	

*For predicted terms of the Y I isoelectronic sequence, see Vol. II, Introduction.

Zr III

(Sr I sequence; 38 electrons) $Z=40$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,4d^2\ ^3\mathrm{F}_2$

$a\ ^3\mathrm{F}_2$ **200000**$\pm$cm^{-1} I. P. 24.8 volts

Kiess has revised the earlier work by himself and Lang, especially for inclusion here, and he has further analysis in progress. The observations extend from 732 A to 3497 A, and the total number of classified lines is about 200. Observed intersystem combinations connect the singlet and triplet series of terms.

His value of the limit quoted here is provisional, since it has been derived by the application of a Rydberg formula to the $nd\ ^3$F and $nd\ ^1$D series (n=4,5).

The observed g-values are from plates and films furnished by Harrison at the Massachusetts Institute of Technology. Kiess has examined the plates and Miss Weeks the films; both have contributed to the values quoted here.

REFERENCES

C. C. Kiess and R. J. Lang, Bur. Std. J. Research **5**, 309, RP 202 (1930). (I P) (T) (C L) (G D)

D. W. Weeks, unpublished material (March 1951). (Z E)

C. C. Kiess, unpublished material (1951). (I P) (T) (C L) (Z E)

Zr III

Config.	Desig.	J	Level	Interval	Obs. g
$4d^2$	$a\ ^3$F	2	0.00	681.0	
		3	681.0	805.4	
		4	1486.4		
$4d^2$	$a\ ^1$D	2	5741.55		
$4d^2$	$a\ ^3$P	0	8062.07	263.58	
		1	8325.65	512.56	
		2	8838.21		
$4d^2$	$a\ ^1$G	4	11048.70		
$4d^2$	$a\ ^1$S	0	13832.0?		
$4d(^2$D$)5s$	$a\ ^3$D	1	18398.87	403.92	0.511
		2	18802.79	730.56	1.173
		3	19533.35		1.344
$4d(^2$D$)5s$	$b\ ^1$D	2	25066.25		1.000
$5s^2$	$b\ ^1$S	0	36257.8??		
$4d(^2$D$)5p$	$z\ ^1$D°	2	*53647.21*		0.927
$4d(^2$D$)5p$	$z\ ^3$F°	2	*55555.63*	519.70	0.789
		3	*56075.33*	1606.07	1.112
		4	*57681.40*		1.233
$4d(^2$D$)5p$	$z\ ^3$D°	1	*55614.42*	821.23	0.519
		2	*56435.65*	911.18	1.119
		3	*57346.83*		1.337
$4d(^2$D$)5p$	$z\ ^3$P°	0	*59944.79*	−247.97	
		1	*59696.82*	659.16	
		2	*60355.98*		
$4d(^2$D$)5p$	$z\ ^1$P°	1	*62115.66*		1.044
$4d(^2$D$)5p$	$z\ ^1$F°	3	*62589.13*		1.000
$5s(^2$S$)5p$	$y\ ^3$P°	0	*79436.7*	666.3	
		1	*80103.0*	1450.6	
		2	*81553.6*		
$5s(^2$S$)5p$	$y\ ^1$P°	1	*86512.3??*		
$4d(^2$D$)5d$	$e\ ^1$F	3	103581.5		
$4d(^2$D$)5d$	$e\ ^3$G	3	104633.4	556.2	
		4	105189.6	530.5?	
		5	105720.1?		

Zr III

Config.	Desig.	J	Level	Interval	Obs. g
$4d(^2$D$)5d$	$e\ ^3$D	1	105006.9	314.0	
		2	105320.9	979.9	
		3	106300.8		
$4d(^2$D$)5d$	$e\ ^1$P	1	105550.2		
$4d(^2$D$)5d$	$e\ ^1$D	2	106499.6		
$4d(^2$D$)5d$	$e\ ^3$F	2	107253.0	567.6	
		3	107820.6	493.8	
		4	108314.4		
$4d(^2$D$)5d$	$e\ ^1$G	4	107456.2		
$4d(^2$D$)5d$	$e\ ^1$S	0	107650.5		
$4d(^2$D$)5d$	$e\ ^3$S	1	109073.3		
$4d(^2$D$)5d$	$e\ ^3$P	2	109268.7	−329.9	
		1	109598.6		
		0			
$4d(^2$D$)4f$	$y\ ^3$F°	4	*117813*	−1713	
		3	*119526*	−1892	
		2	*121418*		
$4d(^2$D$)4f$	$z\ ^3$G°	3	*121923*	677	
		4	*122600*	900	
		5	*123500*		
$4d(^2$D$)4f$	$x\ ^3$P°	0	*123390*	203	
		1	*123593*	362	
		2	*123955*		
$4d(^2$D$)4f$	$y\ ^1$F°	3	*127378*		
$4d(^2$D$)4f$	$y\ ^1$D°	2	*128877*		
$4d(^2$D$)4f$	$y\ ^3$D°	1	*131010*	499	
		2	*131509*	678	
		3	*132187*		
$4d(^2$D$)4f$	$x\ ^1$P°	1	*134614*		
$4d(^2$D$)4f$	$z\ ^1$G°	4	*134975?*		
$4d(^2$D$)4f$	$z\ ^1$H°	5	*138517?*		
Zr VI (^{2}D$_{1½}$)	***Limit***	-----	**200000**		

December 1951.

Zr III Observed Terms*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6+$	Observed Terms	
$4d^2$	*a* ^{3}P *a* ^{3}F *a* ^{1}S *a* ^{1}D *a* ^{1}G	
$5s^2$	*b* ^{1}S?	
	ns ($n\geq5$)	*np* ($n\geq5$)
$4d(^2\mathrm{D})nx$	*a* ^{3}D *b* ^{1}D	*z* ^{3}P° *z* ^{3}D° *z* ^{3}F° *z* ^{1}P° *z* ^{1}D° *z* ^{1}F°
$5s(^2\mathrm{S})nx$		*y* ^{3}P° *y* ^{1}P°?
	nd ($n\geq5$)	*nf* ($n\geq4$)
$4d(^2\mathrm{D})nx$	*e* ^{3}S *e* ^{3}P *e* ^{3}D *e* ^{3}F *e* ^{3}G *e* ^{1}S *e* ^{1}P *e* ^{1}D *e* ^{1}F *e* ^{1}G	*x* ^{3}P° *y* ^{3}D° *y* ^{3}F° *z* ^{3}G° *x* ^{1}P° *y* ^{1}D° *y* ^{1}F° *z* ^{1}G° *z* ^{1}H°

*For predicted terms in the spectra of the Sr I isoelectronic sequence, see Vol. II, Introduction.

Zr IV

(Rb I sequence; 37 electrons) $Z=40$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,4d\ ^2\mathrm{D}_{1\frac{1}{2}}$

$4d\ ^2\mathrm{D}_{1\frac{1}{2}}$ **274067** cm^{-1} I. P. 33.97 volts

Fourteen lines have been classified as transitions among seven terms. The analysis is from the paper by Kiess and Lang who reobserved the spectrum from 628.66 A to 2286.66 A, and extended the earlier work of Bowen and Millikan and of Gibbs and White.

From a Ritz formula applied to the *ns* ^{2}S series ($n=5$ to 7) Kiess and Lang have determined the limit quoted here.

REFERENCE

C. C. Kiess and R. J. Lang, Bur. Std. J. Research **5**, 307, RP202 (1930). (I P) (T) (C L) (G D)

Zr IV

Config.	Desig.	*J*	Level	Interval
$4p^6(^1\mathrm{S})4d$	$4d\ ^2$D	1½ 2½	0 1250	1250
$4p^6(^1\mathrm{S})5s$	$5s\ ^2$S	0½	38258	
$4p^6(^1\mathrm{S})5p$	$5p\ ^2$P°	0½ 1½	*81976* *84462*	2486
$4p^6(^1\mathrm{S})5d$	$5d\ ^2$D	1½ 2½	146650 147001	351
$4p^6(^1\mathrm{S})6s$	$6s\ ^2$S	0½	152509	
$4p^6(^1\mathrm{S})4f$	$4f\ ^2$F°	2½ 3½	*159068* *159088*	20
$4p^6(^1\mathrm{S})7s$	$7s\ ^2$S	0½	198840	
Zr V (^{1}S$_0$)	*Limit*	---	274067	

March 1951.

Zr VI

(Br I sequence; 35 electrons) $Z=40$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$

$4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$ ***798000*** cm^{-1} I. P. 99 volts

The analysis is incomplete. Paul and Rense have classified 46 lines between 236 A and 568 A as due to transitions from the ground term to 15 higher terms.

They have estimated the limit by extrapolation of isoelectronic sequence data.

REFERENCE

F. W. Paul and W. A. Rense, Phys. Rev. **56**, 1110 (1939). (I P) (T) (C L)

Zr VI

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^5$	$4p^5\ {}^2P^{\circ}$	1½ 0½	*0* *15600*	−15600
$4s\ 4p^6$	$4p^6\ {}^2S$	0½	191570	
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4D$	3½ 2½ 1½ 0½	 241099 246007 248938	 −4908 −2931
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4F$	4½ 3½ 2½ 1½	 288606 288680	−74
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4P$	0½ 1½ 2½	289323 291660 295919	2337 4259
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2D$	1½ 2½	296155 306483	10328
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2P$	0½ 1½	298923 299453	530
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^4P$	2½ 1½ 0½	314483 334692 346616	−20209 −11924

Zr VI

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2F$	3½ 2½	 319496	
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2D$	2½ 1½	335527 346344	−10817
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2F$	3½ 2½	 336345	
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2P$	0½ 1½	355280 355604	324
$4s^2\ 4p^4(^1S)4d$	$4d''\ {}^2D$	2½ 1½	 360195	
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^2P$	1½ 0½	369716 379780	−10064
$4s^2\ 4p^4(^1D)5s$	$5s'\ {}^2D$	2½ 1½	380383 384790	−4407
$4s^2\ 4p^4(^1S)5s$	$5s''\ {}^2S$	0½	423215	
Zr VII ($^3P_2$)	***Limit***	--------	***798000***	

February 1951.

Zr VI OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms	
$4s^2\ 4p^5$	$4p^5\ ^2P^\circ$	
$4s\ 4p^6$	$4p^6\ ^2S$	
	ns ($n \geq 5$)	*nd* ($n \geq 4$)
$4s^2\ 4p^4(^3P)nx$	$5s\ ^4P$ $5s\ ^2P$	$4d\ ^4P$ $4d\ ^4D$ $4d\ ^4F$ $4d\ ^2P$ $4d\ ^2D$ $4d\ ^2F$
$4s^2\ 4p^4(^1D)nx'$	$5s'\ ^2D$	$4d'\ ^2P$ $4d'\ ^2D$ $4d'\ ^2F$
$4s^2\ 4p^4(^1S)nx''$	$5s''\ ^2S$	$4d''\ ^2D$

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Zr XIV

(Co I sequence; 27 electrons) $Z=40$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ ^2D_{2\frac{1}{2}}$

$3d^9\ ^2D_{2\frac{1}{2}}$ cm^{-1} I. P. volts

Edlén has observed three lines due to the transition $3p^6\ 3d^9\ ^2D - 3p^5\ 3d^{10}\ ^2P^\circ$. From preliminary unpublished measurements he has furnished the provisional term values quoted in the table. In figure 4 of his paper on the spectra of highly ionized atoms, the observed wave numbers are plotted against atomic numbers for this combination in the Co I-like spectra Rb XI to Mo XVI, and compared with the closely related X-ray transition of the same elements.

Edlén's unit, 10^3 cm^{-1}, has here been changed to cm^{-1}.

REFERENCES

B. Edlén, Physica **13**, No. 9, 550 (1947).

B. Edlén, letter (July 1950). (T)

Zr XIV

Config.	Desig.	*J*	Level	Interval
$3p^6\ 3d^9$	$3d^9\ ^2D$	$2\frac{1}{2}$ $1\frac{1}{2}$	0 20300	−20300
$3p^5\ 3d^{10}$	$3d^{10}\ ^2P^\circ$	$1\frac{1}{2}$ $0\frac{1}{2}$	*1201800* *1314500*	−112700

July 1950.

NIOBIUM

Nb I

41 electrons $Z=41$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,4d^4\,5s\ ^6D_{0\frac{1}{2}}$

$a\ ^6D_{0\frac{1}{2}}$ **54600** cm^{-1} I. P. 6.77 volts

Humphreys and Meggers have observed the Nb I spectrum from 2161.54 A to 10920.7 A. Of the 3313 lines recorded in this range, they have classified 2836 as combinations among 364 atomic energy levels "representing 58 doublet, 55 quartet, and 13 sextet spectral terms." The systems of terms of different multiplicity are connected by observed intersystem combinations.. Zeeman patterns measured for 911 Nb I lines have been utilized in this analysis.

The limit is derived from four two-member series, namely: $4d^4\,ns(^6D)$ and $4d^3\,5s\,np\ ^4(D°\ F°\ G°)$ $(n=5,6)$, by means of a Rydberg formula.

This element is familiarly known as Columbium (Cb). The International Union of Chemistry has recently adopted Niobium as the official name of element 41. In compliance with this agreement, the revised name and symbol are adopted here.

REFERENCES

C. J. Humphreys and W. F. Meggers, J. Research Nat. Bur. Std. **34**, 515, RP1656 (1945).
J. E. Mack, Rev. Mod. Phys. **22**, No. 1, 64 (1950). (Summary hfs)

Nb I

Config.	Desig.	J	Level	Interval	Obs. g
$4d^4(a\,^5D)5s$	$a\,^6D$	0½	0.00	154.19	3.323
		1½	154.19	237.80	1.863
		2½	391.99	303.26	1.652
		3½	695.25	355.01	1.582
		4½	1050.26		1.549
$4d^3\,5s^2$	$a\,^4F$	1½	1142.79	444.11	0.402
		2½	1586.90	567.21	1.029
		3½	2154.11	651.25	1.235
		4½	2805.36		1.330
$4d^3\,5s^2$	$a\,^4P$	0½	4998.17	299.75	2.650
		1½	5297.92	667.53	1.721
		2½	5965.45		1.596
$4d^4(a\,^5D)5s$	$a\,^4D$	0½	8410.90	294.42	0.06
		1½	8705.32	337.82	1.197
		2½	9043.14	454.38	1.360
		3½	9497.52		1.420
$4d^3\,5s^2$	$a\,^2G$	3½	8827.00	501.88	0.885
		4½	9328.88		1.103
$4d^3\,5s^2$	$a\,^2D$	1½	9439.08	798.43	0.953
		2½	10237.51		1.206
$4d^3\,5s^2$	$a\,^2P$	0½	10126.06	1192.03	0.66
		1½	11318.09		1.175
$4d^4(a\,^3H)5s$	$a\,^4H$	3½	10922.74	121.34	0.690
		4½	11044.08	203.80	0.984
		5½	11247.88	276.77	1.12
		6½	11524.65		1.22
$4d^5$	$a\,^6S$	2½	11344.70		1.99
$4d^4(a\,^3G)5s$	$a\,^4G$	2½	12018.25	118.61	0.742
		3½	12136.86	220.84	1.081
		4½	12357.70	654.50	1.23
		5½	13012.20		1.26
$4d^3\,5s^2$	$a\,^2H$	4½	12102.12	400.85	0.93
		5½	12502.97		1.10
$4d^4(b\,^3F)5s$	$b\,^4F$	1½	12288.25	403.87	0.402
		2½	12692.12	290.26	0.852
		3½	12982.38	163.33	1.120
		4½	13145.71		1.224
$4d^3\,5s^2$	$a\,^2F$	2½	13404.77	110.43	0.860
		3½	13515.20		1.130
$4d^4(a\,^3P)5s$	$b\,^4P$	0½	13629.15	592.15	2.64
		1½	14211.30	687.96	1.71
		2½	14899.26		1.54
$4d^4(a\,^3D)5s$	$b\,^4D$	3½	15282.35	−184.73	1.43
		2½	15467.08	27.83	1.42
		1½	15439.25	−21.52	1.21
		0½	15460.77		0.04
$4d^3\,5s(a^5F)5p$	$z\,^6G°$	1½	*16672.00*	309.01	0.00
		2½	*16981.01*	322.95	
		3½	*17303.96*	633.30	
		4½	*17937.26*	497.88	
		5½	*18435.14*	441.32	
		6½	*18876.46*		

Nb I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^4(a\,^3H)5s$	$b\,^2H$	4½	16828.52	647.70	1.04
		5½	17476.22		1.01
$4d^4(a\,^3G)5s$	$b\,^2G$	3½	16918.78	1117.19	0.88
		4½	18035.97		0.97
	183	5½	18332.04		
$4d^3\,5s(a\,^5F)5p$	$z\,^6F°$	0½	*18791.09*	245.46	−0.373
		1½	*19036.55*	391.35	1.145
		2½	*19427.90*	488.79	1.35
		3½	*19916.69*	515.42	1.39
		4½	*20432.11*		1.44
		5½			
$4d^3\,5s(a\,^5F)5p$	$z\,^6D°$	0½	*19623.96*	141.22	3.01
		1½	*19765.18*	228.60	1.72
		2½	*19993.78*	321.96	1.56
		3½	*20315.74*	418.14	1.55
		4½	*20733.88*		1.54
$4d^3\,5s(a\,^3F)5p$	$z\,^4D°$	0½	*20107.36*	276.26	−0.02
		1½	*20383.62*	454.36	1.26
		2½	*20837.98*	674.20	1.39
		3½	*21512.18*		1.44
$4d^4(a\,^5D)5p$	$z\,^4P°$	0½	*22006.74*	1000.12	2.47
		1½	*23006.86*	677.58	1.61
		2½	*23684.44*		1.477
$4d^3\,5s(a\,^3F)5p$	$z\,^4G°$	2½	*22647.03*	375.53	0.578
		3½	*23022.56*	514.21	0.98
		4½	*23536.77*	666.28	1.15
		5½	*24203.05*		1.25
$4d^3\,5s(a\,^3F)5p$	$z\,^4F°$	1½	*23243.87*	330.27	0.416
		2½	*23574.14*	440.97	1.061
		3½	*24015.11*	491.42	1.243
		4½	*24506.53*		1.336
$4d^4(a\,^3P)5p$	$z\,^2D°$	1½	*23525.80*	1247.23	0.898
		2½	*24773.03*		1.30
$4d^4(a\,^3P)5p$	$z\,^2S°$	0½	*23910.90*		2.123
$4d^4(a\,^5D)5p$	$y\,^6F°$	0½	*23984.87*	179.92	−0.601
		1½	*24164.79*	232.01	1.060
		2½	*24396.80*	373.11	1.306
		3½	*24769.91*	429.90	1.380
		4½	*25199.81*	480.55	1.427
		5½	*25680.36*		1.450
$4d^4(a\,^5D)5p$	$z\,^6P°$	1½	*24283.34*	259.79	2.382
		2½	*24543.13*	361.73	1.874
		3½	*24904.86*		1.703
$4d^3\,5s(a\,^5P)5p$	$y\,^6D°$	0½	*25879.81*	187.25	3.22
		1½	*26067.06*	319.30	1.820
		2½	*26386.36*	446.07	1.610
		3½	*26832.43*	587.19	1.248
		4½	*27419.62*		1.422
$4d^4(a\,^5D)5p$	$y\,^4F°$	1½	*25930.01*	130.64	0.467
		2½	*26060.65*	105.14	1.085
		3½	*26165.79*	274.54	1.245
		4½	*26440.33*		1.334
$4d^4(a\,^5D)5p$	$x\,^6D°$	0½	*26552.40*	160.92	2.441
		1½	*26713.32*	270.02	1.45
		2½	*26983.34*	443.73	1.618
		3½	*27427.07*	547.80	1.567
		4½	*27974.87*		1.542

Nb I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^4(a\,^5D)5p$	$y\,^4D°$	0½	*26717.73*	219.13	1.141
		1½	*26936.86*	422.84	1.292
		2½	*27359.70*	237.04	1.32
		3½	*27596.74*		1.422
$4d^4(a\,^3H)5p$	$z\,^2G°$	3½	*26896.68*	435.12	1.013
		4½	*27331.80*		1.078
$4d^3\,5s(c\,^3P)5p$	$y\,^4P°$	0½	*27498.94*	283.63	2.467
		1½	*27782.57*	662.76	1.660
		2½	*28445.33*		1.606
	276°	2½	*27614.10*		1.370
$4d^3\,5s(c\,^3P)5p$	$x\,^4D°$	0½	*27666.46*	412.63	0.222
		1½	*28079.09*	470.33	1.443
		2½	*28549.42*	660.00	1.472
		3½	*29209.42*		1.241
$4d^3\,5s(a\,^3F)5p$	$z\,^2F°$	2½	*27797.44*	737.92	1.16
		3½	*28535.36*		1.12
$4d^3\,5s(a\,^3F)5p$	$y\,^2G°$	3½	*27855.13*	578.61	0.92
		4½	*28433.74*		1.12
	$z\,^2P°$	1½	*27918.85*	−523.31	1.450
		0½	*28442.16*		0.772
$4d^4(a\,^3P)5p$	$z\,^4S°$	1½	*28208.48*		1.794
$4d^3\,5s(a\,^5P)5p$	$y\,^6P°$	1½	*28278.25*	374.41	1.981
		2½	*28652.66*	320.46	1.768
		3½	*28973.12*		1.701
$4d^3\,5s(b\,^3G)5p$	$z\,^4H°$	3½	*29271.99*	247.06	0.890
		4½	*29519.05*	327.45	1.01
		5½	*29846.50*	344.75	1.15
		6½	*30191.25*		1.23
$4d^4(a\,^3H)5p$	$y\,^4G°$	2½	*29359.58*	403.12	0.693
		3½	*29762.70*	354.62	0.999
		4½	*30117.32*	540.28	1.276
		5½	*30657.60*		1.25
$4d^3\,5s(a\,^3F)5p$	$y\,^2D°$	1½	*29622.73*	153.07	0.81
		2½	*29775.80*		1.348
$4d^4(b\,^3F)5p$	$x\,^4F°$	1½	*29779.44*	208.01	0.42
		2½	*29987.45*	174.11	1.006
		3½	*30161.56*	117.67	1.18
		4½	*30279.23*		1.20
$4d^3\,5s(a\,^5P)5p$	$z\,^6S°$	2½	*30059.60*		
$4d^4(a\,^1D)5p$	$y\,^2F°$	2½	*30716.50*	309.02	0.891
		3½	*31025.52*		1.139
$4d^3\,5s(a\,^5F)5p$	$x\,^4G°$	2½	*31056.60*	428.60	0.630
		3½	*31485.20*	519.43	1.012
		4½	*32004.63*	568.09	1.160
		5½	*32572.72*		1.24
$4d^3\,5s(c\,^3P)5p$	$y\,^4S°$	1½	*31174.65*		1.957
$4d^3\,5s(a\,^5F)5p$	$w\,^4F°$	1½	*31551.46*	461.94	0.501
		2½	*32013.40*	319.78	1.01
		3½	*32333.18*	590.69	1.199
		4½	*32923.87*		1.24
$4d^3\,5s(b\,^1G)5p$	$x\,^2F°$	2½			
		3½	*31687.53*		1.20

Nb I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^4(a\,{}^3D)5p$	$v\ {}^4F^\circ$	1½ 2½ 3½ 4½	*31707.94* *31807.55* *31973.24* *32605.39*	99.61 165.69 632.15	0.80 1.048 1.343 1.216
$4d^3\,5s(b\,{}^1G)5p$	$x\ {}^2G^\circ$	3½ 4½	*31800.74* *32213.94*	413.20	0.906 1.092
$4d^4(a\,{}^3G)5p$	$u\ {}^4F^\circ$	1½ 2½ 3½ 4½	*31907.74* *32139.78* *32451.99* *33136.30*	232.04 312.21 684.31	0.791 1.035 1.115 1.240
$4d^4(a\,{}^1G)5p$	$w\ {}^2F^\circ$	2½ 3½	*31933.68* *32087.58*	153.90	0.982 1.074
$4d^4(a\,{}^3P)5p$	$w\ {}^4D^\circ$	0½ 1½ 2½ 3½	*32066.06* *32248.69* *32545.52* *33003.89*	182.63 296.83 458.37	0.046 1.184 1.320 1.341
$4d^4(a\,{}^3H)5p$	$z\ {}^4I^\circ$	4½ 5½ 6½ 7½	*32156.00* *32382.24* *32672.39* *33116.36*	226.24 290.15 443.97	0.835 0.993 1.08 1.19
$4d^4(b\,{}^3F)5p$	$w\ {}^4G^\circ$	2½ 3½ 4½ 5½	 *32501.33* *32802.44* *33428.20*	301.11 625.76	 1.06 1.21 1.27
$4d^3\,5s(a\,{}^1P)5p$	$x\ {}^2D^\circ$	1½ 2½	*32623.02*		1.00
$4d^4(a\,{}^3G)5p$	$v\ {}^2F^\circ$	2½ 3½	*32654.48* *32899.08*	244.60	0.830 1.17
$4d^3\,5s(a\,{}^5F)5p$	$v\ {}^4D^\circ$	0½ 1½ 2½ 3½	*33011.45* *33717.01* *33872.18* *34168.94*	705.56 155.17 296.76	0.46 1.230 1.350 1.390
$4d^3\,5s(b\,{}^1D)5p$	$w\ {}^2D^\circ$	1½ 2½	*33086.98* *33389.87*	302.89	1.058 1.212
$4d^3\,5s(c\,{}^3P)5p$	$y\ {}^2P^\circ$	0½ 1½	*33902.24* *34252.96*	350.72	0.442
$4d^3\,5s(a\,{}^1H)5p$	$z\ {}^2I^\circ$	5½ 6½	*34004.08* *34323.20*	319.12	0.946 1.08
$4d^3\,5s(a\,{}^1H)5p$	$w\ {}^2G^\circ$	4½ 3½	*34235.04* *34319.09*	−84.05	1.10 0.87
$4d^4(a\,{}^3H)5p$	$z\ {}^2H^\circ$	4½ 5½	*34415.52* *34838.33*	422.81	0.819 1.01
$4d^3\,5s(a\,{}^5P)5p$	$x\ {}^4P^\circ$	0½ 1½ 2½	*34644.22* *34867.68* *34703.70*	223.46 −163.98	2.05 1.587 1.55
$4d^4(a\,{}^3G)5p$	$v\ {}^4G^\circ$	2½ 3½ 4½ 5½	*34654.79* *34853.50* *35156.94* *35630.62*	198.71 303.44 473.68	0.627 1.000 1.073 1.160
$4d^3\,5s(b\,{}^3P)5p$	$v\ {}^2D^\circ$	1½ 2½	*34752.70* *35497.48*	744.78	0.948 1.160
$4d^3\,5s(c\,{}^3P)5p$	$y\ {}^2S^\circ$	0½	*34807.57*		2.080
$4d^3\,5s(b\,{}^1D)5p$	$u\ {}^2F^\circ$	2½ 3½	*35099.86* *35178.82*	78.96	0.868 1.117
$4d^3\,5s(b\,{}^3P)5p$	$x\ {}^4S^\circ$	1½	*35119.65*		1.806
$4d^4(a\,{}^3G)5p$	$y\ {}^2H^\circ$	5½ 4½	*35344.86* *35496.39*	−151.53	1.125 0.954
$4d^4(b\,{}^3F)5p$	$u\ {}^2D^\circ$	1½ 2½	*35829.46* *35928.35*	98.89	0.834 1.17
$4d^4(b\,{}^3F)5p$	$u\ {}^4D^\circ$	0½ 1½ 2½ 3½	*35920.45* *36016.26* *36180.13* *36334.21*	95.81 163.87 154.08	0.019 1.195 1.316 1.378
$4d^3\,5s(b\,{}^3G)5p$	$v\ {}^2G^\circ$	3½ 4½	*36048.10* *36333.70*	285.60	0.925 1.086
$4d^4(a\,{}^1G)5p$	$x\ {}^2H^\circ$	4½ 5½	 *35275.77*		 1.14
$4d^3\,5s(a\,{}^5P)5p$	$w\ {}^4S^\circ$	1½	*36371.05*		1.948
$4d^4(a\,{}^3H)5p$	$y\ {}^4H^\circ$	3½ 4½ 5½ 6½	*36460.34* *36717.11* *36976.10* *37254.41*	256.77 258.99 278.31	0.691 0.970 1.15 1.23
$4d^3\,5s(b\,{}^3G)5p$	$t\ {}^2F^\circ$	2½ 3½	 *36511.49*		
$4d^4(a\,{}^3D)5p$	$s\ {}^2F^\circ$	2½ 3½	*36866.60* *36979.20*	112.60	0.846 1.14
$4d^4(c\,{}^3F)5p$	$t\ {}^4F^\circ$	1½ 2½ 3½ 4½	*37111.67* *37286.62* *37539.67* *37831.58*	174.95 253.05 291.91	0.526 0.964 1.172 1.260
$4d^4(c\,{}^3F)5p$	$u\ {}^4G^\circ$	2½ 3½ 4½ 5½	*37188.28* *37343.50* *37523.53* *37760.60*	155.22 180.03 237.07	0.840 1.058 1.190 1.25
$4d^4(a\,{}^5D)6s$	$e\ {}^6D$	0½ 1½ 2½ 3½ 4½	37410.17 37578.72 37842.36 38177.65 38567.85	168.55 263.64 335.29 390.20	
$4d^4(a\,{}^3D)5p$	$t\ {}^4D^\circ$	0½ 1½ 2½ 3½	*37536.56* *37954.99* *38393.49* *38854.14*	418.43 438.50 460.65	0.10 1.051 1.371 1.305
$4d^4(a\,{}^3G)5p$	$x\ {}^4H^\circ$	3½ 4½ 5½ 6½	*37624.53* *37866.06* *38143.76* *38513.85*	241.53 277.70 370.09	0.706 0.992 1.089 1.21
$4d^4(b\,{}^3F)5p$	$r\ {}^2F^\circ$	2½ 3½	*37814.64* *38231.85*	417.21	0.876 1.111
$4d^3\,5s(b\,{}^3D)5p$	$t\ {}^2D^\circ$	1½ 2½	*37865.42* *38180.32*	314.90	0.90 1.077
$4d^3\,5s(a\,{}^5F)6s$	$e\ {}^6F$	0½ 1½ 2½ 3½ 4½ 5½	37871.30 38021.41 38276.59 38638.47 39100.73 39408.88	150.11 255.18 361.88 462.26 308.15	
$4d^4(a\,{}^3D)5p$	$x\ {}^2P^\circ$	0½ 1½	*38182.96* *38446.78*	263.82	0.564 1.29
$4d^4(a\,{}^3H)5p$	$y\ {}^2I^\circ$	5½ 6½	*38251.28* *38583.04*	331.76	0.97 1.09
$4d^3\,5s(b\,{}^1G)5p$	$w\ {}^2H^\circ$	4½ 5½	*38448.77* *39020.81*	572.04	0.936 1.084
$4d^4(a\,{}^3D)5p$	$w\ {}^4P^\circ$	0½ 1½ 2½	*38730.16* *38709.66* *38763.34*	−20.50 53.68	2.55 1.660 1.588
$4d^3\,5s(b\,{}^3G)5p$	$s\ {}^4F^\circ$	1½ 2½ 3½ 4½	*38903.00* *39248.30* *39620.13* *40008.52*	345.30 371.83 388.39	0.448 0.973 1.094 1.108

Nb I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3\,5s(b\,^3H)5p$	$u\ ^2G^\circ$	3½ 4½	*38982.20* *39380.77*	398.57	1.010 1.10
$4d^3\,5s(d\,^3F)5p$	$t\ ^2G^\circ$	3½ 4½	*39426.84* *39637.83*	210.99	0.91 1.04
$4d^3\,5s(b\,^3G)5p$	$t\ ^4G^\circ$	2½ 3½ 4½ 5½	*39530.46* *39885.66* *40421.93* *40481.96*	355.20 536.27 60.03	0.61 1.085 1.228 1.18
$4d^4(a\,^1I)5p$	$v\ ^2H^\circ$	4½ 5½	*39845.51* *40003.00*	157.49	 1.152
$4d^3\,5s(b\,^3D)5p$	$r\ ^4F^\circ$	1½ 2½ 3½ 4½	*39981.20* *40209.72* *40362.00* *40853.89*	228.52 152.28 491.89	0.45 0.886 1.129 1.250
	400°	2½	*40009.84*		
$4d^3\,5s(b\,^3H)5p$	$s\ ^4G^\circ$	2½ 3½ 4½ 5½	*40079.30* *40555.28* *40921.15* *41371.17*	475.98 365.87 450.02	0.929 1.089 1.243 1.25
$4d^3\,5s(b\,^1F)5p$	$q\ ^2F^\circ$	3½ 2½	*40469.71* *40735.18*	−265.47	1.17 0.91
$4d^4(c\,^3F)5p$	$s\ ^4D^\circ$	0½ 1½ 2½ 3½	 *40473.90* *40953.36*	479.46	 1.29 1.367
$4d^3\,5s(b\,^1D)5p$	$w\ ^2P^\circ$	0½ 1½	 *41082.24*		 1.38
	411°	3½	*41139.95*		0.88
	414°	1½	*41460.97*		1.42
	$q\ ^4F^\circ$	1½ 2½ 3½ 4½	*41554.86* *41746.34* *41930.87* *41873.91*	191.48 184.53 −56.96	0.556 1.25 1.186
$4d^4(a\,^3G)5p$	$s\ ^2G^\circ$	3½ 4½	*41571.61* *41895.67*	324.06	
	416°	2½	*41615.40*		
$4d^3\,5s(b\,^3P)5p$	$r\ ^4D^\circ$	0½ 1½ 3½ 2½	*41676.81* *42339.56* *42551.56* *42719.18*	662.75 212.00 167.62	 1.45 1.39
$4d^4(a\,^1F)5p$	$p\ ^2F^\circ$	2½ 3½	*41829.11* *41987.35*	158.24	0.86 1.135
$4d^4(b\,^3F)5p$	$r\ ^2G^\circ$	3½ 4½	 *42193.70*		 1.15
$4d^4(c\,^3F)5p$	$s\ ^2D^\circ$	1½ 2½	 *42316.90*		 1.21
$4d^3\,5s(a\,^5P)5p$	$q\ ^4D^\circ$	0½ 1½ 2½ 3½	*42324.31* *42473.21* *42642.90* *43332.66*	148.90 169.69 689.76	

Nb I—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3\,5s(b\,^3D)5p$	$p\ ^4D^\circ$	0½ 1½ 2½ 3½	*42801.67* *42900.07* *43187.00* *43414.44*	98.40 286.93 227.44	
$4d^3\,5s(b\,^3D)5p$	$o\ ^2F^\circ$	2½ 3½	*42888.84*		
$4d^3\,5s(d\,^3F)5p$	$p\ ^4F^\circ$	1½ 2½ 3½ 4½	*42894.24* *43022.60* *43173.00* *43395.80*	128.36 150.40 222.80	 1.22 1.28
$4d^3\,5s(d\,^3F)5p$	$n\ ^2F^\circ$	2½ 3½	*43342.88* *43553.17*	210.29	
	$q\ ^2G^\circ$	3½ 4½	*43880.22*		
$4d^3\,5s(b\,^3D)5p$	$v\ ^2P^\circ$	1½ 0½	*44063.49* *46004.29*	−1940.80	1.27
	$o\ ^4D^\circ$	0½ 1½ 2½ 3½	 *44939.08* *44905.54* *45170.90*	−33.54 265.36	
$4d^3\,5s(b\,^3G)5p$	$u\ ^2H^\circ$	4½ 5½	*45110.13* *45259.03*	148.90	 1.09
$4d^4(c\,^3F)5p$	$m\ ^2F^\circ$	2½ 3½	*45297.30*		0.94
$4d^4(c\,^3F)5p$	$p\ ^2G^\circ$	3½ 4½	*45719.07* *45982.56*	263.49	0.84
$4d^3\,5s(a\,^3F)6p$	$n\ ^4D^\circ$	0½ 1½ 2½ 3½	*45978.84* *46364.79* *46812.58* *47275.64*	385.95 447.79 463.06	
$4d^3\,5s(a\,^3F)6p$	$r\ ^4G^\circ$	2½ 3½ 4½ 5½	*46011.48* *46470.71* *46724.20* *47080.83*	459.23 253.49 356.63	
$4d^3\,5s(a\,^3F)6p$	$o\ ^4F^\circ$	1½ 2½ 3½ 4½	*46170.04* *46543.56* *47022.78* *47680.59*	373.52 479.22 657.81	
	$n\ ^4F^\circ$	1½ 2½ 3½ 4½	 *46509.80* *46932.06* *47146.06*	422.26 214.00	
	469°	2½	*46919.48*		
$4d^3\,5s(b\,^3H)5p$	$t\ ^2H^\circ$	4½ 5½	*46954.40* *47155.22*	200.82	 1.00
	$o\ ^2G^\circ$	3½ 4½	*47528.49* *48242.44*	713.95	0.92 1.10
	475°	1½	*47537.67*		
	$n\ ^2G^\circ$	3½ 4½	 *51788.30*		
Nb II ($^5D_0$)	*Limit*	-----	54600		

May 1951.

Nb I OBSERVED TERMS*

Config. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6+$	Observed Terms												
$4d^5$	$a\,^6S$												
$4d^3\,5s^2$		$a\,^4P$ $a\,^2P$	$a\,^2D$	$a\,^4F$ $a\,^2F$	$a\,^2G$	$a\,^2H$							
	$ns\ (n \geq 5)$						$np\ (n \geq 5)$						
$4d^4(a\,^5D)nx$			$a, c\,^6D$ $a\,^4D$					$z\,^6P^{\circ}$ $z\,^4P^{\circ}$	$x\,^6D^{\circ}$ $y\,^4D^{\circ}$	$y\,^6F^{\circ}$ $y\,^4F^{\circ}$			
$4d^3\,5s(a\,^5F)nx$				$e\,^6F$					$z\,^6D^{\circ}$ $v\,^4D^{\circ}$	$z\,^6F^{\circ}$ $w\,^4F^{\circ}$	$z\,^6G^{\circ}$ $x\,^4G^{\circ}$		
$4d^4(a\,^3P)nx$		$b\,^4P$					$z\,^4S^{\circ}$ $z\,^2S^{\circ}$		$w\,^4D^{\circ}$ $z\,^2D^{\circ}$				
$4d^3\,5s(a\,^3F)nx$									$z, n\,^4D^{\circ}$ $y\,^2D^{\circ}$	$z, o\,^4F^{\circ}$ $z\,^2F^{\circ}$	$z, r\,^4G^{\circ}$ $y\,^2G^{\circ}$		
$4d^4(a\,^3H)nx$						$a\,^4H$ $b\,^2H$					$y\,^4G^{\circ}$ $z\,^2G^{\circ}$	$y\,^4H^{\circ}$ $z\,^2H^{\circ}$	$z\,^4I^{\circ}$ $y\,^2I^{\circ}$
$4d^4(a\,^3G)nx$					$a\,^4G$ $b\,^2G$					$u\,^4F^{\circ}$ $v\,^2F^{\circ}$	$v\,^4G^{\circ}$ $s\,^2G^{\circ}$	$x\,^4H^{\circ}$ $y\,^2H^{\circ}$	
$4d^3\,5s(a\,^5P)nx$							$z\,^6S^{\circ}$ $w\,^4S^{\circ}$	$y\,^6P^{\circ}$ $x\,^4P^{\circ}$	$y\,^6D^{\circ}$ $q\,^4D^{\circ}$				
$4d^4(a\,^1D)nx$										$y\,^2F^{\circ}$			
$4d^4(b\,^3F)nx$				$b\,^4F$					$u\,^4D^{\circ}$ $u\,^2D^{\circ}$	$x\,^4F^{\circ}$ $r\,^2F^{\circ}$	$w\,^4G^{\circ}$ $r\,^2G^{\circ}$		
$4d^4(a\,^3D)nx$			$b\,^4D$					$w\,^4P^{\circ}$ $x\,^2P^{\circ}$	$t\,^4D^{\circ}$	$v\,^4F^{\circ}$ $s\,^2F^{\circ}$			
$4d^3\,5s(b\,^3P)nx$							$x\,^4S^{\circ}$		$r\,^4D^{\circ}$ $v\,^2D^{\circ}$				
$4d^4(a\,^1G)nx$										$w\,^2F^{\circ}$		$x\,^2H^{\circ}$	
$4d^4(a\,^1I)nx$												$v\,^2H^{\circ}$	
$4d^3\,5s(b\,^3G)nx$										$s\,^4F^{\circ}$ $t\,^2F^{\circ}$	$t\,^4G^{\circ}$ $v\,^2G^{\circ}$	$z\,^4H^{\circ}$ $u\,^2H^{\circ}$	
$4d^3\,5s(b\,^1G)nx$										$x\,^2F^{\circ}$	$x\,^2G^{\circ}$	$w\,^2H^{\circ}$	
$4d^3\,5s(b\,^3H)nx$											$s\,^4G^{\circ}$ $u\,^2G^{\circ}$	$t\,^2H^{\circ}$	
$4d^4(a\,^1F)nx$										$p\,^2F^{\circ}$			
$4d^3\,5s(b\,^3D)nx$								$v\,^2P^{\circ}$	$p\,^4D^{\circ}$ $t\,^2D^{\circ}$	$r\,^4F^{\circ}$ $o\,^2F^{\circ}$			
$4d^3\,5s(c\,^3P)nx$							$y\,^4S^{\circ}$ $y\,^2S^{\circ}$	$y\,^4P^{\circ}$ $y\,^2P^{\circ}$	$x\,^4D^{\circ}$				
$4d^3\,5s(a\,^1P)nx$									$x\,^2D^{\circ}$				
$4d^4(c\,^3F)nx$									$s\,^4D^{\circ}$ $s\,^2D^{\circ}$	$t\,^4F^{\circ}$ $m\,^2F^{\circ}$	$u\,^4G^{\circ}$ $p\,^2G^{\circ}$		
$4d^3\,5s(a\,^1H)nx$											$w\,^2G^{\circ}$		$z\,^2I^{\circ}$
$4d^3\,5s(b\,^1D)nx$								$w\,^2P^{\circ}$	$w\,^2D^{\circ}$	$u\,^2F^{\circ}$			
$4d^3\,5s(d\,^3F)nx$										$p\,^4F^{\circ}$ $n\,^2F^{\circ}$	$t\,^2G^{\circ}$		
$4d^3\,5s(b\,^1F)nx$										$q\,^2F^{\circ}$			

*For predicted terms in the spectra of the Nb I isoelectronic sequence, see Vol. II, Introduction.

Nb II

(Zr I sequence; 40 electrons) $Z=41$

Ground state $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,4d^4\ ^5D_0$

$a\ ^5D_0$ **113000±** cm^{-1} I. P. 14±volts

The analysis is by Humphreys and Meggers, who have observed the spectrum from 2002.41 A to 7026.15 A. Of the 1723 lines recorded by them, 1494 are classified. The singlet, triplet, and quintet systems of terms are connected by observed intersystem combinations. The analysis is confirmed in great detail by the Zeeman patterns observed for 646 Nb II lines.

No series have been found. "The evidence from other spectra indicates that the principal ionization potential . . . will be about 14 volts." The approximate value of the limit corresponding to this ionization potential is quoted above and entered in brackets in the table.

REFERENCE

C. J. Humphreys and W. F. Meggers, J. Research Nat. Bur. Std. **34**, 481 RP 1656 (1945). (I P) (T) (C L) (Z E)

Nb II

Config.	Desig.	J	Level	Interval	Obs. g
$4d^4$	$a\ ^5D$	0	0.00	158.99	0/0
		1	158.99	279.39	1.500
		2	438.38	363.00	1.490
		3	801.38	423.49	1.486
		4	1224.87		1.495
$4d^3(a\ ^4F)5s$	$a\ ^5F$	1	2356.76	272.31	0.000
		2	2629.07	400.50	0.996
		3	3029.57	512.93	1.248
		4	3542.50	603.50	1.350
		5	4146.00		1.390
$4d^4$	$a\ ^3P$	0	5562.26	630.07	0/0
		1	6192.33	1069.00	1.495
		2	7261.33		1.450
$4d^3(a\ ^4F)5s$	$a\ ^3F$	2	7505.78	394.87	0.712
		3	7900.65	419.75	1.070
		4	8320.40		1.230
$4d^4$	$a\ ^3H$	4	9509.67	302.89	0.825
		5	9812.56	373.85	1.050
		6	10186.41		1.157
$4d^4$	$a\ ^3G$	3	10247.04	357.24	0.765
		4	10604.28	314.24	1.052
		5	10918.52		1.180
$4d^3(^4P)5s$	$a\ ^5P$	1	10653.40	182.45	2.477
		2	10835.85	503.71	1.815
		3	11339.56		1.663
$4d^4$	$a\ ^1D$	2	12263.26		1.003
$4d^4$	$b\ ^3F$	2	12805.98	884.22	0.849
		3	13690.20	−24.52	1.150
		4	13665.68		1.152
$4d^4$	$a\ ^3D$	3	13054.69	−424.81	1.246
		2	13479.50	360.88	1.002
		1	13118.62		0.512
$4d^3(^2P)5s$	$b\ ^3P$	2	14660.77	34.51	1.483
		1	14626.26	−52.14	1.504
		0	14678.40		0/0
$4d^4$	$a\ ^1G$	4	14790.79		1.083
$4d^4$	$a\ ^1I$	6	15396.10		1.000

Nb II

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3(^2G)5s$	$b\ ^3G$	3	15551.30	398.10	0.767
		4	15949.40	103.32	1.027
		5	16052.72		1.190
$4d^3(^2G)5s$	$b\ ^1G$	4	16219.04		0.950
$4d^4$	$a\ ^1S$	0	17202.72		0/0
$4d^3(^2H)5s$	$b\ ^3H$	6	17424.88	132.39	1.154
		5	17292.49	−177.28	1.052
		4	17469.77		0.880
$4d^4$	$a\ ^1F$	3	18508.15		1.007
$4d^3(^2D)5s$	$b\ ^3D$	1	18819.57	532.41	0.681
		2	19351.98	337.56	1.171
		3	19689.54		1.312
$4d^3(^4P)5s$	$c\ ^3P$	0	20347.55	692.01	0/0
		1	21039.56	471.90	1.218
		2	21511.46		1.468
$4d^3(^2P)5s$	$a\ ^1P$	1	20437.58		1.115
$4d^4$	$c\ ^3F$	2	20657.82	459.65	0.670
		3	21117.47	355.05	1.080
		4	21472.52		1.240
$4d^3(^2H)5s$	$a\ ^1H$	5	21073.05		0.992
$4d^3(^2D)5s$	$b\ ^1D$	2	24332.87		0.98
$4d^3(^2F)5s$	$d\ ^3F$	4	25357.50	3.84	
		3	25353.66	−60.58	0.93
		2	25414.24		0.71
$4d^4$	$d\ ^3P$	2	27282.18	−511.97	1.49
		1	27794.15	−207.22	1.49
		0	28001.37		0/0
$4d^4$	$c\ ^1G$	4	29634.24		1.087
$4d^4$	$c\ ^1D$	2	31064.80		1.01
$4d^3(^2F)5s$	$b\ ^1F$	3	31762.31		1.01
$4d^3(a\ ^4F)5p$	$z\ ^5G°$	2	*33351.00*	568.20	0.345
		3	*33919.20*	712.80	0.913
		4	*34632.00*	842.17	1.152
		5	*35474.17*	981.30	1.250
		6	*36455.47*		1.31

Nb II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3(a\,{}^4\mathrm{F})5p$	$z\,{}^3\mathrm{D}^\circ$	1	34886.33	634.50	0.420
		2	35520.83	1032.44	1.138
		3	36553.27		1.311
$4d^3(a\,{}^4\mathrm{F})5p$	$z\,{}^5\mathrm{F}^\circ$	1	36731.79	230.97	0.122
		2	36962.76	414.15	1.023
		3	37376.91	151.48	1.266
		4	37528.39	495.93	1.325
		5	38024.32		1.357
$4d^3(a\,{}^4\mathrm{F})5p$	$z\,{}^5\mathrm{D}^\circ$	0	37298.20	181.83	0/0
		1	37480.03	317.26	1.460
		2	37797.29	419.08	1.469
		3	38216.37	74.88	1.466
		4	38291.25		1.473
$4d^3(a\,{}^4\mathrm{F})5p$	$z\,{}^3\mathrm{G}^\circ$	3	38684.96	650.34	0.764
		4	39335.30	768.31	1.072
		5	40103.61		1.234
$4d^3(a\,{}^4\mathrm{F})5p$	$z\,{}^3\mathrm{F}^\circ$	2	38984.40	795.55	0.691
		3	39779.95	781.05	1.088
		4	40561.00		1.260
$4d^3({}^2\mathrm{P})5p$	$z\,{}^1\mathrm{S}^\circ$	0	39791.90		0/0
$4d^3({}^2\mathrm{P})5p$	$z\,{}^1\mathrm{D}^\circ$	2	41710.15		1.312
$4d^3({}^4\mathrm{P})5p$	$y\,{}^5\mathrm{D}^\circ$	0	42596.58	−463.88	0/0
		1	42132.70	1485.65	1.385
		2	43618.35	268.65	1.347
		3	43887.00	1083.73	1.447
		4	44970.73		1.480
$4d^3({}^2\mathrm{G})5p$	$z\,{}^3\mathrm{H}^\circ$	4	42868.97	698.96	0.810
		5	43567.93	964.47	1.040
		6	44532.40		1.167
$4d^3({}^4\mathrm{P})5p$	$y\,{}^3\mathrm{D}^\circ$	1	43649.19	−358.85	0.980
		2	43290.34	1348.43	1.227
		3	44638.77		1.035
$4d^3({}^4\mathrm{P})5p$	$z\,{}^5\mathrm{P}^\circ$	1	43450.00	776.81	2.255
		2	44226.81	544.66	1.745
		3	44771.47		1.562
$4d^3({}^4\mathrm{P})5p$	$z\,{}^3\mathrm{P}^\circ$	0	44286.00	−219.35	0/0
		1	44066.65	857.94	1.230
		2	44924.59		1.253
$4d^3({}^2\mathrm{P})5p$	$y\,{}^3\mathrm{P}^\circ$	0	45206.59	168.37	0/0
		1	45374.96	1170.32	1.765
		2	46545.28		1.506
$4d^3({}^2\mathrm{G})5p$	$z\,{}^1\mathrm{H}^\circ$	5	45342.25		1.018
$4d^3({}^2\mathrm{G})5p$	$y\,{}^3\mathrm{G}^\circ$	3	45919.08	−297.11	1.014
		4	45621.97	877.65	1.126
		5	46499.62		1.171
$4d^3({}^2\mathrm{G})5p$	$y\,{}^3\mathrm{F}^\circ$	2	45655.84	772.79	0.740
		3	46428.63	−133.02	1.123
		4	46295.61		1.111
$4d^3({}^2\mathrm{G})5p$	$z\,{}^1\mathrm{F}^\circ$	3	45802.49		1.085
$4d^3({}^2\mathrm{D})5p$	$x\,{}^3\mathrm{F}^\circ$	2	46343.10	606.37	0.43
		3	46949.47	3602.79	1.00
		4	50552.26		1.22
$4d^3({}^2\mathrm{P})5p$	$z\,{}^3\mathrm{S}^\circ$	1	46358.94		1.821
$4d^3({}^4\mathrm{P})5p$	$z\,{}^5\mathrm{S}^\circ$	2	47072.92		1.940
$4d^3({}^2\mathrm{H})5p$	$y\,{}^3\mathrm{H}^\circ$	4	47345.18	1155.62	0.963
		5	48500.80	270.10	1.038
		6	48770.90		1.132
$4d^3({}^2\mathrm{D})5p$?§	$w\,{}^3\mathrm{F}^\circ$	2	47755.76	321.91	0.63
		3	48077.67	549.53	1.065
		4	48627.20		1.100

Nb II—Continued

Config.	Desig.	J	Level	Interval	Obs. g
$4d^3({}^2\mathrm{H})5p$	$z\,{}^3\mathrm{I}^\circ$	5	48130.50	486.99	0.870
		6	48617.49	772.24	1.051
		7	49389.73		1.15
$4d^3({}^2\mathrm{G})5p$	$z\,{}^1\mathrm{G}^\circ$	4	48253.44		1.083
$4d^3({}^2\mathrm{P})5p$	$z\,{}^1\mathrm{P}^\circ$	1	48520.41		0.936
$4d^3({}^2\mathrm{H})5p$	$y\,{}^1\mathrm{G}^\circ$	4	49158.16		0.950
$4d^3({}^2\mathrm{P})5p$	$x\,{}^3\mathrm{D}^\circ$	1	49687.72	−442.17	0.820
		2	49245.55	513.64	1.257
		3	49759.19		1.288
$4d^2\,5s(\ )5p$	495°	2	49536.62		
$4d^3({}^2\mathrm{D})5p$	$w\,{}^3\mathrm{D}^\circ$	1	49733.45	38.85	0.616
		2	49772.30	91.95	1.167
		3	49864.25		1.308
$4d^2\,5s(\ )5p$	500°	3	50068.70		1.245
$4d^3({}^2\mathrm{D})5p$	$x\,{}^3\mathrm{P}^\circ$	0	50295.20	179.72	0/0
		1	50474.92	−27.56	1.202
		2	50447.36		1.360
$4d^3({}^2\mathrm{H})5p$	$x\,{}^3\mathrm{G}^\circ$	5	50497.90	−353.80	1.188
		4	50851.70	266.39	1.171
		3	50585.31		0.811
$4d^3({}^2\mathrm{D})5p$	$y\,{}^1\mathrm{D}^\circ$	2	51182.16		0.965
$4d^3({}^2\mathrm{H})5p$	$z\,{}^1\mathrm{I}^\circ$	6	51707.49		1.010
$4d^3({}^2\mathrm{D})5p$	$y\,{}^1\mathrm{P}^\circ$	1	51787.87		1.13
$4d^3({}^2\mathrm{F})5p$	$v\,{}^3\mathrm{F}^\circ$	2	51927.28	9.11	0.80
		3	51936.39	343.25	1.085
		4	52279.64		1.261
$4d^2\,5s(\ )5p$?	$w\,{}^3\mathrm{P}^\circ$	0	52129.80	85.05	0/0
		1	52214.85	173.74	1.43
		2	52388.59		1.44
$4d^3({}^4\mathrm{P})5p$	$y\,{}^3\mathrm{S}^\circ$	1	52553.90		1.820
$4d^2\,5s(\ )5p$	527°	3	52714.88		1.415
$4d^3({}^2\mathrm{H})5p$	$y\,{}^1\mathrm{H}^\circ$	5	52788.10		1.006
$4d^3({}^2\mathrm{D})5p$	$y\,{}^1\mathrm{F}^\circ$	3	53035.95		1.036
$4d^3({}^2\mathrm{F})5p$	$w\,{}^3\mathrm{G}^\circ$	3	53702.02	726.55	0.88
		4	54428.57	592.63	1.062
		5	55021.20		1.180
$4d^3({}^2\mathrm{F})5p$	$v\,{}^3\mathrm{D}^\circ$	3	54009.50	−115.30	1.200
		2	54124.80	−47.80	1.164
		1	54172.60		0.527
$4d^3({}^2\mathrm{F})5p$	$x\,{}^1\mathrm{F}^\circ$	3	55460.54		1.06
$4d^3({}^2\mathrm{F})5p$	$x\,{}^1\mathrm{D}^\circ$	2	55721.74		1.000
$4d^3({}^2\mathrm{F})5p$	$x\,{}^1\mathrm{G}^\circ$	4	57145.25		1.000
$4d^2\,5s(b\,{}^4\mathrm{F})5p$	$u\,{}^3\mathrm{F}^\circ$	2	57808.35	694.08	0.98
		3	58502.43	897.37	1.25
		4	59399.80		1.34
$4d^2\,5s(b\,{}^4\mathrm{F})5p$	$u\,{}^3\mathrm{D}^\circ$	1	59622.26	−125.24	0.64
		2	59497.02	208.48	1.19
		3	59705.50		1.33
$4d^2\,5s(b\,{}^4\mathrm{F})5p$	$v\,{}^3\mathrm{G}^\circ$	3	59509.23	585.27	
		4	60094.50	345.25	
		5	60439.75		1.19
Nb III (${}^4\mathrm{F}_{1\frac{1}{2}}$)	*Limit*	-----	**113000**		

May 1951.

Nb II OBSERVED TERMS*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Observed Terms	
$4d^4$	$a\ ^5D$ $a\ ^3P$ $a\ ^3D$ $b\ ^3F$ $a\ ^3G$ $a\ ^3H$ $d\ ^3P$ $c\ ^3F$ $a\ ^1S$ $a\ ^1D$ $a\ ^1F$ $a\ ^1G$ $c\ ^1D$ $c\ ^1G$ $a\ ^1I$	
	$ns\ (n \geq 5)$	$np\ (n \geq 5)$
$4d^3(a\ ^4F)nx$	$a\ ^5F$ $a\ ^3F$	$z\ ^5D^\circ$ $z\ ^5F^\circ$ $z\ ^5G^\circ$ $z\ ^3D^\circ$ $z\ ^3F^\circ$ $z\ ^3G^\circ$
$4d^3(^4P)nx$	$a\ ^5P$ $c\ ^3P$	$z\ ^5S^\circ$ $z\ ^5P^\circ$ $y\ ^5D^\circ$ $y\ ^3S^\circ$ $z\ ^3P^\circ$ $y\ ^3D^\circ$
$4d^3(^2P)nx$	$b\ ^3P$ $a\ ^1P$	$z\ ^3S^\circ$ $y\ ^3P^\circ$ $x\ ^3D^\circ$ $z\ ^1S^\circ$ $z\ ^1P^\circ$ $z\ ^1D^\circ$
$4d^3(^2G)nx$	$b\ ^3G$ $b\ ^1G$	$y\ ^3F^\circ$ $y\ ^3G^\circ$ $z\ ^3H^\circ$ $z\ ^1F^\circ$ $z\ ^1G^\circ$ $z\ ^1H^\circ$
$4d^3(^2H)nx$	$b\ ^3H$ $a\ ^1H$	$x\ ^3G^\circ$ $y\ ^3H^\circ$ $z\ ^3I^\circ$ $y\ ^1G^\circ$ $y\ ^1H^\circ$ $z\ ^1I^\circ$
$4d^3(^2D)nx$	$b\ ^3D$ $b\ ^1D$	$x\ ^3P^\circ$ $w\ ^3D^\circ$ $x\ ^3F^\circ$ $y\ ^1P^\circ$ $y\ ^1D^\circ$ $y\ ^1F^\circ$
$4d^3(^2F)nx$	$d\ ^3F$ $b\ ^1F$	$v\ ^3D^\circ$ $v\ ^3F^\circ$ $w\ ^3G^\circ$ $x\ ^1D^\circ$ $x\ ^1F^\circ$ $x\ ^1G^\circ$
$4d^3(^2D)nx$§		$w\ ^3F^\circ$
$4d^2\ 5s(b\ ^4F)nx$		$u\ ^3D^\circ$ $u\ ^3F^\circ$ $v\ ^3G^\circ$

*For predicted terms in the spectra of the Zr I isoelectronic sequence, see Vol. II, Introduction.
§ This entry denotes the higher of the two ^2D limit terms for this configuration.

Nb III

(Y I sequence; 39 electrons) **Z=41**

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^3\ ^4F_{1\frac{1}{2}}$

$4d^3\ ^4F_{1\frac{1}{2}}$ **227005** cm^{-1} I. P. 28.1 volts

In 1928 Gibbs and White classified 27 lines between 2218.61 A and 2685.75 A as combinations between $5s\ ^4F$ and $5p\ ^4(DFG)^\circ$. Subsequently Eliason classified 26 additional lines, in the range from 1422.87 A to 1599.72 A, as combinations between the ground term, $4d^3\ ^4F$, and the same triad of odd terms. He confirmed the earlier work in detail, except for the level $5p\ ^4F^\circ_{1\frac{1}{2}}$ at 66499.5, which he rejected.

Eliason derived an improved value of the limit by a linear extrapolation of isoelectronic sequence data. His value in round figures is entered in brackets in the table.

REFERENCES

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A. Y. Eliason, Phys. Rev. **43,** 745 (1933). (I P) (T) (C L)

Nb III

Config.	Desig.	J	Level	Interval
$4d^3$	$4d^3\ ^4F$	$1\frac{1}{2}$	0.0	
				516.9
		$2\frac{1}{2}$	516.9	
				659.7
		$3\frac{1}{2}$	1176.6	
				762.7
		$4\frac{1}{2}$	1939.3	
$4d^2(^3F)5s$	$5s\ ^4F$	$1\frac{1}{2}$	25221.2	
				515.3
		$2\frac{1}{2}$	25736.5	
				728.4
		$3\frac{1}{2}$	26464.9	
				909.8
		$4\frac{1}{2}$	27374.7	
$4d^2(^3F)5p$	$5p\ ^4G^\circ$	$2\frac{1}{2}$	*63687.4*	
				1319.7
		$3\frac{1}{2}$	*65007.1*	
				1449.4
		$4\frac{1}{2}$	*66456.5*	
				1605.2
		$5\frac{1}{2}$	*68061.7*	
$4d^2(^3F)5p$	$5p\ ^4F^\circ$	$1\frac{1}{2}$		
		$2\frac{1}{2}$	*67095.1*	
				773.6
		$3\frac{1}{2}$	*67868.7*	
				919.1
		$4\frac{1}{2}$	*68787.8*	
$4d^2(^3F)5p$	$5p\ ^4D^\circ$	$0\frac{1}{2}$	*69184.2*	
				490.1
		$1\frac{1}{2}$	*69674.3*	
				606.4
		$2\frac{1}{2}$	*70280.7*	
				307.3
		$3\frac{1}{2}$	*70588.0*	
Nb IV ($^3F_2$)	*Limit*	-------	[227005]	

April 1951.

Nb III Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Observed Terms			
$4d^3$	$4d^3\ ^4F$			
	ns $(n\geq5)$	*np* $(n\geq5)$		
$4d^2(^3F)nx$	$5s\ ^4F$	$5p\ ^4D^\circ$	$5p\ ^4F^\circ$	$5p\ ^4G^\circ$

*For predicted terms in the spectra of the Y I isoelectronic sequence, see Vol. II, Introduction.

Nb IV

(Sr I sequence; 38 electrons) $Z=41$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^2\ ^3F_2$

$4d^2\ ^3F_2$ **308600** cm^{-1} I. P. 38.3 volts

The analysis is from Lang, who has extended the earlier work on this spectrum. He lists 113 classified lines in the interval from 542.38 A to 2249.98 A. His limit is derived by a Rydberg formula from the 5, 6s ^{1,3}D series.

The values of the $4d\ ^1G$ and $5p\ ^1F^\circ$ terms are tentative. "These values must be nearly correct but . . . . . lack confirmation which can only be supplied by the discovery of the $4f$ singlets."

Observed intersystem combinations connect the singlet and triplet terms.

REFERENCE

R. J. Lang, *Zeeman Verhandelingen* p. 44 (Martinus Nijhoff, The Hague, 1935). (I P) (T) (C L)

Nb IV

Config.	Desig.	J	Level	Interval
$4d^2$	$4d^2\ {}^3F$	2	0.0	
		3	1086.4	1086.4
		4	2344.6	1258.2
$4d^2$	$4d^2\ {}^1G$	4	3054.6?	
$4d^2$	$4d^2\ {}^1D$	2	7163.3	
$4d^2$	$4d^2\ {}^3P$	0	9692.1	
		1	10123.5	431.4
		2	11121.5	998.0
$4d(^2D)5s$	$5s\ {}^1D$	2	46509.3	
$4d(^2D)5s$	$5s\ {}^3D$	1	52062.8	
		2	52628.7	565.9
		3	53809.1	1180.4
$4d(^2D)5p$	$5p\ {}^1F^\circ$	3	*92338.7?*	
$4d(^2D)5p$	$5p\ {}^1D^\circ$	2	*95814.3*	
$4d(^2D)5p$	$5p\ {}^1P^\circ$	1	*97059.8*	
$4d(^2D)5p$	$5p\ {}^3D^\circ$	1	*98991.5*	
		2	*100388.7*	1397.2
		3	*101776.7*	1388.0
$4d(^2D)5p$	$5p\ {}^3F^\circ$	2	*99723.8*	
		3	*100384.8*	661.0
		4	*102993.3*	2608.5
$4d(^2D)5p$	$5p\ {}^3P^\circ$	0	*105273.5*	
		1	*104965.5*	−308.0
		2	*105827.5*	862.0

Nb IV

Config.	Desig.	J	Level	Interval
$4d(^2D)5d$	$5d\ {}^3P$	0	165272.1	
		1	165989.8	717.7
		2	166963.7	973.9
$4d(^2D)5d$	$5d\ {}^3F$	2	169199	
		3	169557	358
		4	170863	1306
$4d(^2D)5d$	$5d\ {}^1D$	2	172552.0	
$4d(^2D)6s$	$6s\ {}^1D$	2	172867.3	
$4d(^2D)5d$	$5d\ {}^1P$	1	172993.9	
$4d(^2D)6s$	$6s\ {}^3D$	1	174484.1	
		2	174783.9	299.8
		3	176319.8	1535.9
$4d(^2D)4f$	$4f\ {}^3F^\circ$	2	*174870*	
		3	*177696*	2826
		4	*180927*	3231
$4d(^2D)4f$	$4f\ {}^3G^\circ$	3	*184372*	
		4	*185218*	846
		5	*185760*	542
	^1D	2	183861.7	
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Nb v ($^2D_{1½}$)	***Limit***	----------	**308600**	

April 1951.

Nb IV Observed Terms*

Config. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6+$	Observed Terms			
$4d^2$	$4d^2\ {}^3P$, $4d^2\ {}^1D$, $4d^2\ {}^3F$, $4d^2\ {}^1G?$			
	$ns\ (n\geq5)$	$np\ (n\geq5)$	$nd\ (n\geq5)$	$nf\ (n\geq4)$
$4d(^2D)nx$	5, 6s ^3D 5, 6s ^1D	$5p\ {}^3P^\circ$ $5p\ {}^3D^\circ$ $5p\ {}^3F^\circ$ $5p\ {}^1P^\circ$ $5p\ {}^1D^\circ$ $5p\ {}^1F^\circ?$	$5d\ {}^3P$ $5d\ {}^3F$ $5d\ {}^1P$ $5d\ {}^1D$	$4f\ {}^3F^\circ$ $4f\ {}^3G^\circ$

*For predicted terms in the spectra of the Sr I isoelectronic sequence, see Vol. II, Introduction.

Nb V

(Rb I sequence; 37 electrons) $Z=41$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d\ {}^2D_{1½}$

$4d\ {}^2D_{1½}$ **400000** cm^{-1} I. P. 50 volts

Thirteen lines have been classified between 464 A and 1877 A as combinations among six terms. The analysis is by Trawick, who has extrapolated the limit (entered in brackets in the table) from isoelectronic sequence data. Charles has recently observed six lines between 464 A and 774 A, which agree well with the earlier measurements. He has resolved the $4d\ {}^2D-4f\ {}^2F^\circ$ group. Of the three terms common to the two lists, an average value is used in the table for $4d\ {}^2D$; $5p\ {}^2P^\circ$ is the same in both; and Charles' value is entered for $4f\ {}^2F^\circ$; but the differences are insignificant.

843210°—52——17

Nb v—Continued

REFERENCES

M. W. Trawick, Phys. Rev. **46**, 63 (1934). (I P) (T) (C L)
G. W. Charles, Phys. Rev. **77**, 120 (1950). (T) (C L)

Nb v

Config.	Desig.	J	Level	Interval
$4p^6(^1S)4d$	$4d\ ^2D$	1½ 2½	0 1870	1870
$4p^6(^1S)5s$	$5s\ ^2S$	0½	75929	
$4p^6(^1S)5p$	$5p\ ^2P^\circ$	0½ 1½	*129196* *132800*	3604
$4p^6(^1S)5d$	$5d\ ^2D$	1½ 2½	211690 212237	547
$4p^6(^1S)4f$	$4f\ ^2F^\circ$	2½ 3½	*215260* *215394*	134
$4p^6(^1S)6s$	$6s\ ^2S$	0½	228500	
Nb vi ($^1S_0$)	*Limit*	-------	[400000]	

March 1951.

Nb vi

(Kr i sequence; 36 electrons) $Z=41$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ ^1S_0$

$4p^6\ ^1S_0$ **829750** cm^{-1} I. P. 103 volts

The analysis is far from complete. Charles has classified seven lines between 164 A and 325 A as due to transitions from the ground term to levels produced by $4d$, $5d$, $5s$, and $6s$ electrons. The level values in the table are the rounded off wave numbers of the observed lines. He has estimated the limit quoted above by applying a Rydberg formula to the $ns\ s_4^\circ$ levels ($n=5,6$). The higher limit in the table has been determined by the writer by adding the interval of the ground term of Nb vii to the lower limit.

As for Kr i the writer has introduced the jl-coupling notation in the general form suggested by Racah. Charles has noted that the $4d$ and $5d$ assignments are open to some question. Consequently, the pair-coupling notation for these levels may need revision.

REFERENCES

G. Racah, Phys. Rev. **61**, 537 (L) (1942).
G. W. Charles, Phys. Rev. **77**, 120 (1950). (I P) (T) (C L)

Nb vi

Author	Config.	Desig.	J	Level
$4p^6\ p_0$	$4p^6$	$4p^6\ ^1S$	0	0
$4d\ d_2^\circ$	$4p^5(^2P^\circ_{1½})4d$	$4d\ [1½]^\circ$	2 1	*306940*
$5s\ s_4^\circ$	$4p^5(^2P^\circ_{1½})5s$	$5s\ [1½]^\circ$	2 1	*402050*
$5s\ s_2^\circ$	$4p^5(^2P^\circ_{0½})5s$	$5s'\ [0½]^\circ$	0 1	*419860*
$5d\ d_5^\circ$?	$4p^5(^2P^\circ_{1½})5d$	$5d\ [0½]^\circ$	0 1	*553870*
$5d\ d_3^\circ$?	$4p^5(^2P^\circ_{1½})5d$	$5d\ [1½]^\circ$	2 1	*563220*
$6s\ s_4^\circ$	$4p^5(^2P^\circ_{1½})6s$	$6s\ [1½]^\circ$	2 1	*587610*
$6s\ s_2^\circ$	$4p^5(^2P^\circ_{0½})6s$	$6s'\ [0½]^\circ$	0 1	*606140*
	Nb vii ($^2P^\circ_{1½}$)	*Limit*	-------	829750
	Nb vii ($^2P^\circ_{0½}$)	*Limit*	-------	848930

February 1951.

Nb VII

(Br I sequence; 35 electrons) $Z=41$

Ground state $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$

$4p^5\ {}^2P^{\circ}_{1\frac{1}{2}}$ ***1005000*** cm^{-1} I. P. 125 volts

The analysis is incomplete. Charles has classified 41 lines between 197 A and 517 A as due to transitions from the ground term to 13 higher terms.

He has extrapolated the value of the limit from isoelectronic sequence data.

REFERENCE

G. W. Charles, Phys. Rev. **77**, 120 (1950). (I P) (T) (C L)

Nb VII

Config.	Desig.	J	Level	Interval
$4s^2\ 4p^5$	$4p^5\ {}^2P^{\circ}$	1½ 0½	*0* *19185*	−19185
$4s\ 4p^6$	$4p^6\ {}^2S$	0½	212501	
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4D$	3½ 2½ 1½ 0½	 270858 277702 283097	−6844 −5395
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^4P$	0½ 1½ 2½	326509 331170 336071	4661 4901
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2D$	1½ 2½	335593 349314	13721
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2P$	0½ 1½?	 339687	
$4s^2\ 4p^4(^3P)4d$	$4d\ {}^2F$	3½ 2½	 364672	
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2D$	2½ 1½	381021 396124	−15103
$4s^2\ 4p^4(^1D)4d$	$4d'\ {}^2P$	1½ 0½?	398817 401699	−2882
$4s^2\ 4p^4(^1S)4d$	$4d''\ {}^2D$	2½? 1½?	403260 407544	−4284
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^4P$	2½ 1½? 0½	 416055 426310	−10255
$4s^2\ 4p^4(^3P)5s$	$5s\ {}^2P$	1½ 0½	446064 458824	−12760
$4s^2\ 4p^4(^1D)5s$	$5s'\ {}^2D$	2½ 1½	455071 464153	−9082
$4s^2\ 4p^4(^1S)5s$	$5s''\ {}^2S$	0½	506552	
Nb VIII ($^3P_2$)	*Limit*	------	[*1005000*]	

February 1951.

Nb VII Observed Terms*

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}+$	Observed Terms	
$4s^2\ 4p^5$	$4p^5\ {}^2P^{\circ}$	
$4s\ 4p^6$	$4p^6\ {}^2S$	
	$ns\ (n\geq5)$	$nd\ (n\geq4)$
$4s^2\ 4p^4(^3P)nx$	$5s\ {}^4P$ $5s\ {}^2P$	$4d\ {}^4P$ $4d\ {}^4D$ $4d\ {}^2P$ $4d\ {}^2D$ $4d\ {}^2F$
$4s^2\ 4p^4(^1D)nx'$	$5s'\ {}^2D$	$4d'\ {}^2P$ $4d'\ {}^2D$
$4s^2\ 4p^4(^1S)nx''$	$5s''\ {}^2S$	$4d''\ {}^2D$

*For predicted terms in the spectra of the Br I isoelectronic sequence, see Vol. II, Introduction.

Additions and Corrections to Volume I

Since the publication of Volume I, in June 1949, some investigations have been carried out that indicate important revisions and additions to data on atomic energy levels included in that work. One survey of all the material has been made quite incidentally, because W. E. Forsythe has requested a revision of the tables of binding energies of electrons for inclusion in the forthcoming revised edition of the Smithsonian Physical Tables. H. N. Russell and the writer [1] have, accordingly, prepared these revised tables of binding energies for the first and second spectra of the elements H to Nb. These calculations are based on the material contained in Volumes I and II of AEL.

In the course of this work Russell [2] has also revised the ionization potentials of the second spectra of the elements of the iron group to take into account the Ritz correction to limits derived from series of only two members. The idea is not a new one, but the excellent series recently observed in some of these spectra now make the revisions fairly definitive. Catalán [3] has similarly corrected the third spectra of the elements Sc through Ga, but from more meager data. These revised limits and ionization potentials are listed below for Sc II, Sc III; Ti II, Ti III; and V II, V III.

The tables of binding energies indicate three other corrections that should be mentioned. (1) The ionization potential of P I estimated by Finkelnburg and Stern [4] from a study of the regularities in the run of screening constants, appears to be preferable to the value published in Volume I. (2) The P I term $5s\ ^4P$ at 75064, etc., should be rejected. (3) The run of the binding energies indicates that in Si I the two $^3D^\circ$ terms *45276*, etc. and *48399*, etc. should possibly have their configurations interchanged, but further observations are needed to settle this question.

Humphreys' [5] recent work on infrared atomic spectra has led to the discovery of the long awaited $3d^2\ ^3F$ term of Ca I. In addition, he has observed and classified new infrared lines in Si I and V I; and has provisionally located the new $3d^5\ ^4D$ term in V I.

The leading revisions for spectra in Volume I are listed below.

[1] C. E. Moore and H. N. Russell, J. Research Nat. Bur. Std. 48, 61, RP2285 (1952).
[2] H. N. Russell, J. Opt. Soc. Am. **40,** 618 (1950).
[3] M. A. Catalán, unpublished material (April 1952).
[4] W. Finkelnburg and F. Stern, Phys. Rev. **77,** 303 (1950).
[5] C. J. Humphreys, J. Research Nat. Bur. Std. 47, 262, RP2252 (1951).

Page	Spectrum	Remarks
4	He I	Observations on He I sequence, see B. Edlén, Ark. f Fys. (Stockholm) **4**, No. 28, 441 (1952).
6	He II	Line 2 of text, p. e. of A should read ±0.0009.
9	Li I	$10d\ ^2D$ should read 42389 instead of 41489, and should be inserted after $10p\ ^2P^\circ$.
60	F I	Add reference: K. Lidén, Ark. för Fys. 1, No. 9, 229 (Stockholm) (1949). (I P) (T) (C L) (hfs); and revise terms accordingly.
		Revised limit should read **140524.5** I. P. 17.418.
76	Ne I	Add reference: K. Burns, K. B. Adams, and J. Longwell, J. Opt. Soc. Am. **40,** 339 (1950). (T) (C L) (revised level values). See also; C. J. Humphreys and H. J. Kostkowski, J. Research Nt. Bur. Std. **49,** RP2345 (1952).
124	Al I	Add reference: W. R. S. Garton, Nature **165,** 322 (1950). (T) (C L) (confirm $3p^2\ ^2S$ term).
154	Si VII	Level $2p^5\ ^3P^\circ_2$ should read *363170*.
163	P I	See discussion above.
		Revised limit should read **85115,** I. P. 10.55
		Reject $5s\ ^4P$ term, 75064.6, etc.
		Add reference: W. Finkelnburg and F. Stern, Phys. Rev. **77,** 303 (1950). (I P)
174	P IX	H. A. Robinson (April 1951) in private conversation has stated that the terms having the configuration $2s\ 2p^4$ need revision.
176	P X	H. A. Robinson (April 1951) in private conversation has stated that the terms having the configuration $2s\ 2p^3$ need revision.
211	A I	Line 8 of the text should read "between 781 A and 786 A."
		Last reference should read: W. R. Sittner and E. R. Peck, J. Opt. Soc. Am. **39,** 474 (1949). (C L)

Page	Spectrum	Remarks
243 245	Ca I	Add Humphreys new term discussed above:

Config.	Desig.	J	Level	Interval
$3d^2$	$3d^2\ {}^3F$	2 3 4	43474. 87 43489. 19 43508. 10	14. 32 18. 91

Page	Spectrum	Remarks
		Reference: C. J. Humphreys, J. Research Nat. Bur. Std. **47,** 262, RP2252 (1951). (T) (C L)
260 261	Sc I	Racah (1951) in private conversation has suggested that the configuration of the term $x\ {}^2P^{\circ}$ should read $4s^2(a\ {}^1S)4p$ instead of $3d^2(a\ {}^1S)4p$.
262	Sc II	See discussion above. Revised limit should read **103240,** I. P. 12.80. Add reference: H. N. Russell, J. Opt. Soc. Am. **40,** 618 (1950). (I P).
263	Sc III	See discussion above. Revised limit should read **199700,** I. P. 24.75. Add references: J. E. Mack, Rev. Mod. Phys. **22,** No. 1, 64 (1950). (Summary hfs.) M. A. Catalán, unpublished material (April 1952). (I P).
279 280	Ti II	See discussion above. Revised limit should read **109506,** I. P. 13.57. Add reference: H. N. Russell, J. Opt. Soc. Am. **40,** 618 (1950). (I P).
281 282	Ti III	See discussion above. Revised limit should read **221600,** I. P. 27.47. Add reference: M. A. Catalán, unpublished material (April 1952). (I P).
291 293 297	V I	Add provisional new term by Humphreys and Kostkowski discussed above:

Config.	Desig.	J	Level	Inverval
$3d^5$	$c\ {}^4D$	0½ 1½ 2½ 3½	34329. 05 34343. 22 34359. 26 34366. 84	14. 17 16. 04 7. 58

Page	Spectrum	Remarks
		Racah (1951 in private conversation) has suggested that the configuration of the term $e\ {}^4F$ should read $3d^4(c\ {}^3F)4s$ instead of $3d^5$. Add reference: C. J. Humphreys and H. J. Kostkowski. J. Opt. Soc. Am. **40,** 801 (A) (1950) and unpublished material (May 1951) (T) (C L)
298 300	V II	See discussion above. Revised limit should read **[118200]** I. P. 14.65. Add reference: H. N. Russell, J. Opt. Soc. Am. **40,** 618 (1950). (I P).
301 302	V III	See discussion above. Revised limit should read **[236500]** I. P. 29.31. Add reference: M. A. Catalán, unpublished material (April 1952). (I P).

The writer hopes that the users of these Volumes will report further additions and corrections that come to their attention. The present list is included here in order that readers may have the benefit of these corrections while this program is still in progress.

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