STRUCTURE OF ATOMIC SPECTRA: SOME RECENT LABORATORY RESEARCH OF INTEREST FOR STELLAR SPECTROSCOPY

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The data covered are wavelength, line classifications, and energy levels, and the references (numbers in brackets) are mainly supplementary to those supplied by Working Group 4 for the 1982 Report of Commission 14 [57].

I. Recent Compilations of Energy Levels and Spectral Lines

New compilations of the energy levels for all the spectra of Fe (Fe I - XXVI) [42] and Co (Co I - XXVII) [43] have been published. Although compilations of the levels for the 235 iron-group spectra (K through Ni) by the NBS AEL Data Center have been published by element during the past five years, the single-volume collection of these levels now under preparation will incorporate fairly extensive additions and revisions for many of the spectra. A compilation of the levels for Si (Si I - XIV) has been completed and should appear early in 1983 [17].

Several references for compilations and predictions of wavelengths and levels for transitions involving the $2s^m2p^k$ configurations of highly ionized atoms were included in the Report [57]. The most recent treatment of such data for the $2s^2 2p^k$ (k=1-5) ground configurations by Edlén [13] should be added. Edlén compares observations with the theoretical results of Cheng et al. [44], whose tables include calculated wavelengths and strengths for allowed and forbidden transitions between levels of $2s^m2p^k$ configurations (Li through F isoelectronic sequences). Reference [78] of the Report [57] should also be mentioned here, since it probably comprises the most complete available compilation of experimental wavelengths for these transitions in ions of Ti, Cr, Fe, Co, and Ni, and includes some predictions.

The wavelength tables in the NSRDS-NBS volume "Wavelengths and Transition Probabilities for Atoms and Atomic Ions" [45] have about 47,000 lines arranged by spectrum and also in a finding list. The stronger lines of the first five spectra (I - V) of all elements are listed, the coverage extending over all wavelength regions. The first part of these tables (lines arranged by spectrum) are included in recent editions of the "CRC Handbook of Chemistry and Physics"; a few corrections are made in the latest edition [46] (notably the inclusion of 13 Fe lines near 2600 Å, 7 of them belonging to the Fe II UV multiplet No. 1, erroneously omitted in the earlier tables).

Striganov and Odintsova [14] have published newly compiled "Tables of Spectral Lines of Atoms and Ions", including all spectra of the elements H through Ne, the first through the sixth spectra of Na through Cl, and Ar I - Ar X. All 30,490 known lines of 109 spectra are listed, by spectrum, with energy-level classifications and excitation potentials.

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R. L. Kelly's just completed tables, "Atomic and Ionic Spectrum Lines Below 2000 Angstroms - Hydrogen through Argon" [15] are complete for the first 18 elements in the stated wavelength range. Classifications and excitation energies are given, and a finding list is included. Kelly's 1979 compilation [47] covering the spectra of the first 36 elements (H - Kr) over the wavelength range 2000 - 3200 Å is now available (in two sections, by spectrum and a finding list) from the U.S. National Technical Information Service.

II. Reviews and Bibliographies

A review by Fawcett [48] of the analysis of spectra of highly ionized atoms during the period 1974-1980 covers the elements up through Ni and includes 281 references keyed to particular spectra. Martinson [49] and Cowan [50] have also recently reviewed progress on the spectra of highly ionized atoms, including references for elements ranging over the periodic table. Feldman's [51] summary of spectroscopic results useful for the diagnostics of hot solar plasmas included

Table 1

Selected References on Energy Levels and Wavelengths

C I (1)	Ti II (3)
	Ti XIV, XV (9)
O III (35)	Ti XVI (10)
O VI (36,58)	Ti XVII (11)
	Ti XVIII (12)
F VI, VII (22)	
	VII (37)
Mg I (2)	V XV, XVI (9)
	V XVII (10)
P I (6,7)	V XVIII (11)
P II (20)	
	Cr I (28)
S I (18)	Cr II (24)
S II (25)	Cr IV (4)
S IV (23)	Cr XII-XVI (31)
S VII (21)	
	Mn I (32)
Cl VI-VIII (21)	
Cl IX, X (9,21)	Fe I (29,30)
Cl XI (10,21)	Fe II (5)
Cl XII (11,21)	Fe III (26)
Cl XIII (12)	Fe XIII-XVIII (31)
K XI, XII (9)	Ni I, II (19)
K XIII (10)	Ni XVI-XX (31)
K XIV (11)	
K XV (12)	Zn V (56)
Ca I (27)	Y IV (38)
Ca XII, XIII (9)	
Ca XIV (10)	Nb IV (39)
Ca XV (11)	
Ca XVI (12)	In IV (40)
Sc II (8)	Sn V (40)
Sc XIII, XIV (9)	
Sc XV (10)	Xe III (54)
Sc XVI (11)	
Sc XVII (12)	Th III (41)

tables of pertinent lines and many references to laboratory data. Edlén [55] has recently reviewed some of the literature pertinent to forbidden lines and given new predictions of wavelengths for certain isoelectronic sequences.

The BNS AEL Data Center maintains a current bibliographic file covering publications on energy levels, wavelength, line classifications, and several other categories of atomic spectroscopic data. The next in a series of bibliographies published from these files will cover the literature from June, 1979, through a date not yet decided. The Center supplies references for two more frequently appearing reports that include bibliographic sections on atomic spectral data: the "International Bulletin on Atomic and Molecular Data for Fusion" [52] appears 3 or 4 times a year, and "Atomic Data for Fusion" [53] is issued bimonthly.

III. Recent and Ongoing Laboratory Research

The selected references sorted according to spectrum in Table 1 include references not available when the similar table in the 1982 Report [57] was prepared, references mistakenly omitted from [57], and a few references to ongoing research. The references for Z > 28 were selected from results on the first five spectra only.

A recent thesis dissertation on O III [35] gives the results of a complete reobservation of this spectrum; the data and analysis will be published and will also serve as the basis for a section on O III of Moore's NSRDS-NBS 3 tables. Results substantially superseding previous data over all or much of the wavelength region pertinent to each spectrum and its analysis have also been recently published for Mg V, P I, S V, S VI, Sc II, Ti II, Cr IV, Mn VII, Fe VI, Co VII, and Ni VI (references in Table 1 or in [57]). For the important element Fe, two somewhat earlier references of this type may be cited again: for Fe II [33] and Fe IV [34]. Some of the references for the more highly ionized atoms and for Z > 28 also fall into the category described above.

The references in Table 1 for P II, S II, S IV, Cl VII, V II and Cr II are also similar to those described above (substantial extensions of the analyses based on new observations of the spectra) except that the new data are as yet unpublished; in each case, however, the results are now being prepared for publication, or the work is at an advanced stage. Extensive reinvestigations of Fe I, Fe III, and Ni I are also underway, as noted.

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