Energy Levels of Magnesium, Mg I through Mg XII

W. C. Martin and Romuald Zalubas

Center for Radiation Research, National Measurement Laboratory, National Bureau of Standards, Washington, D.C. 20234

Energy level data are given for the atom and all positive ions of magnesium ($Z=12$). These data have been critically compiled, mainly from published material on measurements and analyses of the optical spectra. We have derived or recalculated the levels for a number of the ions. In addition to the level value in cm^{-1} and the parity, the J value and the configuration and term assignments are listed if known. Leading percentages from the calculated eigenvectors are tabulated wherever available. Ionization energies are given for all spectra.

Key words: Atomic energy levels; atomic spectra; electron configurations; ionization potentials; magnesium.

Contents

1. Introduction

This compilation is one of a series being published by the NBS Atomic Energy Levels Data Center. The main program of this center is the critical compilation of energy level data, with emphasis at present on the first 30 elements. The more recent publications include compilations for Al I–XIII [Martin and Zalubas, 1979], K I–XIX [Corliss and Sugar, 1979a], Ca I–XX [Sugar and Corliss, 1979], Sc I–XXI [Sugar and Corliss, 1980], Ti I–XXII [Corliss and Sugar, 1979], V I–XXIII [Sugar and Corliss, 1978], Cr I–XXIV [Sugar and Corliss, 1977], Mn I–XXV [Corliss and Sugar, 1977], and Fe I–XXVI [Reader and Sugar, 1975]. Similar compilations for Na and Ni are in progress.

2. Procedures, Explanation of Material Preceding Each Table

Except for Mg XI (He-like) and Mg XII (H-like), the levels are derived almost entirely from analyses of optical spectra. We have tried to give the most accurate data and theoretical interpretations that can be obtained from the available observations and analysis of each spectrum. We made combination arrays for most of the spectra, took weighted averages of different wavelength measurements where appropriate, and recalculated or derived the level values as necessary. Fairly detailed reviews of the analyses appeared warranted for a number of the spectra. The analyses of several of the higher spectra in the region below 100 Å, for example, are complicated by overlapping of spectra from different ionization stages and lack of intersystem transitions.

In the preparation of the tables, the data were transferred to punched cards in a flexible code that accommodates the standard configuration and term notations of atomic spectroscopy. The punched-card records, as revised and expanded to include new material up to the cutoff date (June 1979 for most of the spectra), were transferred to magnetic storage and edited to produce a final tape for automatic typesetting.

Data, Comments, and References Preceding Each Table

The basic data listed after the main heading for each spectrum include the appropriate isoelectronic sequence (for ions), the configuration and term designation of the ground-state level, and the wavenumber corresponding to the principal ionization energy. The ionization energy is also given in electron-volt (eV) units, an equivalence of 1 eV to

0047-2689/80/010001-58/$05.00

Fuhr, J. R., Miller, B. J., and Martin, G. A. [1978], Nat. Bur. Stand. (U.S.) Spec. Publ. 505, 283 pp. (SD Catalog No. C13.10:505).

Hagan, L. [1977], Nat. Bur. Stand. (U.S.) Spec. Publ. 363, Suppl. 1, 186 pp. (SD Catalog No. C13.10:363 Suppl. 1).

Hagan, L., and Martin, W. C. [1972], Nat. Bur. Stand. (U.S.) Spec. Publ. 363, 103 pp. (SD Catalog No. C13.10:363).

Kelly, R. L., and Palumbo, L. J. [1973], *Atomic and Ionic Emission Lines Below 2000 Angstroms,* Nav. Res. Lab. Report 7599, 992 pp.

Martin, W. C., and Zalubas, R. [1979], J. Phys. Chem. Ref. Data **8**, 817-864.

Martin, W. C., Zalubas, R., and Hagan, L. [1978], *Atomic Energy Levels—The Rare-Earth Elements*, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.) **60**, 422 pp. (SD Catalog No. C13.48:60).

Moore, C. E. [1968], Nat. Bur. Stand. (U.S.) Spec. Publ. 306, Sec. 1, 80 pp.

Moore, C. E. [1971], *Atomic Energy Levels,* Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), **35**, Vol. I, 359 pp., Vol. II, 259 pp., Vol. III, 282 pp. (Reprint of NBS Circular 467 published in 1949 (Vol. I), 1952 (Vol. II) and 1958 (Vol. III)).

Reader, J., and Corliss, C. H., Eds. [1978], in *Handbook of Chemistry and Physics*, Ed. R. C. Weast, 59th edition (CRC Press, Cleveland, Ohio). These tables were compiled by a number of contributors under the auspices of the Committee on Line Spectra of the Elements, U.S. National Academy of Sciences—National Research Council.

Reader, J., and Sugar, J. [1975], J. Phys. Chem. Ref. Data **4**, 353–440.

Striganov, A. R., and Sventitskii, N. S. [1968], *Tables of Spectral Lines of Neutral and Ionized Atoms,* (IFI/Plenum Data Corp., New York), 899 pp.

Sugar, J., and Corliss, C. [1977], J. Phys. Chem. Ref. Data **6**, 317–383.

Sugar, J., and Corliss, C. [1978], J. Phys. Chem. Ref. Data **7**, 1191–1262.

Sugar, J., and Corliss, C. [1979], J. Phys. Chem. Ref. Data **8**, 865–916.

Sugar, J., and Corliss, C. [1980], J. Phys. Chem. Ref. Data **9** (in press).

Zalubas, R., and Albright, A. [1980], Nat. Bur. Stand. (U.S.) Spec. Publ. 363, Suppl. 2 (in preparation, July 1979).

[Esteva, Mehlman-Balloffet, and Romand, 1972; Baig and Connerade, 1978]. Such levels are *mainly* $^1\mathrm{P}_1^\circ$ in character or have significant $^1\mathrm{P}_1^\circ$ components, and are subject to autoionization. The $3pns\ ^1\mathrm{P}^\circ$, $3pns\ ^3\mathrm{P}^\circ$, $3pnd\ ^1\mathrm{P}^\circ$ and $4snp\ ^1\mathrm{P}^\circ$ levels were derived from measurements in the 760–1300 Å region by Baig and Connerade. Their improvement and extension of earlier observations gave wavelengths for transitions to higher members of these series than are represented here. The widths of the resonances and thus the accuracies of the level positions vary greatly. The strong asymmetric $3p4s\ ^1\mathrm{P}^\circ$ feature has an apparent width of the order of 3000 cm^{-1} (the $3p4s\ ^3\mathrm{P}^\circ$ resonance being observed as a slight irregularity on the long-wave shoulder) whereas the $3pnd$ resonances are relatively sharp. The levels are rounded to either the nearest 10 cm^{-1} or to the nearest cm^{-1}. The wavelength measurements by Baig and Connerade were made at the absorption maxima, which may not correspond to the theoretical resonance centers of asymmetric features. Esteva et al. measured the $3pns\ ^1\mathrm{P}^\circ$ features at positions to the long wavelength side of the maxima, the resulting value for the $3p4s\ ^1\mathrm{P}^\circ$ level, for example, being 1850 cm^{-1} below the maximum absorption position.

Autoionization is also allowed in the above region for even-parity S and D levels. The value for the $3p^2\ ^1\mathrm{S}_0$ autoionizing level is based on a wavelength of 3009 Å for the $3s3p\ ^1\mathrm{P}_1^\circ$—$3p^2\ ^1\mathrm{S}_0$ transition, as determined by Bradley et al. From ejected-electron spectra, Rassi et al. obtained energies for the $3pnp\ ^1\mathrm{S}$ levels (to $n=8$) and $3pnp\ ^1\mathrm{D}$ levels (to $n=12$), which are not included here. (Theoretical results for the $3p^2\ ^1\mathrm{D}$ level are cited in the next section.)

The values given for the $3p3d\ ^1\mathrm{D}^\circ$ and $^3\mathrm{D}^\circ$ levels were obtained by Risberg from accurate measurements of emission lines above 2000 Å. Autoionization from these levels is forbidden in the Russell-Saunders approximation, no odd-parity continuum for $L=2$ being available below the Mg II $3p\ ^2\mathrm{P}^\circ$ limit. Although some of the lines from these levels are marked "diffuse", their widths must be small compared to strongly autoionizing levels. Rassi et al. identified a feature in their ejected-electron spectra as arising from the level at 80 693 cm^{-1}, previously designated $3p3d\ ^1\mathrm{F}^\circ$ but changed to $3p3d\ ^1\mathrm{D}^\circ$ by Risberg. The assignments of several other resonances to $3pnd\ ^1\mathrm{F}^\circ$ and $3pnd\ ^1\mathrm{D}^\circ$ series by Rassi et al. are inconsistent with Risberg's designation of the $3p3d\ ^1\mathrm{D}^\circ$ level.

The very high autoionizing $J=1$ odd levels arising from configurations including the $2p^5$ open shell are also based on photoabsorption from the ground level. Ederer, Lucatorto, and Mehlman [1979] have made the most complete observations (170–226 Å) using synchrotron radiation as a source. In the region 442 000–470 000 cm^{-1}, we have also used the measurements of Newsom [1971] and Esteva and Mehlman [1974] in obtaining average values for the levels. Most of the level designations in this region are due to Newsom, with several changes by Mansfield and Connerade [1972] or by Ederer et al. being included here. Mansfield and Connerade give predicted energies for terms of seven configurations based on the $2p^5\ ^2\mathrm{P}^\circ$ core, as calculated in single-configuration approximations. The tentative configuration and parentage assignments of the resonances above 489 000 cm^{-1} by Ederer et al. are listed here with question marks. These authors note that extensive configuration-interaction calculations including the appropriate continua would be required for a detailed analysis of the spectrum. The positions of several high Mg II levels based on the excited $2p^5$ core are listed as limits, some of the term designations being only nominal (see Mg II).

Some of the autoionization resonances observed in ejected-electron spectra of Mg arise from configurations not observed in photoabsorption. Pejčev, Ottley, Rassi, and Ross [1977], for example, give measurements of ejected-electron energies for Mg I and Mg II and include references to earlier observations and interpretations of such spectra. The Mg I data of this type have not been included in this compilation.

Theoretical Results

The Mg I $3s3p$ configuration is discussed extensively in the literature in connection with transition probabilities of both allowed and forbidden lines, hyperfine structure, etc. [see, e.g., Garstang, 1962; Lurio, Mandel, and Novick, 1962; Kluge and Sauter, 1974; Bauche, Couarraze, and Labarthe, 1974; Fischer, 1975a; numerous additional references are given in these papers]. Russell-Saunders coupling is very pure for this configuration, the mixing of the $^1\mathrm{P}_1^\circ$ and $^3\mathrm{P}_1^\circ$ levels being only about 0.0004% [Swagel and Lurio, 1968]. The eigenvector percentages given here are from Fischer, who used the multiconfiguration Hartree-Fock approximation to calculate $3snp$ and $3snd$ terms [1975a] and also $3s^2$ and $3sns$ terms [1975b]. All second percentages result from configuration interactions, the (very small) intermediate coupling having been neglected by Fischer.

One of the configurations included in Fischer's $^1\mathrm{D}$ and $^1\mathrm{S}$ calculations was $3p^2$, the strong interaction of $3p^2\ ^1\mathrm{D}$ with the $3snd\ ^1\mathrm{D}$ series having been established by a number of investigations since the early 1930's. Interaction with the (higher) $3p^2\ ^1\mathrm{D}$ depresses the $3snd\ ^1\mathrm{D}$ levels to positions below the corresponding $^3\mathrm{D}$ terms. (The $3snf\ ^1\mathrm{F}^\circ$ levels are similarly below the corresponding $^3\mathrm{F}^\circ$ terms for at least $n=4$ to 6.) The interaction is made evident by large second percentages of $3p^2\ ^1\mathrm{D}$ in the compositions of the $3snd\ ^1\mathrm{D}$ levels; Fischer's calculations give about half the total $3p^2\ ^1\mathrm{D}$ composition distributed amongst the first six $3snd\ ^1\mathrm{D}$ levels ($n=3$ through 8). According to Lu [1974], "the fact that [the $3p^2\ ^1\mathrm{D}$ level] interacts so strongly with the whole series of $3snd\ ^1\mathrm{D}$ and with the adjacent continuum indicates that it should not exist as a well-defined term. Its oscillator strength is presumably distributed over the whole spectral region of transitions with levels in the $3snd\ ^1\mathrm{D}$ series and of the adjacent $3s\epsilon d\ ^1\mathrm{D}$ continuum."

Thompson, Hibbert, and Chandra [1974] give the results of calculations of photoionization from the $3s3p\ ^1\mathrm{P}^\circ$ level *via* the $^1\mathrm{D}$ and $^1\mathrm{S}$ channels of $3p^2$ and $3pnp$ configurations. Additional references for calculations of levels above the principal ionization limit are cited by Baig and Connerade, who give the results of their calculations for $3pns$, $3pnd$, and $4snp$ configurations (to $n=10$). Calculated energies for $^1\mathrm{P}^\circ$ (and $3pns\ ^3\mathrm{P}_1^\circ$) levels are included, and the effects of coupling changes are discussed.

Mg I—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages		
$3s5s$	^{3}S	1	51 872.526	100		
$3s5s$	^{1}S	0	52 556.206	99	1	$3d^2$ ^{1}S
$3s4d$	^{1}D	2	53 134.642	87	13	$3p^2$ ^{1}D
$3s4d$	^{3}D	3	54 192.256	100		
		2	54 192.294	100		
		1	54 192.335	100		
$3s5p$	^{3}P°	0	*54 248.809*	100		
		1	*54 250.086*	100		
		2	*54 252.726*	100		
$3s4f$	^{1}F°	3	*54 676.438*			
$3s4f$	^{3}F°	2,3,4	*54 676.710*			
$3s5p$	^{1}P°	1	*54 706.536*	99	1	$3p3d$ ^{1}P°
$3s6s$	^{3}S	1	55 891.80	100		
$3s6s$	^{1}S	0	56 186.873	99		
$3s5d$	^{1}D	2	56 308.381	93	7	$3p^2$ ^{1}D
$3s5d$	^{3}D	3	56 968.218	100		
		2	56 968.248	100		
		1	56 968.271	100		
$3s6p$	^{3}P°	0	*57 017.078*	100		
		1	*57 017.724*	100		
		2	*57 019.025*	100		
$3s5f$	^{1}F°	3	*57 204.163*			
$3s5f$	^{3}F°	2,3,4	*57 204.275*			
$3s6p$	^{1}P°	1	*57 214.992*	99		
$3p^2$	^{3}P	0	57 812.77			
		1	57 833.40			
		2	57 873.94			
$3s7s$	^{3}S	1	57 855.214			
$3s7s$	^{1}S	0	58 009.41	100		
$3s6d$	^{1}D	2	58 023.246	96	4	$3p^2$ ^{1}D
$3s6d$	^{3}D	3	58 442.843	100		
		2	58 442.853	100		
		1	58 442.874	100		
$3s7p$	^{3}P°	0	*58 476.689*	100		
		1	*58 477.020*	100		
		2	*58 477.760*	100		

Mg I—Continued

Configuration	Term	*J*	Level (cm^{-1})	Leading percentages
3*s*10*f*	$^3\mathrm{F}^\circ$,$^1\mathrm{F}^\circ$	2,3,3,4	*60 562.637*	
3*s*11*p*	$^1\mathrm{P}^\circ$	1	*60 563.35*	
3*s*12*s*	$^3\mathrm{S}$	1	60 650.46	
3*s*11*d*	$^1\mathrm{D}$	2	60 659.69	
3*s*11*d*	$^3\mathrm{D}$	1,2,3	60 735.38	
3*s*11*f*	$^3\mathrm{F}^\circ$,$^1\mathrm{F}^\circ$	2,3,3,4	*60 755.764*	
3*s*12*p*	$^1\mathrm{P}^\circ$	1	*60 756.13*	
3*s*13*s*	$^3\mathrm{S}$	1	[60 822.17]	
3*s*12*d*	$^1\mathrm{D}$	2	60 828.41	
3*s*12*d*	$^3\mathrm{D}$	1,2,3	60 886.83	
3*s*12*f*	$^3\mathrm{F}^\circ$,$^1\mathrm{F}^\circ$	2,3,3,4	*60 902.50*	
3*s*13*p*	$^1\mathrm{P}^\circ$	1	*60 902.93*	
3*s*14*s*	$^3\mathrm{S}$	1	[60 953.90]	
3*s*13*d*	$^1\mathrm{D}$	2	60 958.31	
3*s*13*d*	$^3\mathrm{D}$	1,2,3	61 004.33	
3*s*13*f*	$^3\mathrm{F}^\circ$,$^1\mathrm{F}^\circ$	2,3,3,4	[*61 016.60*]	
3*s*14*p*	$^1\mathrm{P}^\circ$	1	*61 016.93*	
3*s*14*d*	$^1\mathrm{D}$	2	61 060.5	
3*s*14*d*	$^3\mathrm{D}$	1,2,3	[61 097.27]	
3*s*14*f*	$^3\mathrm{F}^\circ$,$^1\mathrm{F}^\circ$	2,3,3,4	[*61 107.05*]	
3*s*15*p*	$^1\mathrm{P}^\circ$	1	*61 107.34*	
3*s*15*d*	$^1\mathrm{D}$	2	61 142.1	
3*s*15*f*	$^3\mathrm{F}^\circ$,$^1\mathrm{F}^\circ$	2,3,3,4	[*61 179.97*]	
3*s*16*p*	$^1\mathrm{P}^\circ$	1	*61 180.24*	
3*s*16*d*	$^1\mathrm{D}$	2	61 208.2	
3*s*17*p*	$^1\mathrm{P}^\circ$	1	*61 239.83*	
3*s*17*d*	$^1\mathrm{D}$	2	61 262.9	
3*s*18*p*	$^1\mathrm{P}^\circ$	1	*61 289.19*	
3*s*18*d*	$^1\mathrm{D}$	2	61 308.4	

Mg I—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages
$3s46p$	$^{1}\mathrm{P}^{\circ}$	1	*61 616.88*	
$3s47p$	$^{1}\mathrm{P}^{\circ}$	1	*61 619.23*	
$3s48p$	$^{1}\mathrm{P}^{\circ}$	1	*61 621.43*	
$3s49p$	$^{1}\mathrm{P}^{\circ}$	1	*61 623.49*	
$3s50p$	$^{1}\mathrm{P}^{\circ}$	1	*61 625.45*	
$3s51p$	$^{1}\mathrm{P}^{\circ}$	1	*61 627.17*	
$3s52p$	$^{1}\mathrm{P}^{\circ}$	1	*61 628.94*	
$3s53p$	$^{1}\mathrm{P}^{\circ}$	1	*61 630.60*	
$3s54p$	$^{1}\mathrm{P}^{\circ}$	1	*61 631.99*	
$3s55p$	$^{1}\mathrm{P}^{\circ}$	1	*61 633.43*	
$3s56p$	$^{1}\mathrm{P}^{\circ}$	1	*61 634.87*	
$3s57p$	$^{1}\mathrm{P}^{\circ}$	1	*61 636.20*	
$3s58p$	$^{1}\mathrm{P}^{\circ}$	1	*61 637.27*	
$3s59p$	$^{1}\mathrm{P}^{\circ}$	1	*61 638.48*	
…………	…………	…………	…………	
Mg II ($^{2}\mathrm{S}_{1/2}$)	***Limit***		**61 671.02**	
$3p^2$	$^{1}\mathrm{S}$	0	68 275	
$3p4s$	$^{3}\mathrm{P}^{\circ}$	1	*76 940*	
$3p4s$	$^{1}\mathrm{P}^{\circ}$	1	*78 660*	
$3p3d$	$^{1}\mathrm{D}^{\circ}$	2	*80 693.01*	
$3p3d$	$^{3}\mathrm{D}^{\circ}$	1	*83 511.25*	
		2	*83 520.47*	
		3	*83 536.84*	
$3p3d$	$^{1}\mathrm{P}^{\circ}$	1	*85 925*	
$3p5s$	$^{3}\mathrm{P}^{\circ}$	1	*87 580*	
$3p5s$	$^{1}\mathrm{P}^{\circ}$	1	*88 060*	
$3p4d$	$^{1}\mathrm{P}^{\circ}$	1	*90 777*	
$3p6s$	$^{3}\mathrm{P}^{\circ}$	1	*91 620*	
$3p6s$	$^{1}\mathrm{P}^{\circ}$	1	*91 840*	
$3p5d$	$^{1}\mathrm{P}^{\circ}$	1	*93 152*	
$3p7s$	$^{3}\mathrm{P}^{\circ}$	1	*93 540*	
$3p7s$	$^{1}\mathrm{P}^{\circ}$	1	*93 680*	
$3p6d$	$^{1}\mathrm{P}^{\circ}$	1	*94 420*	

Mg I—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,5s_{1/2}$	$(\frac{1}{2},\frac{1}{2})^\circ$	1	*456 060*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,4d$	$^2[\frac{3}{2}]^\circ$	1	*456 540*	
$2p^5(^2\mathrm{P}^\circ_{3/2})3s^2\,6s_{1/2}$	$(\frac{3}{2},\frac{1}{2})^\circ$	1	*457 940*	
$2p^5(^2\mathrm{P}^\circ_{3/2})3s^2\,5d$	$^2[\frac{3}{2}]^\circ$ $^2[\frac{1}{2}]^\circ$	1 1	*458 250*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,6s_{1/2}$	$(\frac{1}{2},\frac{1}{2})^\circ$	1	*460 050*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,5d$ $2p^5(^2\mathrm{P}^\circ_{3/2})3s^2\,6d$	$^2[\frac{3}{2}]^\circ$ $^2[\frac{3}{2}]^\circ$	1 1	*460 380*	
$2p^5(^2\mathrm{P}^\circ_{3/2})3s^2\,7d$	$^2[\frac{3}{2}]^\circ$ $^2[\frac{1}{2}]^\circ$	1 1	*461 480*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,7s_{1/2}$	$(\frac{1}{2},\frac{1}{2})^\circ$	1	*462 170*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,6d$	$^2[\frac{3}{2}]^\circ$	1	*462 530*	
Mg II $(^2\mathrm{P}^\circ_{3/2})3s^2$	*Limit*		*464 130*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,9s_{1/2}$?	$(\frac{1}{2},\frac{1}{2})^\circ$?	1	*464 150*	
$2p^5(^2\mathrm{P}^\circ_{1/2})3s^2\,8d$?	$^2[\frac{3}{2}]^\circ$?	1	*464 470*	
Mg II $(^2\mathrm{P}^\circ_{1/2})3s^2$	*Limit*		*466 300*	
$2p^5(^2\mathrm{P}^\circ)3s3p^2(^2\mathrm{S})$	$^1\mathrm{P}^\circ$	1	*468 340*	
$2p^5(^2\mathrm{P}^\circ)3s3p^2(^2\mathrm{P})$	$^1\mathrm{P}^\circ$	1	*476 190*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{P}_{3/2})4p$?		1	*489 380*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})4p$?		1	*491 910*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})4p$?		1	*493 220*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)4p$?		1	*494 020*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{P}_{3/2})5p$?		1	*495 340*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})5p$?		1	*498 930*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})6p$?		1	*501 860*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})7p$?		1	*503 450*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})8p$?		1	*504 390*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^3\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})9p$?		1	*504 920*	
$2p^5(^2\mathrm{P}^\circ)3s3p(^1\mathrm{P}^\circ)\ (^2\mathrm{S}_{1/2})4p$?		1	*508 130*	
$2p^5(^2\mathrm{P}^\circ)3p^2(^1\mathrm{D})\ (^2\mathrm{P}^\circ_{3/2})4s$?		1	*513 720*	

Mg II

$Z=12$

Na I isoelectronic sequence

Ground state $1s^22s^22p^63s\ ^2S_{1/2}$

Ionization energy 121 267.61±0.05 *cm*$^{-1}$ (15.03539±0.00004 *e*V)

Levels Below the Ionization Limit

Most of the levels in this region are from P. Risberg [1955], who gives observed wavelengths for 93 lines between 2790 and 11 620 Å. He estimates an error limit of ±0.05 cm^{-1} in the wavenumbers of 17 vacuum-ultraviolet lines (1307–1753 Å) calculated from the level values. Goorvitch, Mehlman-Balloffet, and Valero [1970] measured 34 Mg II lines between 946 and 2937 Å with estimated wavenumber errors of ±0.32 to ±0.06 cm^{-1}. Several of their wavelength determinations, particularly in the regions near 1480 Å and 1750 Å, differ from Risberg's calculated values by more than the combined estimated errors. We have retained Risberg's level values as being supported by internal Ritz-principle consistency. G. Risberg [1965] measured a number of Mg II lines in the 2329–4332 Å and 17 717–21 432 Å regions; she found good agreement with the corresponding wavenumber differences of P. Risberg's levels and confirmed the $6h\ ^2H^\circ$ position.

The Mg II vacuum-ultraviolet wavelengths measured by Sulmont and Felenbok [1967] and by Esteva, Mehlman-Balloffet, and Romand [1972] are less accurate than values calculated from Risberg's levels. Since the absorption measurements of the principal series by Esteva et al. extended to $3s$–$10p$, we give the $10p\ ^2P^\circ$ levels as calculated from Risberg's series formulae; these levels are probably accurate to ±0.1 cm^{-1}.

Andersen, Isaksen, Iversen, and Ramanujam [1978] have determined the $5d$, $6d$, $7d\ ^2D$ and $4f$, $5f$, $6f\ ^2F^\circ$ fine-structure separations by fast-beam level-crossing and anticrossing techniques. The known ^2D and $^2F^\circ$ splittings are now as follows:

Term	Interval (cm^{-1})
3d ^2D	-0.882 ± 0.002
4d ^2D	-0.52 ± 0.02
5d ^2D	-0.3030 ± 0.0006
6d ^2D	-0.1850 ± 0.0005
7d ^2D	-0.1189 ± 0.0005
4f $^2F^\circ$	0.1177 ± 0.0002
5f $^2F^\circ$	0.0586 ± 0.0003
6f $^2F^\circ$	0.0334 ± 0.0003

The $^2F^\circ$ intervals given by Andersen et al. have been changed from units of MHz to cm^{-1}. We derived the $3d\ ^2D$ interval from the $4f\ ^2F^\circ$ interval combined with Mundie and Meissner's [1944] measurement of the separation of the two strong $3d\ ^2D$—$4f\ ^2F^\circ$ fine-structure lines as 1.000 ±0.002 cm^{-1}. The $4d\ ^2D$ separation is from P. Risberg; in the main table below we have slightly adjusted several of Risberg's other ^2D and $^2F^\circ$ levels with respect to the term baricenters to agree with the above intervals to ±0.01 cm^{-1}.

Andersen et al. give references to some recent theoretical calculations of the anomalous negative ^2D intervals in Mg II. Similar inversions of ^2D terms are observed in the isoelectronic spectra Na I, Al III, and Si IV.

The g values measured by Lott, Roos, and Ginter [1966] for the $3s\ ^2S_{1/2}$, $3p\ ^2P^\circ_{1/2}$, and $^2P^\circ_{3/2}$ levels (1.96, 0.69, 1.33, respectively) agree with the *LS*-coupling values to within the probable accuracy of the determinations.

P. Risberg obtained the ionization limit by fitting the lowest five ^2G terms to a Ritz formula. We take the uncertainty of this limit as equal to his estimated error for the high levels of Mg II relative to the ground level, the average deviation of members of several series from Ritz formulae being only about 0.01 cm^{-1}. (The predictions of series formulae of either the Ritz type or core-polarization type [Bockastén, 1956] are sufficiently accurate in Mg II to make three-place experimental term values useful in comparisons.) The uncertainty of the limit in eV units is due to the uncertainty of the conversion factor.

Levels Above the Ionization Limit

Esteva and Mehlman [1974] observed Mg photoabsorption spectra in the range 100–250 Å using time and space scanning of the absorbing plasma to distinguish Mg I, Mg II, and Mg III lines. The Mg II lines (184–248 Å) were classified as transitions from the $2p^63s\ ^2S_{1/2}$ ground level to upper configurations based on the excited $2p^5$ core. The allowed transitions are thus to levels having $J=\frac{1}{2}$ or $\frac{3}{2}$ and significant $2p^53snl\ ^2P^\circ$ eigenvector components ($nl=ns$ or nd), the system beginning with the $2p^53s^2\ ^2P^\circ$ term a little above 400 000 cm^{-1}. All 38 levels listed by Esteva and Mehlman for Mg II are included here; the values are given to the nearest 10 cm^{-1}, the probable errors being about ±100 cm^{-1}. The leading eigenvector percentages given for ten of these levels are from a Hartree-Fock calculation of the $2p^53p^2$, $2p^53s3d$, $2p^53s4d$ configurations including configuration interaction [Mehlman, Weiss, and Esteva, 1976]. Transitions to the four $^2P^\circ$ levels nominally belonging to

Mg II—Continued

Configuration	Term	*J*	Level (cm⁻¹)	Leading percentages
5*d*	$^{2}\mathrm{D}$	5/2	103 419.70	
		3/2	103 420.00	
5*f*	$^{2}\mathrm{F}^{\circ}$	5/2	*103 689.86*	
		7/2	*103 689.92*	
5*g*	$^{2}\mathrm{G}$	7/2,9/2	103 705.66	
6*p*	$^{2}\mathrm{P}^{\circ}$	1/2	*105 622.34*	
		3/2	*105 629.72*	
7*s*	$^{2}\mathrm{S}$	1/2	108 784.33	
6*d*	$^{2}\mathrm{D}$	5/2	108 900.02	
		3/2	108 900.20	
6*f*	$^{2}\mathrm{F}^{\circ}$	5/2	*109 062.32*	
		7/2	*109 062.35*	
6*g*	$^{2}\mathrm{G}$	7/2,9/2	109 072.05	
6*h*	$^{2}\mathrm{H}^{\circ}$	9/2,11/2	*109 074.00*	
7*p*	$^{2}\mathrm{P}^{\circ}$	1/2	*110 203.58*	
		3/2	*110 207.99*	
8*s*	$^{2}\mathrm{S}$	1/2	112 129.20	
7*d*	$^{2}\mathrm{D}$	5/2	112 197.05	
		3/2	112 197.17	
7*f*	$^{2}\mathrm{F}^{\circ}$	5/2,7/2	*112 301.47*	
7*g*	$^{2}\mathrm{G}$	7/2,9/2	112 307.79	
7*h*	$^{2}\mathrm{H}^{\circ}$	9/2,11/2	*112 309.06*	
8*p*	$^{2}\mathrm{P}^{\circ}$	1/2	*113 030.25*	
		3/2	*113 033.09*	
9*s*	$^{2}\mathrm{S}$	1/2	114 289.36	
8*d*	$^{2}\mathrm{D}$	5/2	114 332.68	
		3/2	114 332.74	
8*f*	$^{2}\mathrm{F}^{\circ}$	5/2,7/2	*114 403.55*	
8*g*	$^{2}\mathrm{G}$	7/2,9/2	114 407.88	
8*h*	$^{2}\mathrm{H}^{\circ}$	9/2,11/2	*114 408.74*	
9*p*	$^{2}\mathrm{P}^{\circ}$	1/2	*114 896.79*	
		3/2	*114 898.72*	
10*s*	$^{2}\mathrm{S}$	1/2	115 764.99	
9*d*	$^{2}\mathrm{D}$	3/2	115 794.41	

Mg II—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages
$2p^5\,3s4d$?			*517 300*	
$2p^5\,3s4d$?			*517 890*	
$2p^5\,3s5s$?			*518 560*	
$2p^5\,3s4d$?			*519 350*	
$2p^5\,3s4d$?			*519 750*	
$2p^5\,3s5s$?			*521 780*	
$2p^5\,3s4d$?			*522 030*	
$2p^5\,3s4d$?			*522 740*	
$2p^5\,3s5d$?			*528 070*	
$2p^5\,3s5d$?			*528 460*	
$2p^5\,3s5d$?			*529 070*	
$2p^5\,3s5d$?			*529 350*	
$2p^5\,3s5d$?			*530 390*	
$2p^5\,3s6d$?			*533 670*	
$2p^5\,3s6d$?			*534 220*	
$2p^5\,3s6d$?			*535 220*	
$2p^5\,3s6d$?			*536 280*	
$2p^5\,3s7d$?			*537 690*	
$2p^5\,3s7d$?			*538 820*	
$2p^5\,3s6d$?			*539 780*	
$2p^5\,3s8d$?			*541 100*	
$2p^5\,3s9d$?			*541 480*	
$2p^5\,3s9d$?			*542 560*	
$2p^5\,3s7d$?			*543 210*	
Mg III $2p^5 3s(^3P^\circ_2)$	*Limit*		*546 908*	
Mg III $2p^5 3s(^3P^\circ_1)$	*Limit*		*548 136*	
Mg III $2p^5 3s(^3P^\circ_0)$	*Limit*		*549 120*	
Mg III $2p^5 3s(^1P^\circ_1)$	*Limit*		*552 798*	

Mg III—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages			
$2p^5 3s$	$^1P^\circ$	1	*431 530.0*	95		5	$^3P^\circ$
$2p^5 3p$	^3S	1	467 378.5	99			
$2p^5 3p$	^3D	3	474 053.2	100			
		2	474 655.0	89			
		1	475 502.9	91			
$2p^5 3p$	^1D	2	477 435.7	61		36	^3P
$2p^5 3p$	^1P	1	478 374.5	61		30	^3P
$2p^5 3p$	^3P	2	478 846.1	62		30	^1D
		0	479 265.3	100			
		1	479 456.0	65		34	^1P
$2p^5 3p$	^1S	0	496 012.1	100			
$2p^5 3d$	$^3P^\circ$	0	*530 178.2*	100			
		1	*530 420.6*	98			
		2	*530 962.9*	93			
$2p^5 3d$	$^3F^\circ$	4	*531 563.0*	100			
		3	*531 833.1*	68		32	$^1F^\circ$
		2	*532 725.7*	77		14	$^1D^\circ$
$2p^5 3d$	$^1F^\circ$	3	*532 971.2*	52		29	$^3D^\circ$
$2p^5 3d$	$^3D^\circ$	1	*534 197.7*	60		40	$^1P^\circ$
		3	*534 923.6*	70		16	$^1F^\circ$
		2	*535 179.6*	56		37	$^1D^\circ$
$2p^5 3d$	$^1D^\circ$	2	*534 776.9*	46		31	$^3D^\circ$
$2p^5 3d$	$^1P^\circ$	1	*536 152.0*	59		39	$^3D^\circ$
$2p^5(^2P^\circ_{3/2})4s$	$^2[3/2]^\circ$	2	*545 820.4*	100	$^3P^\circ$		
		1	*546 531.6*	65	$^3P^\circ$	35	$^1P^\circ$
$2p^5(^2P^\circ_{1/2})4s$	$^2[1/2]^\circ$	0	*548 034.4*	100	$^3P^\circ$		
		1	*548 720.7*	65	$^1P^\circ$	35	$^3P^\circ$
$2p^5(^2P^\circ_{3/2})4p$	$^2[1/2]$	1	559 987.1	87		13	$(^2P^\circ_{1/2})\ ^2[1/2]$
		0	564 300.0	51		49	
$2p^5(^2P^\circ_{3/2})4p$	$^2[5/2]$	3	561 798.7	100			
		2	562 136.1	82		13	$^2[3/2]$
$2p^5(^2P^\circ_{3/2})4p$	$^2[3/2]$	1	562 634.2	91			
		2	562 939.5	84		15	$^2[5/2]$
$2p^5(^2P^\circ_{1/2})4p$	$^2[3/2]$	1	564 289.8	91			
		2	564 664.6	95			
$2p^5(^2P^\circ_{1/2})4p$	$^2[1/2]$	1	564 731.6	87		13	$(^2P^\circ_{3/2})\ ^2[1/2]$
		0	570 112.8	51		49	

Mg III—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages
$2p^5(^2P^\circ_{3/2})5f$	$^2[7/2]$	3 4	606 891.1 606 891.8	
$2p^5(^2P^\circ_{3/2})5g$	$^2[7/2]^\circ$	4,3	*606 896.8*	
$2p^5(^2P^\circ_{3/2})5g$	$^2[9/2]^\circ$	5,4	*606 916.6*	
$2p^5(^2P^\circ_{1/2})5d$	$^2[3/2]^\circ$	1	*608 295*	
$2p^5(^2P^\circ_{1/2})5f$	$^2[5/2]$	3 2	609 045.2 609 050.5	
$2p^5(^2P^\circ_{1/2})5f$	$^2[7/2]$	3 4	609 045.4 609 045.7	
$2p^5(^2P^\circ_{1/2})5g$	$^2[9/2]^\circ$	5,4	*609 111.4*	
$2p^5(^2P^\circ_{1/2})5g$	$^2[7/2]^\circ$	4,3	*609 111.6*	
$2p^5(^2P^\circ_{3/2})6s$	$^2[3/2]^\circ$	1	*609 262*	
$2p^5(^2P^\circ_{1/2})6s$	$^2[1/2]^\circ$	1	*611 389*	
$2p^5(^2P^\circ_{3/2})6d$	$^2[3/2]^\circ$	1	*618 601*	
$2p^5(^2P^\circ_{1/2})6d$	$^2[3/2]^\circ$	1	*620 702*	
$2p^5(^2P^\circ_{3/2})7d$	$^2[3/2]^\circ$	1	*626 013*	
$2p^5(^2P^\circ_{1/2})7d$	$^2[3/2]^\circ$	1	*628 149*	
$2p^5(^2P^\circ_{3/2})8d$	$^2[3/2]^\circ$	1	*630 827*	
$2p^5(^2P^\circ_{1/2})8d$	$^2[3/2]^\circ$	1	*632 988*	
$2p^5(^2P^\circ_{3/2})9d$	$^2[3/2]^\circ$	1	*634 111*	
....	....	....	....	
Mg IV ($^2P^\circ_{3/2}$)	***Limit***		***646 402***	
Mg IV ($^2P^\circ_{1/2}$)	*Limit*		*648 631*	
$2s2p^6\,3p$	$^1P^\circ$	1	*790 500*	
$2s2p^6\,4p$	$^1P^\circ$	1	*874 700*	
$2s2p^6\,5p$	$^1P^\circ$	1	*908 000*	
$2s2p^6\,6p$	$^1P^\circ$	1	*925 200*	
$2s2p^6\,7p$	$^1P^\circ$	1	*934 700*	
$2s2p^6\,8p$	$^1P^\circ$	1	*940 700*	
Mg IV $2s2p^6(^2S_{1/2})$	*Limit*		957 934	

Mg IV

Configuration	Term	J	Level (cm^{-1})	Leading percentages			
$2s^2 2p^5$	$^2P^\circ$	3/2	*0*				
		1/2	*2 228*				
$2s2p^6$	^2S	1/2	311 532	99		1	$2p^4(^1D)3d\ ^2S$
$2s^2 2p^4(^3P)3s$	^4P	5/2	543 720.4	100			
		3/2	545 137.6	99		1	^2P
		1/2	545 955.4	100			
$2s^2 2p^4(^3P)3s$	^2P	3/2	553 666.1	99		1	^4P
		1/2	555 341.9	100			
$2s^2 2p^4(^1D)3s$	^2D	5/2	582 562.4	100			
		3/2	582 578.4	100			
$2s^2 2p^4(^3P)3p$	$^4P^\circ$	5/2	*596 521.8*	99		1	$^4D^\circ$
		3/2	*597 065.7*	99		1	$^4D^\circ$
		1/2	*597 583.6*	100			
$2s^2 2p^4(^3P)3p$	$^4D^\circ$	7/2	*603 138.1*	100			
		5/2	*604 003.1*	96		3	$^2D^\circ$
		3/2	*604 662.9*	98		1	$^2D^\circ$
		1/2	*605 033.5*	100			
$2s^2 2p^4(^3P)3p$	$^2D^\circ$	5/2	*607 891.7*	97		3	$^4D^\circ$
		3/2	*609 305.8*	96		3	$^2P^\circ$
$2s^2 2p^4(^3P)3p$		1/2	*610 983.2**	43	$^2P^\circ$	41	$^2S^\circ$
$2s^2 2p^4(^3P)3p$	$^4S^\circ$	3/2	*612 232.4*	93		4	$^2P^\circ$
$2s^2 2p^4(^3P)3p$	$^2P^\circ$	3/2	*612 501.6*	69		20	$(^1D)\ ^2P^\circ$
$2s^2 2p^4(^3P)3p$		1/2	*612 943.5**	58	$^2S^\circ$	31	$^2P^\circ$
$2s^2 2p^4(^1S)3s$	^2S	1/2	624 109.6	99		1	$2p^4(^1D)3d\ ^2S$
$2s^2 2p^4(^1D)3p$	$^2F^\circ$	5/2	*637 879.7*	100			
		7/2	*638 112.9*	100			
$2s^2 2p^4(^1D)3p$	$^2D^\circ$	3/2	*644 643.4*	99		1	$^2P^\circ$
		5/2	*644 786.4*	100			
$2s^2 2p^4(^1D)3p$	$^2P^\circ$	3/2	*650 061.6*	76		24	$(^3P)\ ^2P^\circ$
		1/2	*651 093.9*	75		25	
$2s^2 2p^4(^3P)3d$	^4D	7/2	670 786.1	98		2	^4F
		5/2	671 028.8	97		1	^4F
		3/2	671 324.1	98		1	^4P
		1/2	671 569.4	99			
$2s^2 2p^4(^3P)3d$	^4F	9/2	675 370.2	100			
		7/2	676 075.3	79		21	^2F
		5/2	676 826.4	88		9	^2F
		3/2	677 363.9	97		2	^2D
$2s^2 2p^4(^3P)3d$	^2F	7/2	677 451.9	79		20	^4F
		5/2	678 395.1	77		11	^4F

Mg IV—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages		
$2s^2 2p^4(^3P_2)4f$	$^2[3]^\circ$	$5/2$	*770 910.9*	97		
		$7/2$	*770 927.5*	73	24	$^2[4]^\circ$
$2s^2 2p^4(^3P_2)4f$	$^2[2]^\circ$	$3/2$	*771 129.2*	93	7	$(^3P_1)\ ^2[2]^\circ$
		$5/2$	*771 163.6*	94	6	
$2s^2 2p^4(^3P_2)4f$	$^2[5]^\circ$	$11/2$	*771 363.4*	100		
		$9/2$	*771 367.6*	100		
$2s^2 2p^4(^3P_2)4f$	$^2[1]^\circ$	$1/2$	*771 561.1*	100		
		$3/2$	*771 582.6*	100		
$2s^2 2p^4(^3P_1)4f$	$^2[2]^\circ$	$3/2$	*772 849.3*	93	7	$(^3P_2)\ ^2[2]^\circ$
		$5/2$	*772 861.8*	93	6	
$2s^2 2p^4(^3P_1)4f$	$^2[4]^\circ$	$9/2$	*772 932.1*	97		
		$7/2$	*772 945.4*	97		
$2s^2 2p^4(^3P_1)4f$	$^2[3]^\circ$	$7/2$	*773 228.7*	99		
		$5/2$	*773 242.1*	99		
$2s^2 2p^4(^3P_0)4f$	$^2[3]^\circ$	$7/2$	*773 747.0*	98		
		$5/2$	*773 757.6*	98		
$2s^2 2p^4(^3P)5s$	^4P	$5/2$	787 315			
		$3/2$				
		$1/2$				
$2s^2 2p^4(^3P)5s$	^2P	$3/2$	788 632			
		$1/2$	789 881			
$2s^2 2p^4(^1S)4s$	^2S	$1/2$	797 056	99	1	$2p^4(^1D)4d\ ^2S$
$2s^2 2p^4(^1D)4d$	^2P	$3/2$	802 244	100		
		$1/2$	802 306	99	1	$(^3P)\ ^2P$
$2s^2 2p^4(^1D)4d$	^2D	$5/2$	802 954	91	9	^2F
		$3/2$	803 054	99		
$2s^2 2p^4(^1D)4d$	^2S	$1/2$	803 754	98	1	$2p^4(^1S)4s\ ^2S$
$2s^2 2p^4(^1D_2)4f$	$^2[1]^\circ$	$1/2$	*806 309.7*	100		
		$3/2$	*806 312.5*	100		
$2s^2 2p^4(^1D_2)4f$	$^2[5]^\circ$	$\left.\begin{matrix}11/2\\9/2\end{matrix}\right\}$	*806 803.4*	100		
				100		
$2s^2 2p^4(^1D_2)4f$	$^2[2]^\circ$	$5/2$	*806 909.2*	100		
		$3/2$	*806 911.5*	100		
$2s^2 2p^4(^1D_2)4f$	$^2[3]^\circ$	$5/2$	*807 455.0*	100		
		$7/2$	*807 456.0*	100		
$2s^2 2p^4(^1D_2)4f$	$^2[4]^\circ$	$7/2$	*807 607.8*	100		
		$9/2$	*807 610.1*	100		
$2s^2 2p^4(^3P)5d$	^4P	$1/2$	808 965			

Mg IV—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages
$2s^2 2p^4(^1S)4d$?	^{2}D?	$5/2$	844 424	100
		$3/2$		100
	^{2}D?	$5/2, 3/2$	846 281	
$2s^2 2p^4(^1D_2)5g$	$^2[2]$	$5/2, 3/2$	846 780.7	
$2s^2 2p^4(^1D_2)5g$	$^2[6]$	$13/2, 11/2$	846 858.7	
$2s^2 2p^4(^1D_2)5g$	$^2[3]$	$7/2, 5/2$	846 926.3	
$2s^2 2p^4(^1D_2)5g$	$^2[4]$	$9/2, 7/2$	847 038.2	
$2s^2 2p^4(^1D_2)5g$	$^2[5]$	$11/2, 9/2$	847 048.2	
....	....	....	....	
Mg V ($^3P_2$)	*Limit*		881 285	
Mg V ($^3P_1$)	*Limit*		883 068	
Mg V ($^3P_0$)	*Limit*		883 807	
Mg V ($^1D_2$)	*Limit*		912 211	
Mg V ($^1S_0$)	*Limit*		958 564	

Mg v—Continued

Configuration	Term	J	Level (cm^{-1})	Leading percentages		
$2s2p^5$	$^3\mathrm{P}^\circ$	2	*283 212.3*	100		
		1	*284 828.3*	100		
		0	*285 712.0*	100		
$2s2p^5$	$^1\mathrm{P}^\circ$	1	*397 482*	100		
$2p^6$	$^1\mathrm{S}$	0	662 970			
$2s^2 2p^3(^4\mathrm{S}^\circ)3s$	$^3\mathrm{S}^\circ$	1	*684 541*	100		
$2s^2 2p^3(^2\mathrm{D}^\circ)3s$	$^3\mathrm{D}^\circ$	3	*727 742*	100		
		2	*727 763*	99		
		1	*727 782*	99		
$2s^2 2p^3(^2\mathrm{D}^\circ)3s$	$^1\mathrm{D}^\circ$	2	*735 546*	99		
$2s^2 2p^3(^2\mathrm{P}^\circ)3s$	$^3\mathrm{P}^\circ$	0	*756 545*	99	1	$2s^2 2p^3(^2\mathrm{D}^\circ)3d\ ^3\mathrm{P}^\circ$
		1	*756 566*	99	1	
		2	*756 641*	98	1	
$2s^2 2p^3(^2\mathrm{P}^\circ)3s$	$^1\mathrm{P}^\circ$	1	*764 628*	98	1	$2s^2 2p^3(^2\mathrm{D}^\circ)3d\ ^1\mathrm{P}^\circ$
$2s^2 2p^3(^4\mathrm{S}^\circ)3d$	$^3\mathrm{D}^\circ$	1	*821 974*	98	2	$(^2\mathrm{D}^\circ)\ ^3\mathrm{D}^\circ$
		2	*821 989*	98	2	
		3	*822 066*	98	2	
$2s^2 2p^3(^2\mathrm{D}^\circ)3d$	$^3\mathrm{D}^\circ$	3	*871 216*	98	2	$(^4\mathrm{S}^\circ)\ ^3\mathrm{D}^\circ$
		2	*871 357*	98	2	
		1	*871 390*	97	2	
$2s^2 2p^3(^2\mathrm{D}^\circ)3d$	$^1\mathrm{P}^\circ$	1	*873 456*	94	3	$(^2\mathrm{P}^\circ)\ ^1\mathrm{P}^\circ$
$2s^2 2p^3(^2\mathrm{D}^\circ)3d$	$^3\mathrm{P}^\circ$	2	*876 795*	96	2	$(^2\mathrm{P}^\circ)\ ^3\mathrm{P}^\circ$
		1	*877 283*	94	4	$^3\mathrm{S}^\circ$
		0	*877 463*	99	1	$2s^2 2p^3(^2\mathrm{P}^\circ)3s\ ^3\mathrm{P}^\circ$
$2s^2 2p^3(^2\mathrm{D}^\circ)3d$	$^1\mathrm{D}^\circ$	2	*877 611*	89	10	$(^2\mathrm{P}^\circ)\ ^1\mathrm{D}^\circ$
$2s^2 2p^3(^2\mathrm{D}^\circ)3d$	$^3\mathrm{S}^\circ$	1	*879 515*	96	4	$^3\mathrm{P}^\circ$
$2s^2 2p^3(^2\mathrm{D}^\circ)3d$	$^1\mathrm{F}^\circ$	3	*882 791*	99	1	$(^2\mathrm{P}^\circ)\ ^1\mathrm{F}^\circ$
$2s^2 2p^3(^2\mathrm{P}^\circ)3d$	$^3\mathrm{P}^\circ$	0	*898 757*	100		
		1	*898 962*	99	1	$(^2\mathrm{D}^\circ)\ ^3\mathrm{P}^\circ$
		2	*899 369*	97	2	$(^2\mathrm{D}^\circ)\ ^3\mathrm{P}^\circ$
$2s^2 2p^3(^2\mathrm{P}^\circ)3d$	$^1\mathrm{D}^\circ$	2	*901 474*	77	14	$^3\mathrm{D}^\circ$
$2s^2 2p^3(^2\mathrm{P}^\circ)3d$	$^3\mathrm{D}^\circ$	3	*902 152*	98		
		2	*902 509*	85	11	$^1\mathrm{D}^\circ$
		1	*902 766*	99		
$2s^2 2p^3(^2\mathrm{P}^\circ)3d$	$^1\mathrm{F}^\circ$	3	*905 370*	99	1	$(^2\mathrm{D}^\circ)\ ^1\mathrm{F}^\circ$
$2s^2 2p^3(^4\mathrm{S}^\circ)4s$	$^3\mathrm{S}^\circ$	1	*910 750*			
$2s^2 2p^3(^2\mathrm{P}^\circ)3d$	$^1\mathrm{P}^\circ$	1	*914 500*	97	3	$(^2\mathrm{D}^\circ)\ ^1\mathrm{P}^\circ$

Mg v—Continued

Configuration	Term	*J*	Level (cm^{-1})	Leading percentages
$2s^2 2p^3(^2D^\circ)5d$	$^1F^\circ$	3	*1 082 450?*	
$2s^2 2p^3(^2P^\circ)5d$	$^1D^\circ$	2	*1 109 990?*	
....	....	....	....	
Mg VI ($^4S^\circ_{3/2}$)	***Limit***		***1 139 420***	
$2s2p^4(^4P)4s$	^3P	2	1 161 770?	
$2s2p^4(^2D)3d$	^3D	3	1 166 530?	
		2	1 166 590?	
		1	1 166 650?	
Mg VI ($^2D^\circ$)	*Limit*		*1 194 780*	
Mg VI ($^2P^\circ_{1/2}$)	*Limit*		*1 223 340*	
Mg VI ($^2P^\circ_{3/2}$)	*Limit*		*1 223 450*	
$2s2p^4(^4P)5s$	^3P	2	1 250 960?	
Mg VI ($^4P_{5/2}$)	*Limit*		1 387 370	

Mg vi—Continued

Configuration	Term	J	Level (cm^{-1})
$2s2p^4$	^{2}D	5/2 3/2	341 751 341 793
$2s2p^4$	^{2}S	1/2	401 822
$2s2p^4$	^{2}P	3/2 1/2	425 190 427 135
$2p^5$	^{2}P°	3/2 1/2	*651 867* *654 473*
$2s^2 2p^2(^3P)3s$	^{4}P	1/2 3/2 5/2	893 940 894 890 896 440
$2s^2 2p^2(^3P)3s$	^{2}P	1/2 3/2	908 410 910 300
$2s^2 2p^2(^1D)3s$	^{2}D	3/2,5/2	938 830
$2s^2 2p^2(^1S)3s$	^{2}S	1/2	983 420?
$2s^2 2p^2(^3P)3d$	^{2}P	3/2 1/2	1 040 060 1 040 680
$2s^2 2p^2(^3P)3d$	^{4}D	7/2 5/2,3/2 1/2	 1 045 210? 1 045 620?
$2s^2 2p^2(^3P)3d$	^{2}F	5/2 7/2	1 046 420 1 048 380
$2s2p^3(^5S°)3s$	^{4}S°	3/2	*1 046 640*
$2s^2 2p^2(^3P)3d$	^{4}P	5/2 3/2 1/2	1 047 310 1 047 990 1 048 380
$2s^2 2p^2(^3P)3d$	^{2}D	3/2 5/2	1 062 050 1 062 620
$2s^2 2p^2(^1D)3d$	^{2}F	7/2 5/2	1 083 340 1 083 640
$2s^2 2p^2(^1D)3d$	^{2}D	3/2 5/2	1 086 570 1 086 920
$2s^2 2p^2(^1D)3d$	^{2}P	1/2 3/2	1 093 760 1 094 250
$2s^2 2p^2(^1D)3d$?	^{2}S?	1/2?	1 099 180
$2s2p^3(^5S°)3p$	^{4}P	1/2–5/2	1 100 150
$2s2p^3(^3D°)3s$	^{4}D°	1/2–7/2	*1 122 020*

Mg VI—Continued

Configuration	Term	J	Level (cm^{-1})
$2s^2 2p^2(^3\mathrm{P})5s$	$^4\mathrm{P}$	1/2	
		3/2	1 317 700?
		5/2	1 318 670?
$2s2p^3(^5\mathrm{S}^\circ)4s$	$^4\mathrm{S}^\circ$	3/2	*1 323 610?*
$2s^2 2p^2(^1\mathrm{S})4d$	$^2\mathrm{D}$	3/2,5/2	1 333 500?
$2s2p^3(^5\mathrm{S}^\circ)4p$	$^4\mathrm{P}$	1/2–5/2	1 340 950?
$2s^2 2p^2(^3\mathrm{P})5d$	$^2\mathrm{F}$	5/2	1 345 510?
		7/2	1 347 260?
$2s2p^3(^5\mathrm{S}^\circ)4d$	$^4\mathrm{D}^\circ$	1/2–7/2	*1 373 760*
$2s^2 2p^2(^1\mathrm{D})5d$	$^2\mathrm{F}$	5/2,7/2	1 382 780?
$2s^2 2p^2(^1\mathrm{D})5d$?	$^2\mathrm{D}$?	3/2,5/2	1 384 290
Mg VII ($^3\mathrm{P}_0$)	***Limit***		**1 504 300**

Mg VII

Configuration	Term	J	Level (cm^{-1})
$2s^2 2p^2$	^{3}P	0	0
		1	1 107
		2	2 924
$2s^2 2p^2$	^{1}D	2	40 948
$2s^2 2p^2$	^{1}S	0	85 153
$2s2p^3$	^{5}S°	2	*118 100+x*
$2s2p^3$	^{3}D°	3	*232 853*
		2	*232 957*
		1	*233 024*
$2s2p^3$	^{3}P°	1	*274 897*
		2	*274 904*
		0	*274 947*
$2s2p^3$	^{1}D°	2	*354 401*
$2s2p^3$	^{3}S°	1	*362 117*
$2s2p^3$	^{1}P°	1	*397 153*
$2p^4$	^{3}P	2	542 316
		1	544 393
		0	545 264
$2p^4$	^{1}D	2	576 280
$2p^4$	^{1}S	0	658 440
$2s^2 2p3s$	^{3}P°	0	*1 047 610*
		1	*1 048 400*
		2	*1 050 890*
$2s^2 2p3s$	^{1}P°	1	*1 061 030*
$2s^2 2p3p$	^{3}P	0	1 123 740?
		1	1 124 940
		2	1 125 840
$2s^2 2p3d$	^{3}F°	2	*1 178 750*
		3	
		4	
$2s2p^2(^4P)3s$	^{5}P	1	
		2	1 179 960+x
		3	1 181 440+x
$2s^2 2p3d$	^{1}D°	2	*1 180 910*
$2s^2 2p3d$	^{3}D°	1	*1 191 750*
		2	*1 192 170*
		3	*1 193 050*

Mg vii—Continued

Configuration	Term	J	Level (cm^{-1})
$2s^2\,2p4d$	$^3\mathrm{D}^\circ$	1	
		2	*1 469 540?*
		3	*1 470 410?*
$2s^2\,2p4d$	$^3\mathrm{P}^\circ$	2	*1 472 130?*
$2s^2\,2p4d$	$^1\mathrm{F}^\circ$	3	*1 477 420?*
$2s^2\,2p4d$	$^1\mathrm{P}^\circ$	1	*1 478 180?*
$2s2p^2(^4\mathrm{P})4s$	$^5\mathrm{P}$	3	1 548 720+x
$2s2p^2(^4\mathrm{P})4p$	$^3\mathrm{D}^\circ$	3	*1 580 310?*
$2s^2\,2p5d$	$^3\mathrm{P}^\circ$	2	*1 597 920?*
$2s2p^2(^4\mathrm{P})4d$	$^5\mathrm{P}$	3	1 599 650+x
		2	1 600 240+x
		1	1 600 610+x
$2s^2\,2p5d$	$^1\mathrm{F}^\circ$	3	*1 600 470?*
$2s2p^2(^4\mathrm{P})4d$	$^3\mathrm{F}$	2	1 604 840?
		3	1 605 600?
		4	1 606 730?
$2s^2\,2p6d$	$^3\mathrm{P}^\circ$	0,1,2	*1 665 770?*
$2s2p^2(^2\mathrm{D})4d$	$^3\mathrm{F}$	4	1 695 870?
$2s2p^2(^4\mathrm{P})5p$	$^3\mathrm{D}^\circ$	3	*1 717 720?*
$2s2p^2(^4\mathrm{P})5d$	$^5\mathrm{P}$	3	1 726 700+x?
$2s2p^2(^4\mathrm{P})5d$	$^3\mathrm{F}$	4	1 730 130?
$2s2p^2(^4\mathrm{P})6d$	$^5\mathrm{P}$	3	1 794 830+x?
Mg viii ($^2\mathrm{P}^\circ_{1/2}$)	***Limit***		**1 814 300**

Mg VIII—Continued

Configuration	Term	J	Level (cm^{-1})
$2p^3$	$^4S^\circ$	3/2	*413 610+x*
$2p^3$	$^2D^\circ$	5/2	*465 745*
		3/2	*465 818*
$2p^3$	$^2P^\circ$	1/2	*524 652*
		3/2	*524 841*
$2s^2\,3s$	^2S	1/2	1 210 690
$2s^2\,3d$	^2D	3/2	1 335 860
		5/2	1 336 030
$2s2p(^3P^\circ)3s$	$^4P^\circ$	1/2	*1 351 390+x*
		3/2	*1 352 530+x*
		5/2	*1 354 550+x*
$2s2p(^3P^\circ)3s$	$^2P^\circ$	1/2	*1 381 450*
		3/2	*1 383 760*
$2s2p(^3P^\circ)3p$	^2P	1/2	1 408 370
		3/2	1 409 400
$2s2p(^3P^\circ)3p$	^2D	3/2	1 440 610
		5/2	1 442 830
$2s2p(^3P^\circ)3p$	^2S	1/2	1 460 910
$2s2p(^3P^\circ)3d$	$^4D^\circ$?	1/2	
		3/2	*1 476 260+x?*
		5/2	*1 476 590+x*
		7/2	*1 477 410+x?*
$2s2p(^3P^\circ)3d$	$^2D^\circ$	3/2	*1 478 340*
		5/2	*1 478 690*
$2s2p(^3P^\circ)3d$	$^4P^\circ$	5/2	*1 483 690+x*
		3/2	*1 484 420+x*
		1/2	*1 484 910+x*
$2s2p(^1P^\circ)3s$	$^2P^\circ$	1/2, 3/2	*1 486 970*
$2s2p(^3P^\circ)3d$	$^2F^\circ$	5/2	*1 504 990*
		7/2	*1 507 040*
$2s2p(^3P^\circ)3d$	$^2P^\circ$	3/2	*1 513 100?*
		1/2	*1 514 260?*
$2s2p(^1P^\circ)3p$	^2D	3/2	
		5/2	1 548 850
$2s2p(^1P^\circ)3p$	^2P	1/2	1 549 990
		3/2	1 550 560
$2s2p(^1P^\circ)3p$	^2S	1/2	1 556 590

Mg VIII—Continued

Configuration	Term	J	Level (cm^{-1})
$2s2p(^3P^\circ)4d$	$^4P^\circ$	$5/2$	*1 838 790+x?*
		$3/2$	*1 839 350+x?*
		$1/2$	
$2s2p(^3P^\circ)4d$	$^2F^\circ$	$5/2$	*1 846 150?*
		$7/2$	*1 848 020?*
$2s^2\,5d$	^2D	$3/2$	1 858 320
		$5/2$	1 858 420
$2s^2\,6d$	^2D	$3/2,5/2$	1 946 060
$2s2p(^1P^\circ)4d$	$^2F^\circ$	$5/2,7/2$	*1 964 300?*
$2s2p(^1P^\circ)4d$	$^2D^\circ$	$3/2,5/2$	*1 968 690?*
$2s2p(^3P^\circ)5d$	$^4D^\circ$	$1/2$	
		$3/2$	
		$5/2$	*2 000 750+x?*
		$7/2$	*2 001 450+x*
$2s2p(^3P^\circ)5d$	$^4P^\circ$	$5/2$	*2 002 380+x*
$2s2p(^3P^\circ)5d$	$^2F^\circ$	$5/2$	*2 005 260?*
		$7/2$	*2 006 650?*
$2p^2(^3P)4p$	$^4D^\circ$	$7/2$	*2 041 290+x?*
$2s2p(^3P^\circ)6d$	$^2F^\circ$	$7/2$	*2 092 940?*
$2s2p(^1P^\circ)5d$	$^2F^\circ$	$5/2,7/2$	*2 130 100?*
$2s2p(^1P^\circ)5d$	$^2D^\circ$	$3/2,5/2$	*2 132 420?*
Mg IX ($^1S_0$)	***Limit***		**2 145 100**

Mg IX

Configuration	Term	J	Level (cm^{-1})
$2s^2$	^{1}S	0	0
$2s2p$	^{3}P$^\circ$	0	*140 504*
		1	*141 631*
		2	*144 091*
$2s2p$	^{1}P$^\circ$	1	*271 687*
$2p^2$	^{3}P	0	365 856
		1	367 159
		2	369 330
$2p^2$	^{1}D	2	405 100
$2p^2$	^{1}S	0	499 633
$2s3s$	^{3}S	1	1 532 450
$2s3s$	^{1}S	0	1 558 080
$2s3p$	^{1}P$^\circ$	1	*1 593 600*
$2s3d$	^{3}D	1	1 631 040
		2	1 631 170
		3	1 631 320
$2s3d$	^{1}D	2	1 654 580
$2p3s$	^{3}P$^\circ$	0	*1 710 140*
		1	*1 711 250*
		2	*1 713 900*
$2p3s$	^{1}P$^\circ$	1	*1 743 040*
$2p3p$	^{1}P	1	1 748 120
$2p3p$	^{3}D	1	1 755 470?
		2	1 756 470?
		3	1 758 970
$2p3p$	^{3}S	1	1 770 380
$2p3p$	^{3}P	0	
		1	1 778 690
		2	1 779 990
$2p3d$	^{1}D$^\circ$	2	*1 789 640*
$2p3p$	^{1}D	2	1 795 870
$2p3d$	^{3}D$^\circ$	1	*1 807 320*
		2	*1 807 860*
		3	*1 808 860*
$2p3d$	^{3}P$^\circ$	2	*1 815 220*
		1	*1 816 210*
		0	*1 816 730*

Mg IX—Continued

Configuration	Term	J	Level (cm^{-1})
2p7d	^{1}F$^\circ$	3	*2 628 160?*
....	....	....	....
Mg X (^{2}S$_{1/2}$)	***Limit***		**2 644 700**
Mg X (^{2}P$^\circ_{1/2}$)	*Limit*		*2 804 700*
Mg X (^{2}P$^\circ_{3/2}$)	*Limit*		*2 808 700*
1*s*2*s*^{2} 2*p*	^{1}P$^\circ$	1	[*10 657 600*]
1*s*(^{2}S)2*s*2*p*^{2}(^{2}D)	^{3}D	3 2 1	[10 763 400] [10 764 000] [10 764 600]
1*s*(^{2}S)2*s*2*p*^{2}(^{4}P)	^{3}P	0 1 2	[10 765 600] [10 767 000] [10 769 300]
1*s*(^{2}S)2*s*2*p*^{2}(^{2}P)	^{3}P	2	[10 865 600]
1*s*(^{2}S)2*s*2*p*^{2}(^{2}P)	^{1}P	1	10 917 900
1*s*2*p*^{3}	^{3}P$^\circ$	2	[*11 020 700*]
1*s*2*p*^{3}	^{1}P$^\circ$	1	*11 080 900*

Fawcett, B. C. [1970], J. Phys. B **3**, 1152–1163. CL W
Fawcett, B. C. [1971], J. Phys. B **4**, 1115–1118. CL W
Feldman, U., Cohen, L., and Behring, W. [1970], J. Opt. Soc. Am. **60**, 891–893. EL CL W
Feldman, U., Doschek, G. A., Nagel, D. J., Cowan, R. D., and Whitlock, R. R. [1974], Astrophys. J. **192**, 213–220. EL CL W
Flemberg, H. [1942], Ark. Mat., Astron. Fys. **28**, 1–47. W
Peacock, N. J., Hobby, M. G., and Galanti, M. [1973], J. Phys. B **6**, L298–L304. CL W AT
Söderqvist, J. [1944], Ark. Mat., Astron. Fys. **30**, 1–20. EL CL W IP

Mg X

Configuration	Term	J	Level (cm^{-1})
$1s^2(^1S)2s$	^{2}S	1/2	0
$1s^2(^1S)2p$	^{2}P°	1/2 3/2	*160 015* *163 990*
$1s^2(^1S)3s$	^{2}S	1/2	1 682 700
$1s^2(^1S)3p$	^{2}P°	1/2 3/2	*1 726 520* *1 727 830*
$1s^2(^1S)3d$	^{2}D	3/2 5/2	1 743 500 1 743 890
$1s^2(^1S)4p$	^{2}P°	1/2,3/2	*2 270 150*
$1s^2(^1S)4d$	^{2}D	3/2 5/2	2 277 380 2 277 700
$1s^2(^1S)4f$	^{2}F°	5/2,7/2	*2 278 010*
$1s^2(^1S)5s$	^{2}S	1/2	2 511 600
$1s^2(^1S)5p$	^{2}P°	1/2,3/2	*2 520 900*
$1s^2(^1S)5d$	^{2}D	3/2 5/2	2 524 400 2 524 600
$1s^2(^1S)6p$	^{2}P°	1/2,3/2	*2 656 500*
$1s^2(^1S)6d$	^{2}D	3/2,5/2	2 658 800
$1s^2(^1S)7p$	^{2}P°	1/2,3/2	*2 738 400*
$1s^2(^1S)7d$	^{2}D	3/2,5/2	2 739 600
$1s^2(^1S)8p$	^{2}P°	1/2,3/2	*2 791 200*
$1s^2(^1S)9p$	^{2}P°	1/2,3/2	*2 827 600*
Mg XI ($^1S_0$)	***Limit***		**2 963 970**
$1s(^2S)2s2p(^3P°)$	^{2}P°	1/2,3/2	*10 772 000*
$1s(^2S)2s2p(^1P°)$	^{2}P°	1/2,3/2	[*10 829 000*]
$1s(^2S)2p^2(^1D)$	^{2}D	3/2,5/2	10 894 000
$1s(^2S)2p^2(^3P)$	^{2}P	1/2,3/2	10 922 000

Mg X

$Z = 12$

He I isoelectronic sequence

Ground state $1s^{2}\ {}^{1}\mathrm{S}_{0}$

Ionization energy 14 210 170±15 cm^{-1} (1761.851±0.005 eV)

$1sns$ and $1snp$ Terms

The $1sns$ and $1snp$ levels for $n=2$–5, as well as the ionization energy, were obtained from calculated values given in an unpublished supplement to the paper by Ermolaev and Jones [1974]. The largest uncertainty estimate given by these authors corresponds to ±10 to ±15 cm^{-1} for the Mg XI levels. Even if the errors are significantly larger, the calculated levels are nevertheless expected to be more accurate than values derived from available observations; for example, Flemberg's measurements of the $1s^{2}\ {}^{1}\mathrm{S}_{0}$—$1snp\ {}^{1}\mathrm{P}^{\circ}_{1}$ wavelengths (7.3–9.2 Å), which are among the most accurate observations of these lines, have estimated uncertainties corresponding to ±600 cm^{-1} or more. The three lowest ${}^{1}\mathrm{P}^{\circ}_{1}$ levels ($n=2,3,4$) as derived from Flemberg's determinations agree with the values given here to within ±400 cm^{-1}. References to more recent observations and analysis of this spectrum in the 7–9 Å region are given by Boiko, Faenov, and Pikuz [1978].

The solar-coronal observations by Walker, Rugge, and Weiss [1974] extended identification of the $1s^{2}\ {}^{1}\mathrm{S}_{0}$—$1snp\ {}^{1}\mathrm{P}^{\circ}_{1}$ series to $n=9$. We have derived the values of the $1snp\ {}^{1}\mathrm{P}^{\circ}_{1}$ levels for $n=6$–10 by a quantum-defect extrapolation based on Ermolaev and Jones' calculations (Figure 1). The accuracy of these levels may be comparable with the accuracy of the lower ($n=2$–5) calculated levels. Predictions of the $1s^{2}\ {}^{1}\mathrm{S}_{0}$—$1snp\ {}^{1}\mathrm{P}^{\circ}_{1}$ series based on either Flemberg's observations or Ermolaev and Jones' calculations of the lower members indicate that the predicted wavelengths listed by Walker et al. for the higher members are in error by up to 0.01 Å (for $n=9$, at 7.12 Å).

$1snd$ and $1snf$ Terms

We have also given theoretical values for the $1snd$ and $1snf$ terms for $n \leqslant 5$. Transitions from the $1snd$ terms may have been observed in solar-flare spectra [Kastner, Neupert, and Swartz], but the theoretical values are preferred until definite identifications and measurements of unblended lines from these terms are available. The theoretical terms are based on variational calculations for $1s3d$ [Brown, 1968] and higher $1snd$ terms [Brown and Cortez, 1971] and for $1snf$ terms [Brown, 1969]. Since these calculations did not include relativistic and radiative corrections, we first combined the resulting $1snl$ term values (obtained from the total energies) with the Mg XII $1s$ ionization limit of Ermolaev and Jones (given above) to obtain $1snl$ levels effectively including these corrections for the $1s$ electron. As an approximation for the much smaller relativistic shift associated with the nl electron, we then assumed the hydrogenic Sommerfeld-Dirac correction for the baricenter of the corresponding nl term in a hydrogenic ion with core charge $Z_{c}=11$ [Edlén, p. 192, Table 51]. This latter relativistic lowering of the levels varies from 475 cm^{-1} for the $1s3d$ terms to 93 cm^{-1} for the $1s5f$ terms. A comparison with the $1s3l$ terms given by Vainshtein and Safronova [1976] is of interest, since their calculations included relativistic and radiative effects: their results give both the $1s3d\ {}^{3}\mathrm{D}$ and ${}^{1}\mathrm{D}$ terms about 100 cm^{-1} lower relative to the $1s3s$ singlet-triplet mean position, or 150 cm^{-1} lower relative to the $1s3p$ mean position, than is obtained with the levels given here. The positions of the $1s3l$ levels with respect to the $1s^{2}\ {}^{1}\mathrm{S}_{0}$ ground level as calculated by Vainshtein and Safronova, however, are higher than the values here by 790 to 940 cm^{-1} for the $1s3s$ and $1s3p$ levels and by 750 cm^{-1} for the $1s3d$ levels. The fine-structure separations of the $1s3d\ {}^{3}\mathrm{D}$ levels are from Vainshtein and Safronova's results. All of the $1snd$ and $1snf$ levels are rounded to the nearest 10 cm^{-1}.

It is also of interest to compare the $1snd$ and $1snf$ terms with values obtained from the core-polarization theory of term defects in two-electron ions. We derived $1snl$ singlet-triplet mean positions using the core-polarization formulae (dipole plus quadrupole-polarizability approximation [Martin, 1970; Edlén, 1964, Sec. 20]) and the same nl relativistic shifts as above. The positions agree with the corresponding means of the term values given here to within 20 cm^{-1} for the $1snd$ terms and 3 cm^{-1} for the $1snf$ terms. These results indicate that relatively accurate values for all the $1snl$ ($l>2$) singlet-triplet mean energies can be similarly obtained.

Doubly-Excited Configurations

Satellites of the Mg XII $1s\ {}^{2}\mathrm{S}$—$2p\ {}^{2}\mathrm{P}^{\circ}$ resonance doublet lines at 8.42 Å have been observed in both laboratory and solar spectra. The satellite lines are mainly blends of transitions of the type $1snl'$—$2pnl'$ in Mg XI, the stronger features being assigned to $2s2p$ and $2p^{2}$ upper configurations [see, for example, Boiko et al., 1978, and their references to earlier work]. Values for the levels of these two doubly-excited configurations are included here, all but one being derived from theoretical wavelengths calculated by Vainshtein and Safronova [1978] combined with lower (single-excitation) levels as given here. The $2p^{2}\ {}^{1}\mathrm{D}_{2}$ level is based on an average value for the $1s2p\ {}^{1}\mathrm{P}^{\circ}_{1}$—$2p^{2}\ {}^{1}\mathrm{D}_{2}$ wavelength as measured by Aglitskii et al. [1974] and by Feldman et al. [1974]. Transitions from the other doubly-

Mg XI

Configuration	Term	*J*	Level (cm^{-1})
1*s*^{2}	^{1}S	0	0
1*s*2*s*	^{3}S	1	[10 736 420]
1*s*2*p*	^{3}P°	0 1 2	[*10 832 260*] [*10 833 090*] [*10 836 650*]
1*s*2*s*	^{1}S	0	[10 839 030]
1*s*2*p*	^{1}P°	1	[*10 906 890*]
1*s*3*s*	^{3}S	1	[12 691 440]
1*s*3*p*	^{3}P°	0 1 2	[*12 717 730*] [*12 717 990*] [*12 719 050*]
1*s*3*s*	^{1}S	0	[12 718 550]
1*s*3*d*	^{3}D	1 2 3	[12 733 490] [12 733 510] [12 733 900]
1*s*3*d*	^{1}D	2	[12 734 480]
1*s*3*p*	^{1}P°	1	[*12 738 290*]
1*s*4*s*	^{3}S	1	[13 362 260]
1*s*4*p*	^{3}P°	0 1 2	[*13 373 090*] [*13 373 200*] [*13 373 640*]
1*s*4*s*	^{1}S	0	[13 373 240]
1*s*4*d*	^{3}D	1,2,3	[13 379 660]
1*s*4*d*	^{1}D	2	[13 380 090]
1*s*4*f*	^{3}F°	2,3,4	[*13 380 160*]
1*s*4*f*	^{1}F°	3	[*13 380 170*]
1*s*4*p*	^{1}P°	1	[*13 381 530*]
1*s*5*s*	^{3}S	1	[13 669 880]
1*s*5*p*	^{3}P°	0 1 2	[*13 675 360*] [*13 675 420*] [*13 675 640*]
1*s*5*s*	^{1}S	0	[13 675 400]
1*s*5*d*	^{3}D	1,2,3	[13 678 690]

Mg XII

Z = 12

H I isoelectronic sequence

Ground state 1*s* $^2S_{1/2}$

Ionization energy 15 829 942±3 cm^{-1} (1962.678±0.005 eV)

The levels are based on Erickson's calculations, given with respect to zero for the ground level and adjusted to a nuclear mass of 24.2984 and to the Rydberg value determined by Goldsmith, Weber, and Hänsch (R_∞ = 109 737.31476±0.00032 cm^{-1}). Erickson calculated the levels for the isotope Mg^{24}, whereas the nuclear mass quoted above corresponds to an atomic mass of 24.305, the value for Mg with natural isotopic abundances [IUPAC Commission on Atomic Weights, 1976]. The net result of the changes is to increase the effective Rydberg constant for Mg, R_M, by 2.74 parts in 10^7 above the value used by Erickson, all level separations being increased accordingly. The increases of 3.3 to 4.3 cm^{-1} in the values of the excited levels (and limit) with respect to the ground level, although negligible compared to the uncertainties attainable with present experimental techniques, are comparable to the standard-deviation error of ±3 cm^{-1} in Erickson's calculations of these separations. The errors for the separations of excited levels are smaller; details are given by Erickson, who lists each level to the number of decimal places appropriate for a quoted quantum-electrodynamics error. His table is complete through $n=11$ and also has the *ns*, *np*, and *nl* ($l=n-1$) levels through $n=20$. We list all levels through $n=5$ and give the *ns* and *np* levels through $n=10$.

The 1*s*–*np* resonance series has been observed from 2*p* to 6*p* (8.4 to 6.5 Å) in the spectra of laser-produced plasmas [see, for example, Aglitskii et al., 1974]. The experimental uncertainties of wavenumber determinations in this region are much greater than the uncertainties of the levels given here; the measurements by Aglitskii et al., for example, have wavenumber uncertainties of about ±2000 cm^{-1}. Experimental resolution of the nominal 1*s* $^2S_{1/2}$—2*p* $^2P^\circ_{1/2,3/2}$ doublet has shown that the intensity ratio of the two components can be very different from the statistical value of 0.5. Beigman, Boiko, Pikuz, and Faenov, for example, observed this ratio to vary from 0.7 to 1.7, depending on experimental conditions in a laser-produced plasma source. They suggest that collision-induced transitions from the 2*s* $^2S_{1/2}$ level, as well as optical-depth effects, significantly affect this ratio under some conditions. Such observations emphasize the need for caution in the assumption of particular theoretical values (such as the statistical-intensities baricenters) for the wavelengths of unresolved members of this series.

References

Aglitskii, E. V., Boiko, V. A., Zakharov, S. M., Pikuz, S. A., and Faenov, A. Ya. [1974], Sov. J. Quantum Electron. **4**, 500–513. CL W

Beigman, I. L., Boiko, V. A., Pikuz, S. A., and Faenov, A. Ya. [1976], Sov. Phys. JETP **44**, 511–515.

Erickson, G. W. [1977], J. Phys. Chem. Ref. Data **6**, 831–869. TE

Goldsmith, J. E. M., Weber, E. W., Hänsch, T. W. [1978], Phys. Rev. Lett. **41**, 1525–1528.

IUPAC Commission on Atomic Weights [1976], Pure Appl. Chem. **47**, 75–95.

Mg XII

Configuration	Term	*J*	Level (cm^{-1})
1*s*	^{2}S	1/2	0
2*p*	^{2}P°	1/2	[*11 869 975.7*]
		3/2	[*11 877 602.3*]
2*s*	^{2}S	1/2	[11 870 287.2]
3*p*	^{2}P°	1/2	[*14 070 804.8*]
		3/2	[*14 073 064.8*]
3*s*	^{2}S	1/2	[14 070 898.0]
3*d*	^{2}D	3/2	[14 073 060.9]
		5/2	[14 073 811.6]