Spectral Data and Grotrian Diagrams for Highly Ionized Vanadium, V VI through V XXIII

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Wavelengths, energy levels, level designations, oscillator strengths, and atomic transition probabilities for the vanadium ions V VI to V XXIII are tabulated. A short review of the line identifications and wavelength measurements is given for each stage of ionization. Grotrian diagrams are also presented to provide graphical overviews. The literature has been surveyed to September 1991.

Key words: atomic data; energy levels; Grotrian diagrams; ions; oscillator strengths; spectra; transition probabilities; vanadium; wavelengths.

Contents

1. Introduction

We have undertaken to publish a series of compilations of spectra of highly ionized atoms of particular interest to the fusion energy community. These selected elements occur as impurities in wall materials of fusion machines or are specifically injected into the hot plasmas for diagnostics. Much new work on these spectra has appeared in recent years. We have critically compiled these data into single monographs for each element including wavelengths, classifications, intensities, Grotrian diagrams, and a short review of the literature for each ion. Oscillator strengths and radiative transition probabilities have been tabulated when available, in order to facilitate identification of emission lines. Monographs are already published for Ti, Fe, Co, Ni, Cu and Mo[1–6]. The present compilation contains data for V VI to V XXIII.

All relevant papers published through September 1991 were collected and surveyed, and the best measurements, in our judgement, were included in the tables. We consulted the following comprehensive compilations: for wavelength data Kelly (1987)[7], for forbidden lines arising within ground configurations of the type ns^2np^k ($n=2$ and 3, $k=1$ to 5) Kaufman and Sugar (1986)[8], and a review article by Fawcett (1984)[9].

Sugar and Corliss (1985)[10] have published a comprehensive critical compilation of energy levels for the iron-group elements K to Ni in all stages of ionization. Their values are adopted for this compilation, except where superceded by more recent data. For the He- and H-sequences, only theoretical results are given since they are considered to be more accurate than the experimental values.

For atomic transition probabilities, calculations in various approximations, including multi-configuration Dirac-Fock calculations, have been reported for allowed and forbidden transitions. Brief reviews of such theoretical data are given in the critical data compilation of allowed and forbidden lines by Martin *et al.* (1988)[11], from which the oscillator strengths (f) and transition probabilities (A) are taken.

In cases where no experimental wavelength data are available but for which calculated f-values exist, the quoted wavelengths are calculated from the known energy levels using the Ritz combination principle. The wavelengths are then used to calculate A-values from the f-values.

We tabulate A-values and gf-values in order to provide a measure of the strength of the lines. When these are not available, we list the rough line intensity estimates provided in the literature. The A-values (or f-values) may be utilized to obtain line intensities from the general relation between the line intensity and transition probability

$$I = (4\pi\lambda)^{-1} hcAN_u,$$

where N_u is the population of the upper energy level. The level populations are source-dependent and are—especially for low density plasmas—difficult to estimate. However, for small energy ranges relative populations may follow Boltzmann distributions, or may even be estimated as constant, aside from the statistical weight factors $g_u = 2J_u + 1$ (where J is the total angular momentum quantum number). Thus for two emission lines originating from closely spaced upper levels one may estimate

$$I_1/I_2 \approx (\lambda_2 A_1 g_1/\lambda_1 A_2 g_{u2}).$$

For some spectra we give both A-value data and line intensity estimates in order to provide a rough correlation between them. We caution that intensity estimates in experimental work are usually visual estimates of relative plate blackening. There is generally no correlation between intensity estimates by different authors, or by the same author for widely different wavelength ranges.

We give wavelengths in air above 2000 Å and in vacuum below 2000 Å. For conversion of ionization energies from cm^{-1} to eV, we use the conversion factor 8065.5410(0.0024) cm^{-1}/eV given by Cohen and Taylor (1987)[12].

In the following section we give brief comments on each ion, including the accuracy of the wavelength data.

1.1. Acknowledgments

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1.2. References for Introduction

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2. Brief Comments on Each Vanadium Ion

V VI (Ar sequence)

Ground state: $1s^22s^22p^63s^23p^6\ {}^1S_0$

The resonance transitions $3p^6\ {}^1S_0 - 3p^5nl$ with $nl = 4s$, 5s were observed by Kruger and Weissberg (1935)[66] in the range of 128–182 Å, by Alexander *et al.* (1965)[5] for $nl = 4d$ at 139.553 Å and 138.261 Å, and by Feldman *et al.* (1965)[46] and Gabriel *et al.* (1965)[53] for $nl = 3d$ at 224.50 Å. Wagner and House (1971)[81] classified the $3p^53d - 3p^54f$ transitions, comprising 12 lines in the range of 213–227 Å. Extensive observations were carried out by Ekberg (1976)[28] in the wavelength range of 117–1630 Å using a vacuum spark discharge. He identified 170 lines as transitions among 56 levels of the $3s^23p^6$, $3s^23p^53d$, $4s$, $4p$, $4d$, $4f$, $5s$, $5d$ and $3s3p^63d$ configurations. We quote Ekberg's results.

Kastner *et al.* (1977)[63] identified seven lines of the inner-shell transitions $3s^23p^6\ {}^1S_0-3s3p^6np\ {}^3P_1^o$ ($n=4,5$) and $3s^23p^6\ {}^1S_0-3s3p^6np\ {}^1P_1^o$ ($n=4-8$) in the range of 85 – 119 Å with an uncertainty of ±0.005 Å.

It should be noted that the lines classified as $3p^6\ {}^1S_0-3p^5({}^2P^o_{3/2,1/2})5d$ at 118.7 Å and 117.7 Å in Fawcett *et al.* (1968)[34] and Ref. 28 were revised as the $3s^23p^6\ {}^1S_0-3s3p^64p\ {}^{3,1}P_1^o$ transitions in Ref. 63 and also that the remaining $3s^23p^6\ {}^1S_0-3s^23p^5({}^2P^o_{3/2})5d\ {}^2[{}^1/_2]_1^o$ line at 119.3 Å in Ref. 34 has been deleted because this line was not observed by Ekberg (1976)[28].

V VII (Cl sequence)

Ground state: $1s^22s^22p^63s^23p^5\ {}^2P^o_{3/2}$

Weissberg and Kruger (1936)[82] identified the $3s^23p^5\ {}^2P^o_{1/2,3/2}-3s3p^6\ {}^2S_{1/2}$ transitions. Subsequently Smitt *et al.* (1976)[78] measured these wavelengths as 472.828 ±0.008 Å and 456.284±0.008 Å in a vacuum spark.

Gabriel *et al.* (1965)[53], (1966)[54] identified the transitions $3p^5\ {}^2P^o_{3/2}-3p^43d\ {}^2P_{3/2}$ and ${}^2P^o_{1/2,3/2}-{}^2D_{3/2,5/2}$. Fawcett and Gabriel (1966)[31] reobserved these three lines at 229.38 Å, 225.79 Å and 225.16 Å using vacuum sparks, and also identified six new lines in the range of 221 – 242 Å as the $3p^5\ {}^2P^o-3p^4({}^1D)3d\ {}^2S$, $({}^3P){}^2P$, $({}^3P){}^2D$ array. Here, the parent states of the $3p^43d$ configuration have been taken from the calculation by Bromage (1980)[12].

The $3p^5\ {}^2P^o-3p^44s\ {}^2P$ doublet was first observed by Weissberg and Kruger (1936)[82] in the range of 159 – 163 Å. Edlén (1937)[26] reobserved the spectrum in the extended range of 148 – 165 Å with a vacuum spark and identified the additional ${}^2P^o-{}^2D,{}^2S$ doublets and the ${}^2P^o-{}^4P$ spin-forbidden transitions.

Fawcett *et al.* (1968)[34] identified six lines as the $3p^5-3p^44d$ transitions in the range of 117 – 127 Å. These lines, except for the ${}^2P^o_{3/2}-({}^1S)\ {}^2D_{5/2}$ line at 117.2 Å, were remeasured by Fawcett *et al.* (1972)[39], who also included identifications of the ${}^2P^o_{1/2,3/2}-({}^1P)\ {}^2S_{1/2}$ and ${}^2P^o_{3/2}-({}^1D)\ {}^2D_{3/2}$ transitions at 124.24 Å, 123.07 Å and 121.89 Å and the $3p^43d-3p^44f$ transitions. The latter include the spin-forbidden ${}^4F_{7/2}-{}^2G^o_{9/2}$ line. Their observations were made in the range of 177 – 184 Å with a laser-produced plasma with an uncertainty of ±0.02 Å.

V VIII (S sequence)

Ground state: $1s^22s^22p^63s^23p^4\ {}^3P_2$

Fawcett and Peacock (1967)[33] and Fawcett (1970)[35] observed the $3s^23p^4\ {}^3P-3s3p^5\ {}^3P^o$ and ${}^1D_2-{}^1P_1^o$ lines in the range of 398 – 473 Å in laser-produced plasmas. Improved measurements for these lines in a vacuum spark with an uncertainty of ±0.008 Å was made by Smitt *et al.* (1976)[78], whose wavelengths are given here. They also identified the ${}^1S_0-{}^1P_1^o$ line at 459.647 Å and the ${}^3P_2-{}^1P_1^o$ spin-forbidden transition at 359.454 Å. A blended ${}^3P_1-{}^3P_2^o$ line at 472.839 Å deviates by 0.022 Å from the wavelength recalculated from the levels.

Gabriel *et al.* (1966)[54] identified the $3p^4\ {}^3P-3p^33d\ {}^3D^o$ triplet and ${}^1D_2-{}^1F_3^o$ singlet in the range of 228 – 232 Å. Their observations were made with vacuum sparks with an uncertainty of ±0.05 Å. Fawcett and Gabriel (1966)[31] identified the three lines of the ${}^3P_{1,2}-{}^3P_2^o$ and ${}^1D_2-{}^1D_2^o$ transitions at 243.69 Å, 240.22 Å and 236.01 Å. The designation of parent term of the upper $3p^33d$ configuration adopted here was provided by Bromage (1980)[12].

Nineteen lines of $3p^4-3p^34s$ transitions in the range of 135 – 148 Å, including the spin-forbidden transitions ${}^1D_2-{}^3P_2^o$ and ${}^3P_2-{}^1D_2^o$ at 140.934 Å and 139.188 Å, were identified by Edlén (1937)[25] using vacuum spark observations.

Fawcett *et al.* (1972)[39] identified eight lines in the range of 154 – 158 Å as the $3p^33d-3p^34f$ transitions and six lines in 113 – 116 Å as the $3p^4-3p^34d$. Wavelengths of these transitions were obtained with a laser-produced plasma with uncertainties of ±0.02 Å and ±0.015 Å, respectively. Fawcett *et al.*[45] gave additional identifications of the $3p^4-3p^34d$ transitions in the range of 110 – 112 Å and the $3p^33d\ {}^1G_4^o-3p^34f\ {}^1H_5$ transition at 159.24 Å.

V IX (P sequence)

Ground state: $1s^22s^22p^63s^23p^3\ {}^4S^o_{3/2}$

Fawcett and Peacock (1967)[33] and Fawcett (1970)[35] classified lines of the $3s^23p^3-3s3p^4$ transition array in the range of 364 – 468 Å, obtained with laser-produced plasmas. Additional classifications were given by Smitt *et al.* (1976)[78] in the extended range of 364 – 489 Å. They observed 16 lines belonging to this array in a vacuum spark discharge with an uncertainty of ±0.008 Å. The lines at 485.110 Å (${}^2P^o_{1/2}-{}^2D_{3/2}$), 437.005 Å (${}^2D^o_{5/2}-{}^2D_{3/2}$), and 399.719 Å (${}^2P^o_{1/2}-{}^2P_{1/2}$) are blends.

Gabriel *et al.* (1965)[53], (1966)[54] classified the line at 235.72±0.05 Å as the $3p^3\ {}^2D^o_{5/2}-3p^2({}^3P)3d\ {}^2F_{7/2}$ transition. The ${}^3P$ parent is from the calculations by Bromage (1980)[12]. Fawcett *et al.* (1967)[32] identified the $3p^3\ {}^4S^o-3p^2({}^3P)3d\ {}^4P$ resonance transitions at ~244 Å. Fawcett (1971)[37] more fully observed the $3p^3-3p^23d$ array in the range of 240 – 276 Å with measurement uncertainties of ±0.05 Å.

Six lines due to the $3p^3-3p^24s$ transitions in the range of 125 – 127 Å were observed in a vacuum spark by Kruger and Pattin (1937)[67]. In the longer wavelength region Fawcett *et al.* (1972)[39] identified the $3p^3\ {}^2P^o-3p^2({}^3P)4s\ {}^2P$, $({}^1D){}^2D$ and ${}^2D^o-({}^3P){}^2P$ doublets in the range of 129 – 135 Å, as well as the $3p^23d-3p^24f$ transitions at 137 – 141 Å. Wavelengths were measured with a laser-produced plasma with an uncertainty of ±0.02 Å. The spin-forbidden $3p^3\ {}^2D^o_{5/2}-3p^24d\ {}^4D_{7/2}$ line at 88.48 Å was reported by Fawcett *et al.*[45] Except for this line no intersystem connection has been established.

V X (Si sequence)

Ground state: $1s^22s^22p^63s^23p^2\ ^3P_0$

Fawcett and Peacock (1967)[33] and Fawcett (1970)[35], (1971)[37] analyzed of the $3s^23p^2-3s3p^3$ transition array in the range of 308 – 471 Å. Improved wavelengths with an uncertainty of ± 0.008 Å were obtained by Smitt *et al.* (1976)[78] with a vacuum spark discharge. They identified 19 lines, including the spin-forbidden transitions $^1D_2-^3D^\circ_3$ at 527.439 Å, $^3P_2-^1D^\circ_2$ at 369.612 Å and $^3P_2-^1P^\circ_1$ at 301.283 Å. The wavelength of the blended $^3P_1-^3P^\circ_2$ line at 399.719 Å is different by 0.03 Å from that recalculated with the level values.

Fawcett *et al.* (1967)[32] and Fawcett (1971)[37] provided classifications of the $3p^2-3p3d$ lines in the range of 245 – 266 Å. They measured wavelengths in a vacuum spark discharge with uncertainties of ± 0.03 Å and ± 0.05 Å, respectively.

The $3p3d-3p4f$, $3p^2-3p4s$ and $3p^2-3p4d$ transitions in the ranges of ~124 Å, 115 – 119 Å and ~94 Å, respectively, were identified by Fawcett *et al.* (1972)[39] in the spectrum of a laser-produced plasma.

V XI (Al sequence)

Ground state: $1s^22s^22p^63s^23p\ ^2P^\circ_{1/2}$

The transitions $3s^23p-3s3p^2$ in the range of 320 – 448 Å were identified by Fawcett and Peacock (1967)[33] and Fawcett (1970)[35], and were remeasured more accurately by Smitt *et al.* (1976)[78] with an uncertainty of ± 0.008 Å in a vacuum spark discharge.

Fawcett (1970)[35] also reported classifications of the $3s3p^2\ ^4P-3p^3\ ^4S^\circ$ lines in the range of 347 – 359 Å. Litzén and Redfors (1988)[70] provided wavelengths for this array with an uncertainty of ± 0.02 Å, which are given here. An extension of the analysis was made by Redfors and Litzén (1989)[77] with data in the range of 238 – 514 Å measured with an uncertainty of ± 0.02 Å using a laser-produced plasma. They added to the $3s3p^2-3p^3$ array the doublets $^2P-^2P^\circ$, $^2D-^2D^\circ$, and $^2D-^2P^\circ$, in the range of 366 – 514 Å. In addition they identified the $3s^23d-3s3p(^1P^\circ)3d$, $3s3p^2-3s3p(^3P^\circ)3d$, and $3s3p^2-3s3p(^1P^\circ)3d$ transitions in the ranges of 338 – 368 Å, 265 – 300 Å, and 238 – 280 Å. Redfors and Litzén also classified the $3s^23p\ ^2P^\circ-3s^23d\ ^2D$ lines in the range of 265 – 273 Å. Energy levels of all terms in the configurations $3s^23p$, $3s3p^2$, $3s^23d$, $3p^3$, and $3s3p3d$ have been taken from Ref. 77. The discrepancies between the observed wavelengths and the recalculated ones from the level values are as large as 0.03 – 0.11 Å for the blended lines at 342.982 Å and 265.988 Å and the perturbed line at 240.333 Å.

The transitions $3s^23p\ ^2P^\circ-3s^24d\ ^2D$ were identified by Edlén (1936)[24] in the range of ~87 Å. Fawcett *et al.* (1972)[38] identified the doublets $3p\ ^2P^\circ-4s\ ^2S$ and $3d\ ^2D-4f\ ^2F^\circ$ and the quartets $3s3p^2\ ^4P-3s3p4s\ ^4P^\circ$ and $3s3p3d\ ^4F^\circ-3s3p4f\ ^4G$ at 104 – 120 Å.

V XII (Mg sequence)

Ground state: $1s^22s^22p^63s^2\ ^1S_0$

Classifications of the $n=3-3$ transitions were made in a series of articles of Fawcett and Peacock (1967)[33], Fawcett (1970)[35], and Fawcett *et al.* (1972)[39] for the transitions between levels in the $3s^2$, $3s3p$, $3s3d$, $3p^2$, and $3p3d$ configurations. Litzén and Redfors (1987)[69] reobserved lines in the range of 246 – 610 Å in a laser-produced plasma and identified 42 lines, including the 19 lines of the earlier work. Wavelengths were measured with an uncertainty of ± 0.02 Å. Following this, Redfors (1988)[76] reported 10 lines of the $3p3d-3d^2$ array in the range of 273 – 383 Å. With a similar source Churilov *et al.* (1989)[13] augmented this to 19 lines. Wavelengths given to the third or to the second decimal place have uncertainties of ± 0.01 Å and ± 0.02 Å, respectively. Energy levels of the configurations with $n=3$ are taken from Ref. 69, with the addition of $3d^2$ levels from Ref. 13. We have interchanged the designations of the $3p3d\ ^3D^\circ_1$ and $^3P^\circ_1$ terms in Ref. 13, as required by the percentage compositions in Ref. 69. We have added 30 cm^{-1} to all the $3d^2$ levels given by Churilov *et al.* as a result of redetermining the $3d^2$ levels with their measured wavelengths and the $3p3d$ levels from Ref. 69. However, their classifications for the $3p3d\ ^3D^\circ_3-3d^2\ ^3P_2$ and $3p3d\ ^3P^\circ_1-3d^2\ ^3P_1$ lines at 301.46 Å and 302.080 Å are questionable, because these lines do not fit the level scheme. The spin-forbidden $3s^2\ ^1S_0-3s3p\ ^3P^\circ_1$ at 522.4 ± 0.2 Å was observed in a tokamak plasma by Finkenthal *et al.* (1982)[51].

Edlén (1936)[24] first identified triplet systems of the $3s3p-3s4s$, $3s3p-3snd$ $(n=4,5)$, and $3s3d-3snf$ $(n=4,5)$ transitions in the range of 61 – 107 Å, and also the $3s^2\ ^1S_0-3s4p\ ^1P^\circ_1$ resonance line at 76.307 Å. Fawcett *et al.* (1972)[38] identified the $3s3d\ ^1D_2-3s4f\ ^1F^\circ_3$ transition at 113.78 ± 0.02 Å, and Fawcett *et al.* (1972)[39] reported the $3s3p\ ^1P^\circ_1-3s4d\ ^1D_2$ and $3p^2\ ^1D_2-3s4f\ ^1F^\circ_3$ transitions at 87.363 ± 0.01 Å and 95.58 ± 0.015 Å. Fawcett *et al.* (1972)[38] also provided nine lines of the $3p3d-3p4f$ transitions in the range of 104 – 114 Å. Additional 35 lines below 105.74 Å are given by Fawcett *et al.*[45] for the triplets, $3s3p\ ^3P^\circ-3sns\ ^3S$ $(n=5-7)$, $3s3p\ ^3P^\circ-3snd\ ^3D$ $(n=5-8)$, and $3s3d\ ^3D_3-3snf\ ^3F^\circ_4$ $(n=6-8)$ and the singlets $3s^2\ ^1S_0-3snp\ ^1P^\circ_1$ $(n=5-10)$, $3s3p\ ^1P^\circ_1-3s4s\ ^1S_0$, $3s5d\ ^1D_2$ and also for the $3s3p-3p4p$ and $3p^2-3p4s,4d$ transitions.

V XIII (Na sequence)

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

The $3s-3p$ and $3p-3d$ lines in the range of 313 – 444 Å were identified by Fawcett and Peacock

(1967)[33] and remeasured by Fawcett *et al.* (1972)[39], except for $3p\ ^2P^o_{3/2}-3d\ ^2D_{3/2}$. An isoelectronic comparison of the measured wavelengths, including $3d-4f$ doublet, with Dirac-Fock calculations was made by Reader *et al.* (1987)[75] for Ar^{7+} to Xe^{43+}, and least squares adjusted wavelengths were derived. The overall uncertainty estimate is ±0.007 Å. We give these results and correct the level values with them.

Edlén (1936)[22] identified the transitions $3s-np$ ($n=4,5$), $3p-4s$, $3p-nd$ ($n=4,5$), and $3d-nf$ ($n=4,5$) in a vacuum spark discharge. Except for the $3d-4f$ doublet, Edlén's wavelengths are given here. The $3d-4p$ lines at ~118 Å and the $3d\ ^2D_{5/2}-5p\ ^2P^o_{3/2}$ line at 74.321±0.01 Å were identified by Fawcett *et al.* (1972)[38] and Fawcett *et al.* (1972)[39], respectively.

Identifications along Rydberg series have been taken from Fawcett *et al.*[45] for the $3p-ns$ ($n=6-11$), $3p-10d$, and $3d-nf$ ($n=10,11$) transitions and from Cohen and Behring (1976)[15] for the $3p-5s$, $3s-np$ ($n=6-11$), $3p-nd$ ($n=6-9,11$), and $3d-nf$ ($n=6-9$) transitions.

The inner-shell transitions $2p^63s\ ^2S_{1/2}-2p^53s^2\ ^2P^o_{3/2,1/2}$ at 24.517±0.005 Å and 24.202±0.005 Å were observed by Feldman and Cohen (1967)[48] with a low-inductance vacuum spark source.

V XIV (Ne sequence)

Ground state: $1s^22s^22p^6\ ^1S_0$

The $2p^6-2p^53s$ and $3d$ transitions were identified by Edlén and Tyrén (1936)[23] with lines at ~23 Å and ~21 Å in a vacuum spark discharge. The $2s^22p^6-2s2p^63p$ and $2p^6-2p^5nd$ ($n=3-5$), $4s$ lines in the range of 15.6−21.3 Å were observed with a low-inductance spark source by Feldman and Cohen (1967)[47], who measured wavelengths with an uncertainty of ±0.005 Å.

The $3s-3p$ and $3p-3d$ arrays were observed by Jupén and Litzén (1984)[59] and (1986)[60] in laser-produced plasmas. In the latter article, 21 lines above 328 Å were identified.

The $3p-4d$ transitions were first found by Kastner *et al.* (1975)[62] in the wavelength range of 70.5−71.6 Å and also reported by Fawcett *et al.* (1979)[43], together with the $3d-4f$ transitions in the range of 85.4−87.2 Å. Improved measurements were carried out by Jupén *et al.* (1987)[61], who identified 26 lines of the $n=3-4$ transitions, including the $2p^5(^2P^o_{3/2})3s\ (^3/_2,^1/_2)^o_2-2p^5(^2P^o_{3/2})4p\ ^2[^5/_2]_3$ and $2p^5(^2P^o_{1/2})3s\ (^1/_2,^1/_2)^o_1-2p^5(^2P^o_{1/2})4p\ ^2[^3/_2]_2$ lines at 65.330 Å and 65.571 Å. Their measurements are quoted. The wavelength uncertainty varies from ±0.005 to ±0.01 Å. The wavelength of 72.317 Å for the $2p^5(^2P^o_{1/2})3p\ ^2[^1/_2]_1-2p^5(^2P^o_{1/2})4d\ ^2[^3/_2]^o_2$ transition is apparently a misprint and should be 71.317 Å.

Jupén *et al.* (1987)[61] also derived the energy levels of the $2s^22p^53l$ and $2s^22p^54l$ configurations. We have adopted their level values except for the $2p^5(^2P^o_{3/2})3d\ ^2[^1/_2]^o_1$, $2p^5(^2P^o_{3/2,1/2})4f\ ^2[^5/_2]_2$, and $2p^5(^2P^o_{3/2})4f\ ^2[^3/_2]_2$. These levels have been modified to fit the the observed wavelengths. The identification of a blended line at 342.202 Å in Ref. 60 is questionable because it dose not fit the level scheme. Therefore, we have deleted it here.

V XV (F sequence)

Ground state: $1s^22s^22p^5\ ^2P^o_{3/2}$

Finkenthal *et al.* (1984)[52] identified the magnetic-dipole transition $2s^22p^5\ ^2P^o_{3/2}-^2P^o_{1/2}$ at 1719.4±1.7 Å in a tokamak plasma.

Fawcett (1971)[36], Doschek *et al.* (1974)[17], and Kaufman *et al.* (1982)[64] observed the $2s^22p^5\ ^2P^o-2s2p^6\ ^2S$ doublet in laser-produced plasmas. Wavelength values of 122.005 Å and 113.930 Å with an uncertainty of ±0.005 Å are taken from the measurements of Ref. 64.

Feldman *et al.* (1973)[49] reported the most extensive set of measurements of the arrays $2s2p^6-2s2p^53s$, $2p^5-2p^43s$ and $2p^5-2p^43d$ in the range of 19−23 Å, compared with the earlier works of Fawcett (1965)[30] and Cohen *et al.* (1968)[14]. We give the Feldman *et al.* results, which have an uncertainty of ±0.01 Å. Three additional lines at 19.91 Å, 19.45 Å, and 19.38 Å, belonging to the $2p^5-2p^43d$ array, in Ref. 14 have been excluded because these lines were not reobserved in Ref. 49.

V XVI (O sequence)

Ground state: $1s^22s^22p^4\ ^3P_2$

Finkenthal *et al.* (1984)[52] identified the magnetic-dipole transitions $2p^4\ ^3P_2-^3P_1$ and $^3P_1-^1S_0$ at 2042.7±0.8 Å (in air) and 529.9±0.2 Å, respectively, in a tokamak plasma.

Identifications of the triplet array $2s^22p^4\ ^3P-2s2p^5\ ^3P^o$ and the singlet $^1S-^1P^o$ and $^1D-^1P^o$ transitions were made by Fawcett (1971)[36] and Doschek *et al.* (1974)[17], comprising eight lines in the range of 108−141 Å. In addition, the line at 138.17±0.02 Å was identified by Fawcett *et al.* (1974)[41] as the $2s2p^5\ ^1P^o_1-2p^6\ ^1S_0$ transition. All the lines were remeasured by Kaufman *et al.* (1982)[64], as produced in a laser-produced plasma. They identified four spin-forbidden transitions: $2s^22p^4\ ^1D_2-2s2p^5\ ^3P^o_2$ at 156.060 Å, $^3P_{0,2}-^1P^o_1$ at 100.440 Å, 95.640 Å, and $2s2p^5\ ^3P^o_1-2p^6\ ^1S_0$ at 103.043 Å. The uncertainty of the wavelengths is ±0.005 Å. The observed levels of $2s^22p^4\ ^3P_1$ and $^1S_0$ agree with those from the above magnetic-dipole lines within the experimental uncertainties.

The $2p^4-2p^33s$ array was first identified by Goldsmith *et al.* (1971)[55], whose wavelengths were remeasured more accurately by Doschek *et al.* (1973)[16] with an uncertainty of ±0.01 Å. The wavelengths of Doschek *et al.* are adopted here, although most of the classifications are characterized as ambiguous. The line, $2p^4\ ^1D_2-2p^3(^2P^o)3s\ ^1P^o_1$, at 20.082 Å in Ref. 55 has been omitted, because it does not fit with the results quoted here.

Analysis of the $2p^4-2p^33d$ array was made by Goldsmith *et al.* (1971)[55], Fawcett (1971)[36], and Fawcett *et al.* (1974)[40]. They were reobserved with a laser-produced plasma source by Fawcett and Hayes (1975)[42]. We adopt the latter results. Additional identifications were made by Bromage and Fawcett (1977)[9] of the $^3P_1-(^2P^o)^3D^o_1$ and $^1D_2-(^2P^o)^1F^o_3$ lines at 18.12 Å and 18.265 Å.

V XVII (N sequence)

Ground state: $1s^22s^22p^3\ ^4S^o_{3/2}$

The $2s^22p^3-2s2p^4$ array was found in the range of 102 − 160 Å by Fawcett (1971)[36], by Fawcett *et al.* (1974)[41], and by Doschek *et al.* (1974)[17], who in addition assigned six new lines to this array. Feldman *et al.* (1975)[50] observed the transition $^2D^o_{3/2}-^2S_{1/2}$ at 113.78 ± 0.02 Å. Fawcett *et al.* (1974)[41] also identified the doublets $2s2p^4\ ^2D,^2P-2p^5\ ^2P^o$. The $^2P_{1/2}-^2P^o_{1/2}$ line at 151.69 Å was revised as 165.32 ± 0.015 Å by Fawcett and Hayes (1975)[42]. Doschek *et al.* (1975)[19] identified the $^2D_{3/2}-^2P^o_{3/2}$ line at 129.94 ± 0.015 Å. New observations of the above transition arrays were made by Kaufman *et al.* (1982)[65] in the range of 96 − 168 Å, using a laser-produced plasma. Improved wavelengths are reported for the 22 allowed lines observed previously. They added several $2s2p^4-2p^5$ lines, $^2P_{3/2}-^2P^o_{1/2}$ at 151.656 Å and $^2S_{1/2}-^2P^o_{3/2}$ at 157.070 Å, as well as the spin-forbidden $2s^22p^3\ ^4S^o_{3/2}-2s2p^4\ ^2P_{3/2}$ line at 96.270 Å. Their wavelength uncertainty is ± 0.005 Å. We give these results.

The $2p^3-2p^23d$ transitions at ~17 Å were observed by Fawcett (1971)[36], Fawcett *et al.* (1974)[40], and Fawcett and Hayes (1975)[42] with laser-produced plasmas. The $2p^3\ ^2P^o_{3/2}-2p^2(^3P)3d\ ^2D_{5/2}$ line at 17.644 Å has been omitted because of the inconsistency with the $2p^3\ ^2D^o_{5/2}-2p^2(^3P)3d\ ^2D_{5/2}$ line at 17.373 Å.

V XVIII (C sequence)

Ground state: $1s^22s^22p^2\ ^3P_0$

Finkenthal *et al.* (1984)[52] identified the magnetic-dipole transitions $2s^22p^2\ ^3P_2-^1D_2$ and $^3P_1-^1S_0$ at 1078.2 ± 1.4 Å and 434.2 ± 0.2 Å, respectively, in a tokamak plasma. The latter line tentatively identified is 1.4 Å longer than wavelength recalculated from the levels.

The $2s^22p^2-2s2p^3$ array was observed in the range of 111 − 177 Å by Fawcett *et al.* (1974)[41] and by Feldman *et al.* (1975)[50] and Fawcett and Hayes (1975)[42]. Fawcett and Hayes also first identified three lines of the $2s2p^3\ ^3D^o-2p^4\ ^3P$ triplet in the range of 127 − 139 Å. Measurements in the range of 136 − 217 Å using a laser-produced plasma was reported by Fawcett *et al.* (1980)[44], who gave identifications for 13 transitions including the $2s^22p^2\ ^3P-2s2p^3\ ^3P^o$ and $2s2p^3\ ^3P^o-2p^4\ ^3P$. Improved measurements were made by Sugar *et al.* (1982)[79] for 16 allowed lines of these arrays and spin-forbidden transitions. The $2s^22p^2\ ^3P_2-2s2p^3\ ^1D^o_2$ line at 119.015 Å and the $^3P_1-^1P^o_1$ at 102.410 Å were newly identified. We give their results with an uncertainty of ± 0.005 Å. Wavelengths with one or two decimal places are taken from Refs. 41, 42, and 44. Designations of the $2s2p^3\ ^3D^o_1-2p^4\ ^3P_0$ transition at 127.27 Å and the $^3P^o_1-^3P_0$ at 147.30 Å are revised as the $2s2p^3\ ^3D^o_1-2p^4\ ^3P_1$ and $^3P^o_0-^3P_1$, respectively, to fit with level scheme adopted.

The $2s^22p^2-2s^22p3s$, $3d$ and $2s2p^3-2s2p^23s$, $3d$ transitions were reported by Goldsmith *et al.* (1972)[57] in the range of 16 − 18 Å observed with a vacuum spark. Their measurement uncertainty is ± 0.005 Å. The $2s2p^3\ ^5S^o_2$ level of 366 868 cm^{-1} is adopted from predicted values along an isoelectronic sequence by Edlén (1985)[86]. An analysis of the $2s^22p^2-2s^22p3d$ transitions was made by Bromage and Fawcett (1977)[10] with the spectrum measured by Fawcett *et al.* (1974)[40] and Fawcett and Hayes (1975)[42]. They confirmed the classifications $^3P_2-^3D^o_3$ at 16.378 Å and $^1D_2-^1F^o_3$ at 16.460 Å in Refs. 40 and 42, and also identified the $^1S_0-^1P^o_1$ and $^1D_2-^3F^o_2$ lines at 16.787 Å and 16.914 Å, respectively. The classifications of Goldsmith *et al.* (1972)[57] for the lines at 16.423 Å and 16.816 Å have been omitted. They contradict those of Fawcett and Hayes (1975)[42] and Bromage and Fawcett (1977)[10].

V XIX (B sequence)

Ground state: $1s^22s^22p\ ^2P^o_{1/2}$

The magnetic-dipole transition $^2P^o_{1/2}-^2P^o_{3/2}$ at 1457.6 ± 0.9 Å within the ground $2s^22p$ configuration was observed in a tokamak plasma by Finkenthal *et al.* (1984)[52].

Fawcett *et al.* (1974)[41] identified seven of the $2s^22p-2s2p^2$ transitions in the range of 124 − 186 Å. Their identification of $^2P^o-^2D$ was revised by Fawcett and Hayes (1975)[42], who also identified the three lines of the $2s2p^2\ ^4P-2p^3\ ^4S^o$ quartet in the range of 143 − 158 Å using a laser-produced plasma. The uncertainty of wavelengths quoted here is ± 0.015 Å. The $2s2p^2-2p^3$ doublet was measured by Fawcett *et al.* (1980)[44] with an uncertainty of ± 0.05 Å in a similar light source.

Fawcett *et al.* (1974)[40] and Fawcett and Hayes (1975)[42] identified the $2s2p^2-2s2p3d$, $2s^22p-2s^23d$, and $2s^22p-2s2p3p$ transitions in the range of 14 − 16 Å in a laser-produced plasma. The uncertainty of the wavelengths is ± 0.007 Å except for the blended line at 15.63 ± 0.01 Å.

V XX (Be sequence)

Ground state: $1s^22s^2\ ^1S_0$

The $2s2p-2p^2$ transitions, including the spin-forbidden $^3P^o_2-^1D_2$ transition at 164.59 ± 0.05 Å, were identified by Fawcett *et al.* (1980)[44] in the range of

164 − 282 Å using a laser-produced plasma. The $2s^2\ ^1S_0 - 2s2p\ ^1P^o_1$ resonance transition at 159.355 Å has been taken from the smoothed wavelengths of Edlén (1981)[27].

The $n = 2-3$ transition arrays in the range of 14 − 16 Å were measured by Fawcett *et al.* (1974)[40], Fawcett and Hayes (1975)[42], Boiko *et al.* (1977)[7], and Boiko *et al.* (1978)[8] in laser-produced plasmas. Bromage *et al.* (1978)[11] reported their measurements with no uncertainty estimate for the $2s^2 - 2snp$, $2s2p - 2pnp$, $2s2p - 2snd$, and $2p^2 - 2pnd$ transitions with $n = 3$ and 4 in the ranges of 14 − 16 Å and 10 − 12 Å, respectively. We adopted their results except for the $2s2p\ ^3P^o_2 - 2s3d\ ^3D_3$ line at 14.976 ± 0.007 Å taken from Ref. 40. The difference between wavelengths in Refs. 11 and 40 is ± 0.02 Å at most.

V XXI (Li sequence)

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

Fawcett *et al.* (1980)[44] identified the resonance transition $2s\ ^2S_{1/2} - 2p\ ^2P^o_{3/2}$ at 240.37 ± 0.05 Å in a laser-produced plasma, and Goldsmith *et al.* (1972)[56] reported the $2s - 3p$, $4p$ and $2p - 3s$, $3d$, $4d$ transitions. Extensive measurements along Rydberg series were made by Aglitskii *et al.* (1975)[3] in a laser-produced plasma. They identified the $2s - np$ $(n = 3-7)$, $2p - 3s$, and $2p - nd$ $(n = 3-8)$ transitions in the range of 8.5 − 15 Å with an uncertainty of ± 0.003 Å. Many of the doublets with $n = 4$ are identified with blended lines.

Identifications of transitions from doubly excited levels were reported by Aglitskii *et al.* (1974)[1], (1974)[2] and Boiko *et al.* (1978)[8] for $1s^22p - 1s2p^2$ and $1s^22s - 1s2s2p$. The lines at 2.3992 Å and 2.4140 Å were identified as the blends of three lines of the transitions $1s^22p\ ^2P^o - 1s2p^2\ ^2P$ and of seven lines of $1s^22p\ ^2P^o - 1s2p^2\ ^4P$ and $1s^22s\ ^2S - 1s(^2S)2s2p(^3P^o)\ ^4P^o$, respectively. The uncertainty of the wavelengths is ± 0.0005 Å. Using an electron-beam trap technique, Beiersdorfer *et al.* (1991)[85] resolved 10 lines, one of which at 2.3912 Å is a blend of two lines. The wavelength uncertainties range from ± 0.0001 Å to ± 0.0003 Å. Their results are given here.

V XXII (He sequence)

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

Calculated energy levels of the configurations $1snl$ with $l = s$, p, and d have been taken from Drake (1985)[20] and (1988)[21] for $n = 2-3$. For the levels with $n = 4-5$, calculations of Vainshtein and Safronova (1985)[80] have been tabulated after adjusting them by about 1300 cm^{-1} to the ground state binding energy obtained by Drake. This value is the arithmetic mean value of the difference between the levels given in the above articles for $3s$, $3p$, and $3d$. Wavelengths are calculated from the energy levels by the Ritz combination principle.

Aglitskii *et al.* (1974)[1] and (1974)[2] identified the resonance transitions $1s^2\ ^1S_0 - 1s2p\ ^{3,1}P^o_1$ at 2.3939 ± 0.0005 Å and 2.3823 ± 0.0005 Å in a laser-produced plasma. Morita and Fujita (1985)[74] and Aglitsky *et al.* (1988)[4] remeasured the latter line at 2.3820 ± 0.0004 Å and 2.38175 ± 0.00025 Å, respectively, in vacuum sparks. Beiersdorfer *et al.* (1989)[6] measured the $1s^2\ ^1S_0 - 1snp\ ^1P^o_1$ $(n = 2,3)$ transitions at 2.38190 ± 0.0001 Å and 2.02627 ± 0.00012 Å in a tokamak plasma. In a recent measurement with an electron-beam ion trap technique, Beiersdorfer *et al.* (1991)[85] identified three new intercombination and forbidden lines from the $1s2p\ ^3P^o_{2,0}$ and $1s2s\ ^3S_1$ levels to the $1s^2\ ^1S_0$ ground state at 2.38943 ± 0.00010 Å, 2.39338 ± 0.00010 Å, and 2.40564 ± 0.0014 Å. The line from level $1s2p\ ^3P^o_0$ is blended with that from level $1s2p\ ^3P^o_1$.

We adopt an uncertainty of 5 parts in 10^5, representing the difference between the calculated values of Drake and those determined experimentally by Beiersdorfer *et al.*

V XXIII (H sequence)

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

No observations of this spectrum have been reported. We have tabulated the wavelengths calculated from the theoretical energy levels of Johnson and Soff (1985)[58] for the $n = 2$ shell whose estimated uncertainty is ± 10 cm^{-1}. Their energy differences are in close agreement with those of Mohr (1983)[72]. The levels for $n = 3-5$ have been calculated by Erickson (1977)[29]. We use his values for the binding energies subtracted from the binding energy of the ground state obtained by Johnson and Soff. Our estimate of the error in the value of $3s$ is ± 30 cm^{-1}, assuming the Lamb shift scales as $1/n^3$ and Erickson's error for $2s$ is 100 cm^{-1}.

Transition probabilities and oscillator strengths were obtained by scaling the data tabulated for hydrogen spectra by Wiese *et al.* (1966)[83]. The scaling was actually performed for the line strengths S, which for a hydrogen-like ion of nuclear charge Z are reduced according to $S_Z = Z^{-2}S_H$, so that

$$S_{\mathrm{V\,XXIII}} = S_H(23)^{-2} = S_H/529.$$

The f and A values were then obtained from the usual numerical conversion formulas, given for example in Ref. 71. For these conversions the very accurate wavelengths listed in the first column of the V XXIII table were used, in which relativistic and QED effects in the energies were taken into account. Relativistic effects in the line strengths are only of the order of 1 − 3% for V XXIII, according to the work by Younger and Weiss (1975)[84], and have been neglected.

3. Explanation of Tables of Spectroscopic Data

V VI, V XXIII, etc.

According to spectroscopic convention, V I indicates the first spectrum, i.e., the spectrum of the neutral atom; V II denotes the second spectrum, belonging to the singly ionized atom; and so on.

H sequence, C sequence, etc.

Indicates that the respective V ion has the same number of electrons as neutral hydrogen, neutral carbon, etc.

IP

Principal ionization energy of the tabulated ions in cm^{-1} (eV).

λ(Å)

Wavelength of listed spectral lines in Angstrom units (10^{-8}cm).

C,T,P

Superscripts to the right of a wavelength value have the following meanings:

- ^{C} wavelength calculated from energy level data using the Ritz combination principle.
- ^{T} wavelength tentatively identified.
- ^{P} wavelength predicted along a isoelectronic sequence.

Classification

Standard spectroscopic designation for lower (first) and upper levels generating the spectral lines; electronic configurations followed by the term in *LS*-, *jj*- or *jK*-coupling notation. The superscript "°" on the term indicates odd parity. A term enclosed in parentheses refers to an intermediate state. Where only the total angular momentum *J* is given in successive listings, the preceding configuration and term labels apply.

Energy Levels

Level values (in cm^{-1}) for lower (first) and upper (second) level of the transition. A symbol ? after the level value indicates level was derived from a tentatively classified line. Theoretical levels are given in square brackets. The symbol $+x$ follows a predicted energy level value and denotes the error in the estimate. All levels with $+x$ in the same ion have the same systematic error.

Int.

Approximate intensity of a spectral line, generally visually estimated from the blackness (or density) of the line on photographic plates. In case where its *gf*-value is available, the intensity data is sometimes omitted. The symbol "bl" following the intensity denotes a blend of lines.

gf

This column lists the product of the statistical weight of lower level and the absorption oscillator strength or *f*-value for electric dipole transitions. 1.23 − 1 means 1.23×10^{-1}. *f*-values are not given for magnetic-dipole (M1) transitions.

A

Radiative transition probability in s^{-1}. 1.23 + 11 means 1.23×10^{11}.

Acc

Accuracy estimate for the oscillator strength and transition probability data, taken from the NIST reference tables on atomic transition probabilities (see, e.g. the introduction of Ref. 11 for detailed explanation). The accuracy is indicated by the following letter symbols, which are identical with the notation used in the NIST reference book:

- A for uncertainties within 3%.
- B for uncertainties within 10%.
- C for uncertainties within 25%.
- D for uncertainties within 50%.
- E for uncertainties greater than 50%.

References

Reference sources for the data. The numbers are keyed to the bibliographic listing following the tables. When several references are listed, they are distinguished by superscripts on the numbers as follows:

- ° reference from which the adopted wavelength value is taken.
- * reference containing the adopted oscillator strength and/or the transition probability.
- $^{\Delta}$ reference from which the estimated intensity is taken.

4. Spectroscopic Data for V VI through V XXIII

V VI (Ar sequence) Ionization Energy = 1 033 400 cm^{-1} (128.13 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
1629.786	$3s^23p^5(^2P^\circ_{1/2})4s$	$^2[1/2]^\circ_0$	$3s^23p^5(^2P^\circ)4p$	$^3D_1$	553 820.1	615 177.8	6				28
1590.506	$3s^23p^5(^2P^\circ_{1/2})4s$	$^2[1/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^1P_1$	557 636.1	620 509.2	9				28
1584.942	$3s^23p^5(^2P^\circ_{3/2})4s$	$^2[3/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^3D_2$	549 298.8	612 392.8	10				28
1517.931		1		1	549 298.8	615 177.8	9				28
1515.020		2		3	546 284.0	612 289.7	12				28
1512.655		2		2	546 284.0	612 392.8	9				28
1451.517		2		1	546 284.0	615 177.8	6				28
1536.373	$3s^23p^5(^2P^\circ_{1/2})4s$	$^2[1/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	557 636.1	622 724.5	10				28
1516.104	$3s^23p^5(^2P^\circ_{1/2})4s$	$^2[1/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^3P_1$	557 636.1	623 594.5	8				28
1433.189		0		1	553 820.1	623 594.5	5				28
1466.460	$3s^23p^5(^2P^\circ_{3/2})4s$	$^2[3/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^3P_2$	549 298.8	617 490.0	7				28
1404.376		2		2	546 284.0	617 490.0	10bl				28
1380.105		1		0	549 298.8	621 757.1	5				28
1293.483		2		1	546 284.0	623 594.5	4				28
1460.991	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_2$	$3s^23p^5(^2P^\circ_{3/2})4f$	$^2[3/2]_2$	709 747.4	778 194.1	1				28
1432.593	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_2$	$3s^23p^5(^2P^\circ_{3/2})4f$	$^2[5/2]_3$	709 747.4	779 550.9	2				28
1426.335	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[5/2]^\circ_2$	$3s^23p^5(^2P^\circ_{3/2})4f$	$^2[7/2]_3$	713 742.3	783 852.1	2				28
1425.525	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[1/2]^\circ_1$	$3s^23p^5(^2P^\circ_{3/2})4f$	$^2[3/2]_2$	708 044.6	778 194.1	2				28
1423.100		0		1	707 280.3	777 549.4	3				28
1416.416	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[7/2]^\circ_4$	$3s^23p^5(^2P^\circ_{3/2})4f$	$^2[9/2]_5$	710 695.2	781 295.9	5				28
1410.054		3		4	711 426.2	782 345.4	3				28
1408.381	$3s^23p^5(^2P^\circ_{1/2})4d$	$^2[5/2]^\circ_3$	$3s^23p^5(^2P^\circ_{1/2})4f$	$^2[7/2]_4$	720 836.0	791 839.6	3				28
1361.923	$3s^23p^5(^2P^\circ_{3/2})4s$	$^2[3/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	549 298.8	622 724.5	3				28
1334.039	$3s^23p^5(^2P^\circ)4p$	$^1S_0$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_1$	641 800.3	716 760.4	1				28
1225.178	$3s^23p^5(^2P^\circ)4p$	$^1S_0$	$3s^23p^5(^2P^\circ_{1/2})4d$	$^2[3/2]^\circ_1$	641 800.3	723 421.6	3				28
1194.950	$3s^23p^5(^2P^\circ)4p$	$^3P_1$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[1/2]^\circ_0$	623 594.5	707 280.3	0				28
1184.130		1		1	623 594.5	708 044.6	0				28
1104.300		2		1	617 490.0	708 044.6	1				28
1188.159	$3s^23p^5(^2P^\circ_{1/2})4s$	$^2[1/2]^\circ_1$	$3s^23p^5(^2P^\circ)4p$	$^1S_0$	557 636.1	641 800.3	9				28
1085.742	$3s^23p^5(^2P^\circ)4p$	$^3D_1$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[1/2]^\circ_0$	615 177.8	707 280.3	1				28
1083.917	$3s^23p^5(^2P^\circ)4p$	$^3P_2$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_2$	617 490.0	709 747.4	2				28
1052.591		0		1	621 757.1	716 760.4	0				28
1057.438	$3s^23p^5(^2P^\circ)4p$	$^3D_1$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_2$	615 177.8	709 747.4	0				28
984.419		1		1	615 177.8	716 760.4	0				28
958.156		2		1	612 392.8	716 760.4	0				28
1038.953	$3s^23p^5(^2P^\circ)4p$	$^1P_1$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_1$	620 509.2	716 760.4	0				28
1029.044	$3s^23p^5(^2P^\circ)4p$	$^3P_2$	$3s^23p^5(^2P^\circ_{3/2})4d$	$^2[5/2]^\circ_3$	617 490.0	714 667.9	5				28
1027.219	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	$3s^23p^5(^2P^\circ_{1/2})4d$	$^2[5/2]^\circ_2$	622 724.5	720 074.9	0				28
1019.249		2		3	622 724.5	720 836.0	5				28

V VI (Ar sequence) Ionization Energy = 1 033 400 cm^{-1} (128.13 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
1024.663	$3s^23p^5(^2P^o)4p$	$^3P_1$	$3s^23p^5(^2P^o_{1/2})4d$	$^2[3/2]^o_2$	623 594.5	721 187.6	4				28
1001.714		1		1	623 594.5	723 421.6	0				28
983.632		0		1	621 757.1	723 421.6	0				28
964.341		2		2	617 490.0	721 187.6	0				28
1016.204	$3s^23p^5(^2P^o)4p$	$^3D_3$	$3s^23p^5(^2P^o_{3/2})4d$	$^2[7/2]^o_4$	612 289.7	710 695.2	7				28
1009.758		2		3	612 392.8	711 426.2	5				28
1008.709		3		3	612 289.7	711 426.2	0				28
1014.565	$3s^23p^5(^2P^o)4p$	$^3D_1$	$3s^23p^5(^2P^o_{3/2})4d$	$^2[5/2]^o_2$	615 177.8	713 742.3	4				28
986.681		2		2	612 392.8	713 742.3	1				28
976.767		3		3	612 289.7	714 667.9	1				28
1004.361	$3s^23p^5(^2P^o)4p$	$^1P_1$	$3s^23p^5(^2P^o_{1/2})4d$	$^2[5/2]^o_2$	620 509.2	720 074.9	4				28
971.700	$3s^23p^5(^2P^o)4p$	$^1P_1$	$3s^23p^5(^2P^o_{1/2})4d$	$^2[3/2]^o_1$	620 509.2	723 421.6	0				28
958.716	$3s^23p^5(^2P^o)4p$	$^3S_1$	$3s^23p^5(^2P^o_{3/2})4d$	$^2[1/2]^o_0$	602 974.3	707 280.3	0				28
951.753		1		1	602 974.3	708 044.6	2				28
936.557	$3s^23p^5(^2P^o)4p$	$^3S_1$	$3s^23p^5(^2P^o_{3/2})4d$	$^2[3/2]^o_2$	602 974.3	709 747.4	3				28
826.458	$3s^23p^5(^2P^o)3d$	$^1P^o_1$	$3s3p^63d$	$^1D_2$	445 435.6	566 433.0	0				28
640.135	$3s^23p^5(^2P^o)4p$	$^1D_2$	$3s^23p^5(^2P^o_{1/2})5s$	$^2[1/2]^o_1$	622 724.5	778 944.0	1				28
632.509	$3s^23p^5(^2P^o)4p$	$^3D_2$	$3s^23p^5(^2P^o_{3/2})5s$	$^2[3/2]^o_2$	612 392.8	770 494.5	0				28
632.084		3		2	612 289.7	770 494.5	3				28
627.627		2		1	612 392.8	771 723.1	2				28
631.164	$3s^23p^5(^2P^o)4p$	$^1P_1$	$3s^23p^5(^2P^o_{1/2})5s$	$^2[1/2]^o_1$	620 509.2	778 944.0	0				28
596.947	$3s^23p^5(^2P^o)4p$	$^3S_1$	$3s^23p^5(^2P^o_{3/2})5s$	$^2[3/2]^o_2$	602 974.3	770 494.5	1				28
581.214	$3s^23p^5(^2P^o)3d$	$^1P^o_1$	$3s^23p^5(^2P^o)4p$	$^3P_2$	445 435.6	617 490.0	0				28
561.297		1		1	445 435.6	623 594.5	0				28
571.190	$3s^23p^5(^2P^o)3d$	$^1P^o_1$	$3s^23p^5(^2P^o)4p$	$^1P_1$	445 435.6	620 509.2	0				28
509.260	$3s^23p^5(^2P^o)3d$	$^1P^o_1$	$3s^23p^5(^2P^o)4p$	$^1S_0$	445 435.6	641 800.3	8				28
500.644	$3s^23p^5(^2P^o)3d$	$^1F^o_3$	$3s3p^63d$	$^3D_3$	350 644.5	550 384.6	3				28
496.985	$3s^23p^5(^2P^o)3d$	$^3D^o_2$	$3s3p^63d$	$^3D_1$	348 325.3	549 538.0	1				28
496.180		2		2	348 325.3	549 863.6	4				28
495.940		1		1	347 899.9	549 538.0	3				28
495.138		1		2	347 899.9	549 863.6	2				28
494.909		2		3	348 325.3	550 384.6	2				28
489.360		3		2	345 516.5	549 863.6	0				28
488.120		3		3	345 516.5	550 384.6	6				28
488.462	$3s^23p^5(^2P^o)3d$	$^1D^o_2$	$3s3p^63d$	$^3D_2$	345 139.4	549 863.6	1				28
487.217		2		3	345 139.4	550 384.6	0				28
463.418	$3s^23p^5(^2P^o)3d$	$^1F^o_3$	$3s3p^63d$	$^1D_2$	350 644.5	566 433.0	6				28
458.487	$3s^23p^5(^2P^o)3d$	$^3D^o_2$	$3s3p^63d$	$^1D_2$	348 325.3	566 433.0	3				28
452.660		3		2	345 516.5	566 433.0	3				28
451.890	$3s^23p^5(^2P^o)3d$	$^1D^o_2$	$3s3p^63d$	$^1D_2$	345 139.4	566 433.0	7				28
449.795	$3s^23p^5(^2P^o)3d$	$^3F^o_2$	$3s3p^63d$	$^3D_1$	327 214.9	549 538.0	8				28
449.129		2		2	327 214.9	549 863.6	0				28
444.634		3		2	324 958.0	549 863.6	9				28
443.601		3		3	324 958.0	550 384.6	0				28
439.344		4		3	322 773.6	550 384.6	10				28

V VI (Ar sequence) Ionization Energy = 1 033 400 cm^{-1} (128.13 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
420.940	$3s^23p^5(^2P^\circ)3d$	$^3P^\circ_2$	$3s3p^63d$	$^3D_1$	311 977.9	549 538.0	0				28
420.370		2		2	311 977.9	549 863.6	5				28
419.458		2		3	311 977.9	550 384.6	8				28
416.418		1		1	309 394.8	549 538.0	4				28
415.861		1		2	309 394.8	549 863.6	7				28
414.273		0		1	308 149.8	549 538.0	6				28
418.041	$3s^23p^5(^2P^\circ)3d$	$^3F^\circ_2$	$3s3p^63d$	$^1D_2$	327 214.9	566 433.0	0				28
392.990	$3s^23p^5(^2P^\circ)3d$	$^3P^\circ_2$	$3s3p^63d$	$^1D_2$	311 977.9	566 433.0	0				28
382.185	$3s^23p^5(^2P^\circ)3d$	$^1F^\circ_3$	$3s^23p^5(^2P^\circ)4p$	$^3D_3$	350 644.5	612 289.7	1				28
382.049		3		2	350 644.5	612 392.8	4				28
378.834	$3s^23p^5(^2P^\circ)3d$	$^3D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3D_3$	348 325.3	612 289.7	0				28
378.687		2		2	348 325.3	612 392.8	3				28
378.081		1		2	347 899.9	612 392.8	2				28
374.851		3		3	345 516.5	612 289.7	5				28
374.747		2		1	348 325.3	615 177.8	1				28
374.705		3		2	345 516.5	612 392.8	0				28
371.523	$3s^23p^5(^2P^\circ)3d$	$^3D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3P_2$	348 325.3	617 490.0	3				28
370.936		1		2	347 899.9	617 490.0	0				28
367.683		3		2	345 516.5	617 490.0	9				28
365.154		1		0	347 899.9	621 757.1	4				28
363.285		2		1	348 325.3	623 594.5	8				28
362.717		1		1	347 899.9	623 594.5	2				28
370.314	$3s^23p^5(^2P^\circ)3d$	$^1D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3D_1$	345 139.4	615 177.8	2				28
367.543	$3s^23p^5(^2P^\circ)3d$	$^1F^\circ_3$	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	350 644.5	622 724.5	9				28
367.404	$3s^23p^5(^2P^\circ)3d$	$^3D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^1P_1$	348 325.3	620 509.2	0				28
367.173	$3s^23p^5(^2P^\circ)3d$	$^1D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3P_2$	345 139.4	617 490.0	0				28
363.153	$3s^23p^5(^2P^\circ)3d$	$^1D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^1P_1$	345 139.4	620 509.2	8				28
360.741	$3s^23p^5(^2P^\circ)3d$	$^3D^\circ_3$	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	345 516.5	622 724.5	1				28
360.250	$3s^23p^5(^2P^\circ)3d$	$^1D^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	345 139.4	622 724.5	1				28
350.781	$3s^23p^5(^2P^\circ)3d$	$^3F^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3D_3$	327 214.9	612 289.7	1				28
350.659		2		2	327 214.9	612 392.8	3				28
348.024		3		3	324 958.0	612 289.7	4				28
347.911		3		2	324 958.0	612 392.8	10				28
347.265		2		1	327 214.9	615 177.8	8				28
345.405		4		3	322 773.6	612 289.7	11				28
343.646	$3s^23p^5(^2P^\circ)3d$	$^3P^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3S_1$	311 977.9	602 974.3	9				28
340.622		1		1	309 394.8	602 974.3	7				28
339.187		0		1	308 149.8	602 974.3	6				28
340.953	$3s^23p^5(^2P^\circ)3d$	$^3F^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^1P_1$	327 214.9	620 509.2	4				28
338.392	$3s^23p^5(^2P^\circ)3d$	$^3F^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^1D_2$	327 214.9	622 724.5	1				28
335.831		3		2	324 958.0	622 724.5	2				28
332.984	$3s^23p^5(^2P^\circ)3d$	$^3P^\circ_2$	$3s^23p^5(^2P^\circ)4p$	$^3D_3$	311 977.9	612 289.7	0				28
332.878		2		2	311 977.9	612 392.8	0				28
330.027		1		2	309 394.8	612 392.8	0				28
329.810		2		1	311 977.9	615 177.8	1				28
325.697		0		1	308 149.8	615 177.8	0				28

V VI (Ar sequence) Ionization Energy = 1 033 400 cm^{-1} (128.13 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
327.322	$3s^23p^5(^2P^o)3d$	$^3P^o_2$	$3s^23p^5(^2P^o)4p$	$^3P_2$	311 977.9	617 490.0	5				28
324.575		1		2	309 394.8	617 490.0	3				28
320.915		2		1	311 977.9	623 594.5	4				28
320.134		1		0	309 394.8	621 757.1	3				28
318.265		1		1	309 394.8	623 594.5	2				28
317.006		0		1	308 149.8	623 594.5	0				28
324.105	$3s^23p^5(^2P^o)3d$	$^3P^o_2$	$3s^23p^5(^2P^o)4p$	$^1P_1$	311 977.9	620 509.2	0				28
321.425		1		1	309 394.8	620 509.2	0				28
323.209	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o)3d$	$^3P^o_1$	0	309 394.8	9				28
321.810	$3s^23p^5(^2P^o)3d$	$^3P^o_2$	$3s^23p^5(^2P^o)4p$	$^1D_2$	311 977.9	622 724.5	3				28
319.149					309 394.8	622 724.5	1				28
287.440	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o)3d$	$^3D^o_1$	0	347 899.9	11	2.1−3	5.7+7	E	28°,71*
231.893	$3s^23p^5(^2P^o)3d$	$^3D^o_2$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^5/_2]_3$	348 325.3	779 550.9	0				28
230.398		3		3	345 516.5	779 550.9	1				28
231.646	$3s^23p^5(^2P^o)3d$	$^1F^o_3$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^9/_2]_4$	350 644.5	782 345.4	1				28
230.841	$3s^23p^5(^2P^o)3d$	$^1F^o_3$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^7/_2]_3$	350 644.5	783 852.1	4				28
229.856		3		4	350 644.5	785 705.4	1				28
229.606	$3s^23p^5(^2P^o)3d$	$^3D^o_2$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^7/_2]_3$	348 325.3	783 852.1	1				28
227.172		3		4	345 516.5	785 705.4	5				28
226.656	$3s^23p^5(^2P^o)3d$	$^1F^o_3$	$3s^23p^5(^2P^o_{1/2})4f$	$^2[^7/_2]_4$	350 644.5	791 839.6	6				28°,81
224.500	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o)3d$	$^1P^o_1$	0	445 435.6	15	3.30	1.46+11	C+	28°,46,53, 54,71*
224.052	$3s^23p^5(^2P^o)3d$	$^3D^o_3$	$3s^23p^5(^2P^o_{1/2})4f$	$^2[^7/_2]_4$	345 516.5	791 839.6	0				28°,81
218.994	$3s^23p^5(^2P^o)3d$	$^3F^o_2$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^7/_2]_3$	327 214.9	783 852.1	7				28°,81
218.636	$3s^23p^5(^2P^o)3d$	$^3F^o_3$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^9/_2]_4$	324 958.0	782 345.4	9				28°,81
218.091		4		5	322 773.6	781 295.9	10				28°,81
217.597		4		4	322 773.6	782 345.4	0				28
214.495	$3s^23p^5(^2P^o)3d$	$^3P^o_2$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^3/_2]_2$	311 977.9	778 194.1	2				28°,81
213.604		1		1	309 394.8	777 549.4	3				28°,81
213.313		1		2	309 394.8	778 194.1	7				28°,81
213.044		0		1	308 149.8	777 549.4	6				28°,81
213.871	$3s^23p^5(^2P^o)3d$	$^3P^o_2$	$3s^23p^5(^2P^o_{3/2})4f$	$^2[^5/_2]_3$	311 977.9	779 550.9	8				28°,81
182.050	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{3/2})4s$	$^2[^3/_2]^o_1$	0	549 298.8	10	1.1−1	7.4+9	D	28°,66,71*
179.330	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{1/2})4s$	$^2[^1/_2]^o_1$	0	557 636.1	13	3.1−1	2.1+10	D	28°,66,71*
141.238	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{3/2})4d$	$^2[^1/_2]^o_1$	0	708 044.6	0				28
139.518	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{3/2})4d$	$^2[^3/_2]^o_1$	0	716 760.4	9				5,28°
138.235	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{1/2})4d$	$^2[^3/_2]^o_1$	0	723 421.6	8				5,28°
129.580	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{3/2})5s$	$^2[^3/_2]^o_1$	0	771 723.1	4				28°,66
128.379	$3s^23p^6$	$^1S_0$	$3s^23p^5(^2P^o_{1/2})5s$	$^2[^1/_2]^o_1$	0	778 944.0	3				28°,66
118.767	$3s^23p^6$	$^1S_0$	$3s3p^64p$	$^3P^o_1$	0	841 980	8				63
117.762	$3s^23p^6$	$^1S_0$	$3s3p^64p$	$^1P^o_1$	0	849 170	8				63

V VI (Ar sequence) Ionization Energy = 1 033 400 cm^{-1} (128.13 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
98.319	$3s^23p^6$	$^1S_0$	$3s3p^65p$	$^3P^o_1$	0	1 017 100	4				63
97.932	$3s^23p^6$	$^1S_0$	$3s3p^65p$	$^1P^o_1$	0	1 021 120	4				63
90.700	$3s^23p^6$	$^1S_0$	$3s3p^66p$	$^1P^o_1$	0	1 102 540	6				63
87.106	$3s^23p^6$	$^1S_0$	$3s3p^67p$	$^1P^o_1$	0	1 148 030	3				63
85.071	$3s^23p^6$	$^1S_0$	$3s3p^68p$	$^1P^o_1$	0	1 175 490	1				63

V VII (Cl sequence) Ionization Energy = 1 215 000 cm^{-1} (150.6 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
472.828	$3s^23p^5$	$^2P^o_{1/2}$	$3s3p^6$	$^2S_{1/2}$	7 668	219 162		6.94–2	1.04+9	C–	78°,82,71*
456.284		3/2		1/2	0	219 162		1.43–1	2.29+9	C–	78°,82,71*
241.91	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^1D)3d$	$^2S_{1/2}$	7 668	421 050		5.92–1	3.38+10	C–	31°,71*
237.50		3/2		1/2	0	421 050		1.42	8.40+10	C–	31°,71*
233.47	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^3P)3d$	$^2P_{3/2}$	7 668	435 970					31
231.99		1/2		1/2	7 668	438 770					31
229.38		3/2		3/2	0	435 970					31°,53,54
227.88		3/2		1/2	0	438 770					31
225.79	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^3P)3d$	$^2D_{3/2}$	7 668	450 550		3.94	1.29+11	C	31°,53,54,71*
225.16		3/2		5/2	0	444 130		6.24	1.37+11	C	31°,53,54,71*
221.95		3/2		3/2	0	450 550		2.0–1	6.9+0	D	31°,71*
183.46	$3s^23p^4(^3P)3d$	$^4F_{7/2}$	$3s^23p^4(^3P)4f$	$^4G^o_{9/2}$							39°,45
183.00		9/2		11/2							39°,45
182.43		5/2		7/2							39°,45
183.12	$3s^23p^4(^1D)3d$	$^2G_{9/2}$	$3s^23p^4(^1D)4f$	$^2H^o_{11/2}$							39°,45
182.27	$3s^23p^4(^3P)3d$	$^4F_{7/2}$	$3s^23p^4(^3P)4f$	$^2G^o_{9/2}$							39°,45
177.20	$3s^23p^4(^3P)3d$	$^4D_{7/2}$	$3s^23p^4(^3P)4f$	$^4F^o_{9/2}$							39°,45
164.523	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^3P)4s$	$^4P_{1/2}$	7 668	615 490	0				26
164.302		3/2		5/2	0	608 640	1				26
163.182		3/2		3/2	0	612 810	4				26
163.135	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^3P)4s$	$^2P_{3/2}$	7 668	620 650	2				26°,82
161.836		1/2		1/2	7 668	625 570	4				26°,82
161.122		3/2		3/2	0	620 650	6				26°,82
159.855		3/2		1/2	0	625 570	3				26°,82
158.467	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^1D)4s$	$^2D_{3/2}$	7 668	638 710	6				26
156.608		3/2		5/2	0	638 540	7				26
150.625	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^1S)4s$	$^2S_{1/2}$	7 668	671 570	2				26
148.903		3/2		1/2	0	671 570	3				26
127.08	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^3P)4d$	$^2D_{3/2}$	7 668	794 570	4				34Δ,39°,45
126.00		3/2		5/2	0	793 650	8				34Δ,39°
124.24	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^1P)4d$	$^2S_{1/2}$	7 668	812 550					39°,45
123.07		3/2		1/2	0	812 550					39°,45
123.03	$3s^23p^5$	$^2P^o_{1/2}$	$3s^23p^4(^1D)4d$	$^2D_{3/2}$	7 668	820 440	4				34Δ,39°,45
121.95		3/2		5/2	0	820 010	6				34Δ,39°
121.89		3/2		3/2	0	820 440					39°,45

V VII (Cl sequence) Ionization Energy = 1 215 000 cm^{-1} (150.6 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
122.60	$3s^23p^5$	$^2P^o_{3/2}$	$3s^23p^4(^1D)4d$	$^2P_{3/2}$	0	815 660	5				34[Δ],39°
117.2	$3s^23p^5$	$^2P^o_{3/2}$	$3s^23p^4(^1S)4d$	$^2D_{5/2}$	0	853 200	3				34

V VIII (S sequence) Ionization Energy = 1 399 000 cm^{-1} (173.4 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
5128.8[C]	$3s^23p^4$	$^3P_0$	$3s^23p^4$	$^1D_2$	7 579.6	27 072		E2	3.9−4	E	71*
4746.1[C]		1		2	6 007.8	27 072		M1	2.6	E	71*
3692.8[C]		2		2	0	27 072		M1	1.6+1	D−	71*
2978.1[C]	$3s^23p^4$	$^1D_2$	$3s^23p^4$	$^1S_0$	27 072	60 641		E2	5.6	D−	71*
1830.4[C]	$3s^23p^4$	$^3P_1$	$3s^23p^4$	$^1S_0$	6 007.8	60 641		M1	1.9+2	E	71*
1649.0[C]		2		0	0	60 641		E2	5.9−1	E	71*
472.839	$3s^23p^4$	$^3P_1$	$3s3p^5$	$^3P^o_2$	6 007.8	217 486.3	12bl				35,78°
465.493		0		1	7 579.6	222 405.6	7				33,35,78°
462.112		1		1	6 007.8	222 405.6	6				33,35,78°
459.799		2		2	0	217 486.3	10	2.0−1	1.3+9	D	33,35,78°,71*
456.134		1		0	6 007.8	225 241.6	7				35,78°
449.629		2		1	0	222 405.6	8				33,35,78°
459.647	$3s^23p^4$	$^1S_0$	$3s3p^5$	$^1P^o_1$	60 641	278 200	1				78
398.204	$3s^23p^4$	$^1D_2$	$3s3p^5$	$^1P^o_1$	27 072	278 200	10	3.5−1	4.9+9	D	33,35,78°,71*
359.454	$3s^23p^4$	$^3P_2$	$3s3p^5$	$^1P^o_1$	0	278 200	0				78
243.69	$3s^23p^4$	$^3P_1$	$3s^23p^3(^2D^o)3d$	$^3P^o_2$	6 007.8	416 330		8.7−1	2+10	D	31°,71*
240.22		2		2	0	416 330		3.6	8.3+10	D	31°,71*
236.01	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2D^o)3d$	$^1D^o_2$	27 072	450 780		4.1	9.8+10	C	31°,71*
231.33	$3s^23p^4$	$^3P_1$	$3s^23p^3(^4S^o)3d$	$^3D^o_2$	6 007.8	438 300					54
230.82		0		1	7 579.6	440 800					54
230.12		2		3	0	434 560					54
230.00		1		1	6 007.8	440 800					54
228.15		2		2	0	438 300					54
228.67	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2D^o)3d$	$^1F^o_3$	27 072	464 380		7.15	1.3+11	C	54°,71*
224.83[C]	$3s^23p^4$	$^3P_1$	$3s^23p^3(^2D^o)3d$	$^1D^o_2$	6 007.8	450 780		9.9−2	2.6+9	D	71*
159.24[T]	$3s^23p^3(^2D^o)3d$	$^1G^o_4$	$3s^23p^3(^2D^o)4f$	$^1H_5$							45
158.04	$3s^23p^3(^2P^o)3d$	$^3F^o_4$	$3s^23p^3(^2P^o)4f$	$^3G_5$							39°,45
157.53	$3s^23p^3(^2D^o)3d$	$^3G^o_5$	$3s^23p^3(^2D^o)4f$	$^3H_6$							39°,45
155.45	$3s^23p^33d$	$^5D^o_4$	$3s^23p^34f$	$^5F_5$							39°,45
155.38		3		4							39°,45
155.38		2		3							39°,45
154.68	$3s^23p^3(^2D^o)3d$	$^3F^o_4$	$3s^23p^3(^2D^o)4f$	$^3G_5$							39°,45
154.55		3		4							39°,45
154.42		2		3							39°,45
147.126	$3s^23p^4$	$^3P_0$	$3s^23p^3(^4S^o)4s$	$^3S^o_1$	7 579.6	687 260	0				25
146.789		1		1	6 007.8	687 260	1				25
145.507		2		1	0	687 260	2				25

V VIII (S sequence) Ionization Energy = 1 399 000 cm^{-1} (173.4 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
146.613	$3s^23p^4$	$^1S_0$	$3s^23p^3(^2P°)4s$	$^1P°_1$	60 641	742 720	1				25
144.653	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2D°)4s$	$^1D°_2$	27 072	718 430	3				25
142.247	$3s^23p^4$	$^3P_0$	$3s^23p^3(^2D°)4s$	$^3D°_1$	7 579.6	710 600	0				25
141.924		1		1	6 007.8	710 600	0				25
141.864		1		2	6 007.8	710 910	1				25
140.665		2		2	0	710 910	1				25
140.451		2		3	0	711 990	3				25
140.934	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2P°)4s$	$^3P°_2$	27 072	736 640	00				25
139.730	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2P°)4s$	$^1P°_1$	27 072	742 720	1				25
139.188	$3s^23p^4$	$^3P_2$	$3s^23p^3(^2D°)4s$	$^1D°_2$	0	718 430	00				25
137.491	$3s^23p^4$	$^3P_0$	$3s^23p^3(^2P°)4s$	$^3P°_1$	7 579.6	734 890	0				25
137.316		1		0	6 007.8	734 250	0				25
137.194		1		1	6 007.8	734 890	00				25
136.867		1		2	6 007.8	736 640	0				25
136.078		2		1	0	734 890	0				25
135.751		2		2	0	736 640	1				25
115.58	$3s^23p^4$	$^3P_0$	$3s^23p^3(^4S°)4d$	$^3D°_1$	7 579.6	872 780					39°,45
115.42		1		2	6 007.8	872 410					39°,45
114.59		2		3	0	872 680					39°,45
113.92	$3s^23p^4$	$^1S_0$	$3s^23p^3(^4S°)4d$	$^1P°_1$	60 641	938 450					39°,45
113.60	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2D°)4d$	$^1D°_2$	27 072	907 350					39°,45
113.27	$3s^23p^4$	$^1D_2$	$3s^23p^3(^2D°)4d$	$^1F°_3$	27 072	909 920					39°,45
111.44	$3s^23p^4$	$^3P_1$	$3s^23p^3(^2D°)4d$	$^3P°_2$	6 007.8	903 350					45
111.11	$3s^23p^4$	$^3P_1$	$3s^23p^3(^2D°)4d$	$^3D°_2$	6 007.8	905 990					45
110.55		2		3	0	904 570					45
110.38		2		2	0	905 990					45

V IX (P sequence) Ionization Energy = 1 660 000 cm^{-1} (205.8 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
4402.3^C	$3s^23p^3$	$^2D°_{5/2}$	$3s^23p^3$	$^2P°_{1/2}$	36 319+x	59 028+x		E2	2.3−1	D−	71*
4110.7^C		3/2		1/2	34 708+x	59 028+x		M1	1.6+1	D	71*
4014.1^C		5/2		3/2	36 319+x	61 224+x		M1	1.6+1	C	71*
3770.2^C		3/2		3/2	34 708+x	61 224+x		M1	3.4+1	C	71*
2880.3^C	$3s^23p^3$	$^4S°_{3/2}$	$3s^23p^3$	$^2D°_{3/2}$	0	34 708+x		M1	5.1	D	71*
2752.6^C		3/2		5/2	0	36 319+x		M1	1.2−1	E	71*
1694.1^C	$3s^23p^3$	$^4S°_{3/2}$	$3s^23p^3$	$^2P°_{1/2}$	0	59 028+x		M1	3.3+1	D	71*
1633.3^C		3/2		3/2	0	61 224+x		M1	7.1+1	D	71*
488.735	$3s^23p^3$	$^2P°_{3/2}$	$3s3p^4$	$^2D_{5/2}$	61 224+x	265 835+x		7.6−2	3.5+8	D	78°,71*
485.110		1/2		3/2	59 028+x	265 160+x		2.8−2	2.0+8	D	78°,71*
467.143	$3s^23p^3$	$^4S°_{3/2}$	$3s3p^4$	$^4P_{5/2}$	0	214 067		2.0−1	9.9+8	D	33,35,78°,71*
457.010		3/2		3/2	0	218 814		1.3−1	1.1+9	D	35,78°,71*
452.132		3/2		1/2	0	221 174		6.8−2	1.1+9	D	35,37,78°,71*

V IX (P sequence) Ionization Energy = 1 660 000 cm^{-1} (205.8 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
437.005	$3s^23p^3$ $^2D^o_{5/2}$	$3s3p^4$ $^2D_{3/2}$	36 319+x	265 160+x		8.4−3	7.3+7	E	78°,71*
435.699	$_{5/2}$	$_{5/2}$	36 319+x	265 835+x		3.1−1	1.8+9	D	35,78°,71*
433.930	$_{3/2}$	$_{3/2}$	34 708+x	265 160+x		2.3−1	2.0+9	D	35,78°,71*
432.663[C]	$_{3/2}$	$_{5/2}$	34 708+x	265 835+x		6.4−3	3.8+7	E	71*
409.097	$3s^23p^3$ $^2P^o_{3/2}$	$3s3p^4$ $^2P_{3/2}$	61 224+x	305 664+x	1				35,78°
405.461	$_{1/2}$	$_{3/2}$	59 028+x	305 664+x	0				35,78°
399.719	$_{1/2}$	$_{1/2}$	59 028+x	309 210+x	2bl				78
387.657	$3s^23p^3$ $^2P^o_{3/2}$	$3s3p^4$ $^2S_{1/2}$	61 224+x	319 184+x	6				35,78°
384.382	$_{1/2}$	$_{1/2}$	59 028+x	319 184+x	0				35,78°
371.271	$3s^23p^3$ $^2D^o_{5/2}$	$3s3p^4$ $^2P_{3/2}$	36 319+x	305 664+x	8				35,78°
369.064	$_{3/2}$	$_{3/2}$	34 708+x	305 664+x	2				78
364.296	$_{3/2}$	$_{1/2}$	34 708+x	309 210+x	6				35,78°
276.08	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^2(^3P)3d$ $^2P_{3/2}$	36 319+x	398 530+x					37
270.38	$_{3/2}$	$_{1/2}$	34 708+x	404 560+x					37
268.79[C]	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^2(^3P)3d$ $^4P_{5/2}$	36 319+x	408 350		2.7−2	4.2+8	E	71*
267.64[C]	$_{3/2}$	$_{5/2}$	34 708+x	408 350		6.4−3	9.9+7	E	71*
265.36[C]	$3s^23p^3$ $^2P^o_{3/2}$	$3s^23p^2(^1D)3d$ $^2D_{5/2}$	61 224+x	438 070+x		3.3−1	5.2+9	D	71*
265.11[C]	$_{3/2}$	$_{3/2}$	61 224+x	438 420+x		1.4−3	3.3+7	E	71*
263.58[C]	$_{1/2}$	$_{3/2}$	59 028+x	438 420+x		1.7−1	4.1+9	D	71*
254.17	$3s^23p^3$ $^2P^o_{1/2}$	$3s^23p^2(^1D)3d$ $^2P_{1/2}$	59 028+x	452 470+x					37
253.21	$_{3/2}$	$_{3/2}$	61 224+x	456 150+x		1.6	4.1+10	E	37°,71*
251.82	$_{1/2}$	$_{3/2}$	59 028+x	456 150+x		4.2−1	1.1+10	E	37°,71*
248.91	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^2(^1D)3d$ $^2D_{5/2}$	36 319+x	438 070+x		2.5	4.4+10	D	37°,71*
248.69[C]	$_{5/2}$	$_{3/2}$	36 319+x	438 420+x		2.6−1	6.9+9	D	71*
247.92[C]	$_{3/2}$	$_{5/2}$	34 708+x	438 070+x		1.1−1	1.9+9	D	71*
247.70	$_{3/2}$	$_{3/2}$	34 708+x	438 420+x		1.7	4.7+10	D	37°,71*
244.89	$3s^23p^3$ $^4S^o_{3/2}$	$3s^23p^2(^3P)3d$ $^4P_{5/2}$	0	408 350		3.6	6.7+10	D	32°,71*
244.46	$_{3/2}$	$_{3/2}$	0	409 060		2.5	6.9+10	D	32°,71*
243.58	$_{3/2}$	$_{1/2}$	0	410 540		1.2	6.9+10	D	32°,71*
240.30	$3s^23p^3$ $^2P^o_{3/2}$	$3s^23p^2(^3P)3d$ $^2D_{5/2}$	61 224+x	477 370+x					37
238.19[C]	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^2(^1D)3d$ $^2P_{3/2}$	36 319+x	456 150+x		3.3−2	9.7+8	E	71*
237.28[C]	$_{3/2}$	$_{3/2}$	34 708+x	456 150+x		1.5−2	4.6+8	E	71*
235.72	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^2(^3P)3d$ $^2F_{7/2}$	36 319+x	460 550+x		5.5	8.3+10	E	53,54°,71*
228.27[C]	$3s^23p^3$ $^4S^o_{3/2}$	$3s^23p^2(^1D)3d$ $^2D_{5/2}$	0	438 070+x		3.8−3	8.2+7	E	71*
140.31	$3s^23p^2(^1D)3d$ $^2G_{9/2}$	$3s^23p^24f$ $^2H^o_{11/2}$							39°,45
139.98	$_{7/2}$	$_{9/2}$							39°,45
137.83	$3s^23p^23d$ $^4F_{9/2}$	$3s^23p^24f$ $^4G^o_{11/2}$							39°,45
134.54	$3s^23p^3$ $^2P^o_{1/2}$	$3s^23p^2(^3P)4s$ $^2P_{1/2}$	59 028+x	802 220+x					39°,45
133.99	$_{3/2}$	$_{3/2}$	61 224+x	807 570+x					39°,45
131.22	$3s^23p^3$ $^2P^o_{3/2}$	$3s^23p^2(^1D)4s$ $^2D_{5/2}$	61 224+x	823 290+x					39°,45
131.13	$_{3/2}$	$_{3/2}$	61 224+x	823 570+x					39°,45
130.32	$3s^23p^3$ $^2D^o_{3/2}$	$3s^23p^2(^3P)4s$ $^2P_{1/2}$	34 708+x	802 220+x					39°,45
129.66	$_{5/2}$	$_{3/2}$	36 319+x	807 570+x					39°,45
127.068	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^2(^1D)4s$ $^2D_{5/2}$	36 319+x	823 290+x	10				39,45,67°
126.810	$_{3/2}$	$_{5/2}$	34 708+x	823 290+x	0				67
126.765	$_{3/2}$	$_{3/2}$	34 708+x	823 570+x	5				39,45,67°

V IX (P sequence) Ionization Energy = 1 660 000 cm^{-1} (205.8 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
126.732	$3s^23p^3$ $^4S^o_{3/2}$	$3s^23p^2(^3P)4s$ $^4P_{1/2}$	0	789 070	5				39,45,67°
126.152	$_{3/2}$	$_{3/2}$	0	792 690	8				39,45,67°
125.420	$_{3/2}$	$_{5/2}$	0	797 320	12				39,45,67°
88.48	$3s^23p^3$ $^2D^o_{5/2}$	$3s^23p^24d$ $^4D_{7/2}$	36 319+x	1 166 518+x					45

V X (Si sequence) Ionization Energy = 1 859 400 cm^{-1} (230.5 eV)

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
4330.0^C	$3s^23p^2$ $^3P_2$	$3s^23p^2$ $^1D_2$	9 421	32 509		M1	1.5+1	E	71*
3528.9^C	$_1$	$_2$	4 180	32 509		M1	9.1	E	71*
3119.9^C	$3s3p^3$ $^3D^o_3$	$3s3p^3$ $^3P^o_1$	222 104	254 147		E2	1.3	D−	71*
3101.5^C	$_3$	$_2$	222 104	254 337		M1	1.8+1	E	71*
3042.0^C	$_2$	$_0$	221 072	253 936		E2	3.1	D−	71*
3033.8^C	$_1$	$_0$	220 984	253 936		M1	2.3+1	E	71*
3022.6^C	$_2$	$_1$	221 072	254 147		E2	2.4−1	D−	71*
3014.5^C	$_1$	$_1$	220 984	254 147		M1	2.3+1	E	71*
3005.3^C	$_2$	$_2$	221 072	254 337		M1	1.4+1	E	71*
2997.4^C	$_1$	$_2$	220 984	254 337		M1	4.2	E	71*
2836.7^C	$3s^23p^2$ $^1D_2$	$3s^23p^2$ $^1S_0$	32 509	67 751		E2	6.3	D−	71*
1714.4^C	$3s^23p^2$ $^3P_2$	$3s^23p^2$ $^1S_0$	9 421	67 751		E2	9.3−1	E	71*
1573.0^C	$_1$	$_0$	4 180	67 751		M1	2.1+2	E	71*
558.329^C	$3s3p^3$ $^3D^o_3$	$3s^23p3d$ $^3D^o_3$	222 104	401 210		M1	3.5+1	E	71*
527.439	$3s^23p^2$ $^1D_2$	$3s3p^3$ $^3D^o_3$	32 509	222 104		5.5−3	1.9+7	E	78°,71*
472.672^C	$3s^23p^2$ $^3P_2$	$3s3p^3$ $^3D^o_1$	9 421	220 984		7.7−4	7.7+6	E	71*
472.476^C	$_2$	$_2$	9 421	221 072		1.3−2	7.7+7	D−	71*
470.183	$_2$	$_3$	9 421	222 104		1.9−1	8.4+8	D	35,78°,71*
461.245	$_1$	$_1$	4 180	220 984		2.6−2	2.7+8	D−	78°,71*
461.059	$_1$	$_2$	4 180	221 072		1.3−1	8.3+8	D	35,78°,71*
452.522	$_0$	$_1$	0	220 984		6.1−2	6.6+8	D	35,78°,71*
408.630	$3s^23p^2$ $^3P_2$	$3s3p^3$ $^3P^o_1$	9 421	254 147		5.5−2	7.4+8	D	35,78°,71*
408.304	$_2$	$_2$	9 421	254 337		2.4−1	2.0+9	D	33,35,37,78°,71*
400.390	$_1$	$_0$	4 180	253 936		6.0−2	2.6+9	C−	78°,71*
400.056	$_1$	$_1$	4 180	254 147		6.9−2	9.6+8	D	33,35,78°,71*
399.719	$_1$	$_2$	4 180	254 337		4.8−2	3.9+8	D	35,78°,71*
393.469	$_0$	$_1$	0	254 147		5.7−2	8.2+8	D	33,35,78°,71*
404.106	$3s^23p^2$ $^1D_2$	$3s3p^3$ $^1D^o_2$	32 509	279 969	7				37,78°
369.612	$3s^23p^2$ $^3P_2$	$3s3p^3$ $^1D^o_2$	9 421	279 969	1bl				78
365.518	$3s^23p^2$ $^1S_0$	$3s3p^3$ $^1P^o_1$	67 751	341 335	1				35,78°
323.811	$3s^23p^2$ $^1D_2$	$3s3p^3$ $^1P^o_1$	32 509	341 335	3bl				35,78°
313.990	$3s^23p^2$ $^3P_2$	$3s3p^3$ $^3S^o_1$	9 421	327 902	5				35,78°
308.903	$_1$	$_1$	4 180	327 902	2				35,78°
304.974	$_0$	$_1$	0	327 902	1				78
301.283	$3s^23p^2$ $^3P_2$	$3s3p^3$ $^1P^o_1$	9 421	341 335	0				78
271.22^C	$3s^23p^2$ $^1D_2$	$3s^23p3d$ $^3D^o_3$	32 509	401 210		5.0−2	6.5+8	E	71*

V x (Si sequence) Ionization Energy = 1 859 400 cm^{-1} (230.5 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
265.70	$3s^23p^2\ ^3P_2$	$3s^23p3d\ ^3P^o_2$	9 421	385 790					37
262.04	$_1$	$_2$	4 180	385 790					37
258.28	$_1$	$_1$	4 180	391 340					37
255.54	$_0$	$_1$	0	391 340					37
255.54	$3s^23p^2\ ^3P_2$	$3s^23p3d\ ^3D^o_2$	9 421	400 740					32
255.24	$_2$	$_3$	9 421	401 210		3.5	5.2+10	D	32°,71*
253.21	$_1$	$_1$	4 180	399 130					32,37°
252.17	$_1$	$_2$	4 180	400 740					32
250.53	$_0$	$_1$	0	399 130					32,37°
245.35	$3s^23p^2\ ^1D_2$	$3s^23p3d\ ^1F^o_3$	32 509	440 090		3.5	5.5+10	C	32°,71*
232.20^C	$3s^23p^2\ ^3P_2$	$3s^23p3d\ ^1F^o_3$	9 421	440 090		4.9−2	8.8+8	E	71*
124.40	$3s^23p3d\ ^3F^o_4$	$3s^23p4f\ ^3G_5$							39°,45
118.18	$3s^23p^2\ ^1D_2$	$3s^23p4s\ ^1P^o_1$	32 509	878 700					39°,45
116.85	$3s^23p^2\ ^3P_2$	$3s^23p4s\ ^3P^o_1$	9 421	865 200					39°,45
115.78	$_2$	$_2$	9 421	873 100					39°,45
115.58	$_0$	$_1$	0	865 200					39°,45
115.09	$_1$	$_2$	4 180	873 100					39°,45
94.96	$3s^23p^2\ ^1D_2$	$3s^23p4d\ ^1F^o_3$	32 509	1 085 600					39°,45
94.23	$3s^23p^2\ ^3P_2$	$3s^23p4d\ ^3D^o_3$	9 421	1 070 600					39°,45

V xi (Al sequence) Ionization Energy = 2 062 000 cm^{-1} (255.7 eV)

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
515.796^C	$3s3p^2\ ^2P_{3/2}$	$3p^3\ ^2P^o_{1/2}$	311 890	505 765		4.4−2	5.4+8	D	71*
513.315	$_{3/2}$	$_{3/2}$	311 890	506 702		2.8−1	1.7+9	D	77°,71*
502.602	$_{1/2}$	$_{1/2}$	306 801	505 765		1.5−1	2.0+9	D	77°,71*
500.248^C	$_{1/2}$	$_{3/2}$	306 801	506 702		6.6−3	4.5+7	E	71*
464.421^C	$3s^23d\ ^2D_{5/2}$	$3s3p(^3P^o)3d\ ^2F^o_{5/2}$	377 650	592 972		3.5−2	1.8+8	E	71*
462.802^C	$_{3/2}$	$_{5/2}$	376 897	592 972		2.2−1	1.2+9	E	71*
448.412^C	$_{5/2}$	$_{7/2}$	377 650	600 659		3.7−1	1.6+9	E	71*
461.146^C	$3s3p^2\ ^2S_{1/2}$	$3p^3\ ^2P^o_{1/2}$	288 914	505 765		2.2−2	3.5+8	D	71*
459.162^C	$_{1/2}$	$_{3/2}$	288 914	506 702		1.6−1	1.2+9	D	71*
455.994^C	$3s3p^2\ ^2D_{5/2}$	$3p^3\ ^2D^o_{3/2}$	233 778	453 079		5.9−2	4.8+8	E	71*
454.325	$_{3/2}$	$_{3/2}$	232 972	453 079		2.1−1	1.7+9	E	77°,71*
453.162	$_{5/2}$	$_{5/2}$	233 778	454 450		3.8−1	2.0+9	E	77°,71*
451.512^C	$_{3/2}$	$_{5/2}$	232 972	454 450		3.4−2	1.8+8	E	71*
447.881	$3s^23p\ ^2P^o_{3/2}$	$3s3p^2\ ^2D_{3/2}$	9 696	232 972		1.2−2	9.6+7	E	33,78°,71*
446.265	$_{3/2}$	$_{5/2}$	9 696	233 778		2.2−1	1.3+9	D	33,35,78°,71*
429.232	$_{1/2}$	$_{3/2}$	0	232 972		1.5−1	1.3+9	D	35,78°,71*
375.528^C	$3s^23d\ ^2D_{5/2}$	$3s3p(^3P^o)3d\ ^2P^o_{3/2}$	377 650	643 942		1.1−2	1.3+8	E	71*
374.469^C	$_{3/2}$	$_{3/2}$	376 897	643 942		1.4−2	1.6+8	E	71*
367.516	$3s^23d\ ^2D_{5/2}$	$3s3p(^1P^o)3d\ ^2F^o_{7/2}$	377 650	649 747		2.9	1.9+10	E	77°,71*
365.070^C	$_{5/2}$	$_{5/2}$	377 650	651 570		1.1−1	9.0+8	E	71*
364.073	$_{3/2}$	$_{5/2}$	376 897	651 570		2.1	1.7+10	E	77°,71*
366.570	$3s3p^2\ ^2D_{3/2}$	$3p^3\ ^2P^o_{1/2}$	232 972	505 765		3.6−1	8.8+9	D	77°,71*
366.403	$_{5/2}$	$_{3/2}$	233 778	506 702		5.8−1	7.2+9	D	77°,71*
365.323^C	$_{3/2}$	$_{3/2}$	232 972	506 702		7.2−2	9.0+8	D	71*

V XI (Al sequence) Ionization Energy = 2 062 000 cm^{-1} (255.7 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
358.846	$3s3p^2$	$^4P_{5/2}$	$3p^3$	$^4S^o_{3/2}$	184 963+x	463 634+x		9.6–1	1.2+10	D	35,70°,71*
352.334		3/2		3/2	179 812+x	463 634+x		6.6–1	8.9+9	D	35,70°,71*
347.787		1/2		3/2	176 101+x	463 634+x		3.4–1	4.6+9	D	35,70°,71*
358.144	$3s^23p$	$^2P^o_{3/2}$	$3s3p^2$	$^2S_{1/2}$	9 696	288 914		9.2–2	2.4+9	D	33,35,78°,71*
346.123		1/2		1/2	0	288 914		3.2–1	8.8+9	D	33,35,78°,71*
342.982	$3s^23d$	$^2D_{5/2}$	$3s3p(^1P^o)3d$	$^2P^o_{3/2}$	377 650	669 304					77
342.982		3/2		1/2	376 897	668 411		8.0–1	2.3+10	D	77°,71*
338.971	$3s^23d$	$^2D_{3/2}$	$3s3p(^1P^o)3d$	$^2D^o_{3/2}$	376 897	671 911					77
338.681		5/2		5/2	377 650	672 931		1.4	1.4+10	E	77°,71*
337.799^C		3/2		5/2	376 897	672 931		5.2–2	5.1+8	E	71*
336.580	$3s^23p$	$^2P^o_{3/2}$	$3s3p^2$	$^2P_{1/2}$	9 696	306 801		4.8–1	1.4+10	D	33,35,78°,71*
330.913		3/2		3/2	9 696	311 890		1.62	2.47+10	C–	33,35,78°,71*
325.945		1/2		1/2	0	306 801		4.4–1	1.4+10	D	33,35,78°,71*
320.626		1/2		3/2	0	311 890		3.28–1	5.3+9	C–	33,35,78°,71*
318.207^C	$3s3p^2$	$^2D_{5/2}$	$3s3p(^3P^o)3d$	$^4P^o_{5/2}$	233 778	548 039+x		3.1–2	3.4+8	E	71*
310.761^C	$3s3p^2$	$^2D_{5/2}$	$3s3p(^3P^o)3d$	$^4D^o_{7/2}$	233 778	555 569+x		1.2–2	1.0+8	E	71*
305.913^C	$3s3p^2$	$^4P_{3/2}$	$3p^3$	$^2P^o_{3/2}$	179 812+x	506 702		8.0–3	1.4+8	E	71*
302.479^C		1/2		3/2	176 101+x	506 702		3.4–3	6.2+7	E	71*
301.158^C	$3s3p^2$	$^2P_{3/2}$	$3s3p(^3P^o)3d$	$^2P^o_{3/2}$	311 890	643 942		4.9–1	9.1+9	D	71*
297.909^C		3/2		1/2	311 890	647 563		1.0–1	3.8+9	D	71*
296.612^C		1/2		3/2	306 801	643 942		5.0–2	9.3+8	D	71*
293.460^C		1/2		1/2	306 801	647 563		4.4–1	1.7+10	D	71*
299.548	$3s3p^2$	$^2D_{5/2}$	$3s3p(^3P^o)3d$	$^2D^o_{5/2}$	233 778	567 614					77
298.960		3/2		3/2	232 972	567 465					77
294.395^C	$3s3p^2$	$^2P_{3/2}$	$3s3p(^1P^o)3d$	$^2F^o_{5/2}$	311 890	651 570		5.4–3	6.9+7	E	71*
281.668	$3s3p^2$	$^2S_{1/2}$	$3s3p(^3P^o)3d$	$^2P^o_{3/2}$	288 914	643 942		1.3	2.7+10	D	77°,71*
278.824		1/2		1/2	288 914	647 563		3.6–1	1.5+10	D	77°,71*
280.488^C	$3s3p^2$	$^2P_{3/2}$	$3s3p(^1P^o)3d$	$^2P^o_{1/2}$	311 890	668 411		1.47–1	6.24+9	C–	71*
279.778		3/2		3/2	311 890	669 304					77
276.541		1/2		1/2	306 801	668 411		1.5–1	6.7+9	D	77°,71*
275.869		1/2		3/2	306 801	669 304					77
278.401^C	$3s3p^2$	$^2D_{5/2}$	$3s3p(^3P^o)3d$	$^2F^o_{5/2}$	233 778	592 972		9.6–2	1.4+9	E	71*
277.778		3/2		5/2	232 972	592 972		7.2–1	1.0+10	E	77°,71*
272.568		5/2		7/2	233 778	600 659		1.1	1.2+10	E	77°,71*
277.778	$3s3p^2$	$^2P_{3/2}$	$3s3p(^1P^o)3d$	$^2D^o_{3/2}$	311 890	671 911					77
276.963		3/2		5/2	311 890	672 931		3.2	4.6+10	E	77°,71*
273.888		1/2		3/2	306 801	671 911					77
275.424^C	$3s3p^2$	$^4P_{5/2}$	$3s3p(^3P^o)3d$	$^4P^o_{5/2}$	184 963+x	548 039+x		2.5–1	3.7+9	D	71*
271.572		3/2		5/2	179 812+x	548 039+x		1.1	1.7+10	D	77°,71*
267.658		1/2		3/2	176 101+x	549 712+x					77
267.249		3/2		1/2	179 812+x	553 995+x		4.8–1	2.2+10	E	77°,71*
264.624^C		1/2		1/2	176 101+x	553 995+x		5.6–2	2.6+9	E	71*
272.332	$3s^23p$	$^2P^o_{3/2}$	$3s^23d$	$^2D_{3/2}$	9 696	376 897		2.6–1	5.8+9	D	77°,71*
271.773		3/2		5/2	9 696	377 650		2.1	3.2+10	D	54,77°,71*
265.324		1/2		3/2	0	376 897		1.1	2.7+10	D	54,77°,71*
269.828	$3s3p^2$	$^4P_{5/2}$	$3s3p(^3P^o)3d$	$^4D^o_{7/2}$	184 963+x	555 569+x		2.84	3.25+10	C–	77°,71*
269.718		5/2		5/2	184 963+x	555 721+x		1.3	1.9+10	D	77°,71*
266.675		1/2		1/2	176 101+x	551 089+x		6.2–1	2.9+10	E	77°,71*
266.202		3/2		3/2	179 812+x	555 467+x					77
265.988		3/2		5/2	179 812+x	555 721+x		7.2–1	1.1+10	D	77°,71*

V XI (Al sequence) Ionization Energy = 2 062 000 cm^{-1} (255.7 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
263.507^C	$3s3p^2$	$^2S_{1/2}$	$3s3p(^1P^o)3d$	$^2P^o_{1/2}$	288 914	668 411		2.6−1	1.2+10	D	71*
241.202^C	$3s3p^2$	$^2D_{3/2}$	$3s3p(^3P^o)3d$	$^2P^o_{1/2}$	232 972	647 563		4.4−4	2.6+7	E	71*
240.560^C	$3s3p^2$	$^4P_{5/2}$	$3s3p(^3P^o)3d$	$^2F^o_{7/2}$	184 963+x	600 659		8.4−3	1.2+8	E	71*
240.333	$3s3p^2$	$^2D_{5/2}$	$3s3p(^1P^o)3d$	$^2F^o_{7/2}$	233 778	649 747		1.5	2.2+10	E	77°,71*
239.354^C		5/2		5/2	233 778	651 570		6.6−2	1.3+9	E	71*
238.892		3/2		5/2	232 972	651 570		1.1	2.1+10	E	77°,71*
229.653^C	$3s3p^2$	$^2D_{3/2}$	$3s3p(^1P^o)3d$	$^2P^o_{1/2}$	232 972	668 411		2.6−3	1.7+8	E	71*
213.748^C	$3s3p^2$	$^4P_{1/2}$	$3s3p(^3P^o)3d$	$^2P^o_{3/2}$	176 101+x	643 942		3.0−3	1.1+8	E	71*
119.36	$3s^23d$	$^2D_{5/2}$	$3s^24f$	$^2F^o_{7/2}$	377 650	1 215 500					38
119.28		3/2		5/2	376 897	1 215 300					38
112.76	$3s3p3d$	$^4F^o_{7/2}$	$3s3p4f$	$^4G_{9/2}$							38
112.63		5/2		7/2							38
112.34		9/2		11/2							38
107.57	$3s^23p$	$^2P^o_{3/2}$	$3s^24s$	$^2S_{1/2}$	9 696	939 500					38
106.42		1/2		1/2	0	939 500					38
106.00	$3s3p^2$	$^4P_{5/2}$	$3s3p4s$	$^4P^o_{3/2}$	184 963+x	1 128 300+x					38
105.34		5/2		5/2	184 963+x	1 134 400+x					38
105.03		1/2		3/2	176 101+x	1 128 300+x					38
104.74		3/2		5/2	179 812+x	1 134 400+x					38
87.868	$3s^23p$	$^2P^o_{3/2}$	$3s^24d$	$^2D_{5/2}$	9 696	1 147 770					24
87.100		1/2		3/2	0	1 147 240					24

V XII (Mg sequence) Ionization Energy = 2 485 000 cm^{-1} (308.1 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
696.083^C	$3s3d$	$^1D_2$	$3p3d$	$^1D^o_2$	613 354	757 015		1.9−1	5.2+8	D−	71*
609.20	$3s3p$	$^1P^o_1$	$3p^2$	$^1D_2$	281 627	445 775		3.3−1	1.2+9	E	39,45,69°,71*
562.25	$3s3p$	$^1P^o_1$	$3p^2$	$^3P_2$	281 627	459 478					69
522.4	$3s^2$	$^1S_0$	$3s3p$	$^3P^o_1$	0	191 509		1.4−3	1.1+7	E	51°,71*
502.147^C	$3s3d$	$^3D_3$	$3p3d$	$^3F^o_2$	545 169	744 314		2.3−3	1.2+7	E	71*
500.448^C		2		2	544 493	744 314		1.2−1	6.1+8	D	71*
499.38		1		2	544 068	744 314		4.8−1	2.6+9	D−	35,69°,71*
490.08		3		3	545 169	749 216		1.5−1	5.8+8	C	69°,71*
488.47		2		3	544 493	749 216		8.0−1	3.2+9	C−	35,69°,71*
476.78		3		4	545 169	754 909		1.25	4.06+9	C	35,69°,71*
421.02	$3s3d$	$^1D_2$	$3p3d$	$^1F^o_3$	613 354	850 871		2.5	1.3+10	D−	69°,71*
411.05	$3s3d$	$^3D_3$	$3p3d$	$^3P^o_2$	545 169	788 448					69
398.498^C		1		0	544 068	795 010		1.9−1	8.0+9	C−	71*
397.72		1		1	544 068	795 499					69
409.64	$3s3p$	$^1P^o_1$	$3p^2$	$^1S_0$	281 627	525 745		3.3−1	1.3+10	C	35,69°,71*
408.65	$3s3d$	$^3D_2$	$3p3d$	$^3D^o_1$	544 493	789 199					69
399.70		3		3	545 169	795 356		9.8−1	5.8+9	C−	35,69°,71*
398.624^C		2		3	544 493	795 356		1.9−1	1.1+9	C−	71*
397.72		2		2	544 493	795 927					69

V XII (Mg sequence) Ionization Energy = 2 485 000 cm^{-1} (308.1 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
404.79	$3s3p$	$^3P^o_2$	$3p^2$	$^1D_2$	198 737	445 775		1.1–1	9.2+8	E	69°,71*
393.30		1		2	191 509	445 775		5.4–2	4.5+8	E	69°,71*
402.90	$3s3d$	$^1D_2$	$3p3d$	$^1P^o_1$	613 354	861 555		7.0–1	9.6+9	D–	69°,71*
396.53	$3s3p$	$^3P^o_2$	$3p^2$	$^3P_1$	198 737	450 927		3.9–1	5.5+9	C–	33,69°,71*
392.53		1		0	191 509	446 265		3.0–1	1.3+10	C	33,69°,71*
385.47		1		1	191 509	450 927		2.4–1	3.6+9	C	33,69°,71*
383.53		2		2	198 737	459 478		1.0	9.3+9	D–	33,69°,71*
380.78		0		1	188 311	450 927		3.2–1	4.9+9	C	33,69°,71*
373.17		1		2	191 509	459 478		3.3–1	3.2+9	D–	33,69°,71*
382.462	$3p3d$	$^1P^o_1$	$3d^2$	$^1D_2$	861 555	1 123 022					13°,76
365.134	$3p3d$	$^1F^o_3$	$3d^2$	$^1G_4$	850 871	1 124 757		2.93	1.63+10	C–	13°,68,76,71*
355.07	$3s^2$	$^1S_0$	$3s3p$	$^1P^o_1$	0	281 627		9.47–1	1.67+10	C+	33,69°,71*
334.97	$3p^2$	$^1D_2$	$3p3d$	$^3F^o_2$	445 775	744 314					69
330.78	$3p3d$	$^3P^o_1$	$3d^2$	$^3F_2$	795 499	1 097 824					13°,68
322.513		2		3	788 448	1 098 514					13°,76
330.486	$3p3d$	$^3D^o_2$	$3d^2$	$^3F_3$	795 927	1 098 514					13°,68,76
328.954		3		4	795 356	1 099 356					13°,68,76
324.014		1		2	789 199	1 097 824					13°,76
321.30	$3p^2$	$^1D_2$	$3p3d$	$^1D^o_2$	445 775	757 015		9.5–1	1.2+10	E	69°,71*
302.080	$3p3d$	$^3D^o_2$	$3d^2$	$^3P_2$	795 927	1 126 966					13
301.46^T		3		2	795 356	1 126 966					13
296.728		1		0	789 199	1 126 208					13
302.080	$3p3d$	$^3P^o_1$	$3d^2$	$^3P_1$	795 499	1 126 476					13
301.680		0		1	795 010	1 126 476					13
301.680		1		2	795 499	1 126 966					13
295.841		2		1	788 448	1 126 476					13
295.405		2		2	788 448	1 126 966					13
301.45	$3s3p$	$^1P^o_1$	$3s3d$	$^1D_2$	281 627	613 354		2.2	3.2+10	D–	39,45,69°,71*
297.73	$3p^2$	$^1S_0$	$3p3d$	$^1P^o_1$	525 745	861 555		7.9–1	2.0+10	C–	69°,71*
297.73	$3p^2$	$^3P_2$	$3p3d$	$^3D^o_3$	459 478	795 356		1.9	2.1+10	E	35,69°,71*
297.22		2		2	459 478	795 927					69
291.60		0		1	446 265	789 199					69
289.85		1		2	450 927	795 927					69
296.28	$3p^2$	$^3P_1$	$3p3d$	$^3P^o_2$	450 927	788 448					69
290.63		1		0	450 927	795 010		2.0–1	1.6+10	C–	69°,71*
290.21		1		1	450 927	795 499					69
290.31	$3p3d$	$^3F^o_4$	$3d^2$	$^3F_4$	754 909	1 099 356					13°,68,76
286.287		3		3	749 216	1 098 514					13°,68,76
282.880		2		2	744 314	1 097 824					13°,68,76
289.577^C	$3s3p$	$^3P^o_2$	$3s3d$	$^3D_1$	198 737	544 068		1.8–2	4.9+8	D–	71*
289.22		2		2	198 737	544 493		2.7–1	4.4+9	C–	39,45.69°,71*
288.65		2		3	198 737	545 169		1.53	1.76+10	C–	35,39,45,69°,71*
283.64		1		1	191 509	544 068		2.8–1	7.7+9	C–	69°,71*
283.30		1		2	191 509	544 493		8.4–1	1.4+10	C–	35,39,45,69°,71*
281.09		0		1	188 311	544 068		3.7–1	1.0+10	C–	39,45,69°,71*
286.05	$3p^2$	$^1D_2$	$3p3d$	$^3D^o_3$	445 775	795 356					69
273.215	$3p3d$	$^1D^o_2$	$3d^2$	$^1D_2$	757 015	1 123 022					13°,76

V XII (Mg sequence) Ionization Energy = 2 485 000 cm^{-1} (308.1 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
255.50	$3p^2$	$^3P_2$	$3p3d$	$^1F^o_3$	459 478	850 871					69
246.86	$3p^2$	$^1D_2$	$3p3d$	$^1F^o_3$	445 775	850 871		1.15	1.8+10	E	69°,71*
240.512^C	$3p^2$	$^1D_2$	$3p3d$	$^1P^o_1$	445 775	861 555		7.0−3	2.7+8	E	71*
113.78	$3s3d$	$^1D_2$	$3s4f$	$^1F^o_3$	613 354	1 492 100					38
113.39	$3p3d$	$^1F^o_3$	$3p4f$	$^1G_4$	850 871	1 732 800					38
108.93	$3p3d$	$^3D^o_3$	$3p4f$	$^3F_4$	795 356	1 713 400					38
107.83	$3p3d$	$^3D^o_3$	$3p4f$	$^3D_3$	795 356	1 722 700					38
107.29	$3p3d$	$^3P^o_1$	$3p4f$	$^3D_1$	795 499	1 727 500					38
107.25		$_0$		$_1$	795 010	1 727 500					38
106.885	$3s3d$	$^3D_3$	$3s4f$	$^3F^o_4$	545 169	1 480 800					24°,45
106.820		$_2$		$_3$	544 493	1 480 600					24°,45
106.781		$_1$		$_2$	544 068	1 480 600					24°,45
105.74	$3s3p$	$^1P^o_1$	$3s4s$	$^1S_0$	281 627	1 227 300					45
105.49	$3p3d$	$^1D^o_2$	$3p4f$	$^3F_3$	757 015	1 705 000					38
104.66	$3p3d$	$^3F^o_3$	$3p4f$	$^3G_4$	749 216	1 704 700					38
104.58		$_2$		$_3$	744 314	1 700 500					38
104.45		$_4$		$_5$	754 909	1 712 300					38
100.37	$3p^2$	$^3P_1$	$3p4s$	$^3P^o_0$	450 927	1 447 200					45
100.13		$_2$		$_2$	459 478	1 458 200					45
98.630	$3s3p$	$^3P^o_2$	$3s4s$	$^3S_1$	198 737	1 212 500					24°,45
97.938		$_1$		$_1$	191 509	1 212 500					24°,45
97.642		$_0$		$_1$	188 311	1 212 500					24°,45
95.58	$3p^2$	$^1D_2$	$3s4f$	$^1F^o_3$	445 775	1 492 100					39°,45
87.363	$3s3p$	$^1P^o_1$	$3s4d$	$^1D_2$	281 627	1 426 300					38,39°,45
83.677	$3p^2$	$^1D_2$	$3p4d$	$^1F^o_3$	445 775	1 640 800					45
83.134	$3p^2$	$^3P_2$	$3p4d$	$^3D^o_3$	459 478	1 662 400					45
82.844		$_1$		$_2$	450 927	1 658 000					45
82.514		$_0$		$_1$	446 265	1 658 200					45
82.348^T	$3p^2$	$^1D_2$	$3p4d$	$^3F^o_3$	445 775	1 660 100?					45
82.024	$3p^2$	$^3P_2$	$3p4d$	$^3P^o_2$	459 478	1 678 600					45
81.550	$3s3p$	$^3P^o_2$	$3s4d$	$^3D_2$	198 737	1 425 000					24
81.513		$_2$		$_3$	198 737	1 425 500					24°,45
81.098		$_1$		$_1$	191 509	1 424 500					24
81.077		$_1$		$_2$	191 509	1 425 000					24°,45
80.896		$_0$		$_1$	188 311	1 424 500					24°,45
76.960	$3s3d$	$^3D_3$	$3s5f$	$^3F^o_4$	545 169	1 844 500					24°,45
76.307	$3s^2$	$^1S_0$	$3s4p$	$^1P^o_1$	0	1 310 500		3.17−1	1.21+11	C−	24°,45,71*
74.32	$3s3p$	$^3P^o_2$	$3p4p$	$^3D_3$	198 737	1 544 300					45
74.257	$3s3p$	$^3P^o_2$	$3p4p$	$^3P_1$	198 737	1 545 400					45
73.978		$_2$		$_2$	198 737	1 550 600					45
73.576		$_1$		$_2$	191 509	1 550 600					45

V XII (Mg sequence) Ionization Energy = 2 485 000 cm^{-1} (308.1 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
73.856	$3s3p$	$^3P^o_2$	$3p4p$	$^3S_1$	198 737	1 552 600					45
73.474		1		1	191 509	1 552 600					45
66.806	$3s3d$	$^3D_3$	$3s6f$	$^3F^o_4$	545 169	2 042 000					45
65.848	$3s3p$	$^3P^o_2$	$3s5s$	$^3S_1$	198 737	1 716 900					45
65.564		1		1	191 509	1 716 900					45
65.445		0		1	188 311	1 716 900					45
64.920	$3s3p$	$^1P^o_1$	$3s5d$	$^1D_2$	281 627	1 822 000					45
61.921	$3s3d$	$^3D_3$	$3s7f$	$^3F^o_4$	545 169	2 160 100					45
61.717	$3s3p$	$^3P^o_2$	$3s5d$	$^3D_3$	198 737	1 819 000					24°,45
61.455		1		2	191 509	1 818 700					24°,45
61.352		0		1	188 311	1 818 300					45
59.092	$3s3d$	$^3D_3$	$3s8f$	$^3F^o_4$	545 169	2 237 400					45
56.655	$3s^2$	$^1S_0$	$3s5p$	$^1P^o_1$	0	1 765 100		1.04−1	7.2+10	C	45°,71*
56.53	$3s3p$	$^3P^o_2$	$3s6s$	$^3S_1$	198 737	1 967 700					45
54.702	$3s3p$	$^3P^o_2$	$3s6d$	$^3D_3$	198 737	2 026 800					45
54.493		1		2	191 509	2 026 600					45
52.315	$3s3p$	$^3P^o_2$	$3s7s$	$^3S_1$	198 737	2 110 200					45
51.208	$3s3p$	$^3P^o_2$	$3s7d$	$^3D_3$	198 737	2 151 600					45
50.056	$3s^2$	$^1S_0$	$3s6p$	$^1P^o_1$	0	1 997 800					45
49.226	$3s3p$	$^3P^o_2$	$3s8d$	$^3D_3$	198 737	2 230 200					45
46.913	$3s^2$	$^1S_0$	$3s7p$	$^1P^o_1$	0	2 131 600					45
45.071	$3s^2$	$^1S_0$	$3s8p$	$^1P^o_1$	0	2 218 700					45
44.03	$3s^2$	$^1S_0$	$3s9p$	$^1P^o_1$	0	2 271 200					45
43.358	$3s^2$	$^1S_0$	$3s10p$	$^1P^o_1$	0	2 306 400					45

V XIII (Na sequence) Ionization Energy = 2 712 250 cm^{-1} (336.279 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
884.02^C	$2p^64p$	$^2P^o_{3/2}$	$2p^64d$	$^2D_{3/2}$	1 392 780	1 505 900		2.0−1	4.2+8	C	71*
879.51^C		3/2		5/2	1 392 780	1 506 480		1.8	2.5+9	C	71*
851.14^C		1/2		3/2	1 388 410	1 505 900		1.0	2.4+9	C	71*
487.40^C	$2p^65d$	$^2D_{3/2}$	$2p^66p$	$^2P^o_{1/2}$	1 946 230	2 151 400		5.6−1	7.8+9	C	71*
485.67^C		5/2		3/2	1 946 500	2 152 400		1.00	7.1+9	C	71*
485.04^C		3/2		3/2	1 946 230	2 152 400		1.1−1	8.0+8	D	71*
465.29^C	$2p^65f$	$^2F^o_{5/2}$	$2p^66d$	$^2D_{3/2}$	1 967 880	2 182 800		2.9−1	2.2+9	C	71*
465.09^C		7/2		5/2	1 967 990	2 183 000		4.1−1	2.1+9	C	71*
464.86^C		5/2		5/2	1 967 880	2 183 000		2.0−2	1.0+8	D	71*
443.427	$2p^63s$	$^2S_{1/2}$	$2p^63p$	$^2P^o_{1/2}$	0	225 520		2.90−1	4.90+9	B	33,39,45,75°,71*
422.784		1/2		3/2	0	236 530		6.10−1	5.69+9	B	33,39,45,75°,71*
424.50^C	$2p^65p$	$^2P^o_{3/2}$	$2p^66s$	$^2S_{1/2}$	1 891 430	2 127 000		6.8−1	1.2+10	C	71*
420.80^C		1/2		1/2	1 889 360	2 127 000		3.34−1	6.3+9	C	71*

V XIII (Na sequence) Ionization Energy = 2 712 250 cm^{-1} (336.279 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
402.58[C]	$2p^65d\ ^2D_{5/2}$	$2p^66f\ ^2F^\circ_{5/2}$	1 946 500	2 194 900		1.7−1	1.2+9	D	71*
402.25[C]	$_{5/2}$	$_{7/2}$	1 946 500	2 195 100		3.5	1.8+10	C	71*
402.14[C]	$_{3/2}$	$_{5/2}$	1 946 230	2 194 900		2.5	1.7+10	C	71*
343.21[C]	$2p^65p\ ^2P^\circ_{3/2}$	$2p^66d\ ^2D_{3/2}$	1 891 430	2 182 800		8.0−2	1.1+9	D	71*
342.97[C]	$_{3/2}$	$_{5/2}$	1 891 430	2 183 000		7.2−1	6.7+9	C	71*
340.79[C]	$_{1/2}$	$_{3/2}$	1 889 360	2 182 800		3.98−1	5.7+9	C	71*
327.55[C]	$2p^65s\ ^2S_{1/2}$	$2p^66p\ ^2P^\circ_{1/2}$	1 846 100	2 151 400		1.45−1	4.50+9	C	71*
326.48[C]	$_{1/2}$	$_{3/2}$	1 846 100	2 152 400		2.90−1	4.53+9	C	71*
324.496	$2p^63p\ ^2P^\circ_{3/2}$	$2p^63d\ ^2D_{3/2}$	236 530	544 700		1.35−1	2.13+9	B	33,75°,71*
323.189	$_{3/2}$	$_{5/2}$	236 530	545 950		1.22	1.3+10	B	33,39,45,75°,71*
313.305	$_{1/2}$	$_{3/2}$	225 520	544 700		7.00−1	1.19+10	B	33,39,45,75°,71*
280.25[C]	$2p^65f\ ^2F^\circ_{5/2}$	$2p^67d\ ^2D_{3/2}$	1 967 880	2 324 700		4.7−2	1.0+9	D	71*
280.10[C]	$_{7/2}$	$_{5/2}$	1 967 990	2 325 000		6.8−2	9.7+8	D	71*
280.02[C]	$_{5/2}$	$_{5/2}$	1 967 880	2 325 000		3.4−3	4.8+7	E	71*
278.40[C]	$2p^65d\ ^2D_{5/2}$	$2p^67p\ ^2P^\circ_{3/2}$	1 946 500	2 305 700		1.69−1	3.63+9	C	71*
278.19[C]	$_{3/2}$	$_{1/2}$	1 946 230	2 305 700		9.6−2	4.1+9	C	71*
278.19[C]	$_{3/2}$	$_{3/2}$	1 946 230	2 305 700		1.9−2	4.0+8	D	71*
260.78[C]	$2p^64d\ ^2D_{3/2}$	$2p^65p\ ^2P^\circ_{1/2}$	1 505 900	1 889 360		3.5−1	1.7+10	C	71*
259.77[C]	$_{5/2}$	$_{3/2}$	1 506 480	1 891 430		6.6−1	1.6+10	C	71*
259.38[C]	$_{3/2}$	$_{3/2}$	1 505 900	1 891 430		7.2−2	1.7+9	D	71*
259.07[C]	$2p^65d\ ^2D_{5/2}$	$2p^67f\ ^2F^\circ_{5/2}$	1 946 500	2 332 500		4.9−2	8.2+8	D	71*
258.89[C]	$_{3/2}$	$_{5/2}$	1 946 230	2 332 500		6.8−1	1.2+10	C	71*
258.87[C]	$_{5/2}$	$_{7/2}$	1 946 500	2 332 800		9.6−1	1.2+10	C	71*
252.00[C]	$2p^64f\ ^2F^\circ_{5/2}$	$2p^65d\ ^2D_{3/2}$	1 549 410	1 946 230		1.1−1	3.0+9	C	71*
251.97[C]	$_{7/2}$	$_{5/2}$	1 549 620	1 946 500		1.65−1	2.89+9	C	71*
251.83[C]	$_{5/2}$	$_{5/2}$	1 549 410	1 946 500		8.4−3	1.5+8	D	71*
250.65[C]	$2p^65p\ ^2P^\circ_{3/2}$	$2p^67s\ ^2S_{1/2}$	1 891 430	2 290 400		1.28−1	6.8+9	C	71*
249.35[C]	$_{1/2}$	$_{1/2}$	1 889 360	2 290 400		6.4−2	3.4+9	C	71*
230.80[C]	$2p^65p\ ^2P^\circ_{3/2}$	$2p^67d\ ^2D_{3/2}$	1 891 430	2 324 700		3.0−2	9.5+8	D	71*
230.64[C]	$_{3/2}$	$_{5/2}$	1 891 430	2 325 000		2.6−1	5.5+9	C	71*
229.71[C]	$_{1/2}$	$_{3/2}$	1 889 360	2 324 700		1.5−1	4.6+9	C	71*
223.01[C]	$2p^65f\ ^2F^\circ_{5/2}$	$2p^68d\ ^2D_{3/2}$	1 967 880	2 416 300		1.8−2	5.9+8	D	71*
222.96[C]	$_{7/2}$	$_{5/2}$	1 967 990	2 416 500		2.6−2	5.8+8	D	71*
222.91[C]	$_{5/2}$	$_{5/2}$	1 967 880	2 416 500		1.3−3	2.9+7	E	71*
220.59[C]	$2p^64p\ ^2P^\circ_{3/2}$	$2p^65s\ ^2S_{1/2}$	1 392 780	1 846 100		4.8−1	3.2+10	C	71*
218.49[C]	$_{1/2}$	$_{1/2}$	1 388 410	1 846 100		2.4−1	1.7+10	C	71*
218.53[C]	$2p^65d\ ^2D_{5/2}$	$2p^68p\ ^2P^\circ_{3/2}$	1 946 500	2 404 100		6.0−2	2.2+9	C	71*
218.40[C]	$_{3/2}$	$_{1/2}$	1 946 230	2 404 100		3.5−2	2.4+9	D	71*
218.40[C]	$_{3/2}$	$_{3/2}$	1 946 230	2 404 100		6.8−3	2.4+8	D	71*
216.73[C]	$2p^64d\ ^2D_{5/2}$	$2p^65f\ ^2F^\circ_{5/2}$	1 506 480	1 967 880		2.1−1	5.0+9	D	71*
216.68[C]	$_{5/2}$	$_{7/2}$	1 506 480	1 967 990		4.1	7.2+10	C	71*
216.46[C]	$_{3/2}$	$_{5/2}$	1 505 900	1 967 880		2.8	6.7+10	C	71*
210.53[C]	$2p^65d\ ^2D_{5/2}$	$2p^68f\ ^2F^\circ_{7/2}$	1 946 500	2 421 500		4.3−1	8.2+9	C	71*
210.53[C]	$_{5/2}$	$_{5/2}$	1 946 500	2 421 500		2.2−2	5.4+8	D	71*
210.41[C]	$_{3/2}$	$_{5/2}$	1 946 230	2 421 500		3.0−1	7.6+9	C	71*
199.37[C]	$2p^65p\ ^2P^\circ_{3/2}$	$2p^68s\ ^2S_{1/2}$	1 891 430	2 393 000		5.00−2	4.19+9	C	71*
198.55[C]	$_{1/2}$	$_{1/2}$	1 889 360	2 393 000		2.50−2	2.11+9	C	71*

V XIII (Na sequence) Ionization Energy = 2 712 250 cm^{-1} (336.279 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
190.52^{C}	$2p^65p$ $^2P^o_{3/2}$	$2p^68d$ $^2D_{3/2}$	1 891 430	2 416 300		1.5−2	6.8+8	D	71*
190.45^{C}	$3/2$	$5/2$	1 891 430	2 416 500		1.3−1	4.1+9	C	71*
189.77^{C}	$1/2$	$3/2$	1 889 360	2 416 300		7.40−2	3.43+9	C	71*
183.59^{C}	$2p^63s$ $^2S_{1/2}$	$2p^63d$ $^2D_{3/2}$	0	544 700		E2	4.89+5	C	71*
183.17^{C}	$1/2$	$5/2$	0	545 950		E2	4.89+5	C	71*
180.68^{C}	$2p^64p$ $^2P^o_{3/2}$	$2p^65d$ $^2D_{3/2}$	1 392 780	1 946 230		8.4−2	4.4+9	D	71*
180.60^{C}	$3/2$	$5/2$	1 392 780	1 946 500		7.6−1	2.6+10	C	71*
179.27^{C}	$1/2$	$3/2$	1 388 410	1 946 230		4.4−1	2.3+10	C	71*
169.82^{C}	$2p^64s$ $^2S_{1/2}$	$2p^65p$ $^2P^o_{1/2}$	1 300 490	1 889 360		1.4−1	1.6+10	C	71*
169.22^{C}	$1/2$	$3/2$	1 300 490	1 891 430		2.70−1	1.57+10	C	71*
157.88^{C}	$2p^64f$ $^2F^o_{7/2}$	$2p^66d$ $^2D_{5/2}$	1 549 620	2 183 000		2.7−2	1.2+9	D	71*
157.88^{C}	$5/2$	$3/2$	1 549 410	2 182 800		1.9−2	1.3+9	D	71*
157.83^{C}	$5/2$	$5/2$	1 549 410	2 183 000		1.4−3	6.1+7	E	71*
154.92^{C}	$2p^64d$ $^2D_{3/2}$	$2p^66p$ $^2P^o_{1/2}$	1 505 900	2 151 400		5.6−2	7.9+9	C	71*
154.82^{C}	$5/2$	$3/2$	1 506 480	2 152 400		1.0−1	7.2+9	C	71*
154.68^{C}	$3/2$	$3/2$	1 505 900	2 152 400		1.2−2	8.1+8	D	71*
145.26^{C}	$2p^64d$ $^2D_{5/2}$	$2p^66f$ $^2F^o_{5/2}$	1 506 480	2 194 900		5.0−2	2.6+9	D	71*
145.22^{C}	$5/2$	$7/2$	1 506 480	2 195 100		1.0	4.1+10	C	71*
145.14^{C}	$3/2$	$5/2$	1 505 900	2 194 900		7.2−1	3.8+10	C	71*
136.20^{C}	$2p^64p$ $^2P^o_{3/2}$	$2p^66s$ $^2S_{1/2}$	1 392 780	2 127 000		9.2−2	1.6+10	C	71*
135.39^{C}	$1/2$	$1/2$	1 388 410	2 127 000		4.4−2	8.2+9	C	71*
128.98^{C}	$2p^64f$ $^2F^o_{5/2}$	$2p^67d$ $^2D_{3/2}$	1 549 410	2 324 700		6.6−3	6.6+8	D	71*
128.97^{C}	$7/2$	$5/2$	1 549 620	2 325 000		9.6−3	6.4+8	D	71*
128.93^{C}	$5/2$	$5/2$	1 549 410	2 325 000		4.7−4	3.2+7	E	71*
126.58^{C}	$2p^64p$ $^2P^o_{3/2}$	$2p^66d$ $^2D_{3/2}$	1 392 780	2 182 800		3.1−2	3.2+9	D	71*
126.55^{C}	$3/2$	$5/2$	1 392 780	2 183 000		2.6−1	1.8+10	C	71*
125.88^{C}	$1/2$	$3/2$	1 388 410	2 182 800		1.5−1	1.6+10	C	71*
125.12^{C}	$2p^64d$ $^2D_{5/2}$	$2p^67p$ $^2P^o_{3/2}$	1 506 480	2 305 700		3.9−2	4.1+9	D	71*
125.03^{C}	$3/2$	$3/2$	1 505 900	2 305 700		4.0−3	4.4+8	E	71*
125.03^{C}	$3/2$	$1/2$	1 505 900	2 305 700		2.1−2	4.5+9	D	71*
121.06^{C}	$2p^64d$ $^2D_{5/2}$	$2p^67f$ $^2F^o_{5/2}$	1 506 480	2 332 500		2.1−2	1.6+9	D	71*
121.02^{C}	$5/2$	$7/2$	1 506 480	2 332 800		4.3−1	2.4+10	C	71*
120.98^{C}	$3/2$	$5/2$	1 505 900	2 332 500		3.0−1	2.3+10	C	71*
118.50	$2p^63d$ $^2D_{3/2}$	$2p^64p$ $^2P^o_{1/2}$	544 700	1 388 410		1.6−1	3.8+10	C	38°,71*
118.08	$5/2$	$3/2$	545 950	1 392 780		2.88−1	3.45+10	C	38°,71*
117.91^{C}	$3/2$	$3/2$	544 700	1 392 780		3.1−2	3.7+9	D	71*
117.52^{C}	$2p^64s$ $^2S_{1/2}$	$2p^66p$ $^2P^o_{1/2}$	1 300 490	2 151 400		4.4−2	1.1+10	C	71*
117.38^{C}	$1/2$	$3/2$	1 300 490	2 152 400		8.8−2	1.1+10	C	71*
115.36^{C}	$2p^64f$ $^2F^o_{7/2}$	$2p^68d$ $^2D_{5/2}$	1 549 620	2 416 500		4.7−3	4.0+8	E	71*
115.35^{C}	$5/2$	$3/2$	1 549 410	2 416 300		3.2−3	4.0+8	E	71*
115.33^{C}	$5/2$	$5/2$	1 549 410	2 416 500		2.3−4	2.0+7	E	71*
111.41^{C}	$2p^64p$ $^2P^o_{3/2}$	$2p^67s$ $^2S_{1/2}$	1 392 780	2 290 400		3.6−2	9.5+9	D	71*
110.87^{C}	$1/2$	$1/2$	1 388 410	2 290 400		1.7−2	4.7+9	D	71*
111.41^{C}	$2p^64d$ $^2D_{5/2}$	$2p^68p$ $^2P^o_{3/2}$	1 506 480	2 404 100		1.8−2	2.4+9	D	71*
111.33^{C}	$3/2$	$1/2$	1 505 900	2 404 100		1.0−2	2.7+9	D	71*
111.33^{C}	$3/2$	$3/2$	1 505 900	2 404 100		2.0−3	2.7+8	E	71*
109.29^{C}	$2p^64d$ $^2D_{5/2}$	$2p^68f$ $^2F^o_{5/2}$	1 506 480	2 421 500		1.1−2	1.0+9	D	71*
109.29^{C}	$5/2$	$7/2$	1 506 480	2 421 500		2.2−1	1.6+10	C	71*
109.22^{C}	$3/2$	$5/2$	1 505 900	2 421 500		1.6−1	1.5+10	C	71*

V XIII (Na sequence) Ionization Energy = 2 712 250 cm^{-1} (336.279 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
107.31[C]	$2p^64p$ $^2P^\circ_{3/2}$	$2p^67d$ $^2D_{3/2}$	1 392 780	2 324 700		1.5−2	2.2+9	D	71*
107.27[C]	$_{3/2}$	$_{5/2}$	1 392 780	2 325 000		1.4−1	1.3+10	C	71*
106.80[C]	$_{1/2}$	$_{3/2}$	1 388 410	2 324 700		7.6−2	1.1+10	C	71*
99.978[C]	$2p^64p$ $^2P^\circ_{3/2}$	$2p^68s$ $^2S_{1/2}$	1 392 780	2 393 000		1.8−2	6.0+9	D	71*
99.543[C]	$_{1/2}$	$_{1/2}$	1 388 410	2 393 000		9.2−3	3.1+9	D	71*
99.655[C]	$2p^63d$ $^2D_{5/2}$	$2p^64f$ $^2F^\circ_{5/2}$	545 950	1 549 410		2.6−1	2.9+10	D	71*
99.634	$_{5/2}$	$_{7/2}$	545 950	1 549 620		5.2	4.4+11	C	22,75°,71*
99.531	$_{3/2}$	$_{5/2}$	544 700	1 549 410		3.7	4.1+11	C	22,75°,71*
97.702[C]	$2p^64p$ $^2P^\circ_{3/2}$	$2p^68d$ $^2D_{3/2}$	1 392 780	2 416 300		8.8−3	1.5+9	D	71*
97.683[C]	$_{3/2}$	$_{5/2}$	1 392 780	2 416 500		7.88−2	9.2+9	C	71*
97.287[C]	$_{1/2}$	$_{3/2}$	1 388 410	2 416 300		4.40−2	7.8+9	C	71*
93.994	$2p^63p$ $^2P^\circ_{3/2}$	$2p^64s$ $^2S_{1/2}$	236 530	1 300 490					22°
93.025	$_{1/2}$	$_{1/2}$	225 520	1 300 490					22°,45
78.783	$2p^63p$ $^2P^\circ_{3/2}$	$2p^64d$ $^2D_{3/2}$	236 530	1 505 900		1.0−1	2.8+10	D	15,22°,71*
78.746	$_{3/2}$	$_{5/2}$	236 530	1 506 480		9.28−1	1.66+11	C	22°,45,71*
78.101	$_{1/2}$	$_{3/2}$	225 520	1 505 900		5.20−1	1.42+11	C	22°,45,71*
74.368[C]	$2p^63d$ $^2D_{3/2}$	$2p^65p$ $^2P^\circ_{1/2}$	544 700	1 889 360		2.4−2	1.5+10	D	71*
74.321	$_{5/2}$	$_{3/2}$	545 950	1 891 430		4.5−2	1.4+10	D	15,39°,45,71*
74.254[C]	$_{3/2}$	$_{3/2}$	544 700	1 891 430		4.8−3	1.5+9	E	71*
72.025	$2p^63s$ $^2S_{1/2}$	$2p^64p$ $^2P^\circ_{1/2}$	0	1 388 410		1.29−1	8.3+10	B	22°,45,71*
71.799	$_{1/2}$	$_{3/2}$	0	1 392 780		2.44−1	7.9+10	B	22°,45,71*
70.327[C]	$2p^63d$ $^2D_{5/2}$	$2p^65f$ $^2F^\circ_{5/2}$	545 950	1 967 880		4.7−2	1.1+10	D	71*
70.323	$_{5/2}$	$_{7/2}$	545 950	1 967 990		9.78−1	1.65+11	C	22°,45,71*
70.262	$_{3/2}$	$_{5/2}$	544 700	1 967 880		6.84−1	1.54+11	C	22°,45,71*
62.249[C]	$2p^63d$ $^2D_{5/2}$	$2p^66p$ $^2P^\circ_{3/2}$	545 950	2 152 400		1.6−2	6.7+9	D	71*
62.239[C]	$_{3/2}$	$_{1/2}$	544 700	2 151 400		8.8−3	7.6+9	D	71*
62.201[C]	$_{3/2}$	$_{3/2}$	544 700	2 152 400		1.7−3	7.4+8	E	71*
62.132	$2p^63p$ $^2P^\circ_{3/2}$	$2p^65s$ $^2S_{1/2}$	236 530	1 846 100		5.28−2	4.56+10	C	15°,45,71*
61.705	$_{1/2}$	$_{1/2}$	225 520	1 846 100		2.6−2	2.3+10	C	15°,45,71*
60.645[C]	$2p^63d$ $^2D_{5/2}$	$2p^66f$ $^2F^\circ_{5/2}$	545 950	2 194 900		1.9−2	5.6+9	D	71*
60.640	$_{5/2}$	$_{7/2}$	545 950	2 195 100		3.7−1	8.4+10	C	15°,45,71*
60.596	$_{3/2}$	$_{5/2}$	544 700	2 194 900		2.6−1	7.9+10	C	15°,71*
58.490[C]	$2p^63p$ $^2P^\circ_{3/2}$	$2p^65d$ $^2D_{3/2}$	236 530	1 946 230		3.5−2	1.7+10	D	71*
58.482	$_{3/2}$	$_{5/2}$	236 530	1 946 500		3.1−1	1.0+11	C	15,22°,45,71*
58.116	$_{1/2}$	$_{3/2}$	225 520	1 946 230		1.7−1	8.5+10	C	15,22°,45,71*
56.826[C]	$2p^63d$ $^2D_{5/2}$	$2p^67p$ $^2P^\circ_{3/2}$	545 950	2 305 700		7.2−3	3.9+9	D	71*
56.786[C]	$_{3/2}$	$_{1/2}$	544 700	2 305 700		4.4−3	4.4+9	D	71*
56.786[C]	$_{3/2}$	$_{3/2}$	544 700	2 305 700		8.4−4	4.4+8	E	71*
55.974[C]	$2p^63d$ $^2D_{5/2}$	$2p^67f$ $^2F^\circ_{5/2}$	545 950	2 332 500		9.0−3	3.3+9	D	71*
55.967	$_{5/2}$	$_{7/2}$	545 950	2 332 800		1.8−1	4.8+10	C	15°,45,71*
55.932	$_{3/2}$	$_{5/2}$	544 700	2 332 500		1.2−1	4.4+10	C	15°,71*
53.817[C]	$2p^63d$ $^2D_{5/2}$	$2p^68p$ $^2P^\circ_{3/2}$	545 950	2 404 100		4.4−3	2.5+9	E	71*
53.781[C]	$_{3/2}$	$_{1/2}$	544 700	2 404 100		2.4−3	2.8+9	E	71*
53.781[C]	$_{3/2}$	$_{3/2}$	544 700	2 404 100		4.8−4	2.8+8	E	71*
53.318	$2p^63d$ $^2D_{5/2}$	$2p^68f$ $^2F^\circ_{7/2}$	545 950	2 421 500		1.04−1	3.04+10	C	15°,45,71*
53.318[C]	$_{5/2}$	$_{5/2}$	545 950	2 421 500		5.2−3	2.0+9	E	71*
53.281	$_{3/2}$	$_{5/2}$	544 700	2 421 500		7.24−2	2.84+10	C	15°,71*
52.928	$2p^63s$ $^2S_{1/2}$	$2p^65p$ $^2P^\circ_{1/2}$	0	1 889 360		4.0−2	4.8+10	C	22°,45,71*
52.870	$_{1/2}$	$_{3/2}$	0	1 891 430		8.0−2	4.8+10	C	22°,45,71*

V XIII (Na sequence) Ionization Energy = 2 712 250 cm^{-1} (336.279 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
52.897[C]	$2p^63p\ ^2P^o_{3/2}$	$2p^66s\ ^2S_{1/2}$	236 530	2 127 000		2.0−2	2.4+10	D	71*
52.590	$_{1/2}$	$_{1/2}$	225 520	2 127 000		1.0−2	1.3+10	D	45°,71*
51.620	$2p^63d\ ^2D_{5/2}$	$2p^69f\ ^2F^o_{7/2}$	545 950	2 483 200					15°,45
51.380[C]	$2p^63p\ ^2P^o_{3/2}$	$2p^66d\ ^2D_{3/2}$	236 530	2 182 800		1.6−2	1.0+10	D	71*
51.376	$_{3/2}$	$_{5/2}$	236 530	2 183 000		1.46−1	6.2+10	C	15°,45,71*
51.091	$_{1/2}$	$_{3/2}$	225 520	2 182 800		8.14−2	5.2+10	C	15°,45,71*
50.494	$2p^63d\ ^2D_{5/2}$	$2p^610f\ ^2F^o_{7/2}$	545 950	2 526 400					45
49.642	$2p^63d\ ^2D_{5/2}$	$2p^611f\ ^2F^o_{7/2}$	545 950	2 560 400					45
48.682	$2p^63p\ ^2P^o_{3/2}$	$2p^67s\ ^2S_{1/2}$	236 530	2 290 400		1.1−2	1.5+10	D	15,45°,71*
48.435	$_{1/2}$	$_{1/2}$	225 520	2 290 400		5.2−3	7.4+9	D	15,45°,71*
47.889[C]	$2p^63p\ ^2P^o_{3/2}$	$2p^67d\ ^2D_{3/2}$	236 530	2 324 700		8.8−3	6.5+9	D	71*
47.884	$_{3/2}$	$_{5/2}$	236 530	2 325 000		8.12−2	3.94+10	C	15°,45,71*
47.637	$_{1/2}$	$_{3/2}$	225 520	2 324 700		4.6−2	3.3+10	C	15°,45,71*
46.482	$2p^63s\ ^2S_{1/2}$	$2p^66p\ ^2P^o_{1/2}$	0	2 151 400		1.9−2	2.9+10	D	15°,71*
46.460	$_{1/2}$	$_{3/2}$	0	2 152 400		3.8−2	2.9+10	C	15°,45,71*
46.395	$2p^63p\ ^2P^o_{3/2}$	$2p^68s\ ^2S_{1/2}$	236 530	2 393 000		6.0−3	9.4+9	D	45°,71*
46.118	$_{1/2}$	$_{1/2}$	225 520	2 393 000		3.0−3	4.9+9	D	45°,71*
45.876[C]	$2p^63p\ ^2P^o_{3/2}$	$2p^68d\ ^2D_{3/2}$	236 530	2 416 300		5.6−3	4.5+9	D	71*
45.873	$_{3/2}$	$_{5/2}$	236 530	2 416 500		5.2−2	2.7+10	C	15°,45,71*
45.645	$_{1/2}$	$_{3/2}$	225 520	2 416 300		2.82−2	2.25+10	C	15°,45,71*
44.919	$2p^63p\ ^2P^o_{3/2}$	$2p^69s\ ^2S_{1/2}$	236 530	2 462 800					45
44.594	$2p^63p\ ^2P^o_{3/2}$	$2p^69d\ ^2D_{5/2}$	236 530	2 479 000					15°,45
44.376	$_{1/2}$	$_{3/2}$	225 520	2 479 000					15°,45
44.013	$2p^63p\ ^2P^o_{3/2}$	$2p^610s\ ^2S_{1/2}$	236 530	2 508 600					45
43.741	$2p^63p\ ^2P^o_{3/2}$	$2p^610d\ ^2D_{5/2}$	236 530	2 522 800					45
43.371	$2p^63s\ ^2S_{1/2}$	$2p^67p\ ^2P^o_{3/2}$	0	2 305 700					15°,45
43.371	$_{1/2}$	$_{1/2}$	0	2 305 700					15
43.268	$2p^63p\ ^2P^o_{3/2}$	$2p^611s\ ^2S_{1/2}$	236 530	2 547 800					45
43.103	$2p^63p\ ^2P^o_{3/2}$	$2p^611d\ ^2D_{5/2}$	236 530	2 556 600					15
42.909	$_{1/2}$	$_{3/2}$	225 520	2 556 000					15
41.596	$2p^63s\ ^2S_{1/2}$	$2p^68p\ ^2P^o_{3/2}$	0	2 404 100					15°,45
41.596	$_{1/2}$	$_{1/2}$	0	2 404 100					15
40.477	$2p^63s\ ^2S_{1/2}$	$2p^69p\ ^2P^o_{3/2}$	0	2 470 500					15°,45
40.477	$_{1/2}$	$_{1/2}$	0	2 470 500					15
39.721	$2p^63s\ ^2S_{1/2}$	$2p^610p\ ^2P^o_{3/2}$	0	2 517 600					15°,45
39.721	$_{1/2}$	$_{1/2}$	0	2 517 600					15°
39.181	$2p^63s\ ^2S_{1/2}$	$2p^611p\ ^2P^o_{3/2}$	0	2 552 300					15
39.181	$_{1/2}$	$_{1/2}$	0	2 552 300					15
24.517	$2p^63s\ ^2S_{1/2}$	$2p^53s^2\ ^2P^o_{3/2}$	0	4 079 000					48
24.202	$_{1/2}$	$_{1/2}$	0	4 132 000					48

V XIV (Ne sequence) Ionization Energy = 7 227 000 cm^{-1} (896.0 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
720.456[C]	$2s^22p^5(^2P^\circ_{1/2})3s$	$(^1/_2,^1/_2)^\circ_0$	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^1/_2]_1$	4 248 410	4 387 211		5.3−3	2.3+7	E	71*
508.625	$2s^22p^5(^2P^\circ_{3/2})3s$	$(^3/_2,^1/_2)^\circ_2$	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^1/_2]_1$	4 190 606	4 387 211	2	2.4−1	2.1+9	D	60°,71*
379.694		1		0	4 202 700	4 466 070	2				60
471.884	$2s^22p^5(^2P^\circ_{3/2})3s$	$(^3/_2,^1/_2)^\circ_1$	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^5/_2]_2$	4 202 700	4 414 607	4				60
437.516		2		3	4 190 606	4 419 174	5	7.5−1	3.8+9	D	59,60°,71*
451.865	$2s^22p^5(^2P^\circ_{1/2})3s$	$(^1/_2,^1/_2)^\circ_0$	$2s^22p^5(^2P^\circ_{1/2})3p$	$^2[^3/_2]_1$	4 248 410	4 469 715	2				60
434.887		1		2	4 257 100	4 487 045	3				59,60°
442.779	$2s^22p^5(^2P^\circ_{3/2})3s$	$(^3/_2,^1/_2)^\circ_1$	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^3/_2]_1$	4 202 700	4 428 554	2				60
423.92		1		2	4 202 700	4 438 597	2				60
403.239		2		2	4 190 606	4 438 597	3				60
436.978	$2s^22p^5(^2P^\circ_{1/2})3s$	$(^1/_2,^1/_2)^\circ_1$	$2s^22p^5(^2P^\circ_{1/2})3p$	$^2[^1/_2]_1$	4 257 100	4 485 944	3bl				60
304.211		1		0	4 257 100	4 585 819	1				60
434.91[C]	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^1/_2]_0$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^1/_2]^\circ_1$	4 466 070	4 696 000		1.6−2	1.9+8	D−	71*
327.55[C]		1		0	4 387 211	[4 692 510]		1.2−1	7.5+9	D	71*
323.85[C]		1		1	4 387 211	4 696 000		2.9−1	6.2+9	D	71*
346.161[C]	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^5/_2]_3$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^3/_2]^\circ_2$	4 419 174	4 708 057		2.8−2	3.1+8	E	71*
343.715	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^5/_2]_3$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^7/_2]^\circ_4$	4 419 174	4 710 105	5	1.1	7.2+9	D	59,60°,71*
337.53		3		3	4 419 174	4 715 469	1				60
332.373		2		3	4 414 607	4 715 469	5				59,60
342.783[C]	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^1/_2]_0$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^3/_2]^\circ_1$	4 466 070	4 757 800		1.9−1	3.7+9	D	71*
311.676		1		2	4 387 211	4 708 057	2	2.9−1	4.0+9	E	60°,71*
340.954	$2s^22p^5(^2P^\circ_{1/2})3p$	$^2[^1/_2]_1$	$2s^22p^5(^2P^\circ_{1/2})3d$	$^2[^3/_2]^\circ_2$	4 485 944	4 779 239	3				60
340.392	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^3/_2]_2$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^5/_2]^\circ_3$	4 438 597	4 732 377	3				59,60°
336.177		1		2	4 428 554	4 726 016	2				60
339.852	$2s^22p^5(^2P^\circ_{1/2})3p$	$^2[^3/_2]_2$	$2s^22p^5(^2P^\circ_{1/2})3d$	$^2[^5/_2]^\circ_3$	4 487 045	4 781 291	4				59,60°
328.342		1		2	4 469 715	4 774 275	3				59,60°
109.67[C]	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^1/_2]_1$	$2s2p^63p$	$^3P^\circ_1$	4 387 211	5 299 000		8.1−2	1.5+10	E	71*
90.227	$2s^22p^5(^2P^\circ_{1/2})3d$	$^2[^3/_2]^\circ_1$	$2s^22p^5(^2P^\circ_{1/2})4f$	$^2[^5/_2]_2$	4 827 200	5 935 500	5				61
86.356		2		3	4 779 239	5 937 239	20				43,61°
89.103	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^3/_2]^\circ_1$	$2s^22p^5(^2P^\circ_{3/2})4f$	$^2[^5/_2]_2$	4 757 800	5 880 100	5				61
85.360		2		3	4 708 057	5 879 567	20				43,61°
87.141	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^5/_2]^\circ_3$	$2s^22p^5(^2P^\circ_{3/2})4f$	$^2[^7/_2]_4$	4 732 377	5 879 941	60				43,61°
86.684		2		3	4 726 016	5 879 633	30				43,61°
86.609	$2s^22p^5(^2P^\circ_{1/2})3d$	$^2[^5/_2]^\circ_3$	$2s^22p^5(^2P^\circ_{1/2})4f$	$^2[^7/_2]_4$	4 781 291	5 935 911	40				43,61°
86.125		2		3	4 774 275	5 935 375	15				43,61°
86.148	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^7/_2]^\circ_3$	$2s^22p^5(^2P^\circ_{3/2})4f$	$^2[^9/_2]_4$	4 715 469	5 876 259	80bl				43,61°
85.758		4		5	4 710 105	5 876 175	60				43,61°
85.899	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^7/_2]^\circ_3$	$2s^22p^5(^2P^\circ_{3/2})4f$	$^2[^7/_2]_3$	4 715 469	5 879 633	10				61
85.482		4		4	4 710 105	5 879 941	15				43,61°
84.757	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[^1/_2]^\circ_1$	$2s^22p^5(^2P^\circ_{3/2})4f$	$^2[^3/_2]_2$	4 696 000	5 875 800	5				61
84.420		0		1	[4 692 510]	[5 877 442]	3				61
71.589	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[^3/_2]_2$	$2s^22p^5(^2P^\circ_{3/2})4d$	$^2[^5/_2]^\circ_3$	4 438 597	5 835 457	5				43,61°,62
71.187		1		2	4 428 554	5 833 302	4				61°,62
71.317	$2s^22p^5(^2P^\circ_{1/2})3p$	$^2[^1/_2]_1$	$2s^22p^5(^2P^\circ_{1/2})4d$	$^2[^3/_2]^\circ_2$	4 485 944	5 888 124	2				61°,62

V XIV (Ne sequence) Ionization Energy = 7 227 000 cm^{-1} (896.0 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
71.290	$2s^22p^5(^2P^\circ_{1/2})3p$	$^2[3/2]_2$	$2s^22p^5(^2P^\circ_{1/2})4d$	$^2[5/2]^\circ_3$	4 487 045	5 889 775	4				61°,62
70.573		$_1$		$_2$	4 469 715	5 886 695	2				43,61°,62
71.022	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[5/2]_3$	$2s^22p^5(^2P^\circ_{3/2})4d$	$^2[7/2]^\circ_4$	4 419 174	5 827 194	10				43,61°,62
70.677		$_2$		$_3$	4 414 607	5 829 497	5				43,61°,62
70.487	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[5/2]_2$	$2s^22p^5(^2P^\circ_{3/2})4d$	$^2[5/2]^\circ_2$	4 414 607	5 833 302	1				43,61°
69.726	$2s^22p^5(^2P^\circ_{3/2})3p$	$^2[1/2]_1$	$2s^22p^5(^2P^\circ_{3/2})4d$	$^2[1/2]^\circ_0$	4 387 211	5 821 381	2				61
69.609		$_1$		$_1$	4 387 211	5 823 811	1				61
65.571	$2s^22p^5(^2P^\circ_{1/2})3s$	$(1/2,1/2)^\circ_1$	$2s^22p^5(^2P^\circ_{1/2})4p$	$^2[3/2]_2$	4 257 100	5 782 170	1				61
65.330	$2s^22p^5(^2P^\circ_{3/2})3s$	$(3/2,1/2)^\circ_2$	$2s^22p^5(^2P^\circ_{3/2})4p$	$^2[5/2]_3$	4 190 606	5 721 285	3				61
23.794	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{3/2})3s$	$(3/2,1/2)^\circ_1$	0	4 202 700		1.07−1	4.2+11	C−	23°,71*
23.490	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{1/2})3s$	$(1/2,1/2)^\circ_1$	0	4 257 100		1.23−1	4.96+11	C−	23°,71*
21.294	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[1/2]^\circ_1$	0	4 696 000		9.6−3	4.7+10	E	30,47°,71*
21.018	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{3/2})3d$	$^2[3/2]^\circ_1$	0	4 757 800		3.8−1	1.9+12	D	23°,71*
20.716	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{1/2})3d$	$^2[3/2]^\circ_1$	0	4 827 200		2.51	1.30+13	C−	23°,71*
18.870	$2s^22p^6$	$^1S_0$	$2s2p^63p$	$^3P^\circ_1$	0	5 299 000	3				47
18.782	$2s^22p^6$	$^1S_0$	$2s2p^63p$	$^1P^\circ_1$	0	5 324 000	7				30,47°
17.754	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{3/2})4s$	$(3/2,1/2)^\circ_1$	0	5 632 000	1				47
17.575	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{1/2})4s$	$(1/2,1/2)^\circ_1$	0	5 690 000	1				47
17.094	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{3/2})4d$	$^2[3/2]^\circ_1$	0	5 850 000	4				30,47°
16.939	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{1/2})4d$	$^2[3/2]^\circ_1$	0	5 904 000	5				30,47°
15.748	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{3/2})5d$	$^2[3/2]^\circ_1$	0	6 350 000	1				47
15.609	$2s^22p^6$	$^1S_0$	$2s^22p^5(^2P^\circ_{1/2})5d$	$^2[3/2]^\circ_1$	0	6 407 000	2				47

V XV (F sequence) Ionization Energy = 7 870 000 cm^{-1} (976 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
1719.4	$2s^22p^5$	$^2P^\circ_{3/2}$	$2s^22p^5$	$^2P^\circ_{1/2}$	0	58 093		M1	3.53+3	B	52°,71*
122.005	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s2p^6$	$^2S_{1/2}$	58 093	877 732		1.24−1	2.77+10	C+	17,36,64°,71*
113.930		$_{3/2}$		$_{1/2}$	0	877 732		2.68−1	6.90+10	C+	17,36,64°,71*
22.375	$2s2p^6$	$^2S_{1/2}$	$2s2p^5(^3P^\circ)3s$	$^2P^\circ_{3/2}$	877 732	5 347 000	16				14,30,49°
22.214		$_{1/2}$		$_{1/2}$	877 732	5 379 400	12				49
22.232	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^3P)3s$	$^4P_{1/2}$	58 093	4 556 100	6				49
22.192		$_{3/2}$		$_{5/2}$	0	4 506 100	18	1.3−2	3.0+10	E	13,30,49°,71*
22.083		$_{3/2}$		$_{3/2}$	0	4 528 400	35				14,30,49°
22.192	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^3P)3s$	$^2P_{3/2}$	58 093	4 564 300	18				49
22.083		$_{1/2}$		$_{1/2}$	58 093	4 586 800	35	1.3−1	9.0+11	C−	49°,71*
21.909		$_{3/2}$		$_{3/2}$	0	4 564 300	30				14,30,49°
21.800		$_{3/2}$		$_{1/2}$	0	4 586 800	20	1.12−1	7.9+11	C−	49°,71*

V XV (F sequence) Ionization Energy = 7 870 000 cm^{-1} (976 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
21.832	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^1D)3s$	$^2D_{3/2}$	58 093	4 638 500	20	2.0–1	7.0+11	D	14,30,49°,71*
21.568		3/2		5/2	0	4 636 500	30	2.6–1	6.2+11	D	14,30,49°,71*
21.285	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^1S)3s$	$^2S_{1/2}$	58 093	4 756 200	20	6.8–2	5.0+11	D	49°,71*
21.019		3/2		1/2	0	4 756 200	40bl	3.0–2	2.3+11	E	49°,71*
20.078	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^3P)3d$	$^4P_{3/2}$	58 093	5 039 000	20				49
19.888		3/2		1/2	0	5 028 200	15	1.2–1	9.8+11	E	49°,71*
19.844		3/2		3/2	0	5 039 000	25				49
19.782		3/2		5/2	0	5 055 100	10				49
20.038	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^3P)3d$	$^2P_{1/2}$	58 093	5 048 600	3				14,49°
19.903		1/2		3/2	58 093	5 082 500	18				14,49°
19.80		3/2		1/2	0	5 048 600	5*bl*				14,49°
19.671		3/2		3/2	0	5 082 500	9*bl*				14,49°
19.988	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^3P)3d$	$^2D_{3/2}$	58 093	5 061 300	17				49
19.757		3/2		3/2	0	5 061 300	6				14,49°
19.645		3/2		5/2	0	5 090 400	15				14,30,49°
19.844	$2s^22p^5$	$^2P^\circ_{3/2}$	$2s^22p^4(^3P)3d$	$^4F_{5/2}$	0	5 039 300	25				49
19.725	$2s^22p^5$	$^2P^\circ_{3/2}$	$2s^22p^4(^3P)3d$	$^2F_{5/2}$	0	5 069 700	8				49
19.671	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^1D)3d$	$^2S_{1/2}$	58 093	5 143 200	9*bl*	2.0–1	1.7+12	D	49°,71*
19.443		3/2		1/2	0	5 143 200	25	9.6–1	8.5+12	D	49°,71*
19.589	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^1D)3d$	$^2P_{3/2}$	58 093	5 163 000	15	3.6–1	1.6+12	D	49°,71*
19.369^C		3/2		3/2	0	5 163 000		2.5	1.1+13	D	71*
19.518	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^1D)3d$	$^2D_{3/2}$	58 093	5 181 800	35	2.0	8.8+12	D	49°,71*
19.366		3/2		5/2	0	5 163 700	50				14,30,49°
19.298		3/2		3/2	0	5 181 800	30	3.9–1	1.8+12	D	49°,71*
19.203	$2s^22p^5$	$^2P^\circ_{1/2}$	$2s^22p^4(^1S)3d$	$^2D_{3/2}$	58 093	5 265 600	15	1.4	6.3+12	D	14,49°,71*
19.028		3/2		5/2	0	5 255 400	12	3.6–1	1.1+12	D	14,49°,71*
18.991^C		3/2		3/2	0	5 265 600		2.2–2	1.0+11	E	71*

V XVI (O sequence) Ionization Energy = 8 549 000 cm^{-1} (1060 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
2042.7	$2s^22p^4$	$^3P_2$	$2s^22p^4$	$^3P_1$	0	48 937		M1	2.48+3	C+	52°,71*
2000.6^C		2		0	0	49 970		E2	1.0–1	E	71*
1386.9^C	$2s^22p^4$	$^3P_1$	$2s^22p^4$	$^1D_2$	48 937	121 039		M1	3.0+2	D	71*
826.180^C		2		2	0	121 039		M1	4.0+3	D	71*
857.148^C	$2s^22p^4$	$^1D_2$	$2s^22p^4$	$^1S_0$	121 039	237 705		E2	2.2+1	E	71*
529.9	$2s^22p^4$	$^3P_1$	$2s^22p^4$	$^1S_0$	48 937	237 705		M1	4.2+4	D	52°,71*
178.191^C	$2s^22p^4$	$^1S_0$	$2s2p^5$	$^3P^\circ_1$	237 705	798 899		5.3–3	3.7+8	E	71*
156.060	$2s^22p^4$	$^1D_2$	$2s2p^5$	$^3P^\circ_2$	121 039	761 824		2.0–2	1.1+9	E	64°,71*
140.277	$2s^22p^4$	$^3P_1$	$2s2p^5$	$^3P^\circ_2$	48 937	761 824		1.29–1	8.7+9	C	17,36,64°,71*
133.525		0		1	49 970	798 899		1.02–1	1.27+10	C	17,36,64°,71*
133.338		1		1	48 937	798 899		8.07–2	1.01+10	C	17,36,64°,71*
131.263		2		2	0	761 824		3.9–1	3.0+10	C	17,36,64°,71*
129.195		1		0	48 937	822 961		1.13–1	4.52+10	C	17,36,64°,71*
125.173		2		1	0	798 899		1.52–1	2.16+10	C	17,36,64°,71*

V XVI (O sequence) Ionization Energy = 8 549 000 cm^{-1} (1060 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
138.168	$2s2p^5$	$^1P^o_1$	$2p^6$	$^1S_0$	1 045 590	1 769 360		3.72−1	1.30+11	C	19,41,64°,71*
123.780	$2s^22p^4$	$^1S_0$	$2s2p^5$	$^1P^o_1$	237 705	1 045 590		6.2−2	9.0+9	C	17,36,64°,71*
108.160	$2s^22p^4$	$^1D_2$	$2s2p^5$	$^1P^o_1$	121 039	1 045 590		6.50−1	1.24+11	C	17,36,64°,71*
103.043	$2s2p^5$	$^3P^o_1$	$2p^6$	$^1S_0$	798 899	1 769 360		6.3−3	4.0+9	E	64°,71*
100.440	$2s^22p^4$	$^3P_0$	$2s2p^5$	$^1P^o_1$	49 970	1 045 590		3.2−3	7.1+8	E	64°,71*
100.336^C		1		1	48 937	1 045 590		1.5−3	3.3+8	E	71*
95.640		2		1	0	1 045 590		2.7−2	6.7+9	E	64°,71*
20.659	$2s^22p^4$	$^3P_0$	$2s^22p^3(^4S^o)3s$	$^3S^o_1$	49 970	4 891 000		5.0−2	2.6+11	C−	16°,55,71*
20.659		1		1	48 937	4 891 000		1.02−1	5.3+11	C−	16°,55,71*
20.444		2		1	0	4 891 000		2.6−1	1.4+12	C−	16°,55,71*
20.513	$2s^22p^4$	$^1S_0$	$2s^22p^3(^2P^o)3s$	$^1P^o_1$	237 705	5 113 000		1.5−1	7.9+11	D	16°,55,71*
20.444	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2D^o)3s$	$^1D^o_2$	121 039	5 012 000		4.2−1	1.4+12	C−	16°,55,71*
20.278	$2s^22p^4$	$^3P_0$	$2s^22p^3(^2D^o)3s$	$^3D^o_1$	49 970	4 981 000		3.0−2	1.6+11	C−	16°,55,71*
20.278		1		2	48 937	4 980 000		6.0−2	1.9+11	D	16°,55,71*
20.275^C		1		1	48 937	4 981 000		9.9−2	5.4+11	C−	71*
20.079		2		2	0	4 980 000		1.4−1	4.8+11	D−	16°,55,71*
20.017		2		3	0	4 996 000		2.7−1	6.4+11	C−	16°,55,71*
20.214^C	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2P^o)3s$	$^3P^o_2$	121 039	5 068 000		1.0−1	3.2+11	E	71*
20.149^C	$2s^22p^4$	$^3P_1$	$2s^22p^3(^2D^o)3s$	$^1D^o_2$	48 937	5 012 000		3.9−2	1.3+11	E	71*
19.952^C		2		2	0	5 012 000		2.3−2	7.7+10	E	71*
20.032^C	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2P^o)3s$	$^1P^o_1$	121 039	5 113 000		1.3−1	7.5+11	D	71*
19.924^C	$2s^22p^4$	$^3P_1$	$2s^22p^3(^2P^o)3s$	$^3P^o_2$	48 937	5 068 000		1.0−1	3.5+11	D	71*
19.730		2		2	0	5 068 000		3.7−2	1.3+11	D−	55°,71*
18.890	$2s^22p^4$	$^3P_1$	$2s^22p^3(^4S^o)3d$	$^3D^o_2$	48 937	5 343 000		3.9−1	1.5+12	D	42°,55,71*
18.716^C		2		2	0	5 343 000		2.8−1	1.1+12	D	71*
18.689		2		3	0	5 351 000		1.30	3.55+12	C−	40,42°,71*
18.678^C	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2D^o)3d$	$^3D^o_3$	121 039	5 475 000		5.5−2	1.5+11	E	71*
18.630	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2D^o)3d$	$^1D^o_2$	121 039	5 489 000					42°,55
18.525	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2D^o)3d$	$^1F^o_3$	121 039	5 518 000		2.0	5.6+12	D	40,42°,55,71*
18.492	$2s^22p^4$	$^3P_1$	$2s^22p^3(^2D^o)3d$	$^3D^o_2$	48 937	5 457 000					40°,42
18.265		2		3	0	5 475 000		3.6	1.0+13	C−	36,40,42°,71*
18.265	$2s^22p^4$	$^1D_2$	$2s^22p^3(^2P^o)3d$	$^1F^o_3$	121 039	5 596 000					9°,40,42
18.26	$2s^22p^4$	$^3P_2$	$2s^22p^3(^2D^o)3d$	$^3P^o_2$	0	5 476 000					42°,55
18.123^C	$2s^22p^4$	$^3P_2$	$2s^22p^3(^2D^o)3d$	$^1F^o_3$	0	5 518 000		8.5−1	2.5+12	E	71*
18.12	$2s^22p^4$	$^3P_0$	$2s^22p^3(^2P^o)3d$	$^3D^o_1$	49 970	5 568 000					36,42°
18.12		1		1	48 937	5 568 000					9
18.008		2		3	0	5 552 000					36,40,42°,55

V XVII (N sequence) Ionization Energy = 9 420 000 cm^{-1} (1168 eV)

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
5172.^{C}	$2s^22p^3\ ^2D^o_{3/2}$	$2s^22p^3\ ^2D^o_{5/2}$	120 930	140 260		M1	6.2+1	C	71*
3438.^{C}	$2s^22p^3\ ^2P^o_{1/2}$	$2s^22p^3\ ^2P^o_{3/2}$	211 420	240 500		M1	1.71+2	C	71*
1624.^{C}	$2p^5\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	1 636 530	1 698 100		M1	4.29+3	C+	71*
1405.^{C}	$2s^22p^3\ ^2D^o_{5/2}$	$2s^22p^3\ ^2P^o_{1/2}$	140 260	211 420		E2	5.8−1	E	71*
1105.^{C}	3/2	1/2	120 930	211 420		M1	2.4+3	D	71*
997.61^{C}	5/2	3/2	140 260	240 500		M1	3.3+3	D	71*
836.33^{C}	3/2	3/2	120 930	240 500		M1	9.0+3	D	71*
826.92^{C}	$2s^22p^3\ ^4S^o_{3/2}$	$2s^22p^3\ ^2D^o_{3/2}$	0	120 930		M1	3.6+3	D	71*
712.96^{C}	3/2	5/2	0	140 260		M1	1.5+2	D−	71*
472.99^{C}	$2s^22p^3\ ^4S^o_{3/2}$	$2s^22p^3\ ^2P^o_{1/2}$	0	211 420		M1	8.2+3	D−	71*
415.80^{C}	3/2	3/2	0	240 500		M1	1.1+4	D	71*
258.36^{C}	$2s^22p^3\ ^2P^o_{3/2}$	$2s(^2S)2p^4(^3P)\ ^4P_{5/2}$	240 500	627 560		1.2−3	2.0+7	E	71*
234.90^{C}	3/2	3/2	240 500	666 210		2.8−3	8.6+7	E	71*
212.69^{C}	1/2	1/2	211 420	681 580		8.8−4	6.5+7	E	71*
205.21^{C}	$2s^22p^3\ ^2D^o_{5/2}$	$2s(^2S)2p^4(^3P)\ ^4P_{5/2}$	140 260	627 560		3.9−3	1.0+8	E	71*
197.38^{C}	3/2	5/2	120 930	627 560		5.6−3	1.6+8	E	71*
183.39^{C}	3/2	3/2	120 930	666 210		4.4−4	2.2+7	E	71*
178.36^{C}	3/2	1/2	120 930	681 580		7.2−4	7.5+7	E	71*
184.05^{C}	$2s(^2S)2p^4(^3P)\ ^2P_{1/2}$	$2p^5\ ^2P^o_{3/2}$	1 093 200	1 636 530		4.40−2	2.17+9	C	71*
167.279	3/2	3/2	1 038 740	1 636 530		4.48−1	2.67+10	C	41,42,65°,71*
165.322	1/2	1/2	1 093 200	1 698 100		2.16−1	2.64+10	C	41,42,65°,71*
151.656	3/2	1/2	1 038 740	1 698 100		1.56−1	2.26+10	C	65°,71*
159.65^{C}	$2s^22p^3\ ^2P^o_{3/2}$	$2s(^2S)2p^4(^1D)\ ^2D_{3/2}$	240 500	866 880		8.0−3	5.2+8	D	71*
158.143	3/2	5/2	240 500	872 820		1.12−1	5.0+9	C	41,65°,71*
152.566	1/2	3/2	211 420	866 880		3.82−2	2.74+9	C	17,41,65°,71*
159.347	$2s^22p^3\ ^4S^o_{3/2}$	$2s(^2S)2p^4(^3P)\ ^4P_{5/2}$	0	627 560		2.5−1	1.1+10	C	17,36,41,65°,71*
150.103	3/2	3/2	0	666 210		1.81−1	1.34+10	C	17,36,41,65°,71*
146.719	3/2	1/2	0	681 580		9.52−2	1.47+10	C	17,41,65°,71*
157.070	$2s(^2S)2p^4(^1S)\ ^2S_{1/2}$	$2p^5\ ^2P^o_{3/2}$	999 840	1 636 530		9.30−2	6.3+9	C	65°,71*
143.21^{C}	1/2	1/2	999 840	1 698 100		2.8−3	4.6+8	D	71*
137.62^{C}	$2s^22p^3\ ^2D^o_{5/2}$	$2s(^2S)2p^4(^1D)\ ^2D_{3/2}$	140 260	866 880		5.1−3	4.5+8	E	71*
136.511	5/2	5/2	140 260	872 820		4.3−1	2.5+10	C	17,36,41,65°,71*
134.056	3/2	3/2	120 930	866 880		3.3−1	3.1+10	C	17,36,41,65°,71*
133.00^{C}	3/2	5/2	120 930	872 820		1.1−4	7.0+6	E	71*
131.687	$2s^22p^3\ ^2P^o_{3/2}$	$2s(^2S)2p^4(^1S)\ ^2S_{1/2}$	240 500	999 840		3.6−2	6.8+9	D	36,50,65°,71*
126.832	1/2	1/2	211 420	999 840		1.4−1	2.9+10	C	36,50,65°,71*
130.941	$2s(^2S)2p^4(^1D)\ ^2D_{5/2}$	$2p^5\ ^2P^o_{3/2}$	872 820	1 636 530		3.8−1	3.7+10	C	19,41,42,65°,71*
129.927	3/2	3/2	866 880	1 636 530		1.06−1	1.05+10	C	19,65°,71*
120.304	3/2	1/2	866 880	1 698 100		1.75−1	4.04+10	C	19,41,42,65°,71*
125.278	$2s^22p^3\ ^2P^o_{3/2}$	$2s(^2S)2p^4(^3P)\ ^2P_{3/2}$	240 500	1 038 740		8.28−2	8.8+9	C	17,41,65°,71*
120.873	1/2	3/2	211 420	1 038 740		6.2+9	5.42−2	C	17,36,41,65°,71*
117.276	3/2	1/2	240 500	1 093 200		2.8−1	6.9+10	C	17,36,41,65°,71*
113.406	1/2	1/2	211 420	1 093 200		2.02−2	5.2+9	C	17,41,65°,71*
115.36^{C}	$2s^22p^3\ ^4S^o_{3/2}$	$2s(^2S)2p^4(^1D)\ ^2D_{3/2}$	0	866 880		2.6−3	3.3+8	E	71*
113.785	$2s^22p^3\ ^2D^o_{3/2}$	$2s(^2S)2p^4(^1S)\ ^2S_{1/2}$	120 930	999 840		1.1−1	2.9+10	E	50,65°,71*
111.299	$2s^22p^3\ ^2D^o_{5/2}$	$2s(^2S)2p^4(^3P)\ ^2P_{3/2}$	140 260	1 038 740		6.00−1	8.08+10	C	17,36,41,65°,71*
108.952	3/2	3/2	120 930	1 038 740		1.08−1	1.51+10	C	17,41,65°,71*
102.854	3/2	1/2	120 930	1 093 200		1.02−1	3.22+10	C	17,36,41,65°,71*

V XVII (N sequence) Ionization Energy = 9 420 000 cm^{-1} (1168 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
104.72[C]	$2s(^2S)2p^4(^3P)$	$^4P_{1/2}$	$2p^5$	$^2P^\circ_{3/2}$	681 580	1 636 530		1.1−3	1.6+8	E	71*
103.06[C]		3/2		3/2	666 210	1 636 530		3.1−3	4.9+8	E	71*
99.111[C]		5/2		3/2	627 560	1 636 530		7.2−3	1.2+9	E	71*
98.375[C]		1/2		1/2	681 580	1 698 100		1.2−3	4.1+8	E	71*
100.02[C]	$2s^22p^3$	$^4S^\circ_{3/2}$	$2s(^2S)2p^4(^1S)$	$^2S_{1/2}$	0	999 840		1.9−3	6.3+8	E	71*
96.270	$2s^22p^3$	$^4S^\circ_{3/2}$	$2s(^2S)2p^4(^3P)$	$^2P_{3/2}$	0	1 038 740		9.6−3	1.7+9	E	65°,71*
91.475[C]		3/2		1/2	0	1 093 200		4.0−4	1.6+8	E	71*
17.644	$2s^22p^3$	$^2D^\circ_{3/2}$	$2s^22p^2(^3P)3d$	$^2F_{5/2}$	120 930	5 789 000					40
17.536		5/2		7/2	140 260	5 843 000					40°,42
17.490	$2s^22p^3$	$^2P^\circ_{3/2}$	$2s^22p^2(^1D)3d$	$^2D_{5/2}$	240 500	5 958 000					40°,42
17.373	$2s^22p^3$	$^2D^\circ_{5/2}$	$2s^22p^2(^3P)3d$	$^2D_{5/2}$	140 260	5 897 000					40°,42
17.259	$2s^22p^3$	$^2D^\circ_{5/2}$	$2s^22p^2(^1D)3d$	$^2F_{7/2}$	140 260	5 934 000					36,40°,42
17.16		3/2		5/2	120 930	5 948 000					42
17.158	$2s^22p^3$	$^4S^\circ_{3/2}$	$2s^22p^2(^3P)3d$	$^4P_{3/2}$	0	5 828 000					40°,42
17.158		3/2		5/2	0	5 828 000					40°,42

V XVIII (C sequence) Ionization Energy = 10 160 000 cm^{-1} (1260 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
3307.[C]	$2s^22p^2$	$^3P_1$	$2s^22p^2$	$^3P_2$	37 960	68 190		M1	3.24+2	C+	71*
2634.[C]		0		1	0	37 960		M1	9.21+2	E	71*
1466.[C]		0		2	0	68 190		E2	7.9−2	E	71*
1078.2	$2s^22p^2$	$^3P_2$	$2s^22p^2$	$^1D_2$	68 190	160 910		M1	3.7+3	D+	52°,71*
813.34[C]		1		2	37 960	160 910		M1	3.2+3	D	71*
925.15[C]	$2s^22p^2$	$^1D_2$	$2s^22p^2$	$^1S_0$	160 910	269 000		E2	1.3+1	E	71*
434.2[T]	$2s^22p^2$	$^3P_1$	$2s^22p^2$	$^1S_0$	37 960	269 000		M1	4.3+4	D	52°,71*
334.81[C]	$2s^22p^2$	$^3P_2$	$2s(^2S)2p^3(^4S^\circ)$	$^5S^\circ_2$	68 190	366 868		1.0−3	1.2+7	E	71*
304.04[C]		1		2	37 960	366 868		6.3−4	9.1+6	E	71*
290.45[C]	$2s(^2S)2p^3(^2P^\circ)$	$^1P^\circ_1$	$2p^4$	$^3P_2$	1 014 420	1 358 710		4.8−3	7.6+7	E	71*
252.30[C]		1		1	1 014 420	1 410 770		1.0−2	3.6+8	E	71*
280.87[C]	$2s^22p^2$	$^1S_0$	$2s(^2S)2p^3(^2D^\circ)$	$^3D^\circ_1$	269 000	625 040		1.0−3	2.8+7	E	71*
222.08[C]	$2s(^2S)2p^3(^2D^\circ)$	$^1D^\circ_2$	$2p^4$	$^3P_2$	908 420	1 358 710		1.9−2	5.1+8	E	71*
199.06[C]		2		1	908 420	1 410 770		1.6−3	9.0+7	E	71*
216.69	$2s(^2S)2p^3(^4S^\circ)$	$^3S^\circ_1$	$2p^4$	$^3P_2$	897 330	1 358 710		2.1−1	6.0+9	C	44°,71*
194.76[C]		1		1	897 330	1 410 770		1.7−1	9.8+9	C	71*
192.76[C]		1		0	897 330	1 416 110		6.93−2	1.24+10	C	71*
216.01[C]	$2s^22p^2$	$^1D_2$	$2s(^2S)2p^3(^2D^\circ)$	$^3D^\circ_2$	160 910	623 860		1.0−3	3.0+7	E	71*
215.46[C]		2		1	160 910	625 040		1.8−3	8.8+7	E	71*
210.95[C]		2		3	160 910	634 950		2.1−2	4.6+8	E	71*
214.63[C]	$2s(^2S)2p^3(^2P^\circ)$	$^1P^\circ_1$	$2p^4$	$^1D_2$	1 014 420	1 480 330		1.31−1	3.79+9	C	71*
214.40[C]	$2s^22p^2$	$^1S_0$	$2s(^2S)2p^3(^2P^\circ)$	$^3P^\circ_1$	269 000	735 420		1.8−3	8.7+7	E	71*

V XVIII (C sequence) Ionization Energy = 10 160 000 cm^{-1} (1260 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
179.96^C	$2s^22p^2$	$^3P_2$	$2s(^2S)2p^3(^2D^o)$	$^3D^o_2$	68 190	623 860		9.5−4	3.9+7	E	71*
179.58^C		2		1	68 190	625 040		2.6−4	1.8+7	E	71*
176.440		2		3	68 190	634 950		1.82−1	5.6+9	C	41,42,79°,71*
170.678		1		2	37 960	623 860		1.6−1	7.4+9	C	41,42,79°,71*
170.33^C		1		1	37 960	625 040		1.6−2	1.2+9	D	71*
159.991		0		1	0	625 040		8.7−2	7.6+9	C	41,42,44,79°,71*
174.852	$2s(^2S)2p^3(^2D^o)$	$^1D^o_2$	$2p^4$	$^1D_2$	908 420	1 480 330		6.60−1	2.88+10	C	44,79°,71*
174.06^C	$2s^22p^2$	$^1D_2$	$2s(^2S)2p^3(^2P^o)$	$^3P^o_1$	160 910	735 420		3.3−3	2.4+8	E	71*
171.69^C		2		2	160 910	743 350		3.3−3	1.5+8	E	71*
162.53	$2s(^2S)2p^3(^2P^o)$	$^3P^o_2$	$2p^4$	$^3P_2$	743 350	1 358 710		6.95−2	3.51+9	C	44°,71*
160.40		1		2	735 420	1 358 710		5.82−2	3.02+9	C	44°,71*
149.86		2		1	743 350	1 410 770		1.21−1	1.2+10	C	44°,71*
148.07^C		1		1	735 420	1 410 770		4.8−4	4.9+7	E	71*
147.30		0		1	731 870	1 410 770		3.67−2	3.76+9	C	44°,71*
146.91^C		1		0	735 420	1 416 110		5.16−2	1.59+10	C	71*
159.15^C	$2s^22p^2$	$^1S_0$	$2s(^2S)2p^3(^4S^o)$	$^3S^o_1$	269 000	897 330		3.5−3	3.0+8	E	71*
152.933	$2s(^2S)2p^3(^2P^o)$	$^1P^o_1$	$2p^4$	$^1S_0$	1 014 420	1 668 300		2.3−1	6.7+10	C	44,79°,71*
149.86	$2s^22p^2$	$^3P_2$	$2s(^2S)2p^3(^2P^o)$	$^3P^o_1$	68 190	735 420		3.7−2	3.6+9	D	41,44°,71*
148.113		2		2	68 190	743 350		2.5−1	1.5+10	C	41,42,44,50,79°, 71*
144.111		1		0	37 960	731 870		5.61−2	1.8+10	C	41,44,79°,71*
143.377		1		1	37 960	735 420		9.36−2	1.01+10	C	41,44,79°,71*
141.73		1		2	37 960	743 350		1.3−2	8.8+8	D	41°,71*
136.00		0		1	0	735 420		3.27−2	3.93+9	C	41°,44,71*
138.168	$2s(^2S)2p^3(^2D^o)$	$^3D^o_3$	$2p^4$	$^3P_2$	634 950	1 358 710		3.9−1	2.7+10	C	42,79°,71*
136.30^C		1		2	625 040	1 358 710		2.6−2	1.9+9	D	71*
136.08^C		2		2	623 860	1 358 710		1.47−1	1.06+10	C	71*
127.27		1		1	625 040	1 410 770		9.03−2	1.24+10	C	42°,71*
127.079		2		1	623 860	1 410 770		1.47−1	2.02+10	C	42,79°,71*
126.411		1		0	625 040	1 416 110		7.44−2	3.11+10	C	79°,71*
135.69^C	$2s(^2S)2p^3(^2P^o)$	$^3P^o_2$	$2p^4$	$^1D_2$	743 350	1 480 330		8.5−3	6.2+8	E	71*
134.24^C		1		2	735 420	1 480 330		6.6−3	4.9+8	E	71*
134.1	$2s^22p^2$	$^1S_0$	$2s(^2S)2p^3(^2P^o)$	$^1P^o_1$	269 000	1 014 420		1.17−1	1.45+10	C	41°,71*
133.778	$2s^22p^2$	$^1D_2$	$2s(^2S)2p^3(^2D^o)$	$^1D^o_2$	160 910	908 420		5.50−1	4.10+10	C	41,42,50,79°,71*
129.71^C	$2s(^2S)2p^3(^4S^o)$	$^3S^o_1$	$2p^4$	$^1S_0$	897 330	1 668 300		9.3−3	3.7+9	E	71*
120.607	$2s^22p^2$	$^3P_2$	$2s(^2S)2p^3(^4S^o)$	$^3S^o_1$	68 190	897 330		3.3−1	5.0+10	C	41,42,50,79°,71*
116.365		1		1	37 960	897 330		1.44−1	2.37+10	C	41,42,50,79°,71*
111.442		0		1	0	897 330		4.73−2	8.5+9	C	41,42,50,79°,71*
119.015	$2s^22p^2$	$^3P_2$	$2s(^2S)2p^3(^2D^o)$	$^1D^o_2$	68 190	908 420		4.4−2	4.1+9	E	79°,71*
114.88^C		1		2	37 960	908 420		1.8−3	1.8+8	E	71*
118.29^C	$2s(^2S)2p^3(^2D^o)$	$^3D^o_3$	$2p^4$	$^1D_2$	634 950	1 480 330		3.0−2	2.9+9	E	71*
116.76^C		2		2	623 860	1 480 330		4.5−3	4.4+8	E	71*
117.163	$2s^22p^2$	$^1D_2$	$2s(^2S)2p^3(^2P^o)$	$^1P^o_1$	160 910	1 014 420		3.5−1	5.6+10	C	41,42,50,79°,71*
107.19^C	$2s(^2S)2p^3(^2P^o)$	$^3P^o_1$	$2p^4$	$^1S_0$	735 420	1 668 300		3.0−3	1.7+9	E	71*
102.410	$2s^22p^2$	$^3P_1$	$2s(^2S)2p^3(^2P^o)$	$^1P^o_1$	37 960	1 014 420		1.3−2	2.8+9	E	79°,71*
100.83^C	$2s(^2S)2p^3(^4S^o)$	$^5S^o_2$	$2p^4$	$^3P_2$	366 960	1 358 710		3.8−3	5.0+8	E	71*
95.803^C		2		1	366 960	1 410 770		6.0−4	1.5+8	E	71*

V XVIII (C sequence) Ionization Energy = 10 160 000 cm^{-1} (1260 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
17.717	$2s^22p^2$	$^1D_2$	$2s^22p3s$	$^1P^\circ_1$	160 910	5 805 000					57
17.678	$2s^22p^2$	$^3P_2$	$2s^22p3s$	$^3P^\circ_1$	68 190	5 726 000					57
17.482		2		2	68 190	5 786 000					57
17.400		1		2	37 960	5 786 000					57
17.545	$2s(^2S)2p^3(^2D^\circ)$	$^3D^\circ_2$	$2s2p^2(^2D)3s$	$^3D_2$	623 860	6 323 300					57
17.442	$2s(^2S)2p^3(^4S^\circ)$	$^5S^\circ_2$	$2s2p^2(^4P)3s$	$^5P_3$	366 960	6 100 000					57
17.018	$2s(^2S)2p^3(^2D^\circ)$	$^3D^\circ_2$	$2s2p^2(^4P)3d$	$^3F_3$	623 860	6 500 000					57
16.914	$2s^22p^2$	$^1D_2$	$2s^22p3d$	$^3F^\circ_2$	160 910	6 073 000					10
16.787	$2s^22p^2$	$^1S_0$	$2s^22p3d$	$^1P^\circ_1$	269 000	6 226 000					10°,57
16.558	$2s(^2S)2p^3(^2D^\circ)$	$^3D^\circ_3$	$2s2p^2(^2D)3d$	$^3F_4$	634 950	6 674 000					40,57°
16.467	$2s^22p^2$	$^1D_2$	$2s^22p3d$	$^1F^\circ_3$	160 910	6 234 000					40,42,57
16.378	$2s^22p^2$	$^3P_2$	$2s^22p3d$	$^3D^\circ_3$	68 190	6 174 000		3.1	1.1+13	E	40,42°,57,71*
16.341	$2s(^2S)2p^3(^4S^\circ)$	$^5S^\circ_2$	$2s2p^2(^4P)3d$	$^5P_3$	366 868	6 486 000					57
16.32^C	$2s^22p^2$	$^3P_2$	$2s^22p3d$	$^3P^\circ_1$	68 190	6 195 000		3.5−1	2.9+12	E	71*
16.24^C		1		1	37 960	6 195 000		6.9−1	5.8+12	E	71*

V XIX (B sequence) Ionization Energy = 10 930 000 cm^{-1} (1355 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
1457.6	$2s^22p$	$^2P^\circ_{1/2}$	$2s^22p$	$^2P^\circ_{3/2}$	0	68 610		M1	2.9+3	B	52°,71*
438.0^C	$2s2p^2$	$^2P_{3/2}$	$2p^3$	$^4S^\circ_{3/2}$	802 560	1 030 850+x		1.7−3	1.4+7	E	71*
306.8^C	$2s^22p$	$^2P^\circ_{3/2}$	$2s2p^2$	$^4P_{5/2}$	68 610	394 560+x		1.8−3	2.2+7	E	71*
301.0^C		1/2		1/2	0	332 180+x		7.8−4	2.9+7	E	71*
285.4^C	$2s2p^2$	$^2P_{3/2}$	$2p^3$	$^2D^\circ_{3/2}$	802 560	1 152 900		3.2−3	6.5+7	E	71*
275.1^C		3/2		5/2	802 560	1 166 100		1.89−1	2.78+9	C	71*
230.8^C	$2s2p^2$	$^2D_{3/2}$	$2p^3$	$^4S^\circ_{3/2}$	597 590	1 030 850+x		7.2−4	2.3+7	E	71*
204.0^C	$2s2p^2$	$^2P_{3/2}$	$2p^3$	$^2P^\circ_{1/2}$	802 560	1 292 800		2.9−2	2.3+9	D	71*
198.51		1/2		1/2	788 850	1 292 800					44
193.93		3/2		3/2	802 560	1 318 200		3.1−1	1.4+10	C	44°,71*
189.04^C	$2s^22p$	$^2P^\circ_{3/2}$	$2s2p^2$	$^2D_{3/2}$	68 610	597 590		3.3−3	1.6+8	E	71*
186.32		3/2		5/2	68 610	605 320		1.54−1	4.92+9	C	41,42°,71*
167.34		1/2		3/2	0	597 590		1.2−1	7.3+9	C	41,42°,71*
182.6^C	$2s2p^2$	$^2D_{5/2}$	$2p^3$	$^2D^\circ_{3/2}$	605 320	1 152 900		7.08−2	3.54+9	C	71*
180.07		3/2		3/2	597 590	1 152 900		1.33−1	6.9+9	C	44°,71*
178.32		5/2		5/2	605 320	1 166 100		2.98−1	1.04+10	C	44°,71*
175.9^C		3/2		5/2	597 590	1 166 100		5.52−2	1.98+9	C	71*
166.19	$2s2p^2$	$^2S_{1/2}$	$2p^3$	$^2P^\circ_{3/2}$	716 370	1 318 200					44
157.17	$2s2p^2$	$^4P_{5/2}$	$2p^3$	$^4S^\circ_{3/2}$	394 560+x	1 030 850+x		2.44−1	1.64+10	C	42°,71*
149.42		3/2		3/2	361 600+x	1 030 850+x		1.68−1	1.25+10	C	42°,71*
143.13		1/2		3/2	332 180+x	1 030 850+x		9.12−2	7.4+9	C	42°,71*

V XIX (B sequence) Ionization Energy = 10 930 000 cm^{-1} (1355 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
143.82	$2s2p^2$ $^2D_{3/2}$	$2p^3$ $^2P^o_{1/2}$	597 590	1 292 800		1.35–1	2.18+10	C	44°,71*
140.25	$_{5/2}$	$_{3/2}$	605 320	1 318 200		1.43–1	1.21+10	C	44°,71*
138.78	$_{3/2}$	$_{3/2}$	597 590	1 318 200		4.44–2	3.84+9	C	44°,71*
139.59	$2s^22p$ $^2P^o_{1/2}$	$2s2p^2$ $^2S_{1/2}$	0	716 370					41,42°
138.84	$2s^22p$ $^2P^o_{3/2}$	$2s2p^2$ $^2P_{1/2}$	68 610	788 850					41,42°
136.25	$_{3/2}$	$_{3/2}$	68 610	802 560		3.8–1	3.4+10	C	18,41,42°,71*
124.60^{C}	$_{1/2}$	$_{3/2}$	0	802 560		5.06–2	5.4+9	C	41,71*
129.6^{C}	$2s2p^2$ $^4P_{5/2}$	$2p^3$ $^2D^o_{5/2}$	394 560+x	1 166 100		1.0–2	6.7+8	E	71*
126.4^{C}	$_{3/2}$	$_{3/2}$	361 600+x	1 152 900		6.0–3	6.3+8	E	71*
108.3^{C}	$2s2p^2$ $^4P_{5/2}$	$2p^3$ $^2P^o_{3/2}$	394 560+x	1 318 200		6.0–4	8.6+7	E	71*
104.5^{C}	$_{3/2}$	$_{3/2}$	361 600+x	1 318 200		1.0–3	1.6+8	E	71*
104.1^{C}	$_{1/2}$	$_{1/2}$	332 180+x	1 292 800		3.6–4	1.1+8	E	71*
16.007	$2s2p^2$ $^2D_{3/2}$	$2s2p(^3P^o)3d$ $^2F^o_{5/2}$	597 590	6 845 000					40°,42
15.924	$_{5/2}$	$_{7/2}$	605 320	6 885 000					40°,42
15.73^{C}	$2s^22p$ $^2P^o_{3/2}$	$2s^23d$ $^2D_{3/2}$	68 610	6 427 000		2.6–1	1.7+12	D	71*
15.702	$_{3/2}$	$_{5/2}$	68 610	6 437 000		2.3	1.0+13	D	40°,42,71*
15.560	$_{1/2}$	$_{3/2}$	0	6 427 000		1.3	9.0+12	D	40°,42,71*
15.63	$2s2p^2$ $^4P_{5/2}$	$2s2p(^3P^o)3d$ $^4D^o_{7/2}$	394 560+x	6 792 000+x					42
15.63	$2s2p^2$ $^4P_{5/2}$	$2s2p(^3P^o)3d$ $^4P^o_{5/2}$	394 560+x	6 792 000+x					42
15.495	$2s2p^2$ $^2D_{5/2}$	$2s2p(^1P^o)3d$ $^2F^o_{7/2}$	605 320	7 059 000					40°,42
15.333	$2s^22p$ $^2P^o_{3/2}$	$2s2p(^3P^o)3p$ $^2P_{3/2}$	68 610	6 590 000					40°,42
15.039	$2s^22p$ $^2P^o_{3/2}$	$2s2p(^3P^o)3p$ $^2D_{5/2}$	68 610	6 718 000					40°,42
14.636	$2s^22p$ $^2P^o_{3/2}$	$2s2p(^1P^o)3p$ $^2D_{5/2}$	68 610	6 901 000					40

V XX (Be sequence) Ionization Energy = 11 990 000 cm^{-1} (1486 eV)

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
5127.^{C}	$2s2p$ $^3P^o_0$	$2s2p$ $^3P^o_1$	303 100	322 600		M1	1.29+2	C+	71*
1908.^{C}	$_1$	$_2$	322 600	375 000		M1	1.91+3	C+	71*
3154.^{C}	$2p^2$ $^3P_1$	$2p^2$ $^3P_2$	856 900	888 600		M1	3.53+2	C	71*
2717.^{C}	$_0$	$_1$	820 100	856 900		M1	8.3+2	C	71*
1064.^{C}	$2p^2$ $^3P_2$	$2p^2$ $^1D_2$	888 600	982 600		M1	4.1+3	D+	71*
795.5^{C}	$_1$	$_2$	856 900	982 600		M1	4.1+3	D+	71*
686.8^{C}	$2s3p$ $^1P^o_1$	$2s3d$ $^1D_2$	6 964 000	7 109 600		1.6–1	4.5+8	E	71*
519.2^{C}	$2s2p$ $^1P^o_1$	$2p^2$ $^3P_0$	627 500	820 100		6.3–4	1.6+7	E	71*
435.9^{C}	$_1$	$_1$	627 500	856 900		2.5–4	2.9+6	E	71*
383.0^{C}	$_1$	$_2$	627 500	888 600		1.6–2	1.5+8	D	71*
396.0^{C}	$2s2p$ $^3P^o_2$	$2s2p$ $^1P^o_1$	375 000	627 500		M1	4.5+3	D	71*
328.0^{C}	$_1$	$_1$	322 600	627 500		M1	4.8+3	D–	71*
308.3^{C}	$_0$	$_1$	303 100	627 500		M1	7.7+3	D–	71*
311.8^{C}	$2p^2$ $^3P_1$	$2p^2$ $^1S_0$	856 900	1 177 600		M1	6.2+4	D	71*
310.0^{C}	$2s^2$ $^1S_0$	$2s2p$ $^3P^o_1$	0	322 600		8.3–4	1.9+7	D	71*

V XX (Be sequence) Ionization Energy = 11 990 000 cm^{-1} (1486 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
281.62	$2s2p$	$^1P^o_1$	$2p^2$	$^1D_2$	627 500	982 600		1.94−1	3.26+9	B	44°,71*
207.51	$2s2p$	$^3P^o_2$	$2p^2$	$^3P_1$	375 000	856 900		7.40−2	3.82+9	B	44°,71*
201.02		1		0	322 600	820 100		6.21−2	1.03+10	B	44°,71*
194.74		2		2	375 000	888 600		2.04−1	7.18+9	B	44°,71*
187.17		1		1	322 600	856 900		4.89−2	3.10+9	B	44°,71*
180.58		0		1	303 100	856 900		6.88−2	4.69+9	B	44°,71*
176.68		1		2	322 600	888 600		8.94−2	3.82+9	B	44°,71*
181.78	$2s2p$	$^1P^o_1$	$2p^2$	$^1S_0$	627 500	1 177 600		1.23−1	2.48+10	B	44°,71*
164.59	$2s2p$	$^3P^o_2$	$2p^2$	$^1D_2$	375 000	982 600		4.2−2	2.1+9	C	44°,71*
151.5[C]		1		2	322 600	982 600		2.9−3	1.7+8	D	71*
159.355[P]	$2s^2$	$^1S_0$	$2s2p$	$^1P^o_1$	0	627 500		1.69−1	1.48+10	B	27°,71*
15.639	$2p^2$	$^1S_0$	$2p3d$	$^1P^o_1$	1 177 600	7 571 900		1.29	1.17+13	C−	11°,71*
15.526[C]	$2p^2$	$^1D_2$	$2p3d$	$^1D^o_2$	982 600	7 423 300		3.0−1	1.7+12	C−	71*
15.427	$2s2p$	$^1P^o_1$	$2s3d$	$^1D_2$	627 500	7 109 600		1.8	1.0+13	C−	7,8,11°,42,71*
15.336	$2p^2$	$^3P_2$	$2p3d$	$^3F^o_3$	888 600	7 409 200		7.0−1	2.8+12	C−	11°,71*
15.332[C]	$2p^2$	$^1D_2$	$2p3d$	$^3P^o_2$	982 600	7 505 000		4.5−1	2.6+12	C−	71*
15.303[C]	$2p^2$	$^3P_2$	$2p3d$	$^1D^o_2$	888 600	7 423 300		1.1−1	6.3+11	C−	71*
15.229		1		2	856 900	7 423 300		1.1	6.4+12	D	11°,71*
15.272[C]	$2p^2$	$^3P_2$	$2p3d$	$^3D^o_1$	888 600	7 436 500		6.5−3	6.2+10	D	71*
15.198[C]		1		1	856 900	7 436 500		3.0−1	2.9+12	C−	71*
15.187[C]		2		2	888 600	7 473 300		1.3−1	7.5+11	D	71*
15.141		2		3	888 600	7 493 200		3.5	1.5+13	C−	8,11°,40,42,71*
15.114		1		2	856 900	7 473 300		1.36	7.9+12	C−	11°,42,71*
15.114		0		1	820 100	7 436 500		1.28	1.25+13	C−	11°,71*
15.216	$2p^2$	$^1D_2$	$2p3d$	$^1F^o_3$	982 600	7 554 600		5.25	2.16+13	C−	8,11°,40,42,71*
15.176[C]	$2p^2$	$^1D_2$	$2p3d$	$^1P^o_1$	982 600	7 571 900		7.5−2	7.2+11	D	71*
15.114	$2p^2$	$^3P_2$	$2p3d$	$^3P^o_2$	888 600	7 505 000		1.44	8.4+12	C−	11°,71*
15.042[C]		1		2	856 900	7 505 000		1.5−1	8.8+11	D	71*
14.989[C]	$2s2p$	$^3P^o_2$	$2s3d$	$^3D_1$	375 000	7 046 600		3.6−2	3.6+11	C−	71*
14.987[C]		2		2	375 000	7 047 500		5.5−1	3.3+12	C−	71*
14.976		2		3	375 000	7 052 400		3.0	1.3+13	C−	7,8,40°,42,71*
14.872[C]		1		1	322 600	7 046 600		5.4−1	5.4+12	C−	71*
14.870		1		2	322 600	7 047 500		1.6	1.0+13	C−	7,8,11°,40,42,71*
14.829		0		1	303 100	7 046 600		7.4−1	7.5+12	C−	11°,71*
14.759[C]	$2s2p$	$^1P^o_1$	$2p3p$	$^3P_2$	627 500	7 402 900		1.4−1	8.6+11	D	71*
14.649	$2s2p$	$^1P^o_1$	$2p3p$	$^1D_2$	627 500	7 453 900		7.2−1	4.5+12	C−	7,8,11°,71*
14.401	$2s^2$	$^1S_0$	$2s3p$	$^3P^o_1$	0	6 943 800		3.1−1	3.3+12	C−	11°,71*
14.387[C]	$2s2p$	$^3P^o_2$	$2p3p$	$^3D_2$	375 000	7 325 900		3.1−2	2.0+11	D	71*
14.279		1		2	322 600	7 325 900		4.5−1	2.9+12	C−	7,8,11°,71*
14.279		2		3	375 000	7 378 300		7.0−1	3.3+12	C−	7,11°,40,42,71*
14.360	$2s^2$	$^1S_0$	$2s3p$	$^1P^o_1$	0	6 964 000		3.8−1	4.1+12	C−	7,8,11°,40,42,71*
14.229	$2s2p$	$^3P^o_2$	$2p3p$	$^3P_2$	375 000	7 402 900		4.9−1	3.2+12	C−	11°,40,71*
14.124[C]		1		2	322 600	7 402 900		3.9−2	2.6+11	D	71*

V xx (Be sequence) Ionization Energy = 11 990 000 cm^{-1} (1486 eV) – Continued

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
11.615	$2s2p\ ^1P^o_1$	$2s4d\ ^1D_2$	627 500	9 237 100					11
11.523	$2p^2\ ^1D_2$	$2p4d\ ^1F^o_3$	982 600	9 660 900					11
11.523	$2p^2\ ^3P_2$	$2p4d\ ^3F^o_3$	888 600	9 567 000					11
11.478	$2p^2\ ^3P_1$	$2p4d\ ^3D^o_2$	856 900	9 569 200					11
11.427	0	1	820 100	9 571 300					11
11.427	2	3	888 600	9 639 800					11
11.427	$2p^2\ ^3P_2$	$2p4d\ ^3P^o_2$	888 600	9 639 800					11
11.378	$2p^2\ ^3P_1$	$2p4d\ ^1D^o_2$	856 900	9 645 800					11
11.308	$2s2p\ ^3P^o_2$	$2s4d\ ^3D_3$	375 000	9 218 300					11
11.243	1	2	322 600	9 217 000					11
11.215	0	1	303 100	9 219 700					11
10.941	$2s^2\ ^1S_0$	$2s4p\ ^1P^o_1$	0	9 140 000		1.6−1	3.0+12	D	11[c],71*
10.838	$2s2p\ ^3P^o_2$	$2p4p\ ^3D_3$	375 000	9 601 800					11

V xxi (Li sequence) Ionization Energy = 12 660 000 cm^{-1} (1569.6 eV)

λ (Å)	Classification		Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
1324.[C]	$1s^22p\ ^2P^o_{1/2}$	$1s^22p\ ^2P^o_{3/2}$	340 470	416 020		M1	3.87+3	B	71*
293.71[C]	$1s^22s\ ^2S_{1/2}$	$1s^22p\ ^2P^o_{1/2}$	0	340 470		4.04−2	1.56+9	B+	71*
240.37	1/2	3/2	0	416 020		9.96−2	2.87+9	B+	44[c],71*
89.45[C]	$1s^24p\ ^2P^o_{3/2}$	$1s^25d\ ^2D_{5/2}$	9 603 000	10 721 000		2.08	2.89+11	C+	71*
89.45[C]	1/2	3/2	9 603 000	10 721 000		1.15	2.41+11	C+	71*
89.45[C]	3/2	3/2	9 603 000	10 721 000		2.3−1	4.8+10	D	71*
48.26[C]	$1s^24p\ ^2P^o_{3/2}$	$1s^27d\ ^2D_{5/2}$	9 603 000	11 675 000		2.21−1	1.05+11	C+	71*
48.26[C]	1/2	3/2	9 603 000	11 675 000		1.23−1	8.79+10	C+	71*
48.26[C]	3/2	3/2	9 603 000	11 675 000		2.4−2	1.8+10	D	71*
41.75[C]	$1s^23p\ ^2P^o_{3/2}$	$1s^24d\ ^2D_{3/2}$	7 232 000	9 627 200		2.3−1	2.2+11	C+	71*
41.68[C]	3/2	5/2	7 232 000	9 631 000		2.1	1.4+12	B	71*
41.37[C]	1/2	3/2	7 210 000	9 627 200		1.2	1.1+12	B	71*
28.66[C]	$1s^23p\ ^2P^o_{3/2}$	$1s^25d\ ^2D_{5/2}$	7 232 000	10 721 000		4.94−1	6.68+11	C+	71*
28.66[C]	3/2	3/2	7 232 000	10 721 000		5.6−2	1.1+11	D	71*
28.48[C]	1/2	3/2	7 210 000	10 721 000		2.76−1	5.67+11	C+	71*
24.49[C]	$1s^23p\ ^2P^o_{3/2}$	$1s^26d\ ^2D_{5/2}$	7 232 000	11 315 000		2.00−1	3.70+11	C+	71*
24.49[C]	3/2	3/2	7 232 000	11 315 000		2.2−2	6.2+10	D	71*
24.36[C]	1/2	3/2	7 210 000	11 315 000		1.12−1	3.14+11	C+	71*
14.929	$1s^22p\ ^2P^o_{3/2}$	$1s^23s\ ^2S_{1/2}$	416 020	7 114 400					3[c],40,56
14.758	1/2	1/2	340 470	7 114 400					3[c],40,56
14.592	$1s^22p\ ^2P^o_{3/2}$	$1s^23d\ ^2D_{3/2}$	416 020	7 269 100		2.7−1	2.1+12	B	3[c],71*
14.578	3/2	5/2	416 020	7 275 700		2.44	1.28+13	B	3[c],40,56,71*
14.435	1/2	3/2	340 470	7 269 100		1.34	1.07+13	B	3[c],40,56,71*
13.870	$1s^22s\ ^2S_{1/2}$	$1s^23p\ ^2P^o_{1/2}$	0	7 210 000		2.52−1	4.37+12	B	3[c],40,56,71*
13.828	1/2	3/2	0	7 232 000		4.88−1	4.26+12	B	3[c],40,56,71*

V XXI (Li sequence) Ionization Energy = 12 660 000 cm^{-1} (1569.6 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
10.853	$1s^22p$	$^2P^o_{3/2}$	$1s^24d$	$^2D_{5/2}$	416 020	9 631 000		4.4−1	4.2+12	B	3°,56,71*
10.853		3/2		3/2	416 020	9 627 200		4.8−2	6.7+11	C+	3°,71*
10.768		1/2		3/2	340 470	9 627 200		2.4−1	3.5+12	B	3°,56,71*
10.413	$1s^22s$	$^2S_{1/2}$	$1s^24p$	$^2P^o_{1/2}$	0	9 603 000					3°,56
10.413		1/2		3/2	0	9 603 000					3°,56
9.704	$1s^22p$	$^2P^o_{3/2}$	$1s^25d$	$^2D_{5/2}$	416 020	10 721 000		1.62−1	1.91+12	C+	3°,71*
9.704		3/2		3/2	416 020	10 721 000		1.8−2	3.2+11	D	3°,71*
9.633		1/2		3/2	340 470	10 721 000		9.06−2	1.63+12	C+	3°,71*
9.352	$1s^22s$	$^2S_{1/2}$	$1s^25p$	$^2P^o_{3/2}$	0	10 693 000					3
9.352		1/2		1/2	0	10 693 000					3
9.175	$1s^22p$	$^2P^o_{3/2}$	$1s^26d$	$^2D_{5/2}$	416 020	11 315 000		7.92−2	1.04+12	C+	3°,71*
9.175		3/2		3/2	416 020	11 315 000		8.8−3	1.8+11	D	3°,71*
9.111		1/2		3/2	340 470	11 315 000		4.44−2	8.91+11	C+	3°,71*
8.882	$1s^22p$	$^2P^o_{3/2}$	$1s^27d$	$^2D_{5/2}$	416 020	11 675 000		4.52−2	6.06+11	C+	3°,71*
8.882		3/2		3/2	416 020	11 675 000		5.2−3	1.1+11	D	3°,71*
8.826		1/2		3/2	340 470	11 675 000		2.52−2	5.40+11	C+	3°,71*
8.843	$1s^22s$	$^2S_{1/2}$	$1s^26p$	$^2P^o_{3/2}$	0	11 308 000					3
8.843		1/2		1/2	0	11 308 000					3
8.703	$1s^22p$	$^2P^o_{3/2}$	$1s^28d$	$^2D_{5/2}$	416 020	11 906 000					3
8.703		3/2		3/2	416 020	11 906 000					3
8.643		1/2		3/2	340 470	11 906 000					3
8.576	$1s^22s$	$^2S_{1/2}$	$1s^27p$	$^2P^o_{3/2}$	0	11 660 000					3
8.576		1/2		1/2	0	11 660 000					3
2.4450	$1s^22p$	$^2P^o_{3/2}$	$1s2s^2$	$^2S_{1/2}$	416 020	41 317 000					85
2.4403		1/2		1/2	340 470	41 317 000					85
2.4130	$1s^22p$	$^2P^o_{3/2}$	$1s2p^2$	$^4P_{5/2}$	416 020	41 858 000					8,85°
2.4038	$1s^22p$	$^2P^o_{3/2}$	$1s2p^2$	$^2D_{5/2}$	416 020	42 017 000		7.2−1	1.4+14	C	1,2,8,85°,71*
2.4006		1/2		3/2	340 470	41 997 000		6.6−1	1.9+14	C	1,2,8,85°,71*
2.3993	$1s^22s$	$^2S_{1/2}$	$1s(^2S)2s2p(^3P^o)$	$^2P^o_{1/2}$	0	41 679 000		1.56−1	9.0+13	C	85°,71*
2.3970		1/2		3/2	0	41 719 000		2.4−2	7.2+12	D	85°,71*
2.3990	$1s^22p$	$^2P^o_{3/2}$	$1s2p^2$	$^2P_{3/2}$	416 020	42 100 000		1.4	3.9+14	C	1,2,8,85°,71*
2.3912	$1s^22s$	$^2S_{1/2}$	$1s(^2S)2s2p(^1P^o)$	$^2P^o_{1/2}$	0	41 820 000					1,2,8,85
2.3912		1/2		3/2	0	41 820 000					2,8,85
2.3906	$1s^22p$	$^2P^o_{3/2}$	$1s2p^2$	$^2S_{1/2}$	416 020	42 247 000		2.4−1	1.4+14	D	1,2,8,85°,71*

V XXII (He sequence) Ionization Energy = 55 259 380 cm^{-1} (6851.292 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	gf	A (s^{-1})	Acc.	References
$8128.^C$	$1s5s$	$^1S_0$	$1s5p$	$^1P^o_1$	[53 119 700]	[53 132 000]		1.0−1	3.4+6	E	71*
$7872.^C$	$1s5s$	$^3S_1$	$1s5p$	$^3P^o_1$	[53 107 300]	[53 120 000]		9.6−2	3.4+6	E	71*
$4165.^C$	$1s4s$	$^1S_0$	$1s4p$	$^1P^o_1$	[51 911 000]	[51 935 000]		8.1−2	1.0+7	E	71*
$4015.^C$	$1s4s$	$^3S_1$	$1s4p$	$^3P^o_1$	[51 886 600]	[51 911 500]		7.8−2	1.1+7	E	71*
$1755.^C$	$1s3s$	$^1S_0$	$1s3p$	$^1P^o_1$	[49 292 760]	[49 349 740]		5.8−2	4.2+7	D	71*

V XXII (He sequence) Ionization Energy = 55 259 380 cm⁻¹ (6851.292 eV) – Continued

λ (Å)	Classification				Energy Levels (cm⁻¹)		Int.	gf	A (s⁻¹)	Acc.	References
1695.[C]	1s3s	$^3S_1$	1s3p	$^3P^o_1$	[49 234 710]	[49 293 700]		5.4−2	4.2+7	E	71*
513.98[C]	1s2s	$^1S_0$	1s2p	$^1P^o_1$	[41 787 780]	[41 982 340]		3.27−2	2.76+8	B	71*
496.77[C]	1s2s	$^3S_1$	1s2p	$^3P^o_0$	[41 568 820]	[41 770 120]		1.15−2	3.12+8	B	71*
469.07[C]		1		1	[41 568 820]	[41 782 010]		3.51−2	3.54+8	B	71*
355.86[C]		1		2	[41 568 820]	[41 849 830]		8.04−2	8.48+8	B	71*
241.83[C]	1s2s	$^3S_1$	1s2p	$^1P^o_1$	[41 568 820]	[41 982 340]		3.72−3	1.41+8	B	71*
84.410[C]	1s4p	$^1P^o_1$	1s5s	$^1S_0$	[51 935 000]	[53 119 700]		1.7−1	1.6+11	C	71*
83.626[C]	1s4p	$^3P^o_1$	1s5s	$^3S_1$	[51 911 500]	[53 107 300]		1.6−1	5.2+10	D	71*
81.900[C]	1s4s	$^1S_0$	1s5p	$^1P^o_1$	[51 911 000]	[53 132 000]		4.5−1	1.5+11	D	71*
81.077[C]	1s4s	$^3S_1$	1s5p	$^3P^o_1$	[51 886 600]	[53 120 000]		4.56−1	1.54+11	C	71*
39.043[C]	1s3p	$^1P^o_1$	1s4s	$^1S_0$	[49 349 740]	[51 911 000]		1.0−1	4.5+11	C	71*
38.743[C]	1s3d	$^1D_2$	1s4p	$^1P^o_1$	[49 353 910]	[51 935 000]		5.5−2	8.2+10	C	71*
38.654[C]	1s3p	$^1P^o_1$	1s4d	$^1D_2$	[49 349 740]	[51 936 800]		1.9	1.7+12	C	71*
38.567[C]	1s3p	$^3P^o_1$	1s4s	$^3S_1$	[49 293 700]	[51 886 600]		1.0−1	1.5+11	C−	71*
37.847[C]	1s3s	$^1S_0$	1s4p	$^1P^o_1$	[49 292 760]	[51 935 000]		4.08−1	6.3+11	C	71*
37.358[C]	1s3s	$^3S_1$	1s4p	$^3P^o_1$	[49 234 710]	[51 911 500]		4.08−1	6.5+11	C	71*
26.525[C]	1s3p	$^1P^o_1$	1s5s	$^1S_0$	[49 349 740]	[53 119 700]		2.3−2	2.2+11	C	71*
26.222[C]	1s3p	$^3P^o_1$	1s5s	$^3S_1$	[49 293 700]	[53 107 300]		2.3−2	7.5+10	D	71*
26.047[C]	1s3s	$^1S_0$	1s5p	$^1P^o_1$	[49 292 760]	[53 132 000]		1.05−1	3.44+11	C+	71*
25.738[C]	1s3s	$^3S_1$	1s5p	$^3P^o_1$	[49 234 710]	[53 120 000]		1.0−1	3.5+11	C	71*
13.679[C]	1s2p	$^1P^o_1$	1s3s	$^1S_0$	[41 982 340]	[49 292 760]		4.5−2	1.6+12	C+	71*
13.566[C]	1s2p	$^1P^o_1$	1s3d	$^1D_2$	[41 982 340]	[49 353 910]		2.1	1.5+13	C+	71*
13.418[C]	1s2p	$^3P^o_1$	1s3s	$^3S_1$	[41 782 010]	[49 234 710]		4.2−2	5.2+11	C−	71*
13.224[C]	1s2s	$^1S_0$	1s3p	$^1P^o_1$	[41 787 780]	[49 349 740]		3.70−1	4.70+12	C	71*
12.945[C]	1s2s	$^3S_1$	1s3p	$^3P^o_1$	[41 568 820]	[49 293 700]		3.72−1	4.94+12	C	71*
10.072[C]	1s2p	$^1P^o_1$	1s4s	$^1S_0$	[41 982 340]	[51 911 000]		9.3−3	6.1+11	C	71*
10.046[C]	1s2p	$^1P^o_1$	1s4d	$^1D_2$	[41 982 340]	[51 936 800]		3.6−1	4.8+12	C	71*
9.8965[C]	1s2p	$^3P^o_1$	1s4s	$^3S_1$	[41 782 010]	[51 886 600]		9.6−3	2.2+11	D	71*
9.8549[C]	1s2s	$^1S_0$	1s4p	$^1P^o_1$	[41 787 780]	[51 935 000]		9.0−2	2.1+12	C+	71*
9.6687[C]	1s2s	$^3S_1$	1s4p	$^3P^o_1$	[41 568 820]	[51 911 500]		9.0−2	2.1+12	C+	71*
8.9788[C]	1s2p	$^1P^o_1$	1s5s	$^1S_0$	[41 982 340]	[53 119 700]		3.9−3	3.2+11	C	71*
8.8298[C]	1s2p	$^3P^o_1$	1s5s	$^3S_1$	[41 782 010]	[53 107 300]		3.9−3	1.1+11	D	71*
8.8151[C]	1s2s	$^1S_0$	1s5p	$^1P^o_1$	[41 787 780]	[53 132 000]		3.7−2	1.1+12	C+	71*
8.6571[C]	1s2s	$^3S_1$	1s5p	$^3P^o_1$	[41 568 820]	[53 120 000]		3.6−2	1.1+12	C+	71*

V XXII (He sequence) Ionization Energy = 55 259 380 cm^{-1} (6851.292 eV) – Continued

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
2.4056^C	$1s^2$	$^1S_0$	$1s2s$	$^3S_1$	0	[41 568 820]		M1	6.07+7	B	71*,85
2.3941^C	$1s^2$	$^1S_0$	$1s2p$	$^3P^o_0$	0	[41 770 120]					85
2.3934^C		0		1	0	[41 782 010]		4.22−2	1.64+13	B	1,2,71*,85
2.3895^C		0		2	0	[41 849 830]		M2	2.43+9	B	71*,85
2.3820^C	$1s^2$	$^1S_0$	$1s2p$	$^1P^o_1$	0	[41 982 340]		7.28−1	2.85+14	B	1,2,4,6,71*,73,74
2.0287^C	$1s^2$	$^1S_0$	$1s3p$	$^3P^o_1$	0	[49 293 700]		1.1−2	5.9+12	E	71*
2.0264^C	$1s^2$	$^1S_0$	$1s3p$	$^1P^o_1$	0	[49 349 740]		1.40−1	7.58+13	C+	6,71*
1.9264^C	$1s^2$	$^1S_0$	$1s4p$	$^3P^o_1$	0	[51 911 500]		3.8−3	2.3+12	E	71*
1.9255^C	$1s^2$	$^1S_0$	$1s4p$	$^1P^o_1$	0	[51 935 000]		5.18−2	3.11+13	C+	71*
1.8825^C	$1s^2$	$^1S_0$	$1s5p$	$^3P^o_1$	0	[53 120 000]		1.9−3	1.2+12	E	71*
1.8821^C	$1s^2$	$^1S_0$	$1s5p$	$^1P^o_1$	0	[53 132 000]		2.50−2	1.57+13	C+	71*

V XXIII (H sequence) Ionization Energy = 58 443 920 cm^{-1} (7246.18 eV)

λ (Å)	Classification				Energy Levels (cm^{-1})		Int.	*gf*	*A* (s^{-1})	Acc.	References
987.36^C	$2s$	$^2S_{1/2}$	$2p$	$^2P^o_{3/2}$	[43 804 530]	[43 905 810]		2.10−2	3.58+7	A	83*
35.294^C	$3p$	$^2P^o_{3/2}$	$4d$	$^2D_{5/2}$	[51 978 720]	[54 812 040]		2.23	1.99+12	A	83*
34.977^C	$3s$	$^2S_{1/2}$	$4p$	$^2P^o_{3/2}$	[51 948 740]	[54 807 770]		6.55−1	8.93+11	A	83*
24.203^C	$3d$	$^2D_{5/2}$	$5f$	$^2F^o_{7/2}$	[51 988 830]	[56 120 600]		8.96−1	1.28+12	A	83*
24.150^C	$3p$	$^2P^o_{3/2}$	$5d$	$^2D_{5/2}$	[51 978 720]	[56 119 500]		5.03−1	9.59+11	A	83*
23.989^C	$3s$	$^2S_{1/2}$	$5p$	$^2P^o_{3/2}$	[51 948 740]	[56 117 320]		1.63−1	4.72+11	A	83*
12.372^C	$2p$	$^2P^o_{3/2}$	$3d$	$^2D_{5/2}$	[43 905 810]	[51 988 830]		2.51	1.82+13	A	83*
12.234^C	$2s$	$^2S_{1/2}$	$3p$	$^2P^o_{3/2}$	[43 804 530]	[51 978 720]		5.88−1	6.55+12	A	83*
9.1691^C	$2p$	$^2P^o_{3/2}$	$4d$	$^2D_{5/2}$	[43 905 810]	[54 812 040]		4.39−1	5.81+12	A	83*
9.0882^C	$2s$	$^2S_{1/2}$	$4p$	$^2P^o_{3/2}$	[43 804 530]	[54 807 770]		1.38−1	2.80+12	A	83*
8.1875^C	$2p$	$^2P^o_{3/2}$	$5d$	$^2D_{5/2}$	[43 905 810]	[56 119 500]		1.60−1	2.65+12	A	83*
8.1216^C	$2s$	$^2S_{1/2}$	$5p$	$^2P^o_{3/2}$	[43 804 530]	[56 117 320]		5.65−2	1.43+12	A	83*
2.2830^C	$1s$	$^2S_{1/2}$	$2p$	$^2P^o_{1/2}$	0	[43 801 550]		2.79−1	1.79+14	A	83*
2.2776^C		$_{1/2}$		$_{3/2}$	0	[43 905 810]		5.60−1	1.80+14	A	83*
1.9239^C	$1s$	$^2S_{1/2}$	$3p$	$^2P^o_{3/2}$	0	[51 978 720]		1.06−1	4.79+13	A	83*
1.8246^C	$1s$	$^2S_{1/2}$	$4p$	$^2P^o_{3/2}$	0	[54 807 770]		3.89−2	1.95+13	A	83*
1.7820^C	$1s$	$^2S_{1/2}$	$5p$	$^2P^o_{3/2}$	0	[56 117 320]		1.87−2	9.83+12	A	83*

5. Explanation of Grotrian Diagrams

Notations on the Diagrams generally have the same meanings as for the Tables (see Explanation of Tables).

Abscissa

Energy of the levels in cm^{-1}.

Short vertical lines

Energy levels are indicated as the vertical lines. The electronic configuration (with the parentage in parentheses) and the level energy in cm^{-1} are given to the right of the vertical line, and at the top is the J value. Energy levels with the same LS label for the upper term are grouped together. The term designation is given at the right of the diagram; the ordering is by increasing multiplicity and orbital angular momentum. For the lower level, the term is adjacent to the configuration.

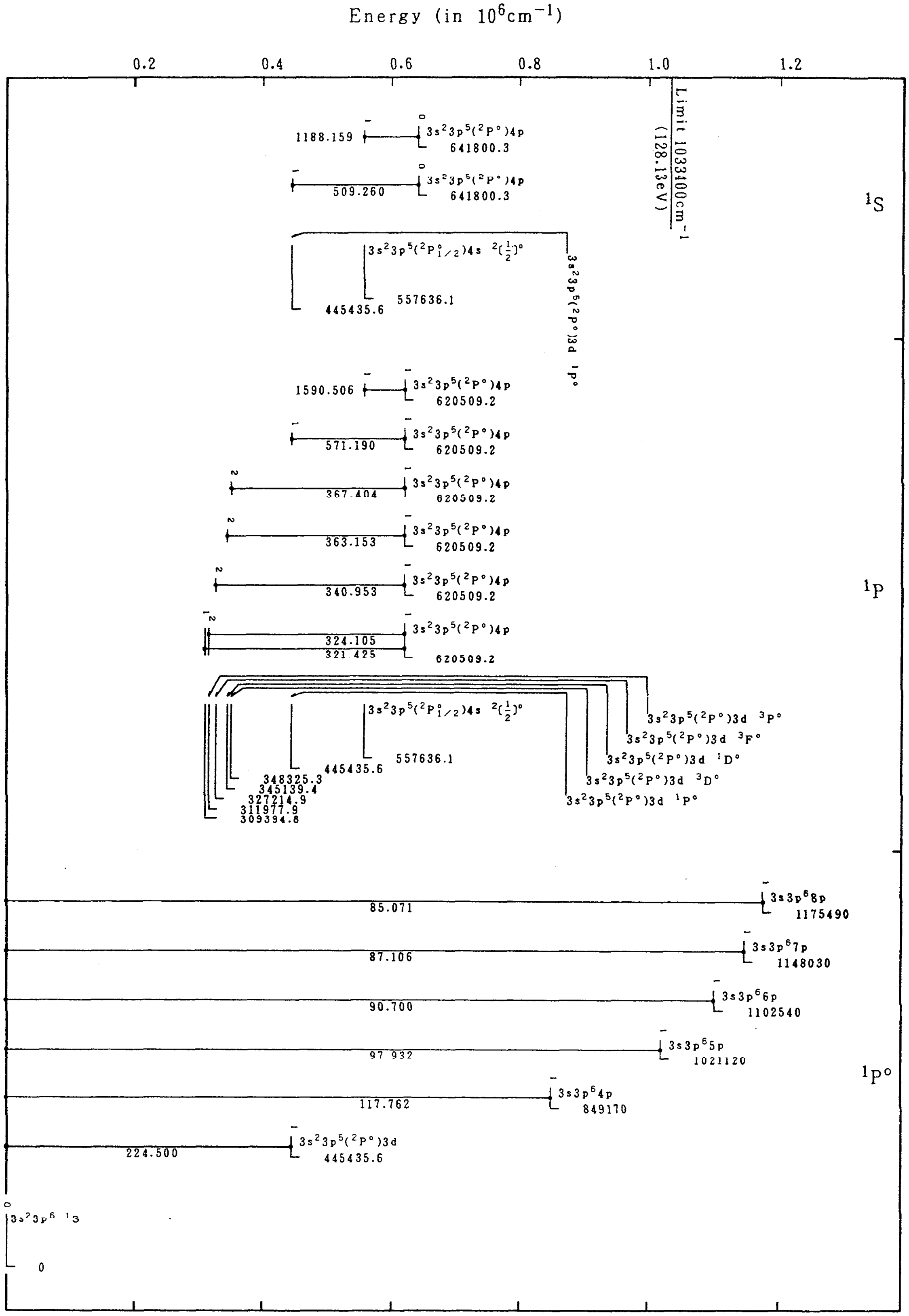
Horizontal lines

Transitions between levels. The number below each line gives the transition wavelength in Angstroms (10^{-8} cm). Heavier lines indicate resonance transitions with absorption oscillator strengths $f \geq 0.01$.

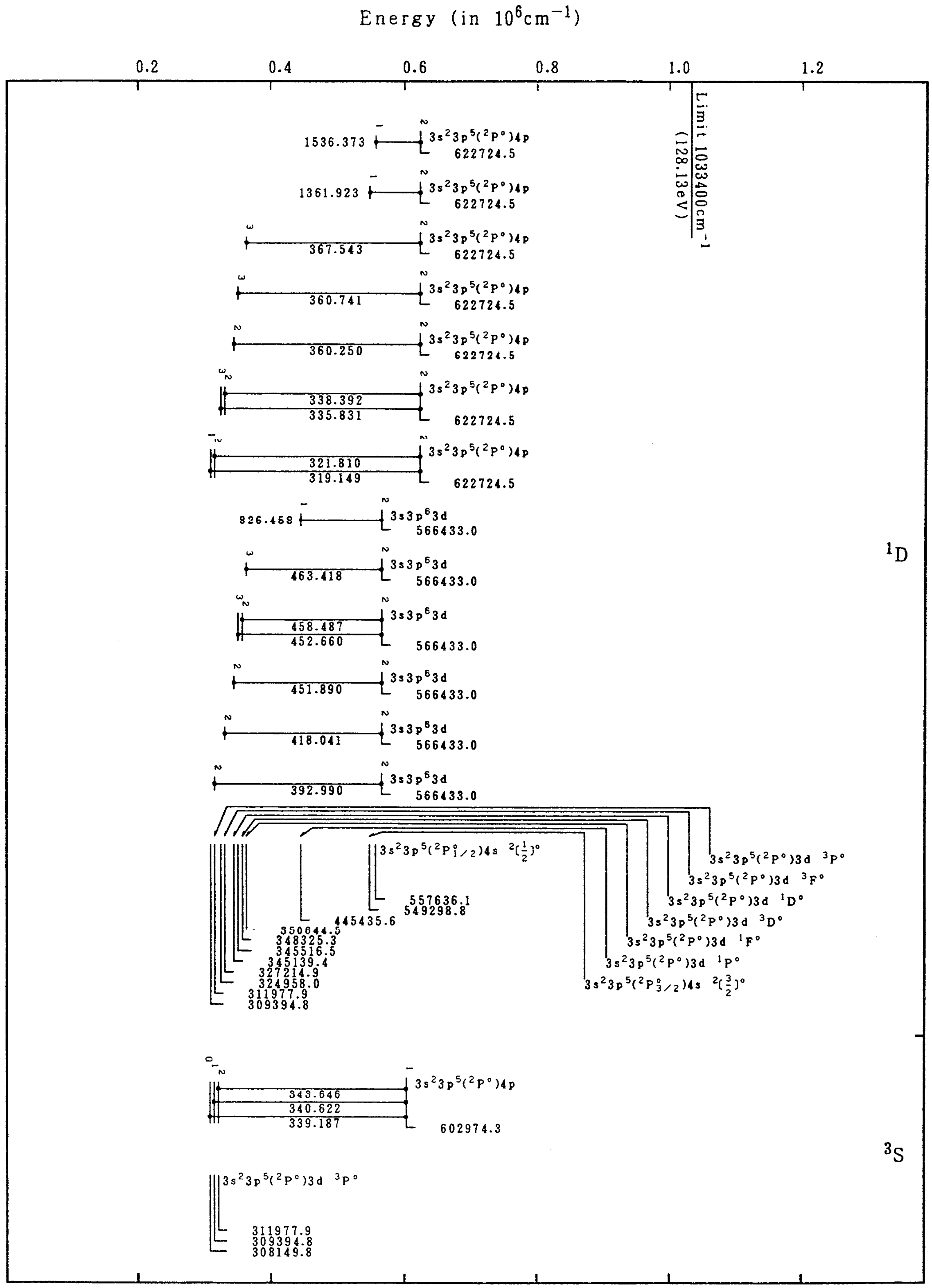
Limit

Principal ionization limit in cm^{-1} and eV.

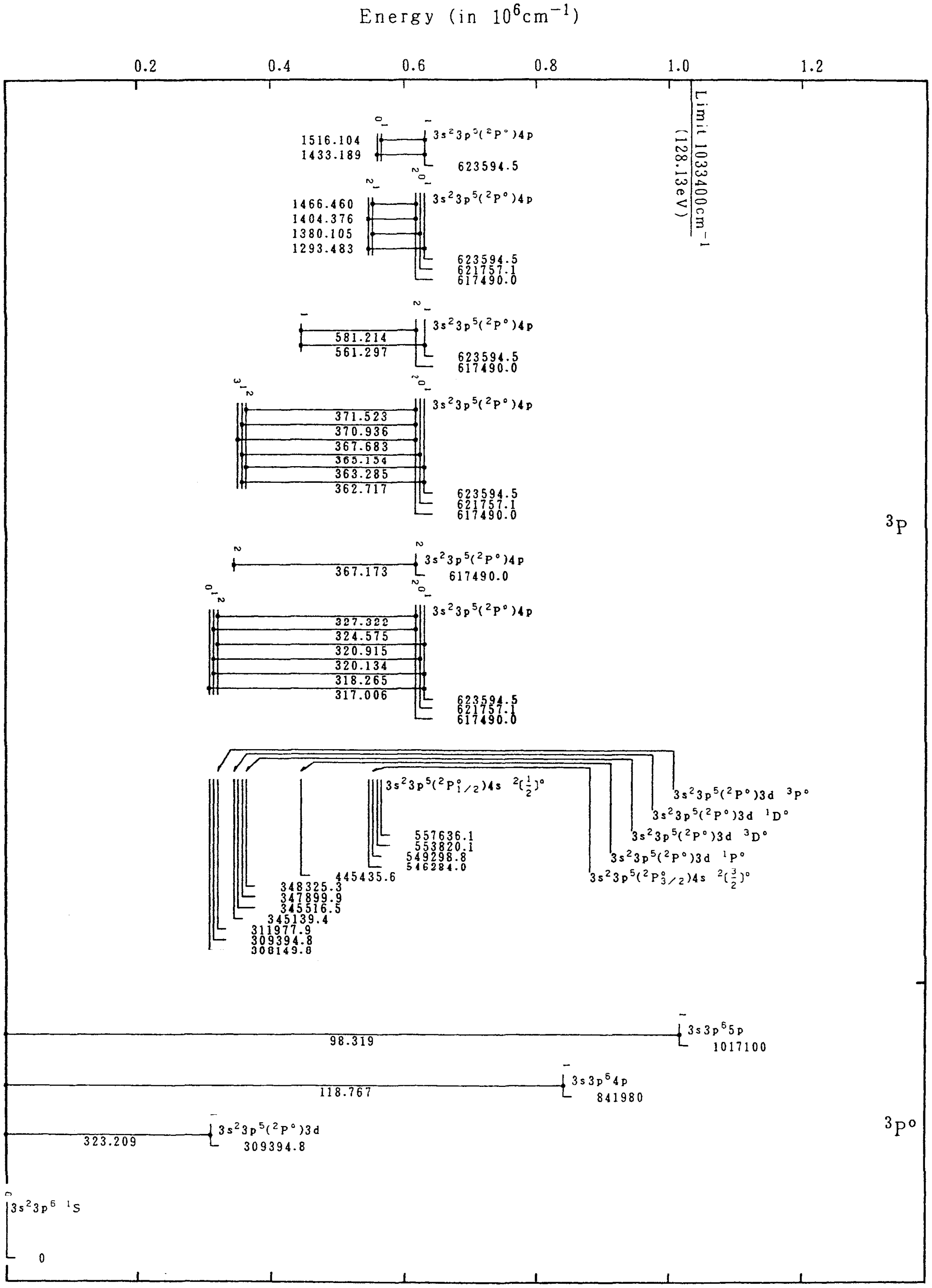
6. Grotrian Diagrams for V VI through V XXIII



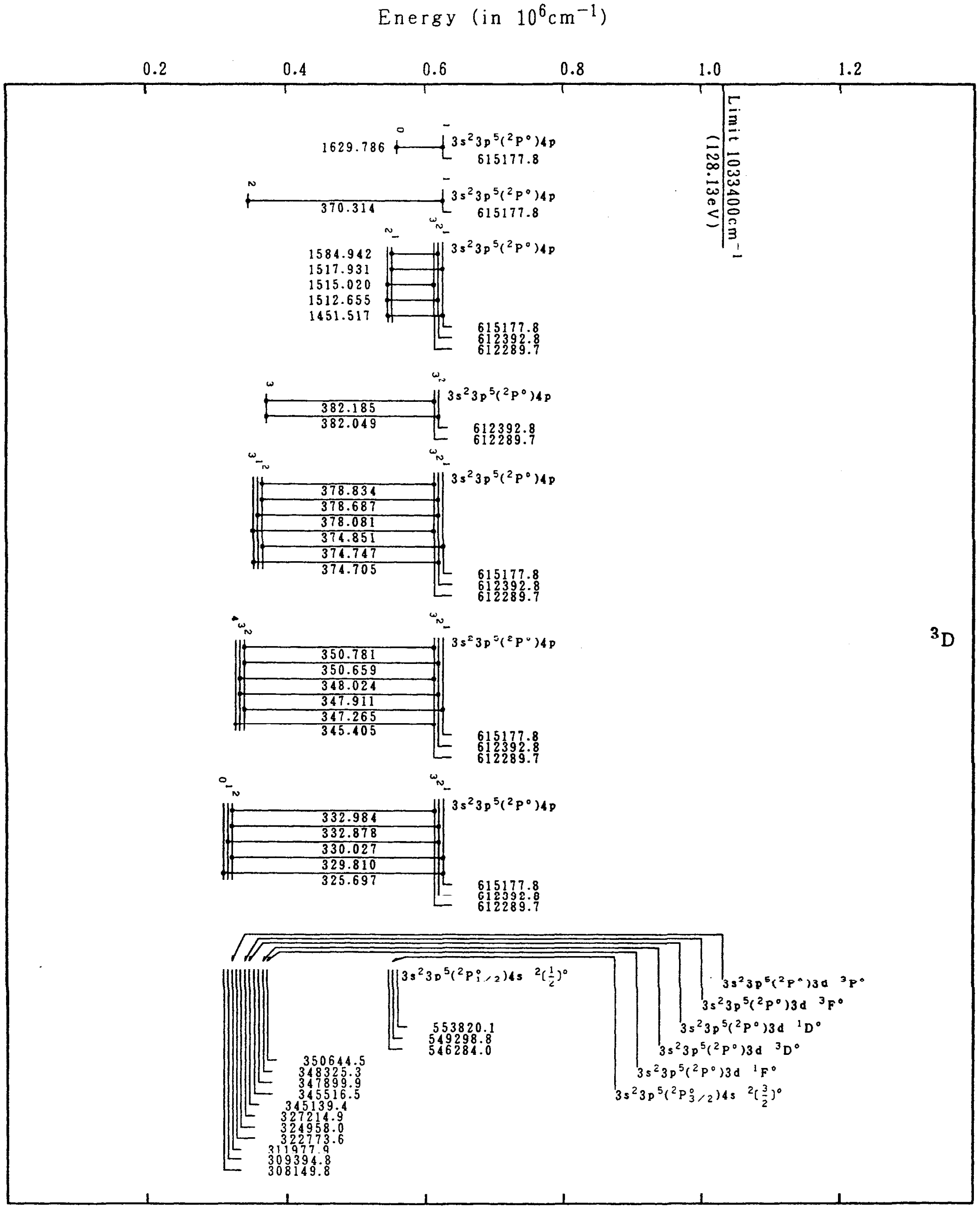
V VI(Ar–Sequence)



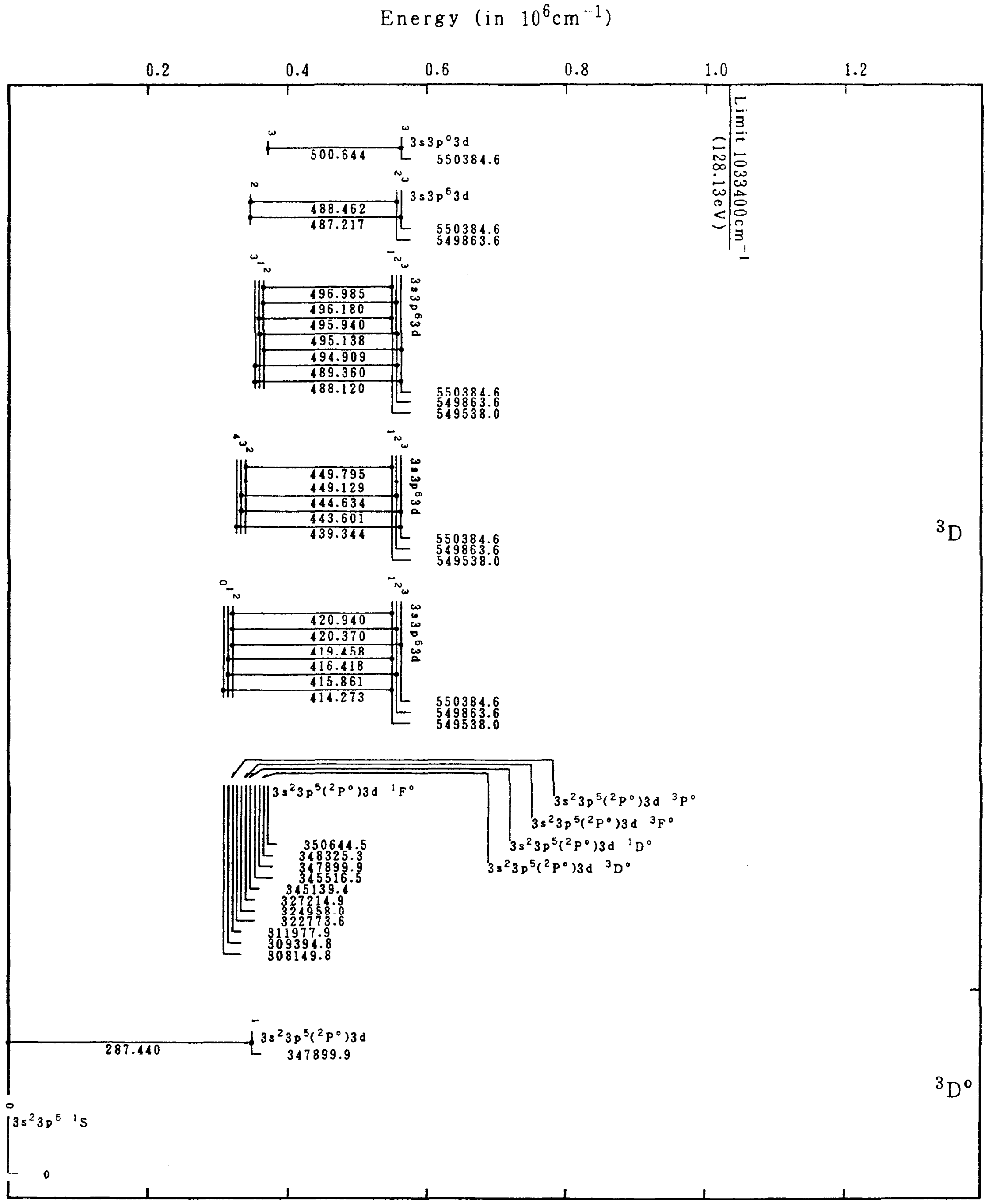
V VI(Ar–Sequence)



V VI(Ar–Sequence)



V VI(Ar–Sequence)



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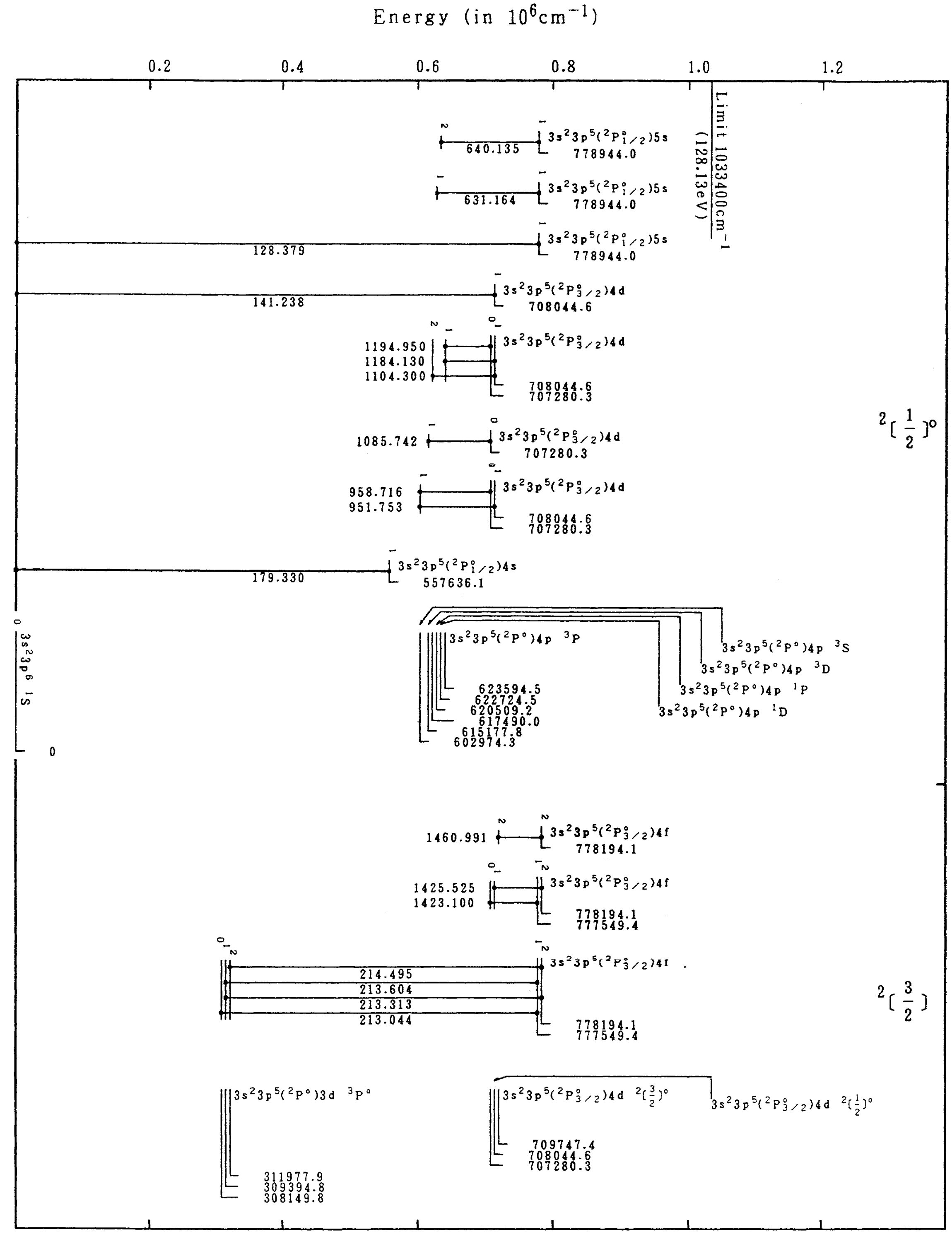

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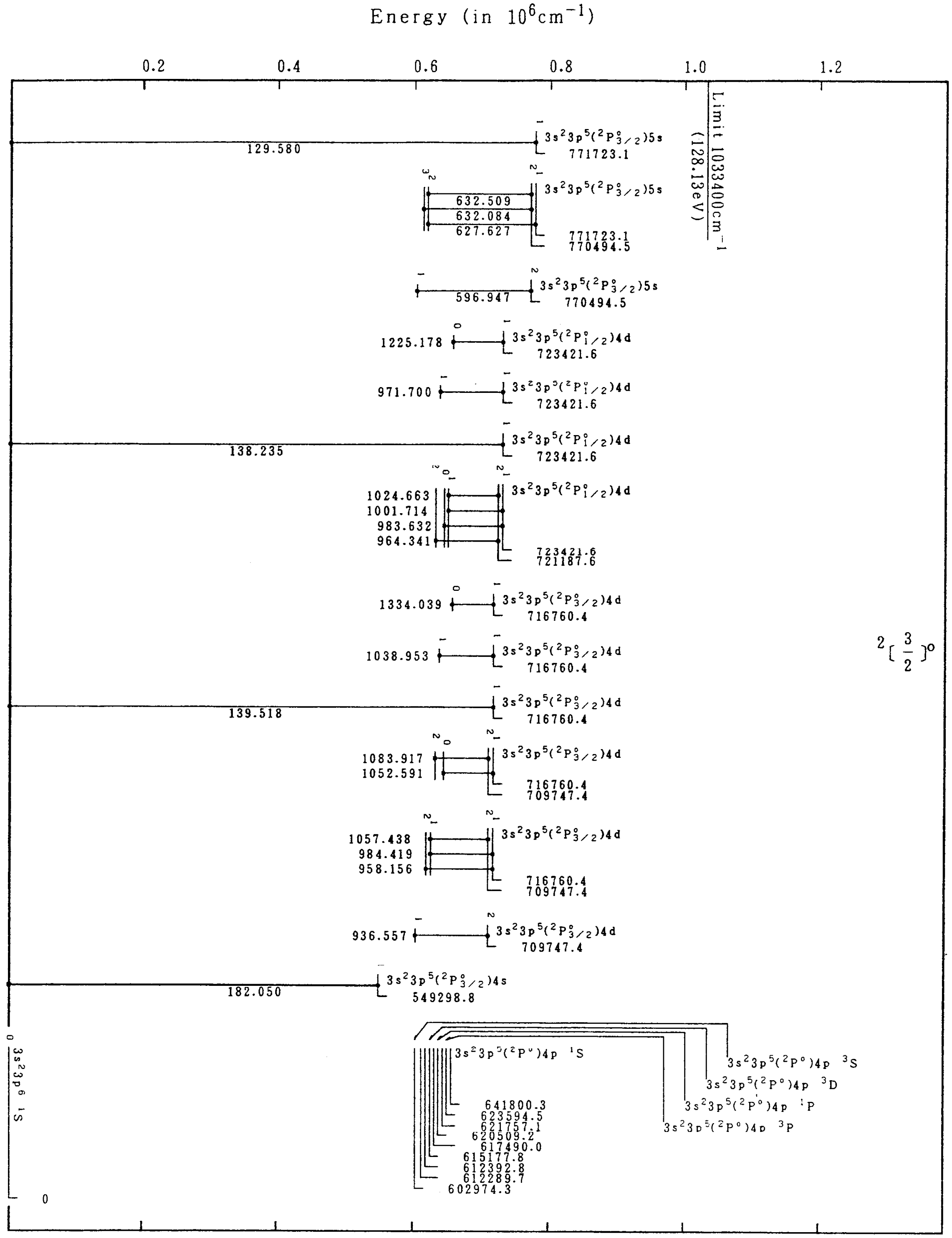

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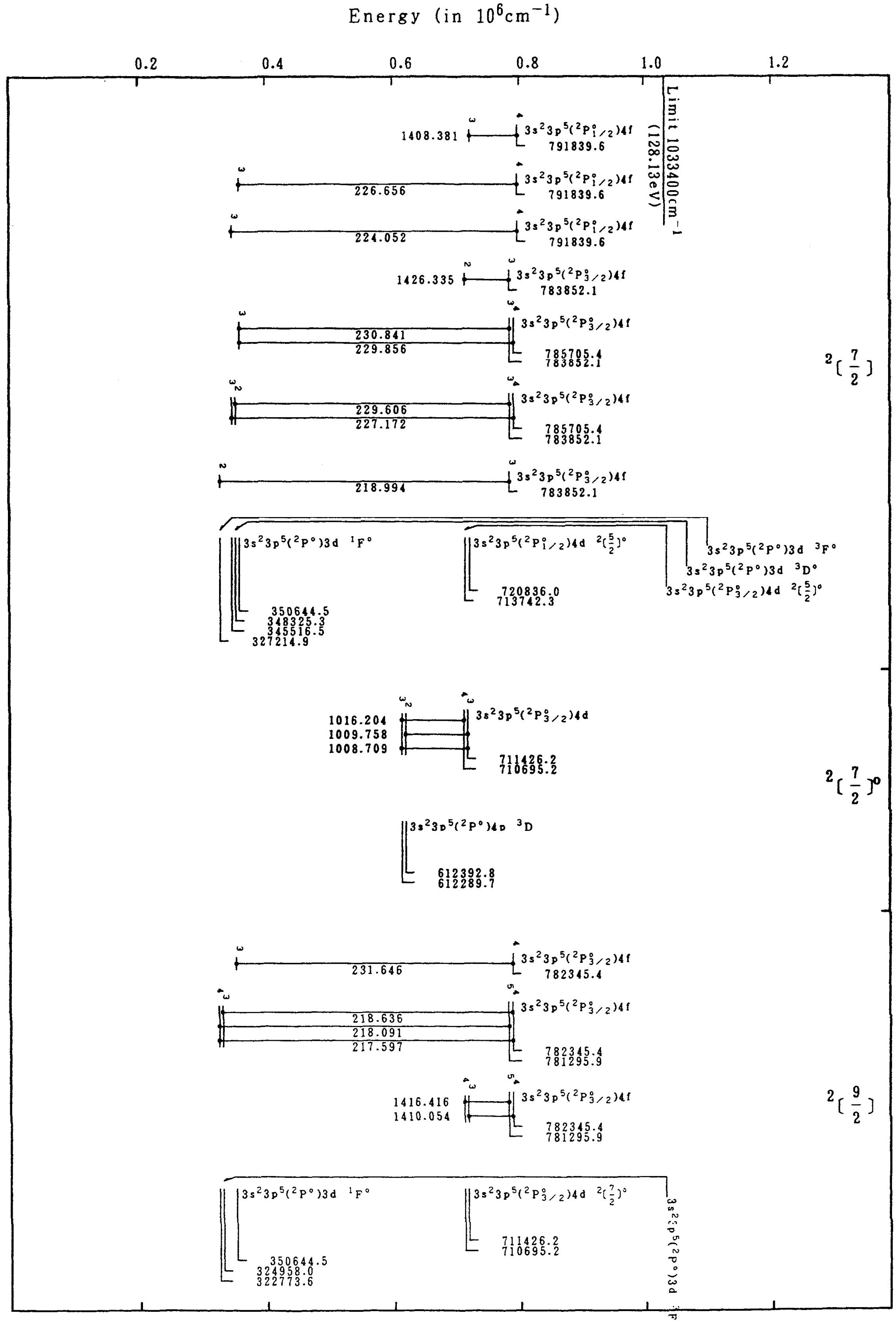

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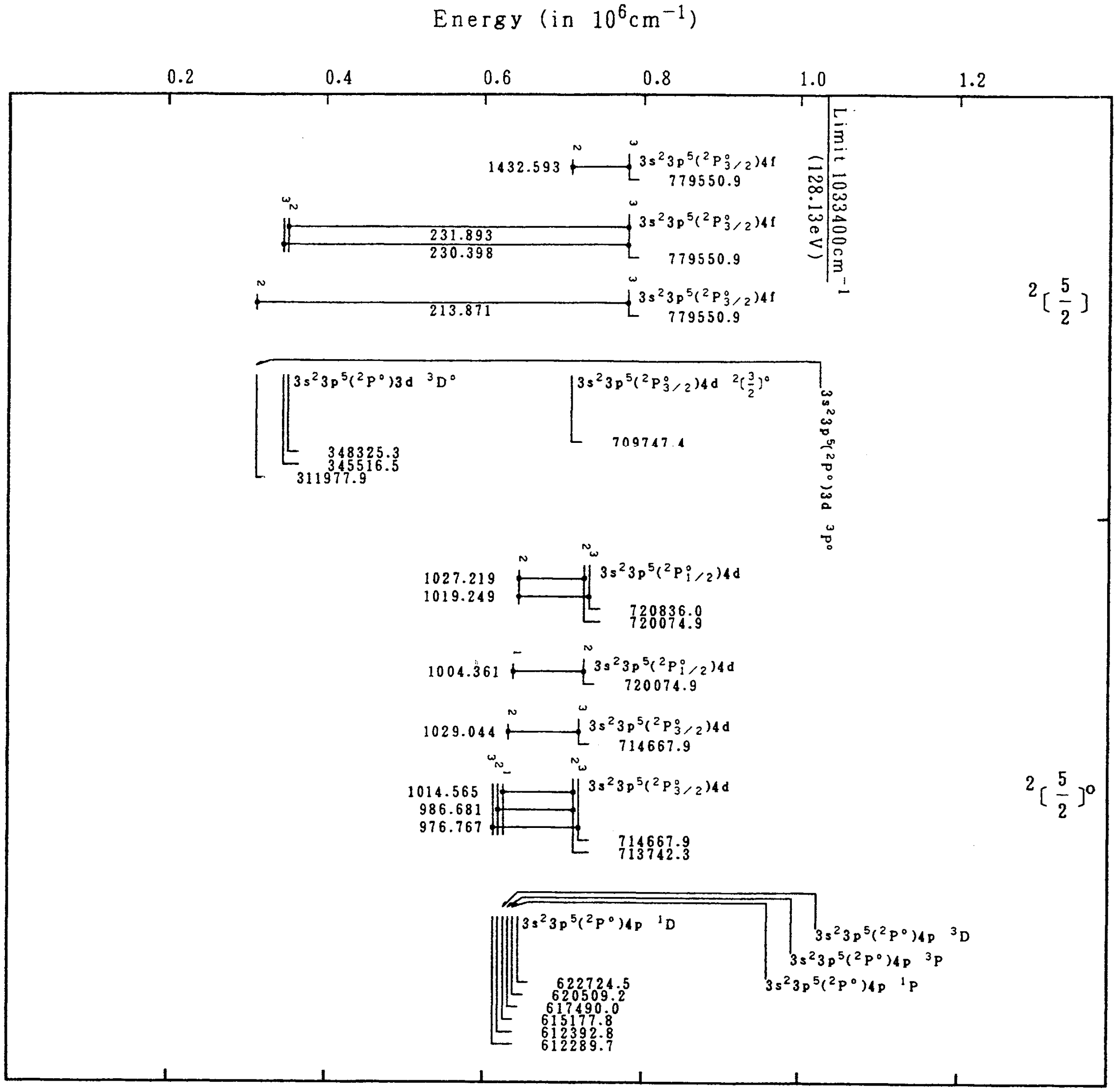

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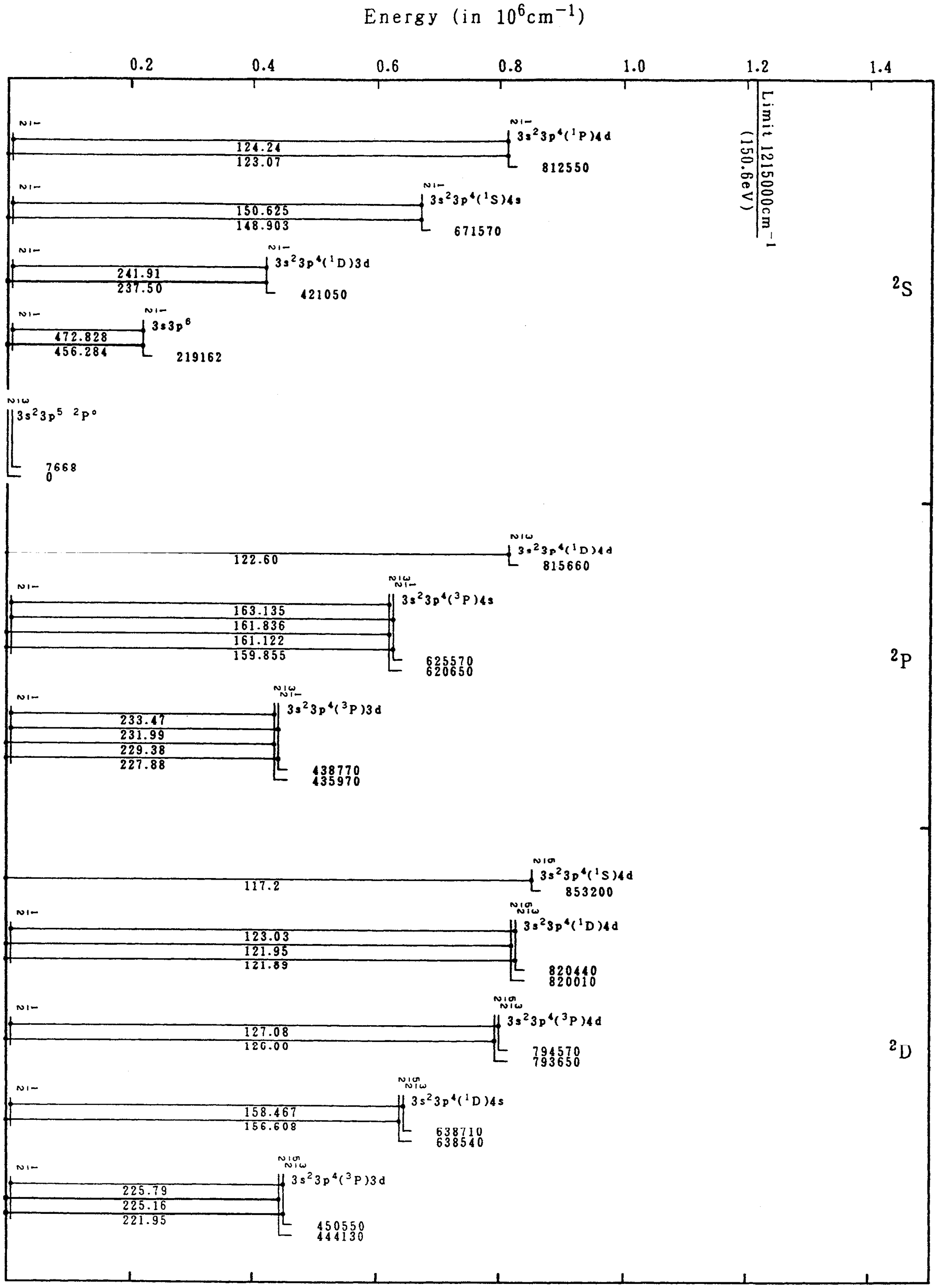

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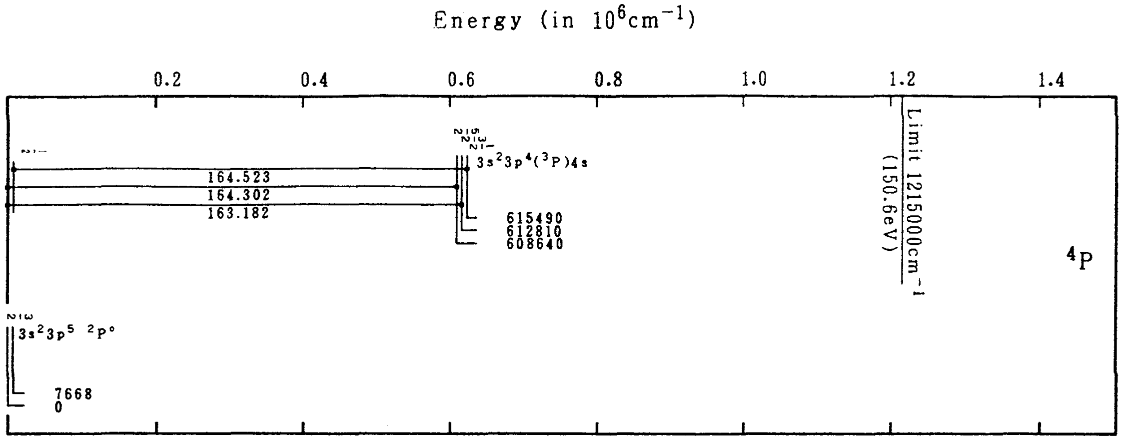

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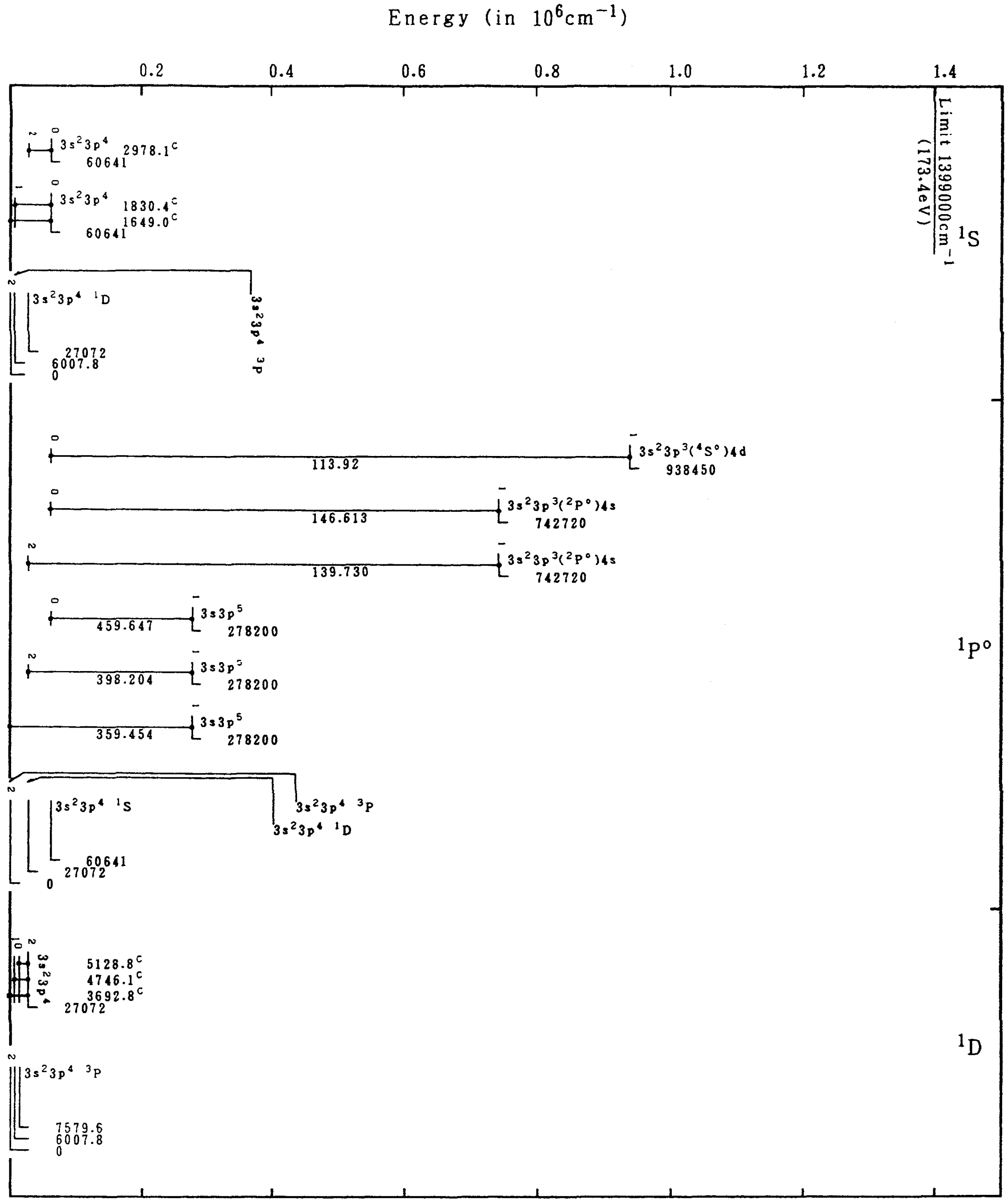

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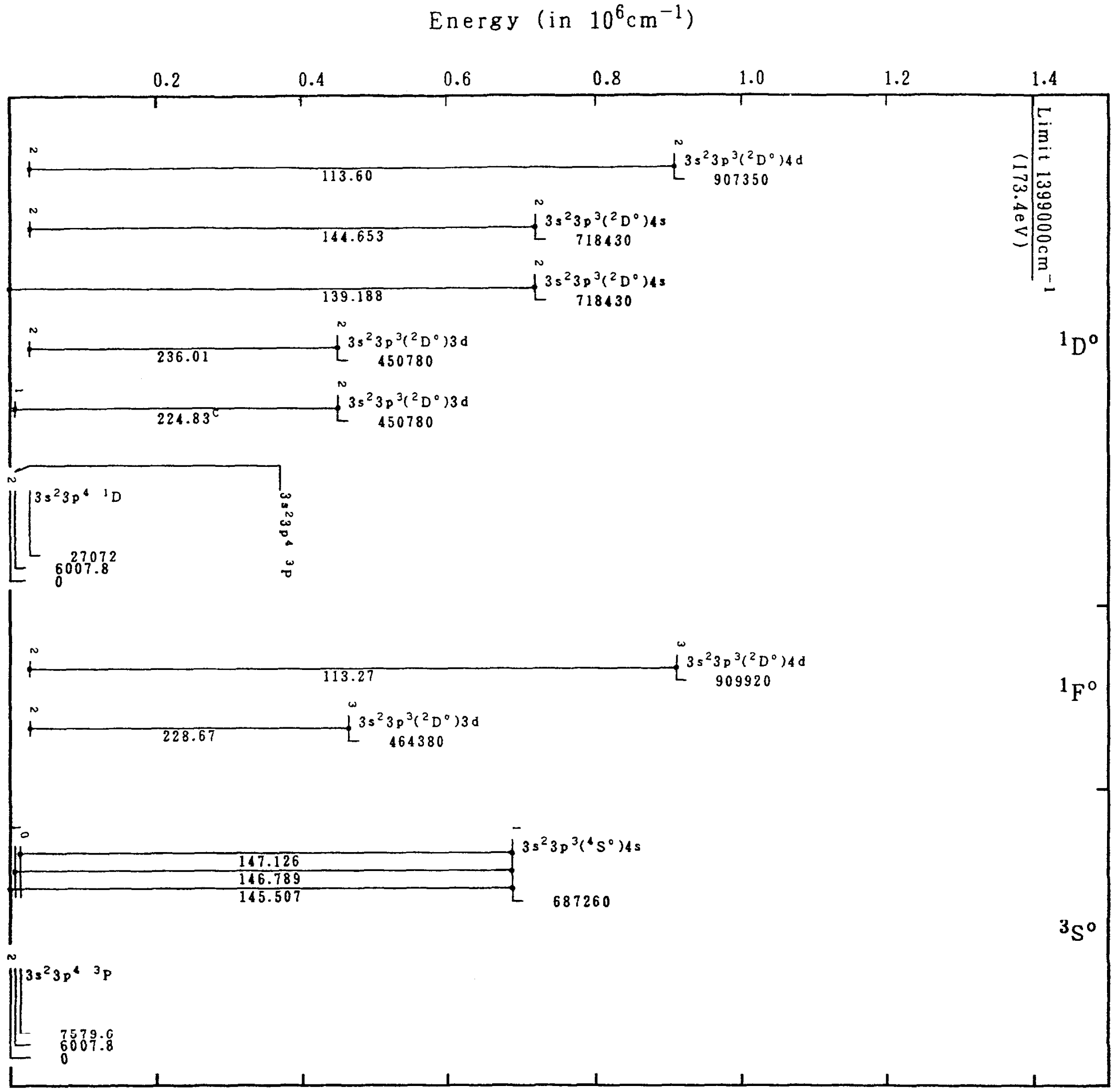

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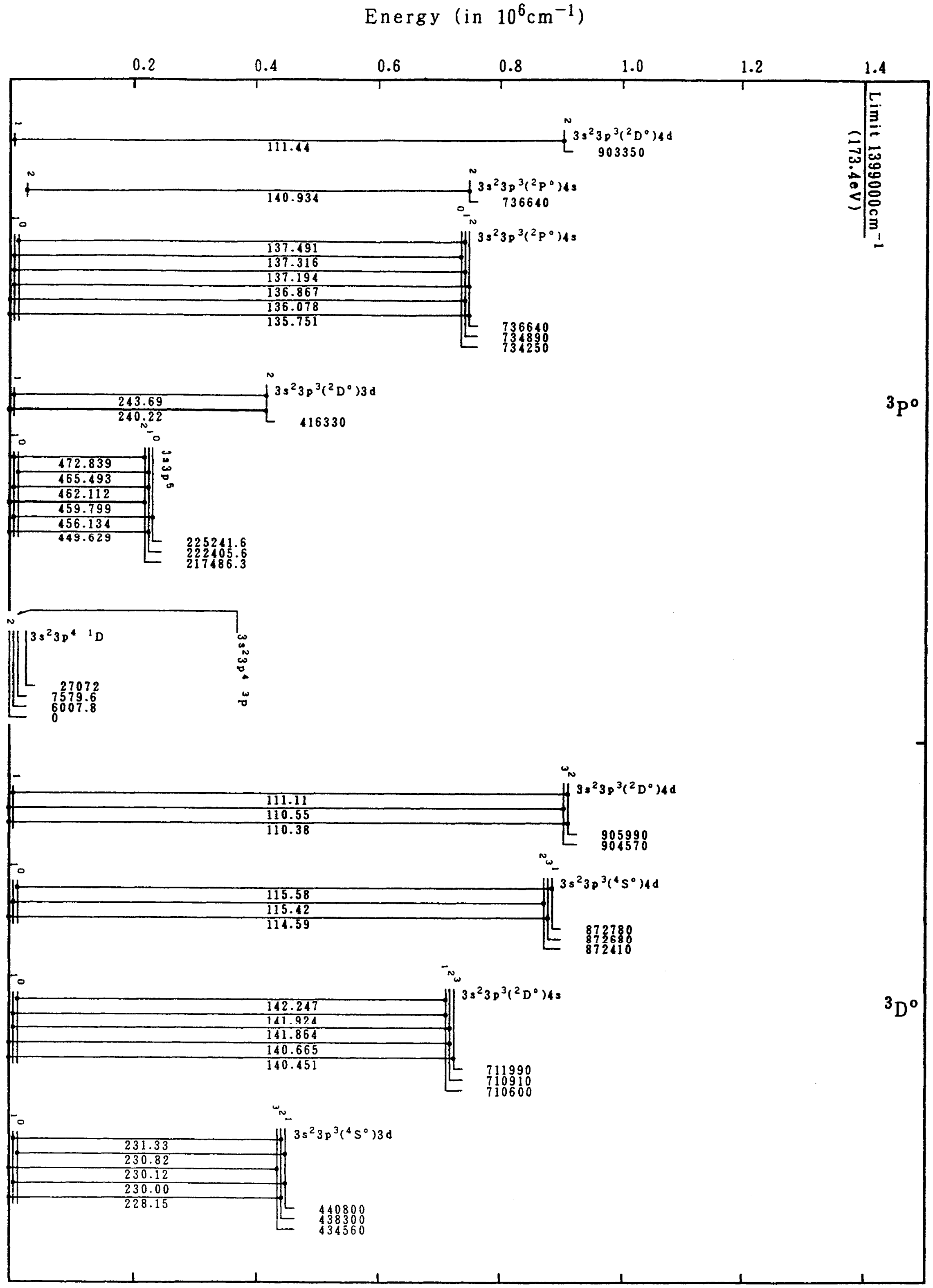

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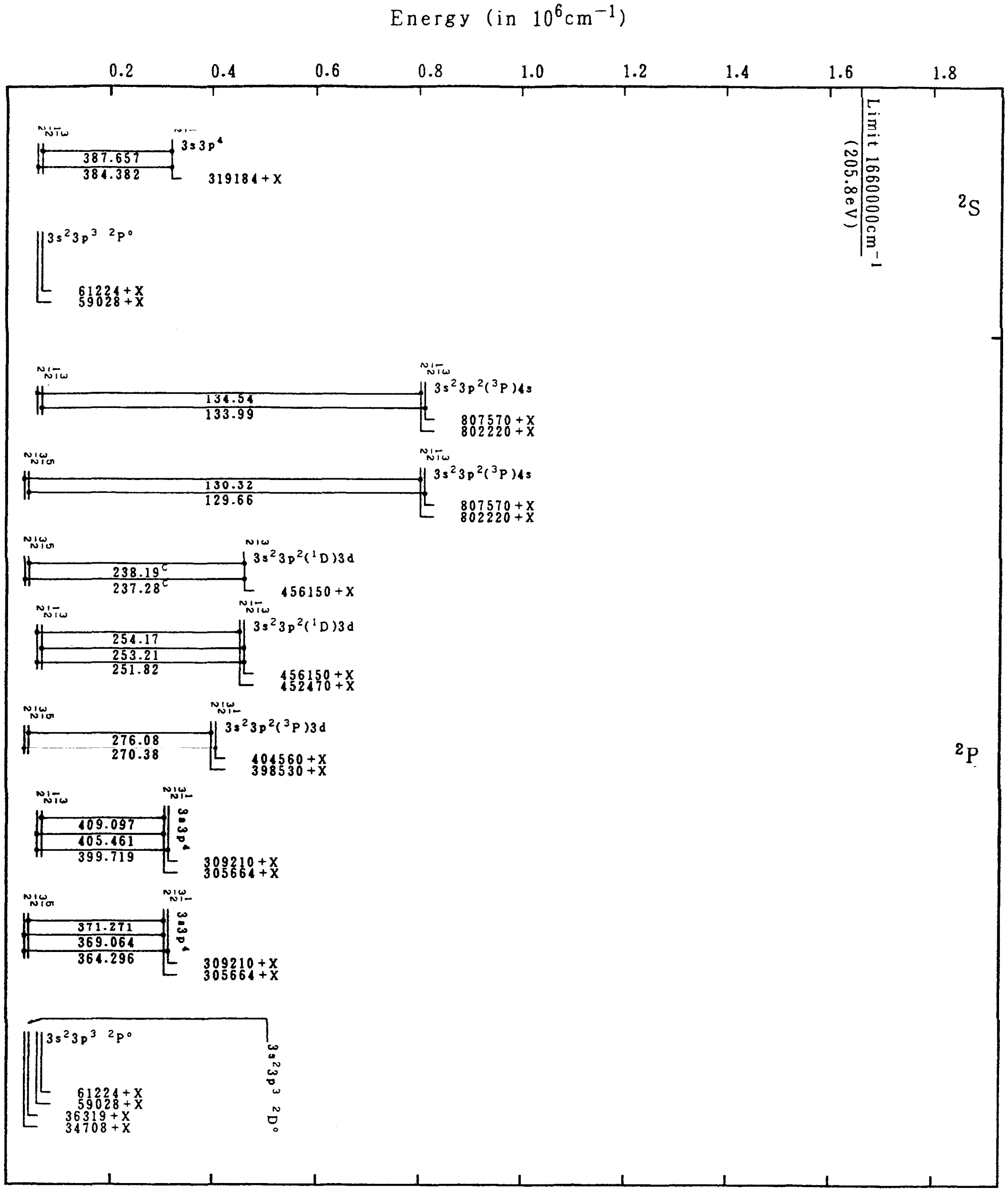

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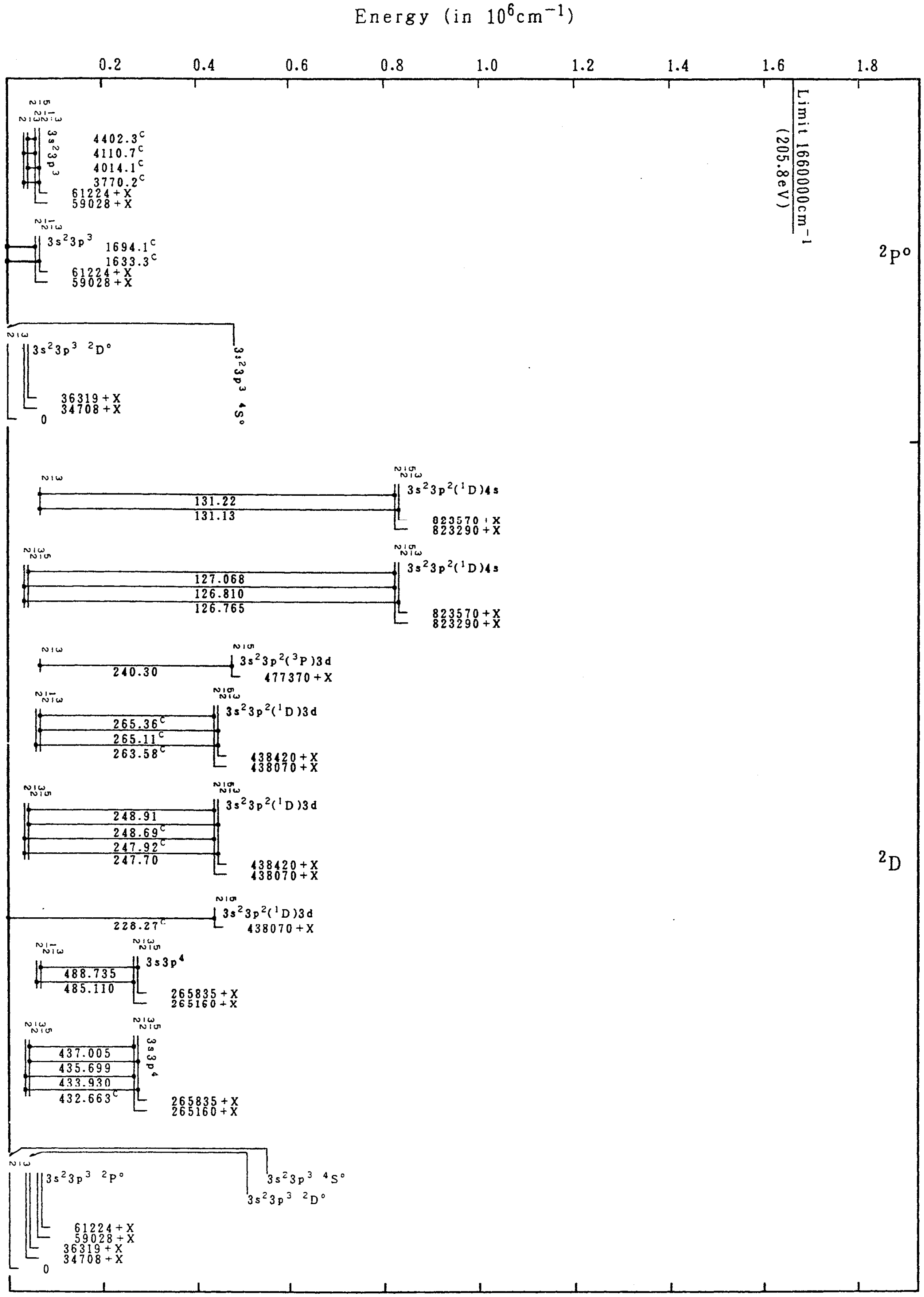

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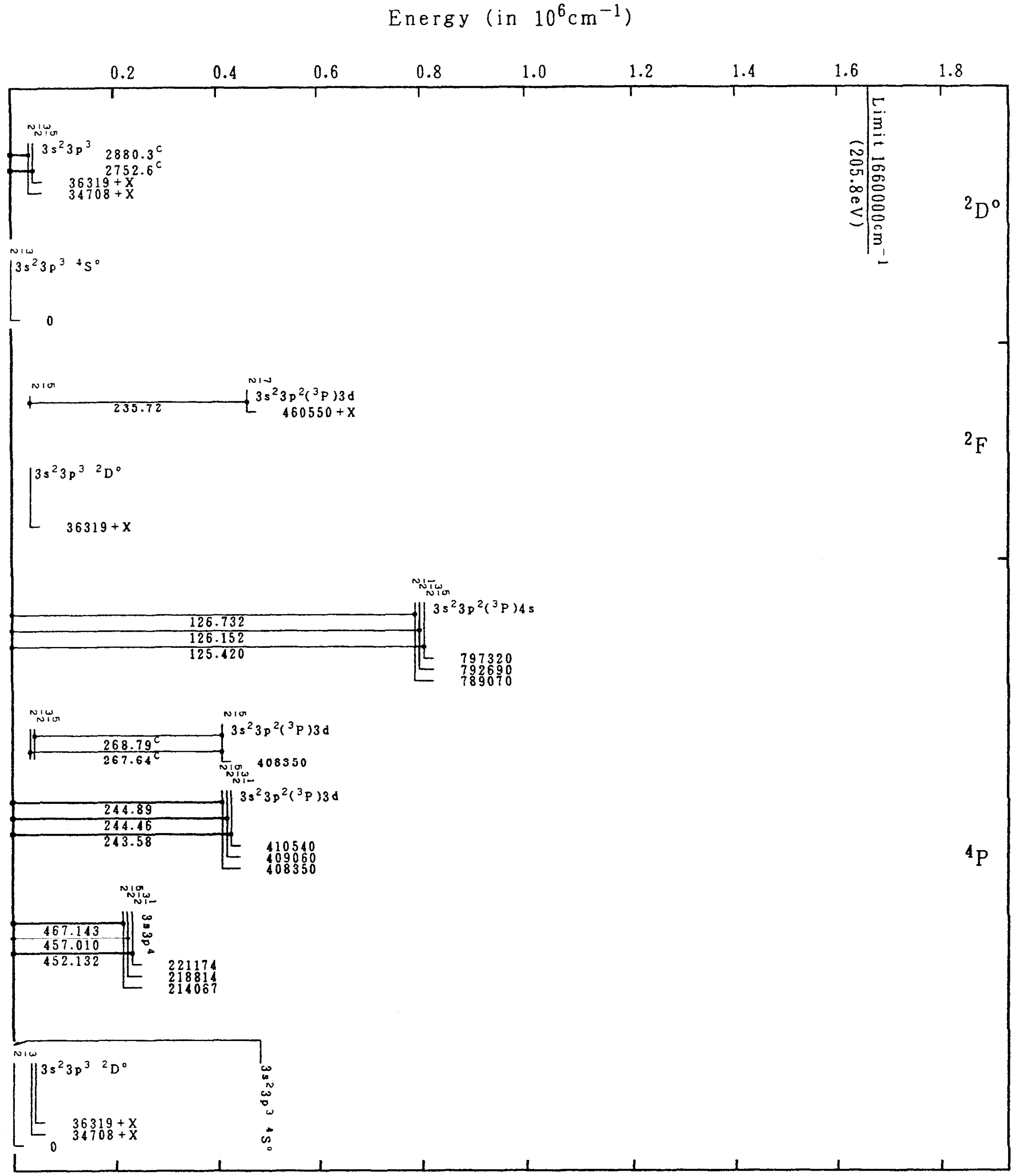

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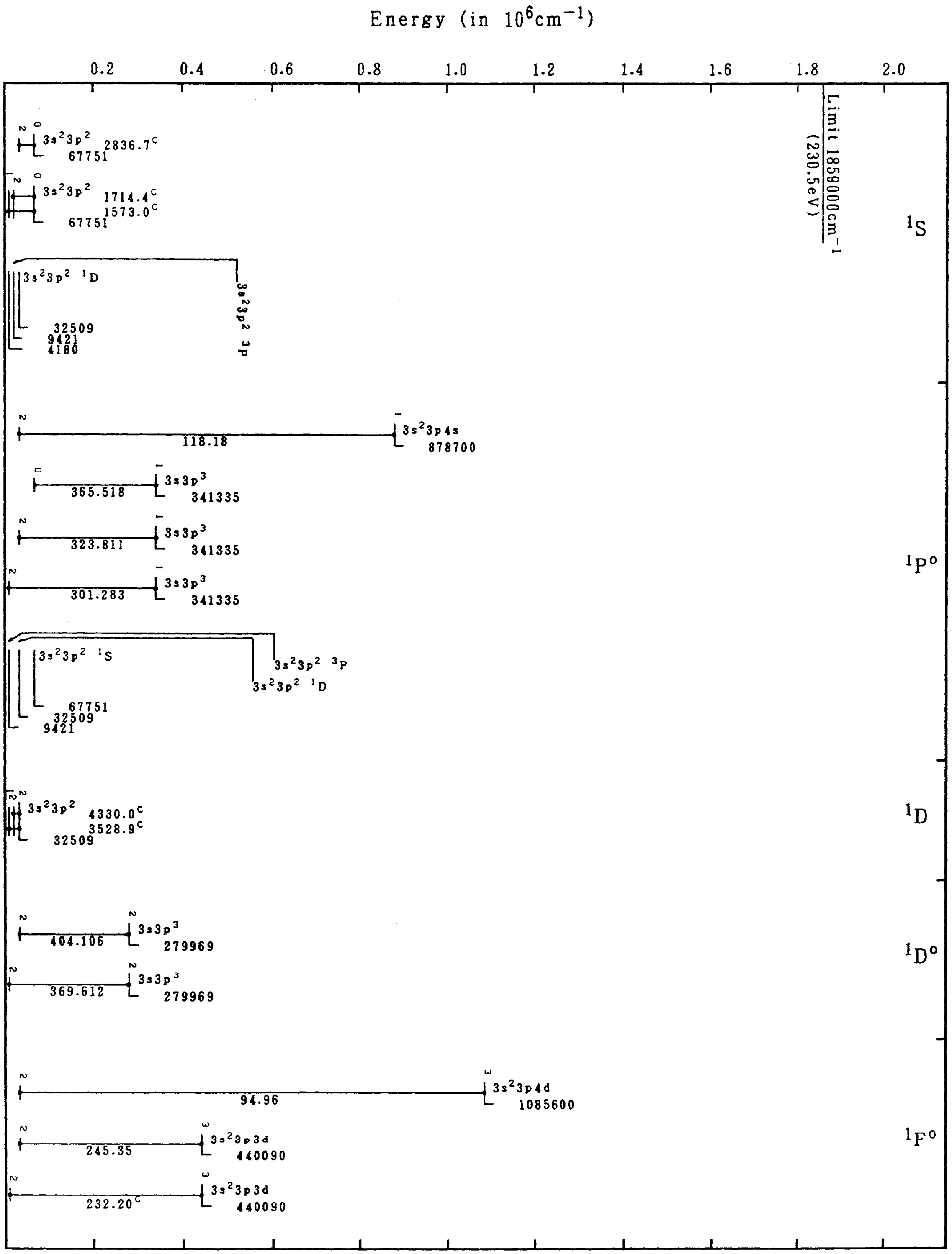

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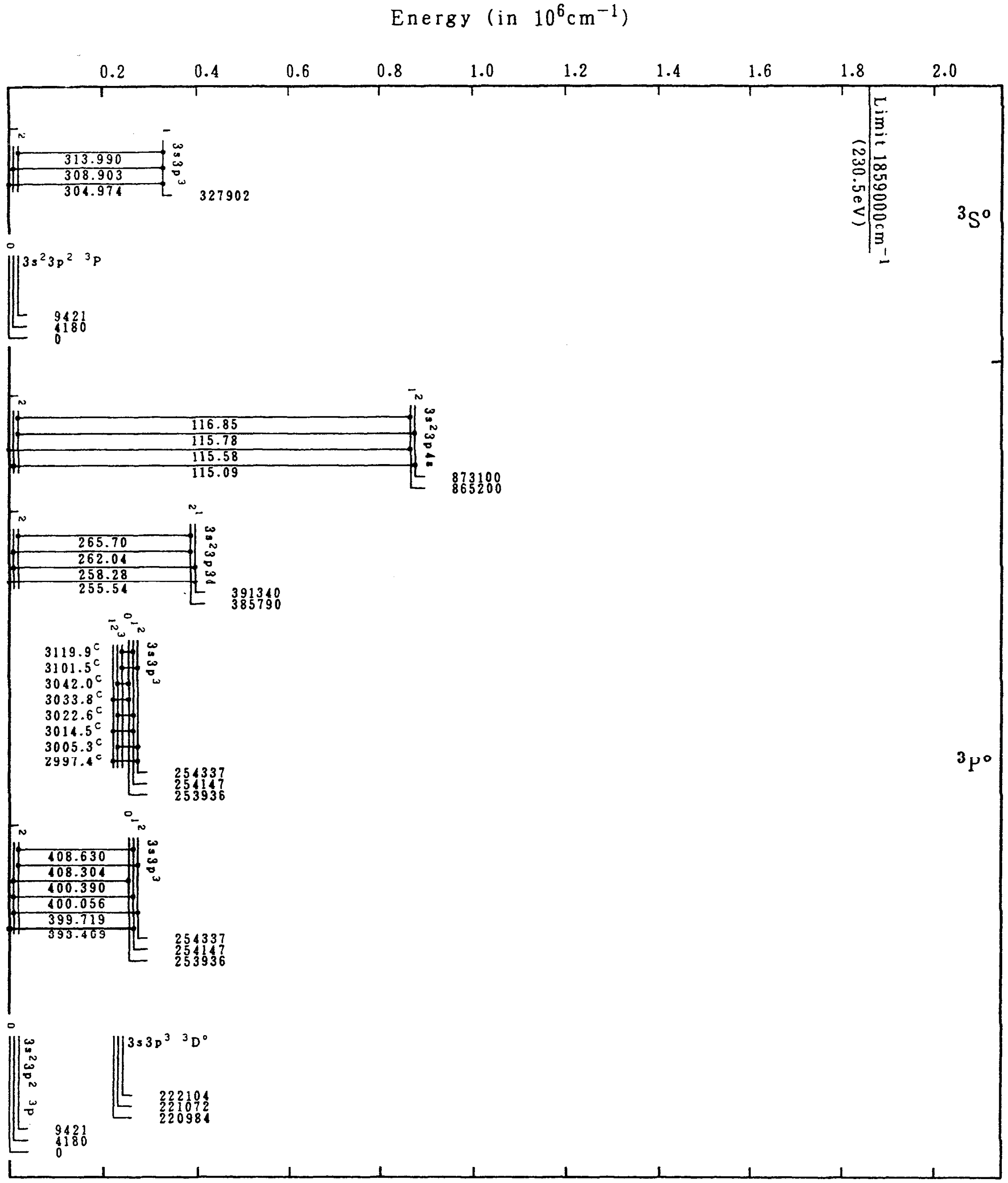

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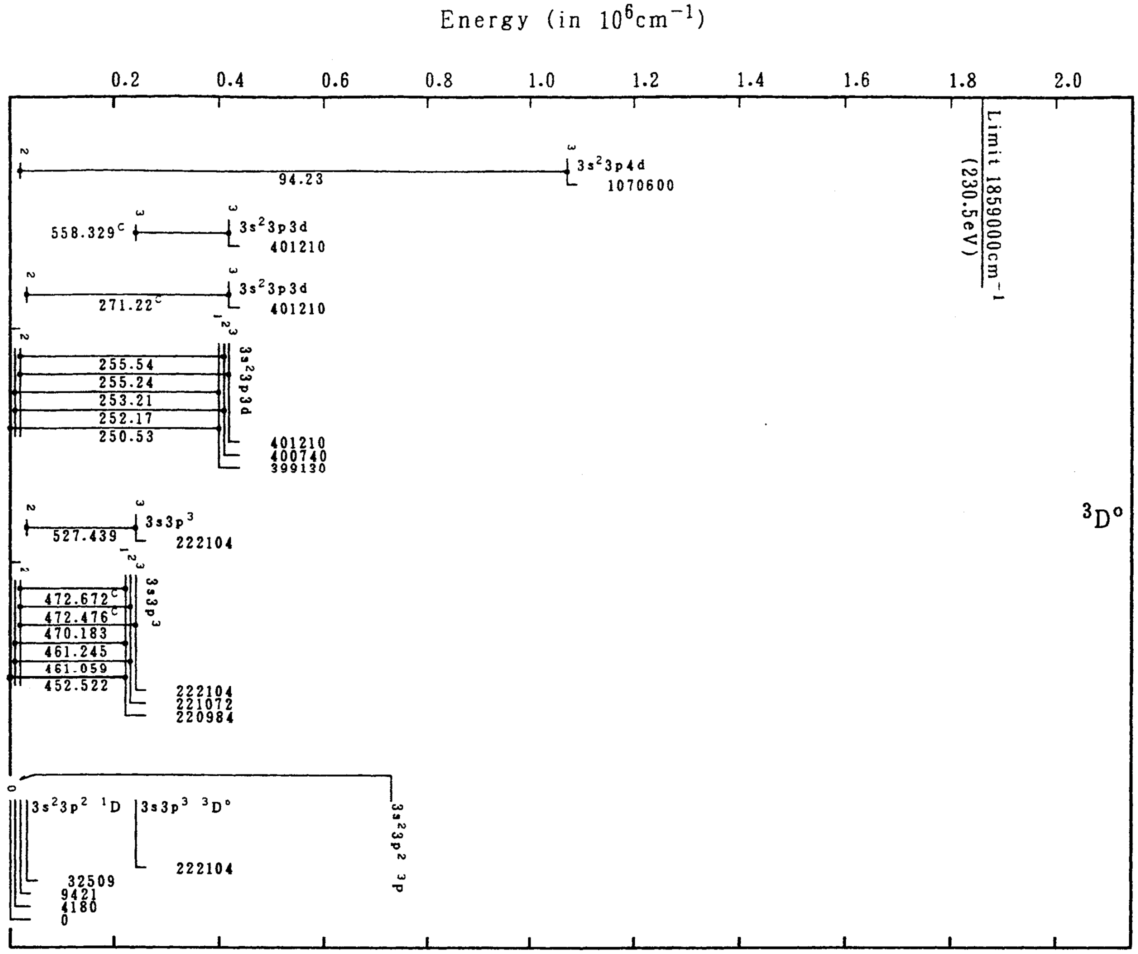

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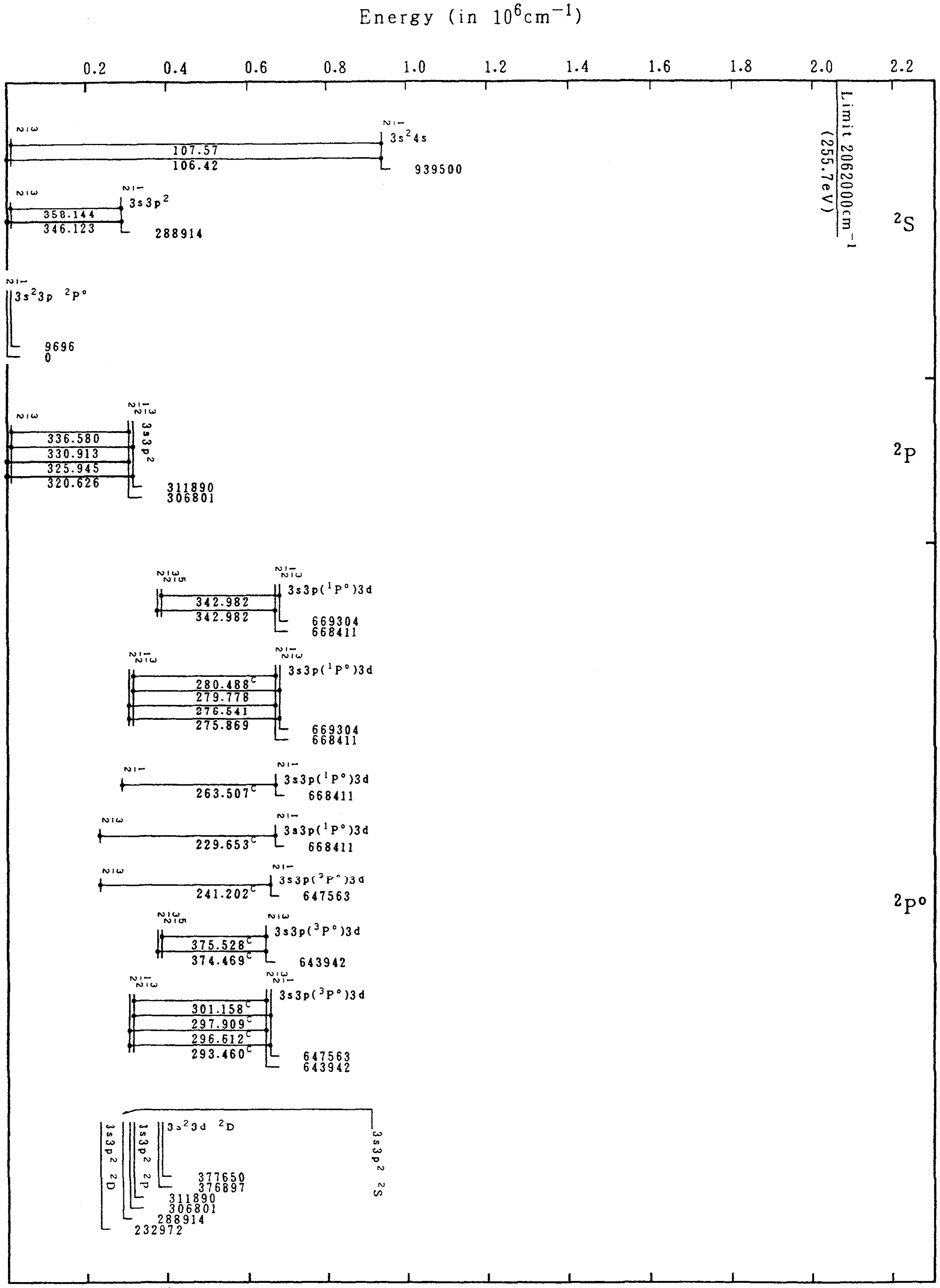

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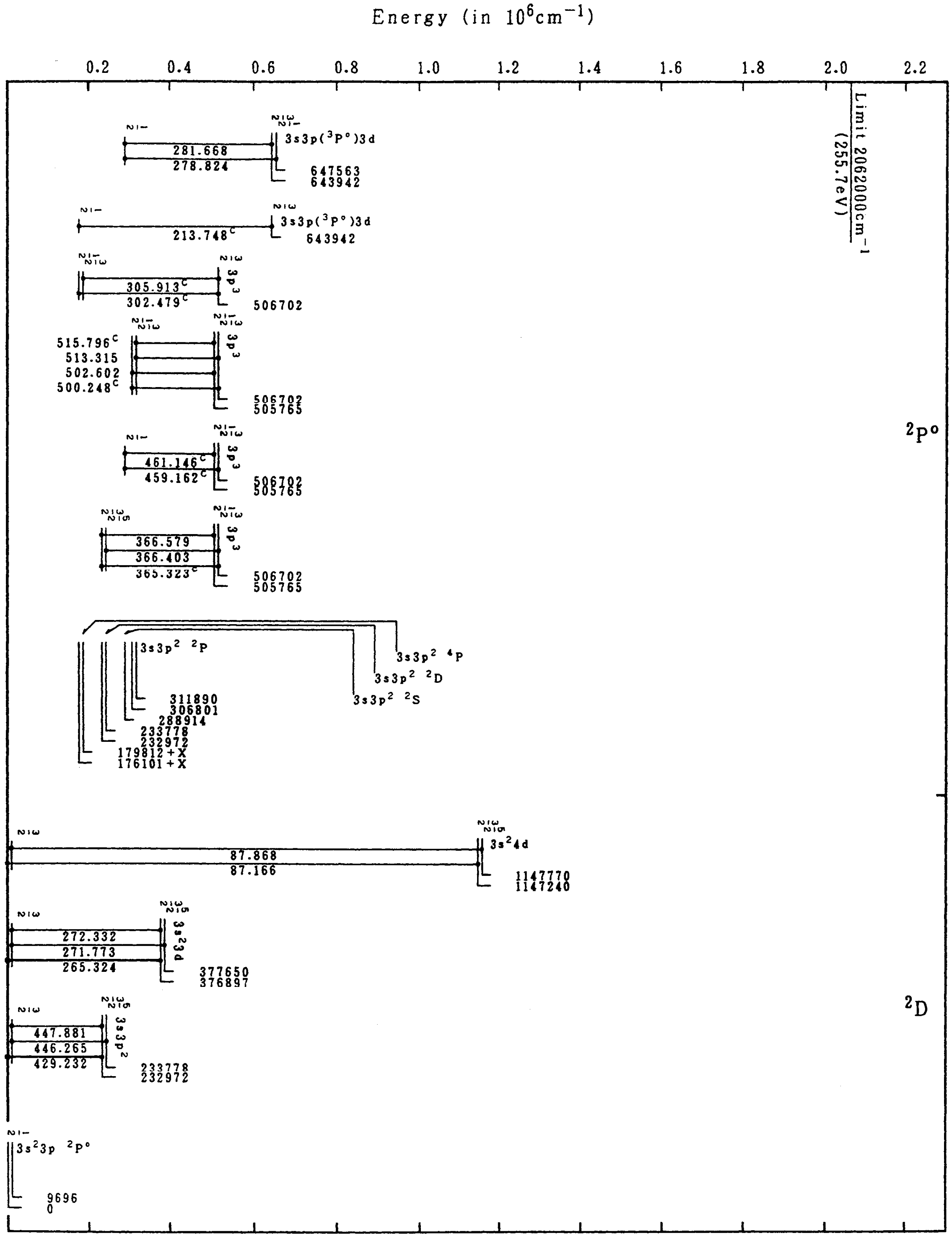

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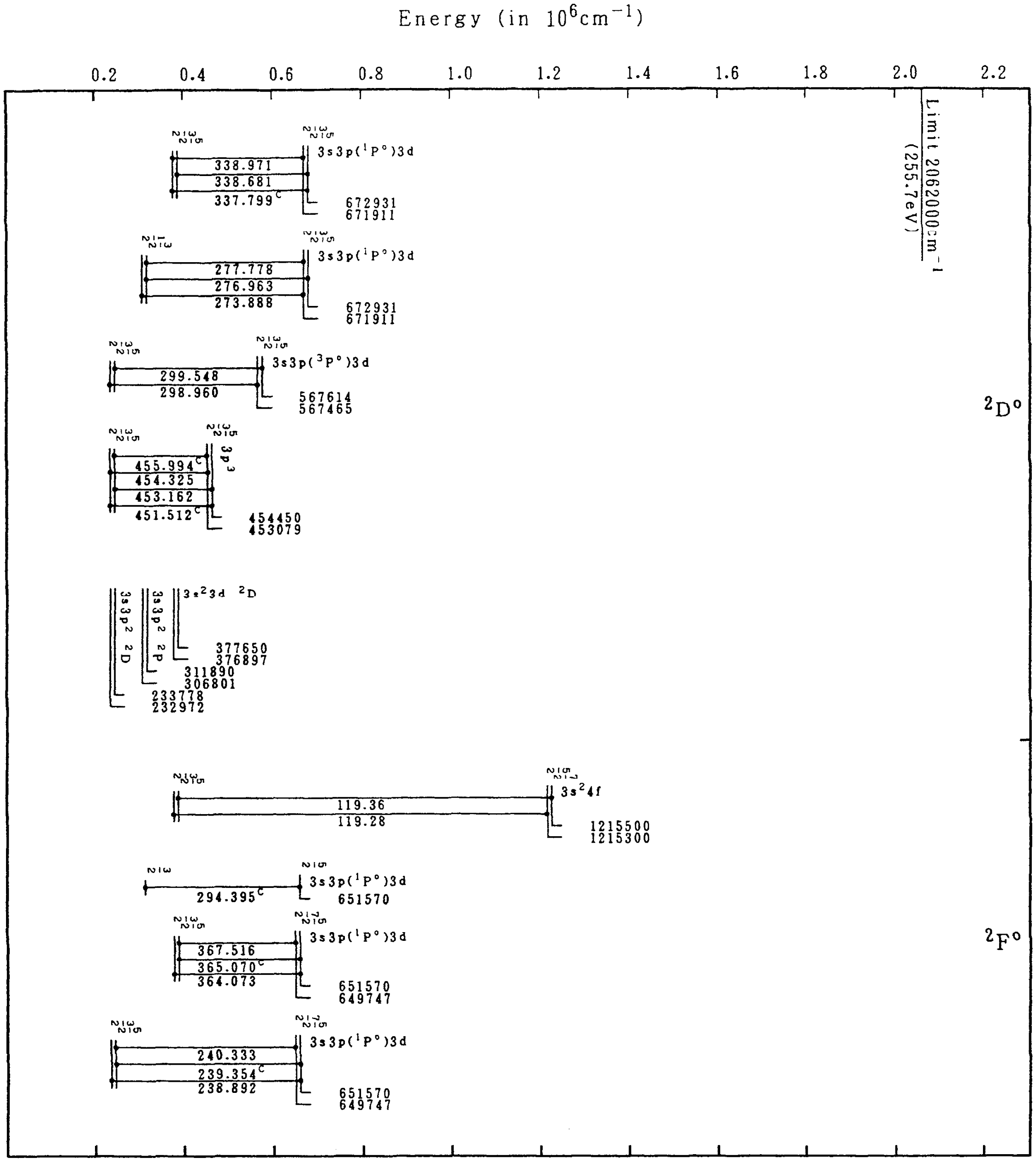

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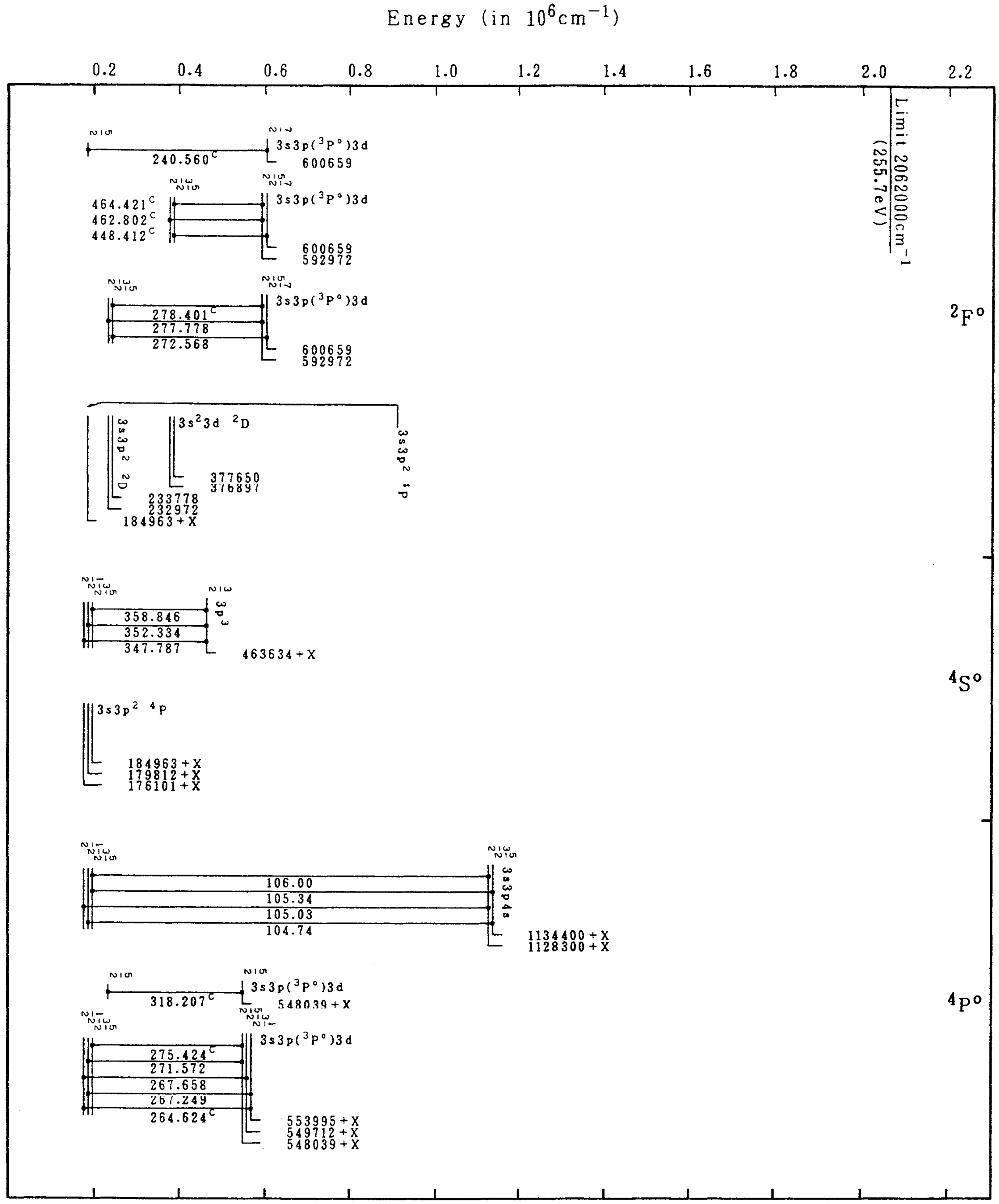

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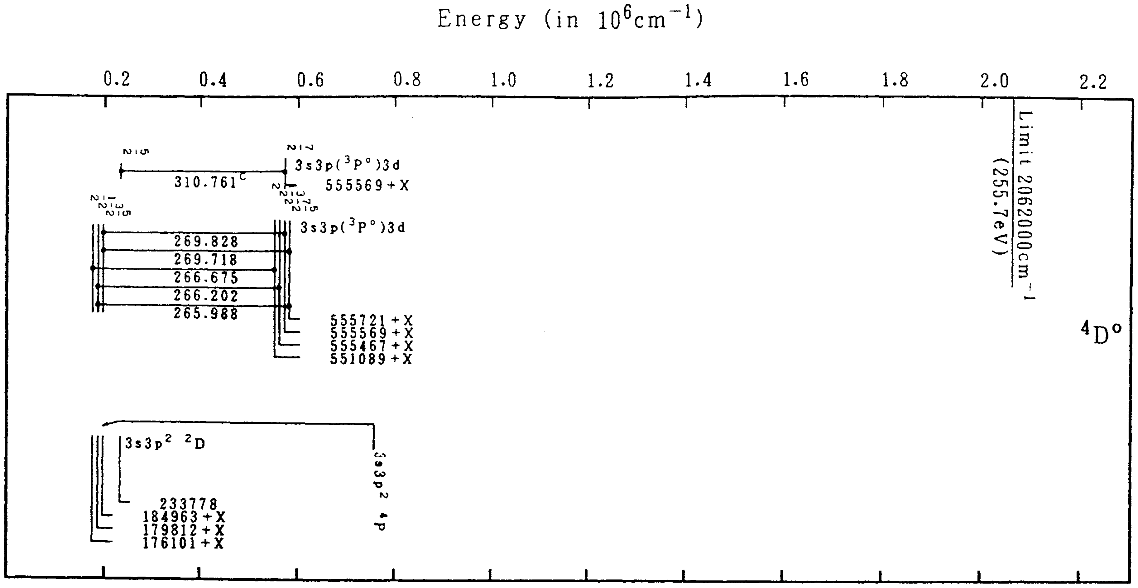

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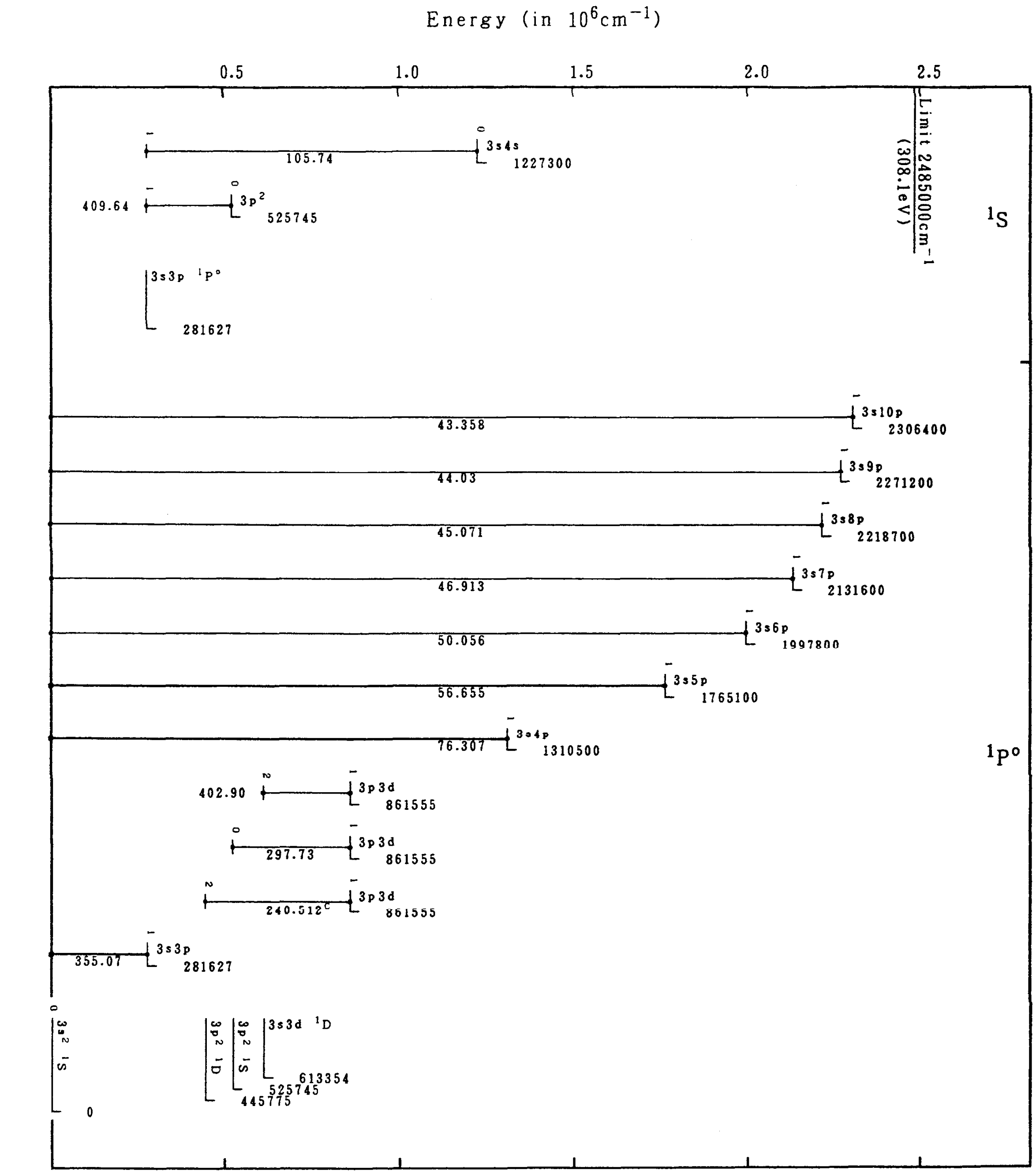

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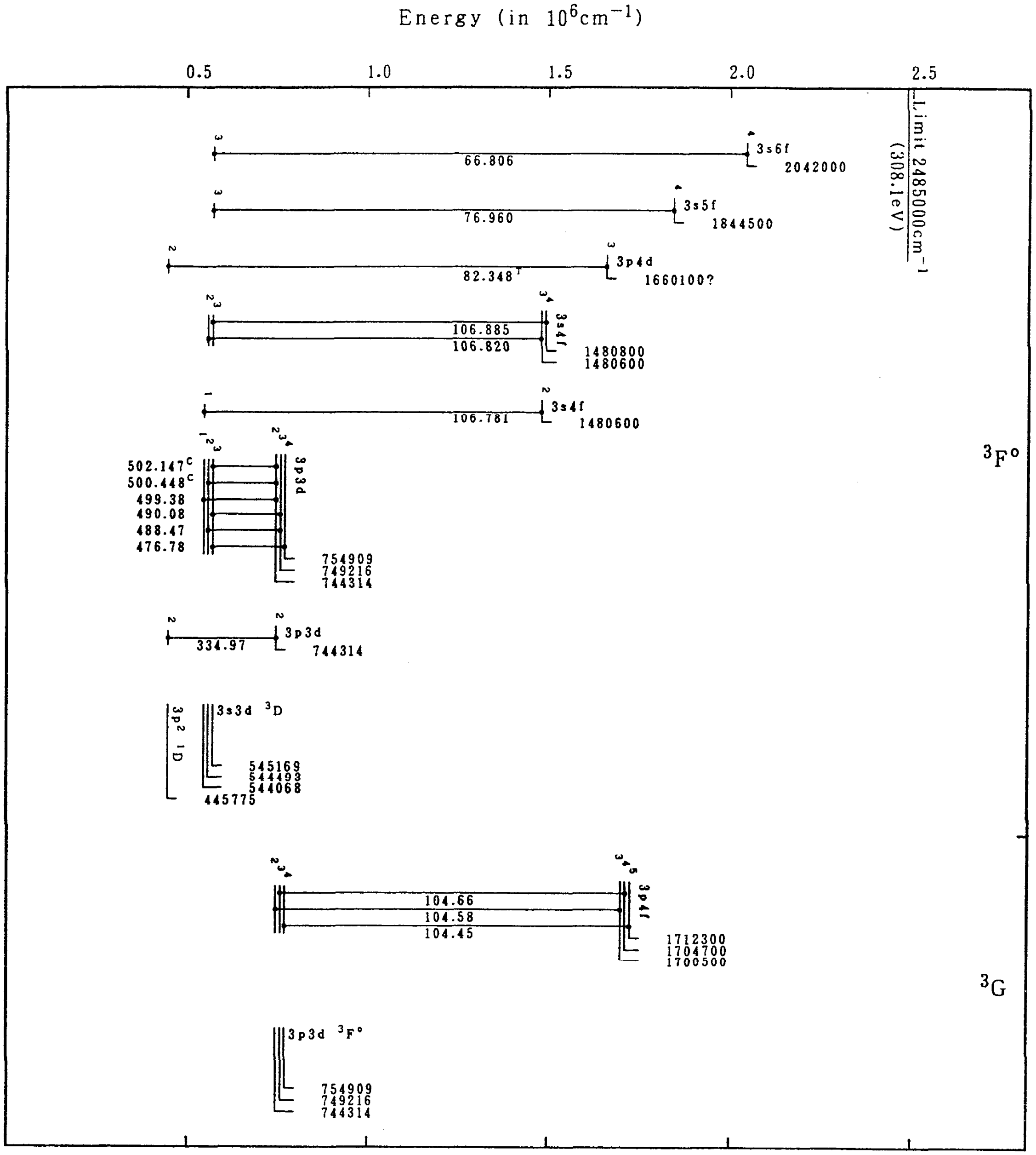

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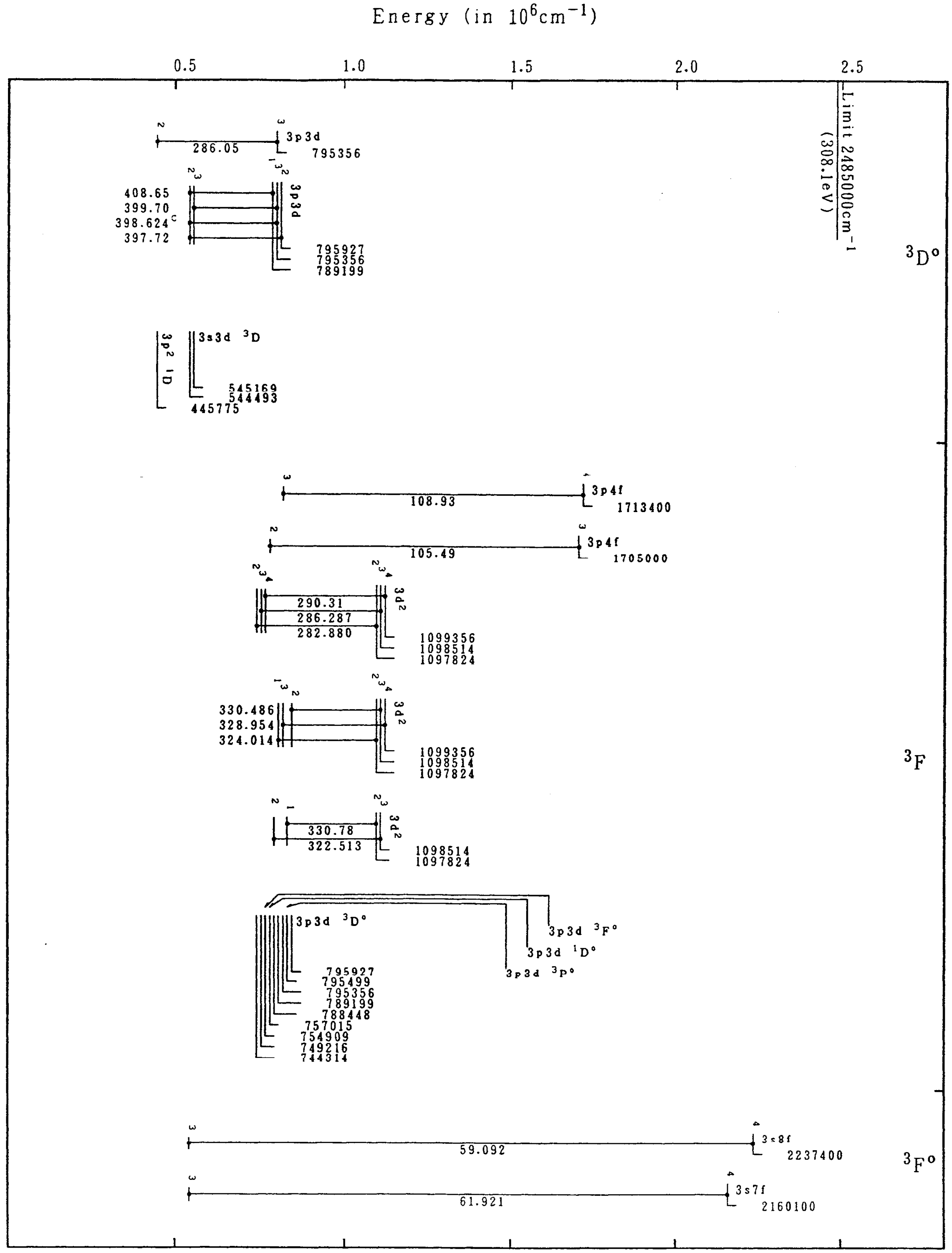

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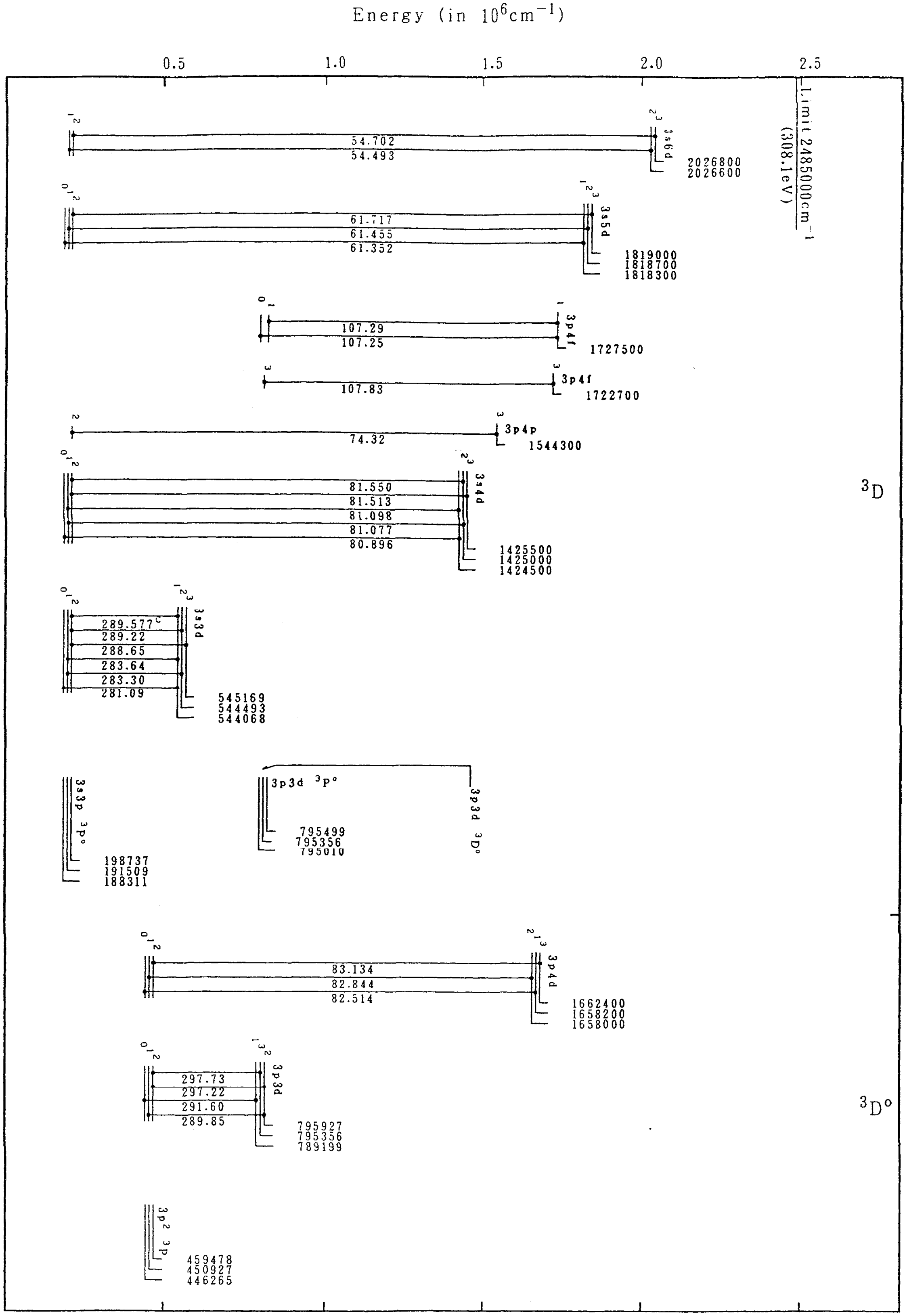

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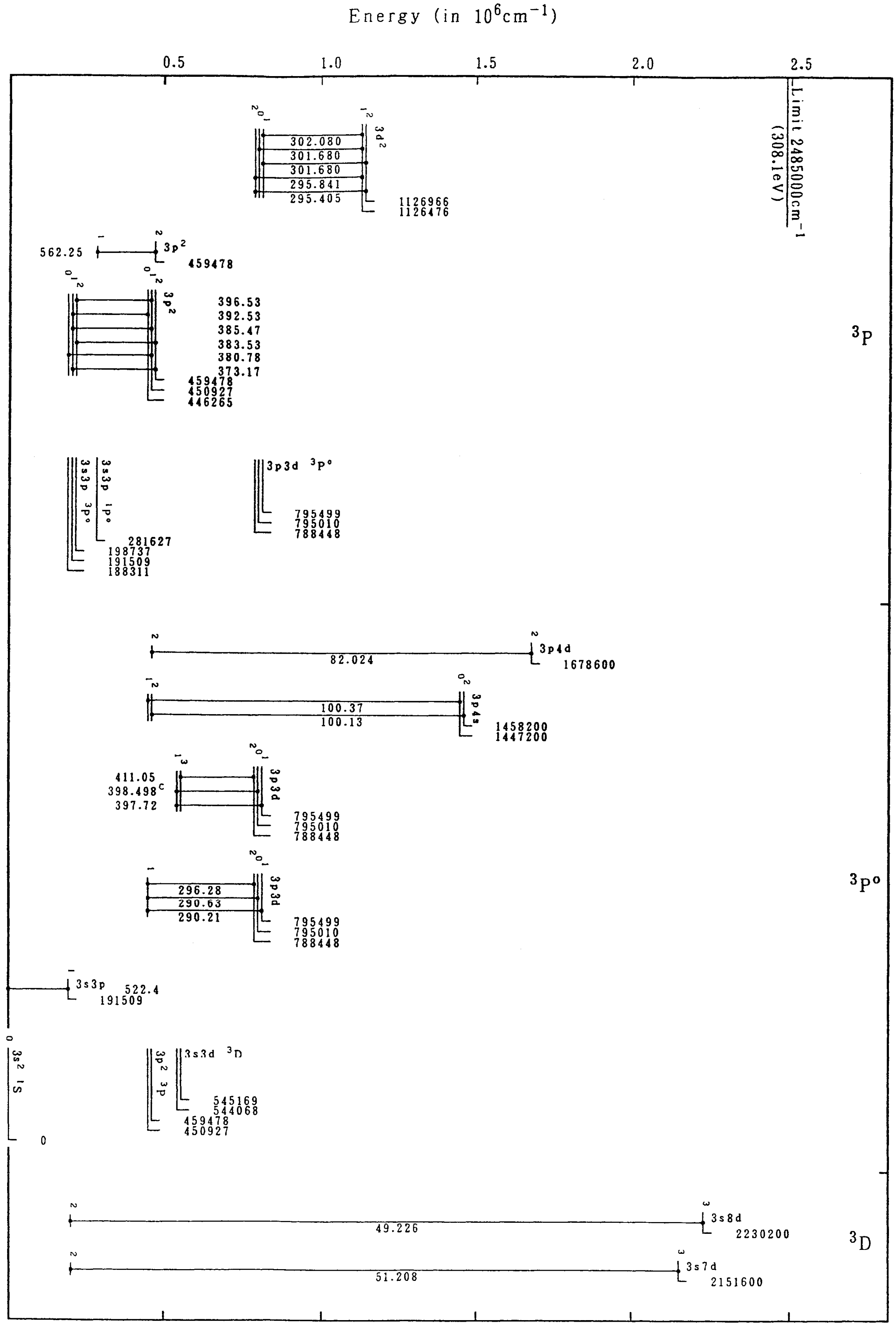

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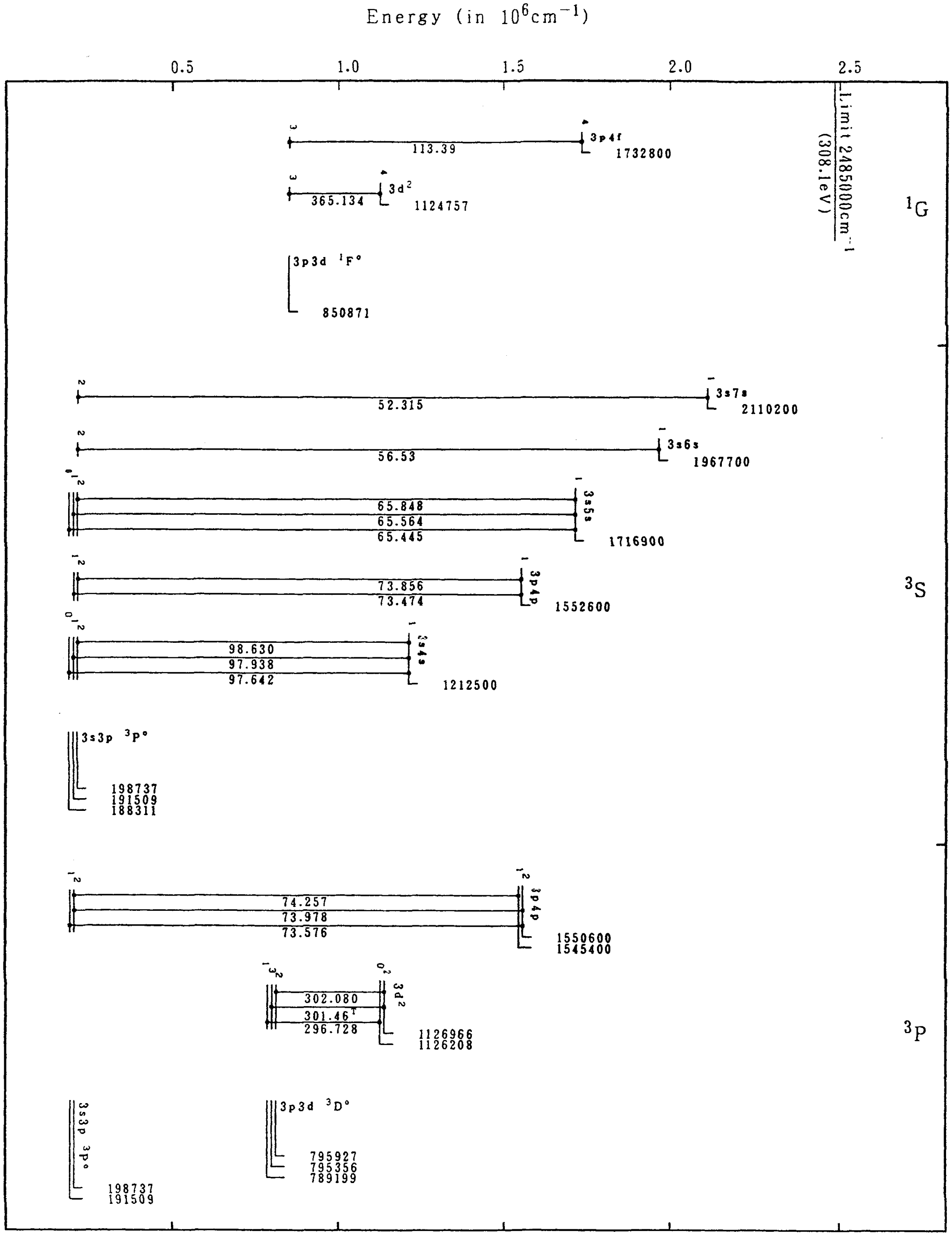

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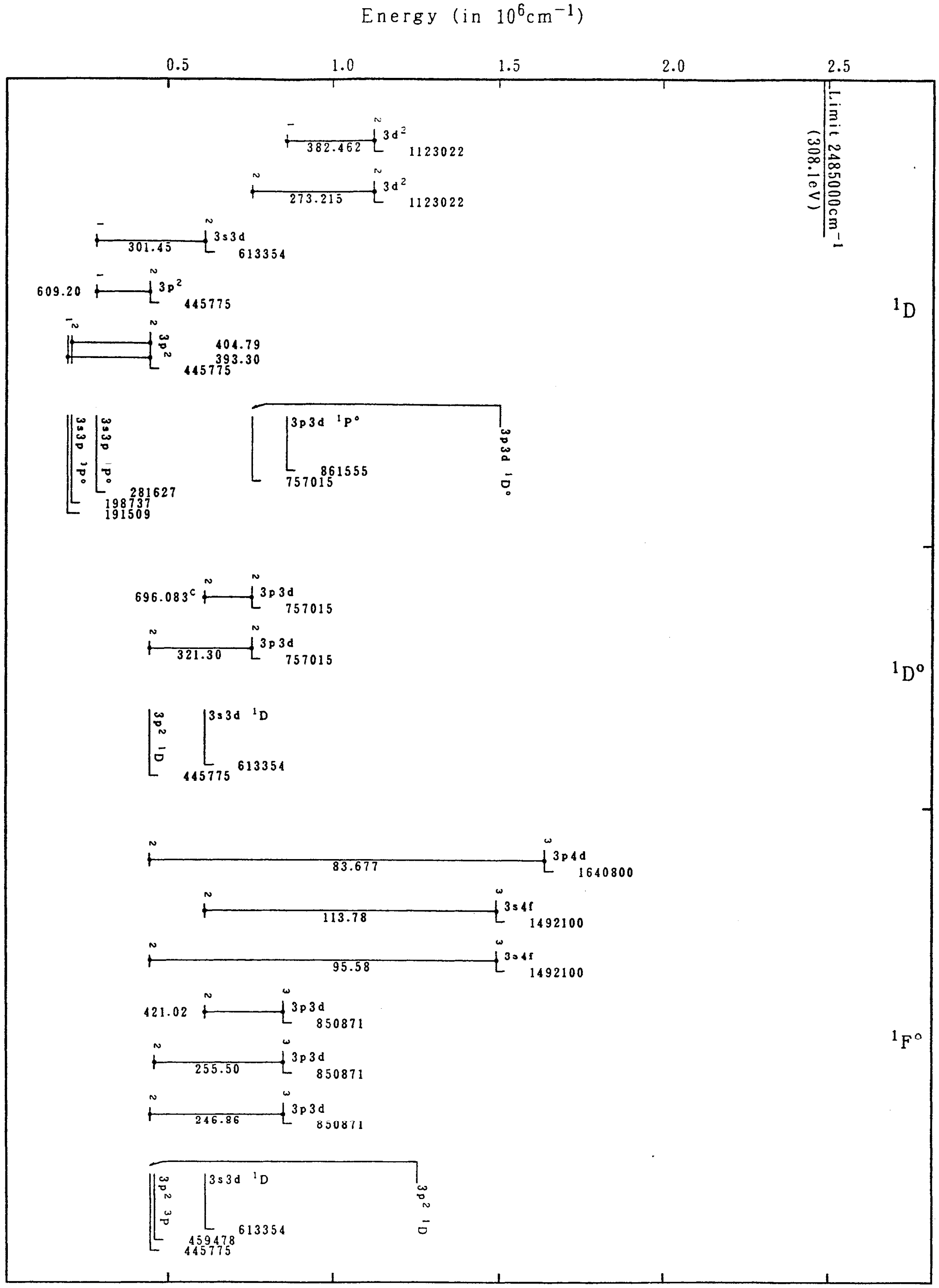

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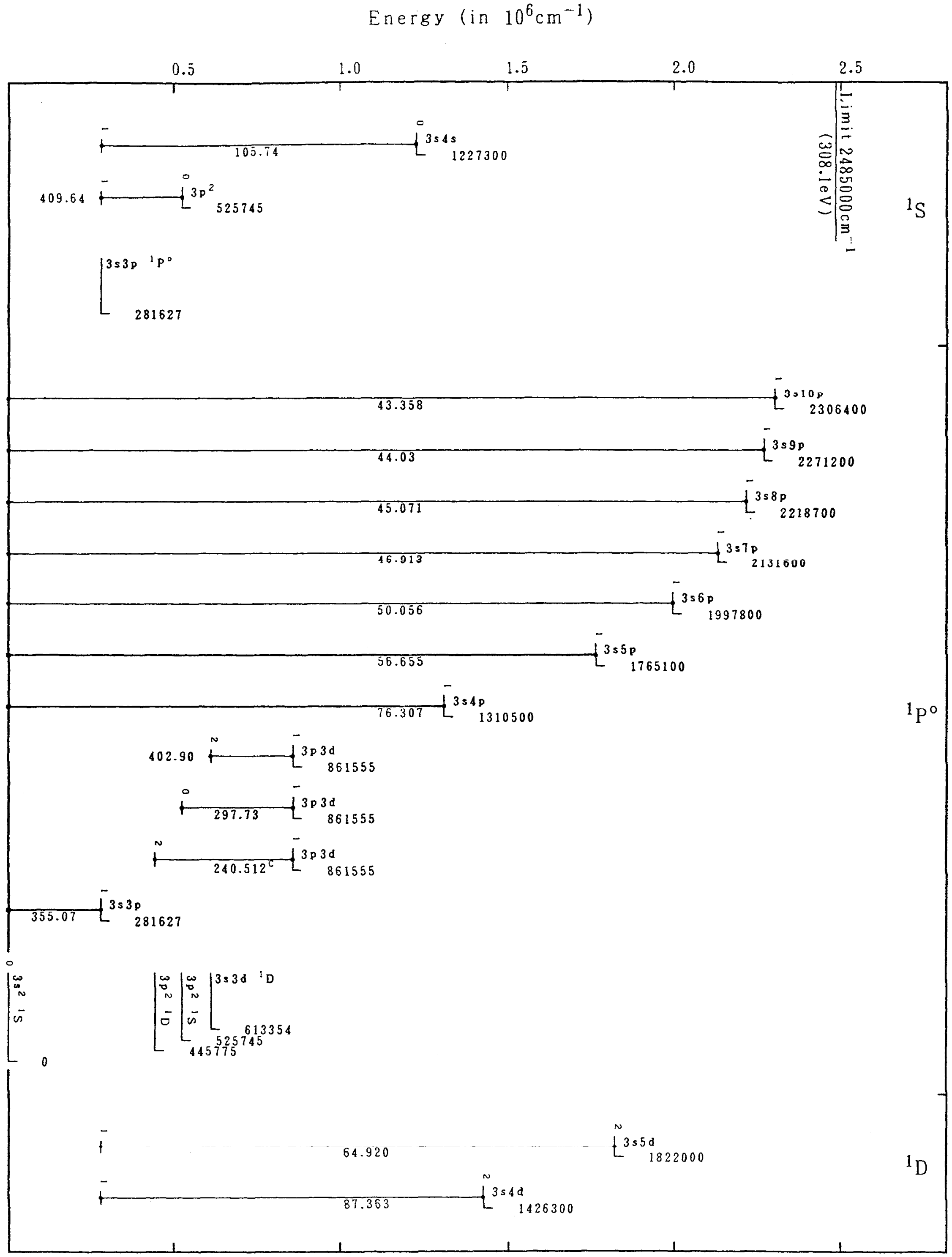

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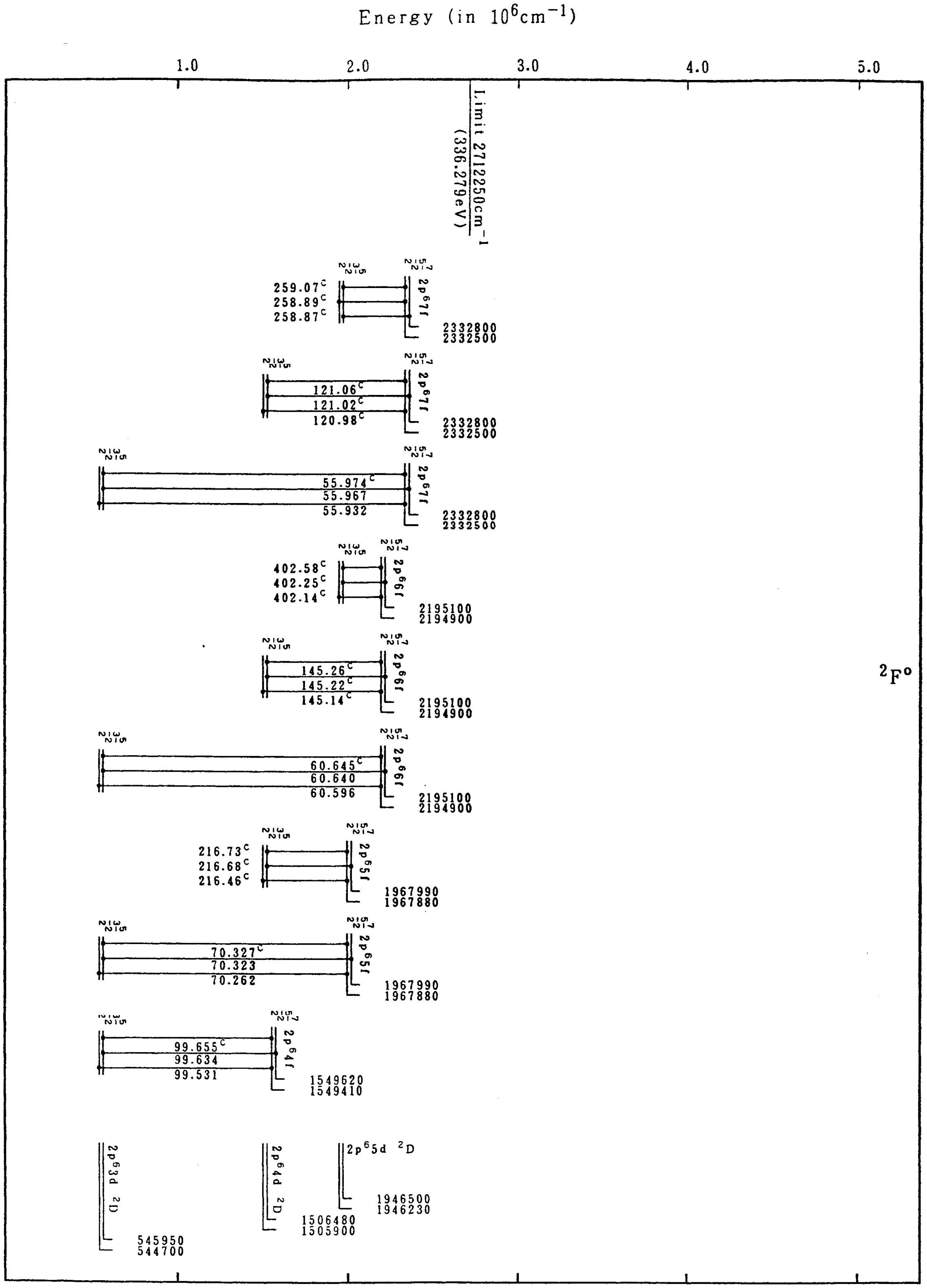

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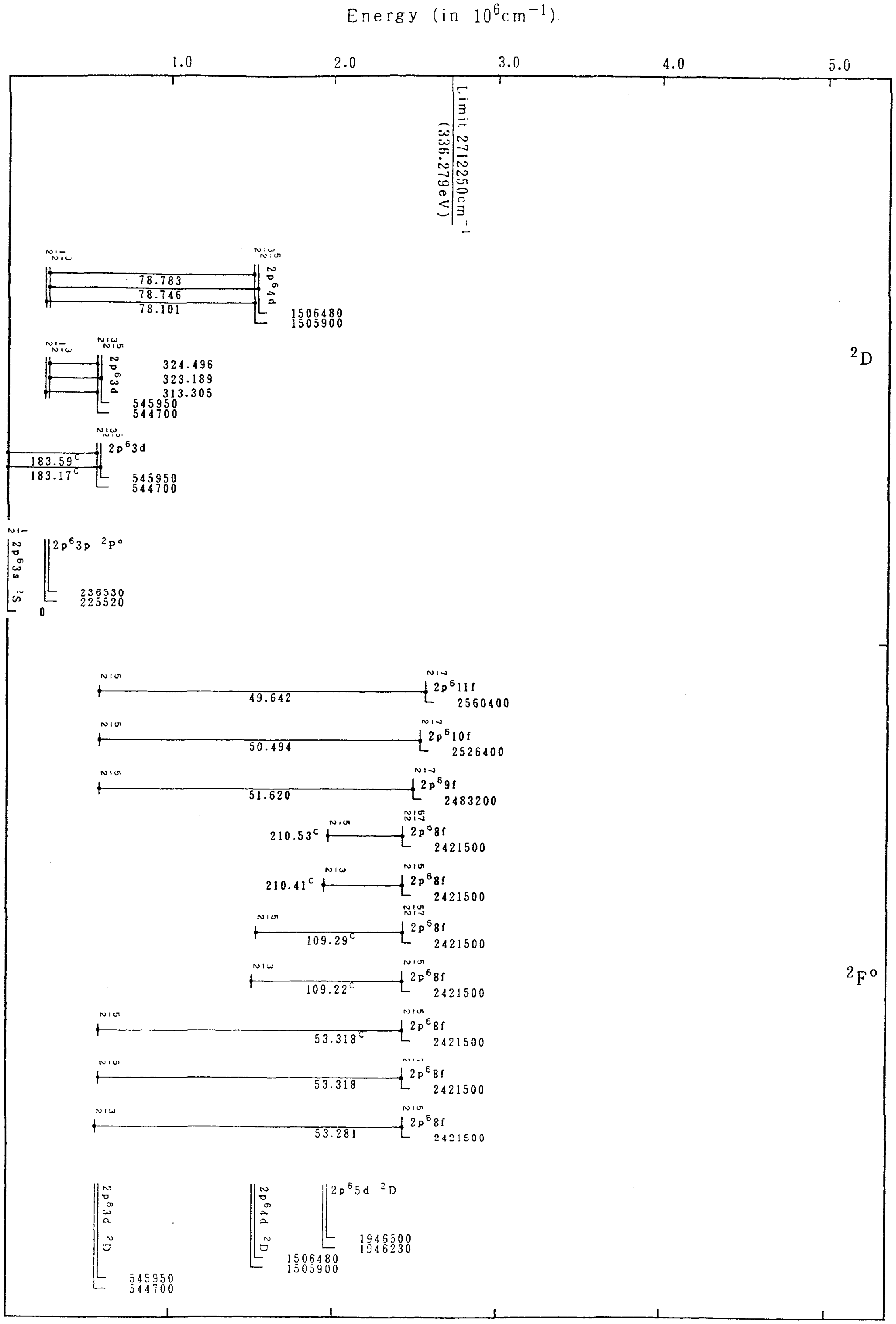

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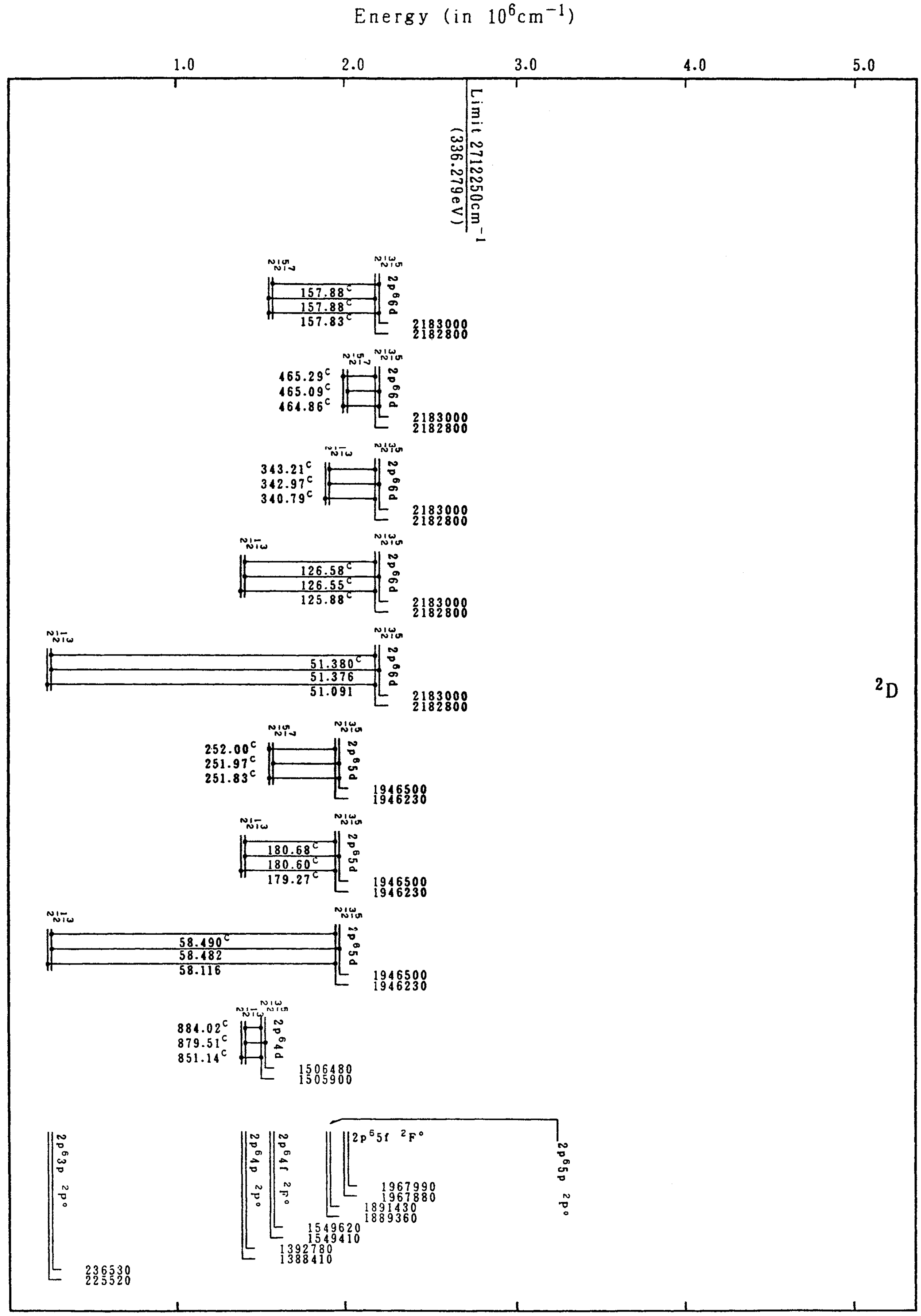

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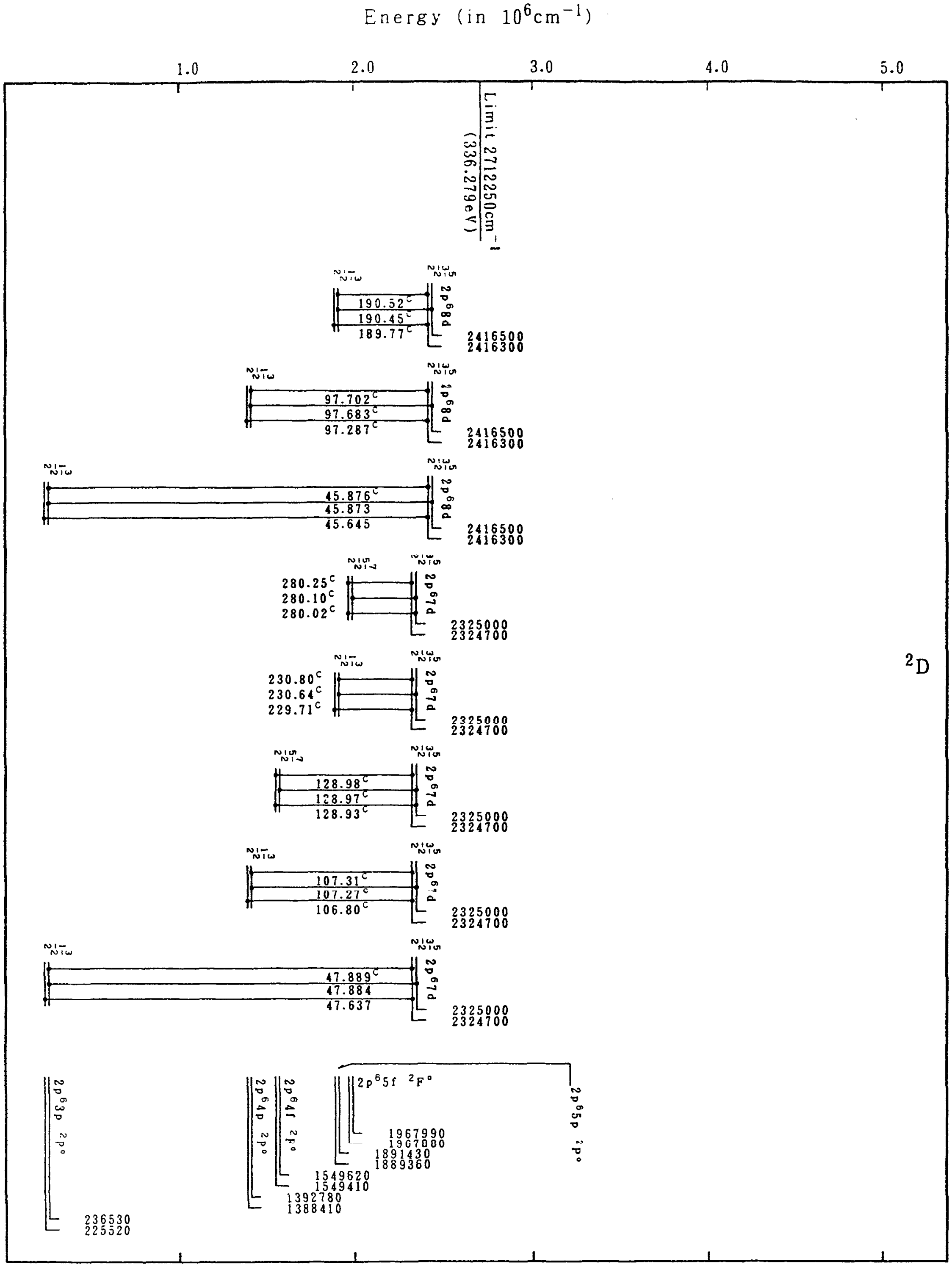

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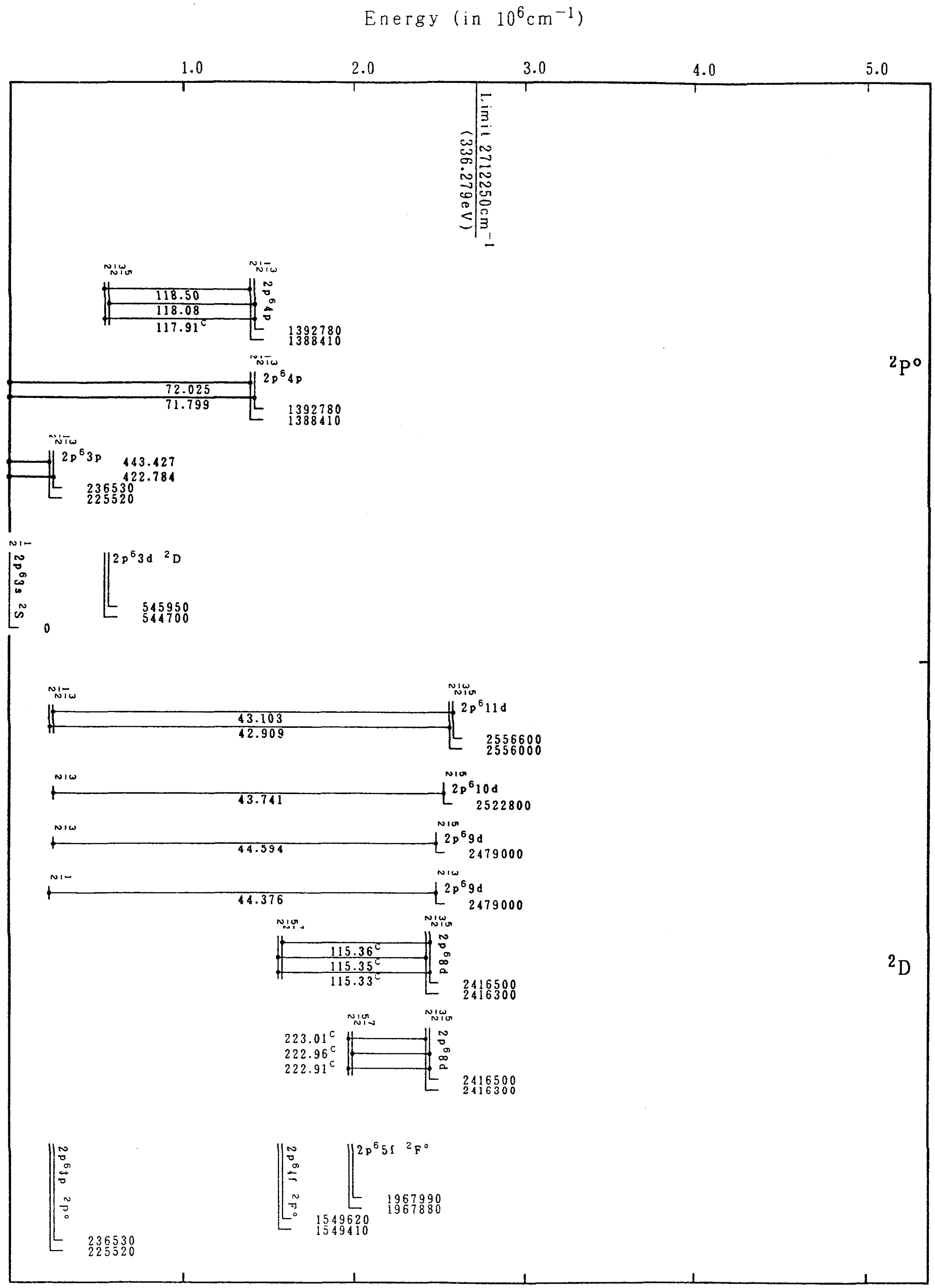

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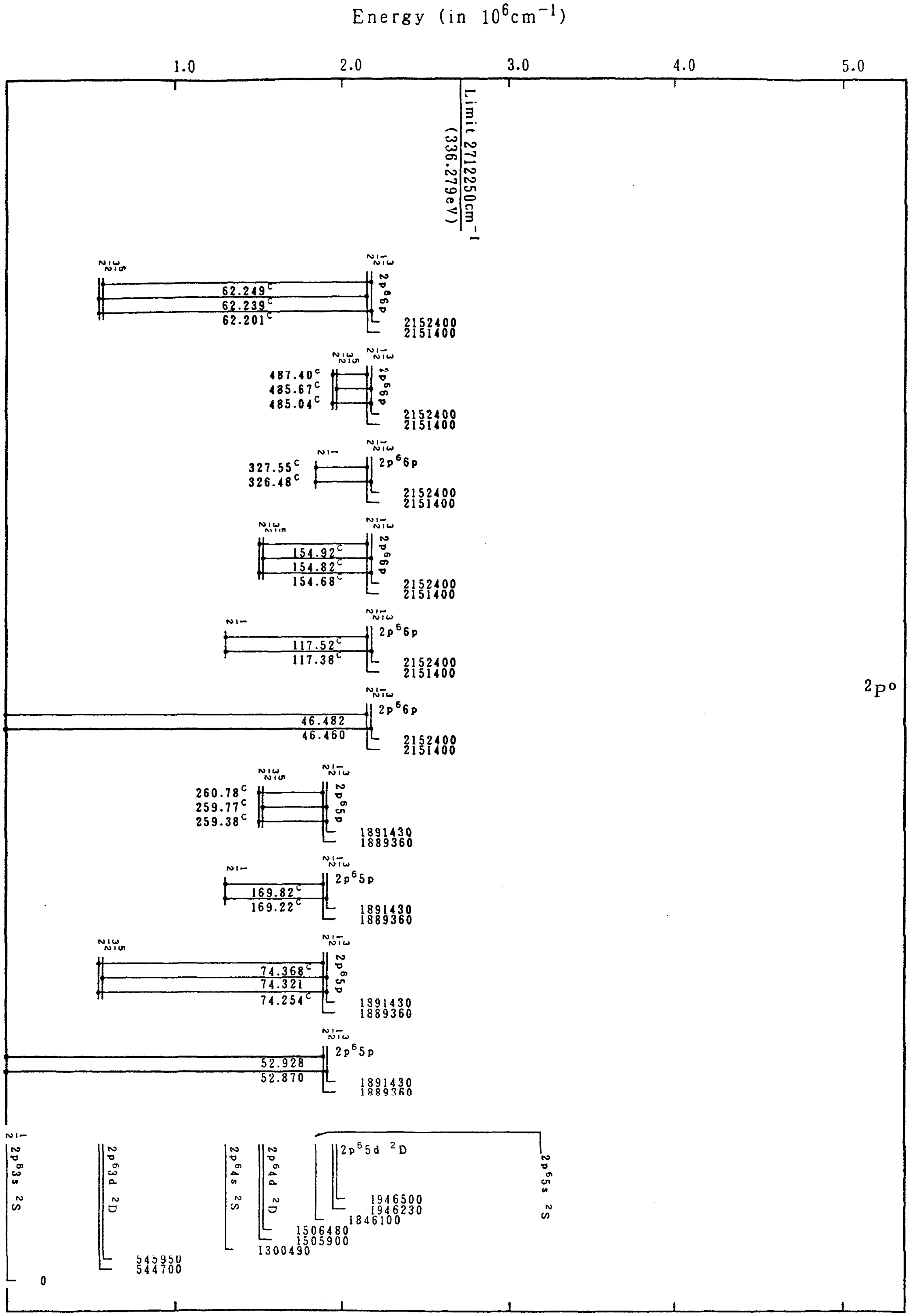

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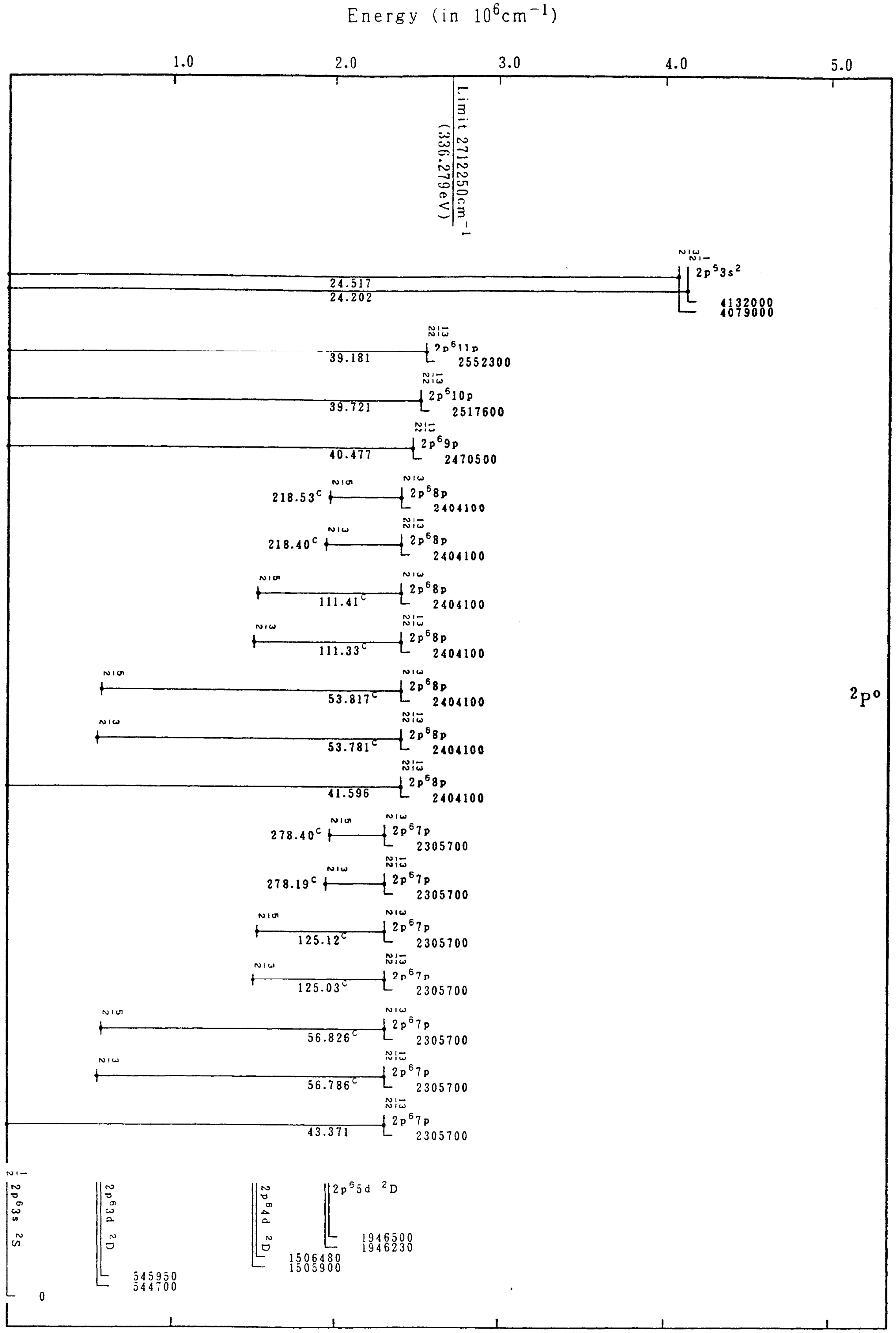

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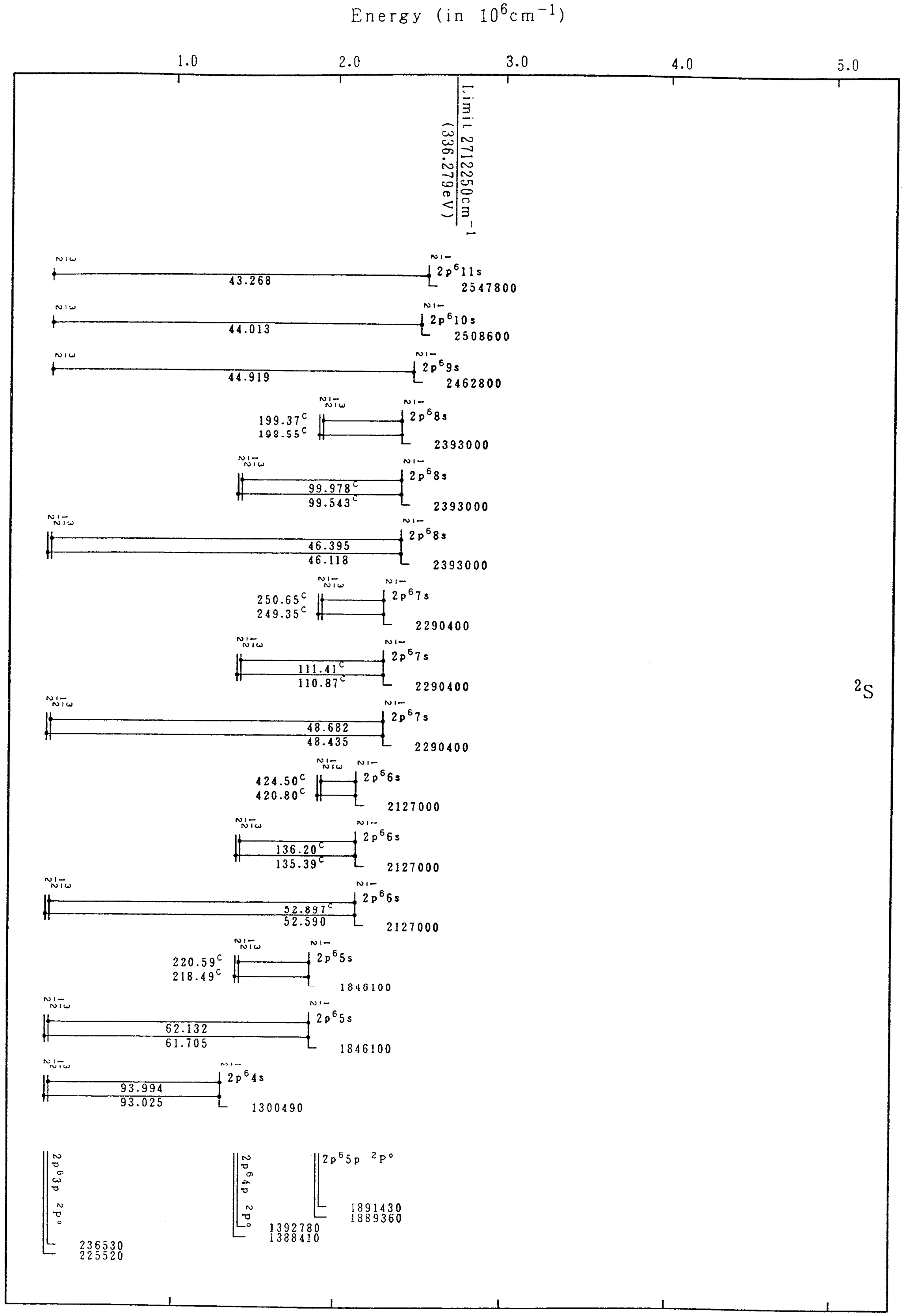

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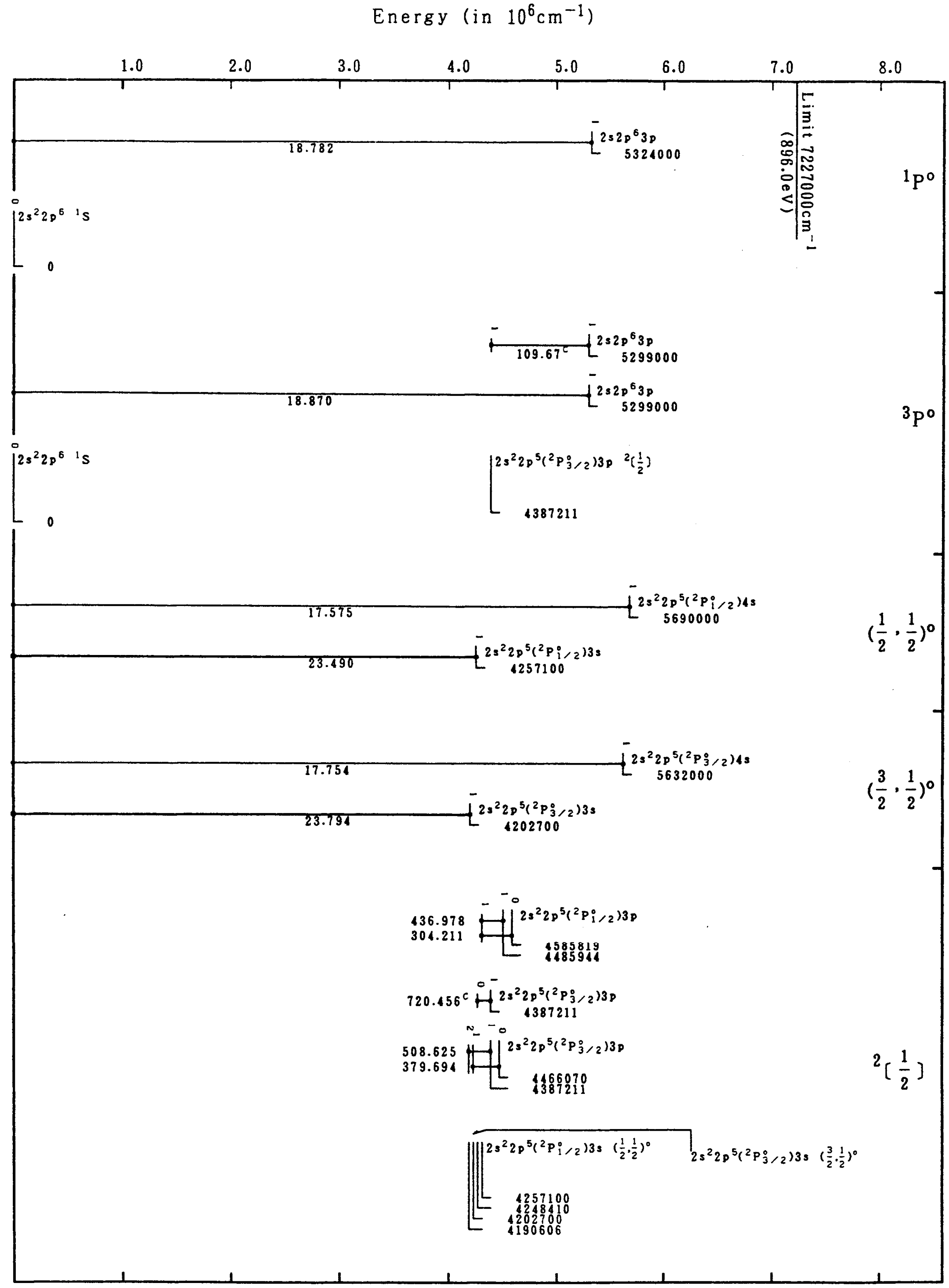

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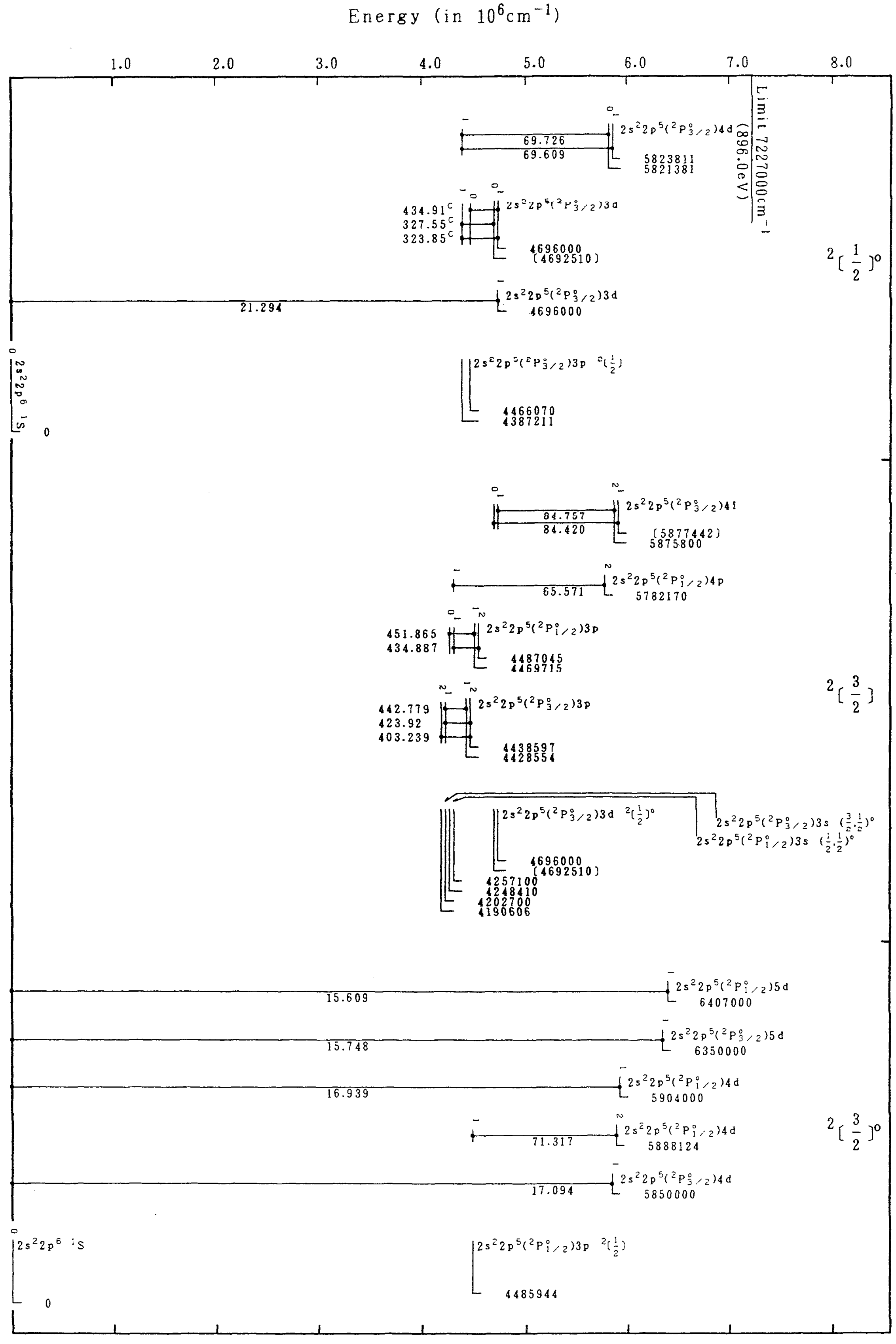

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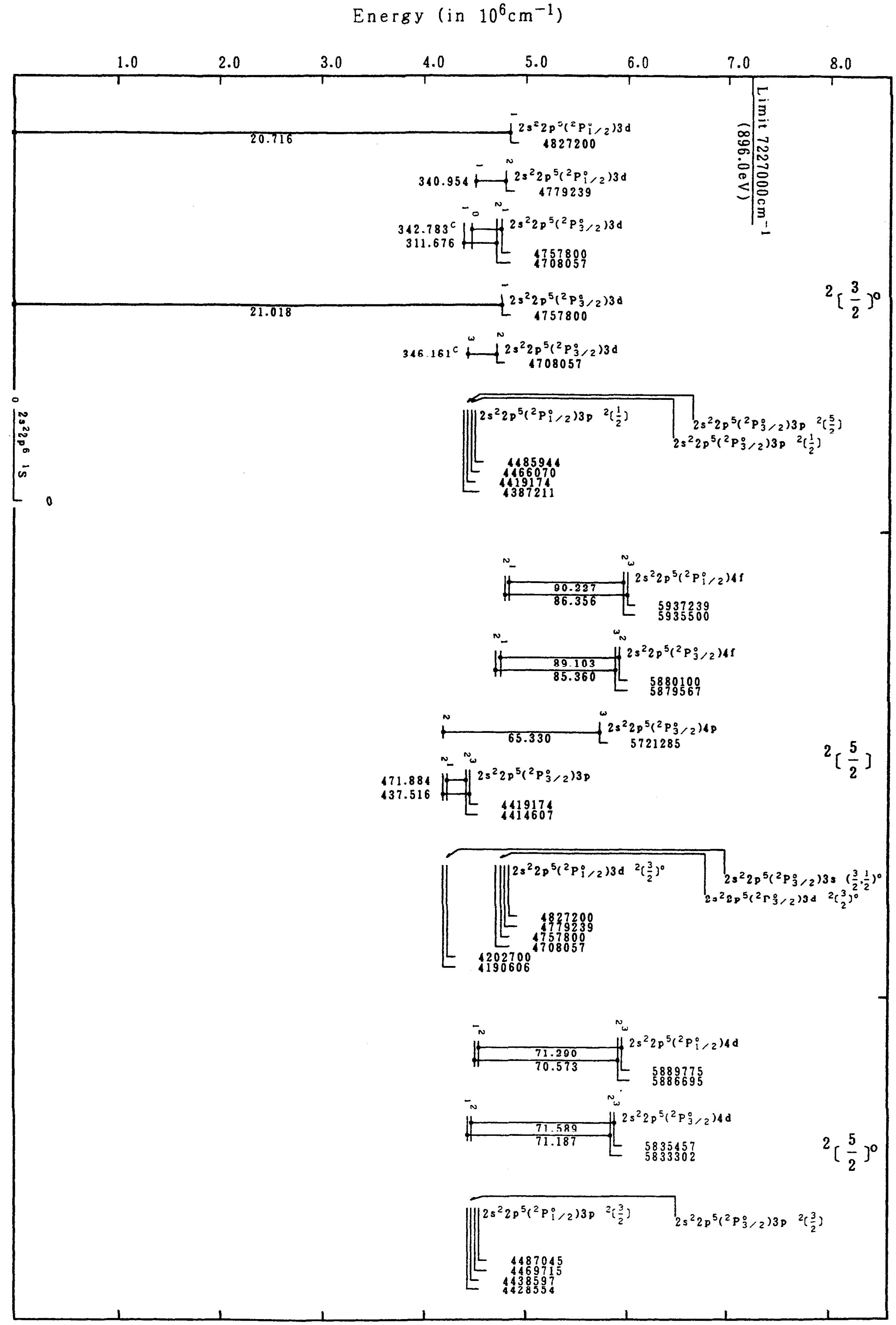

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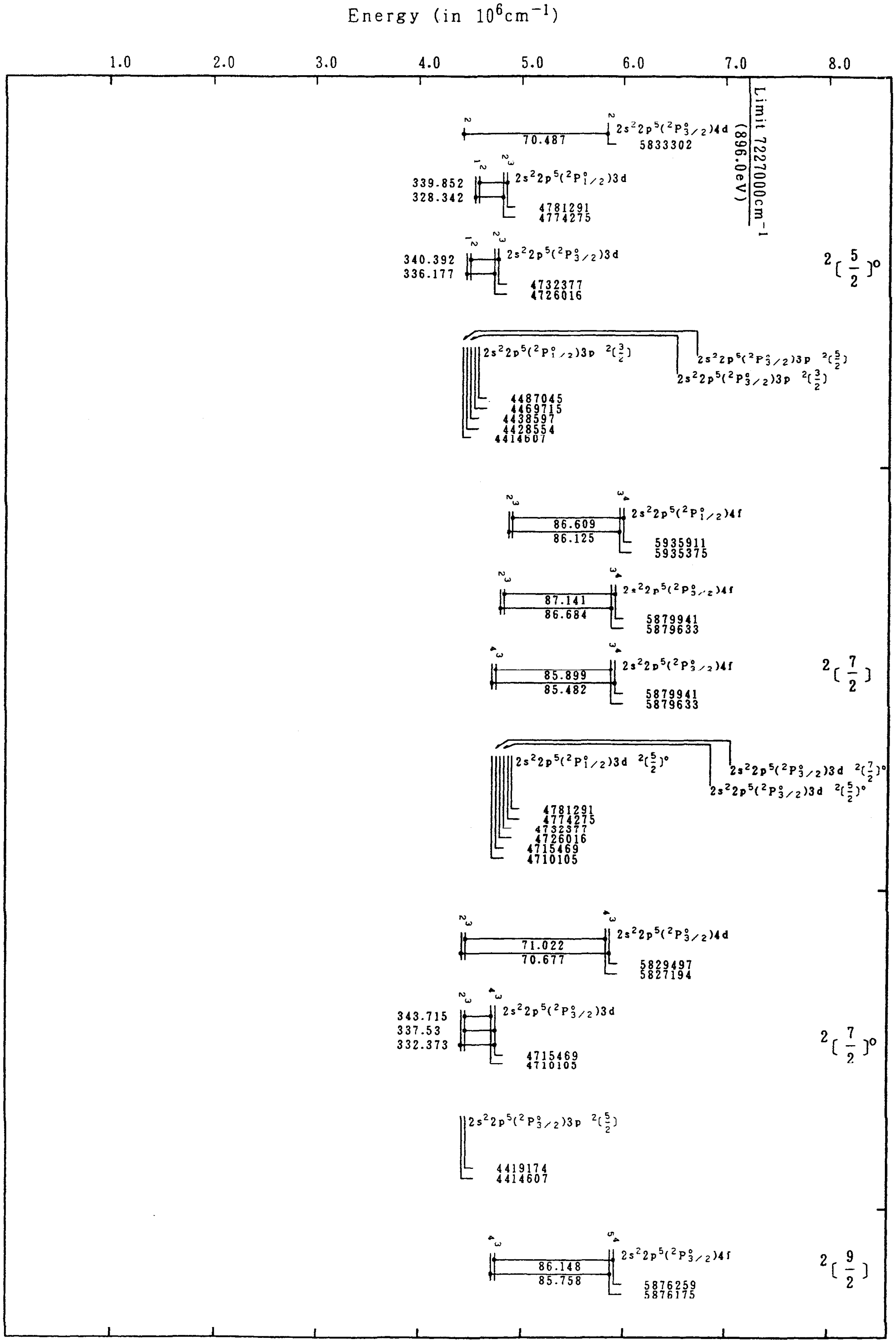

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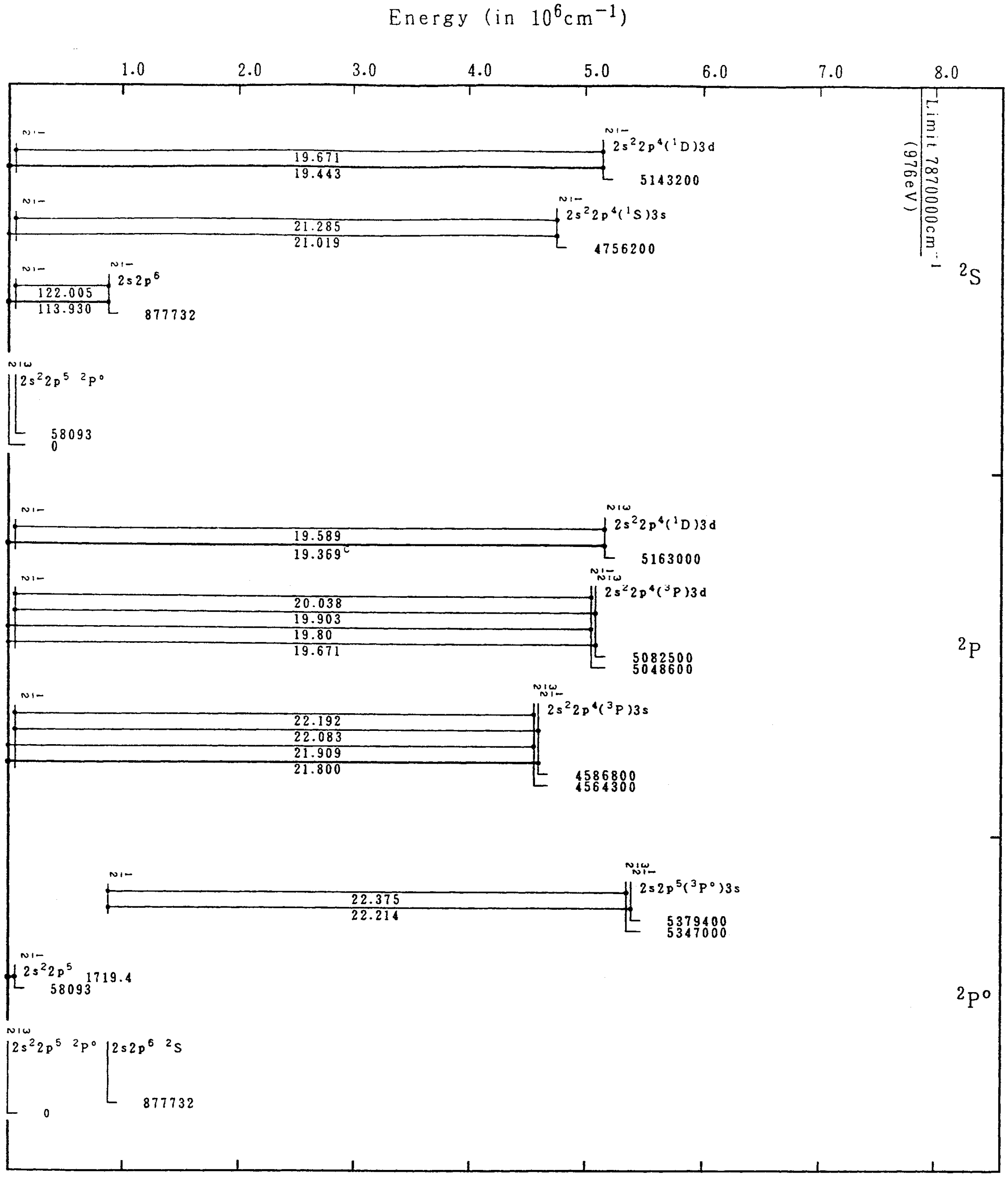

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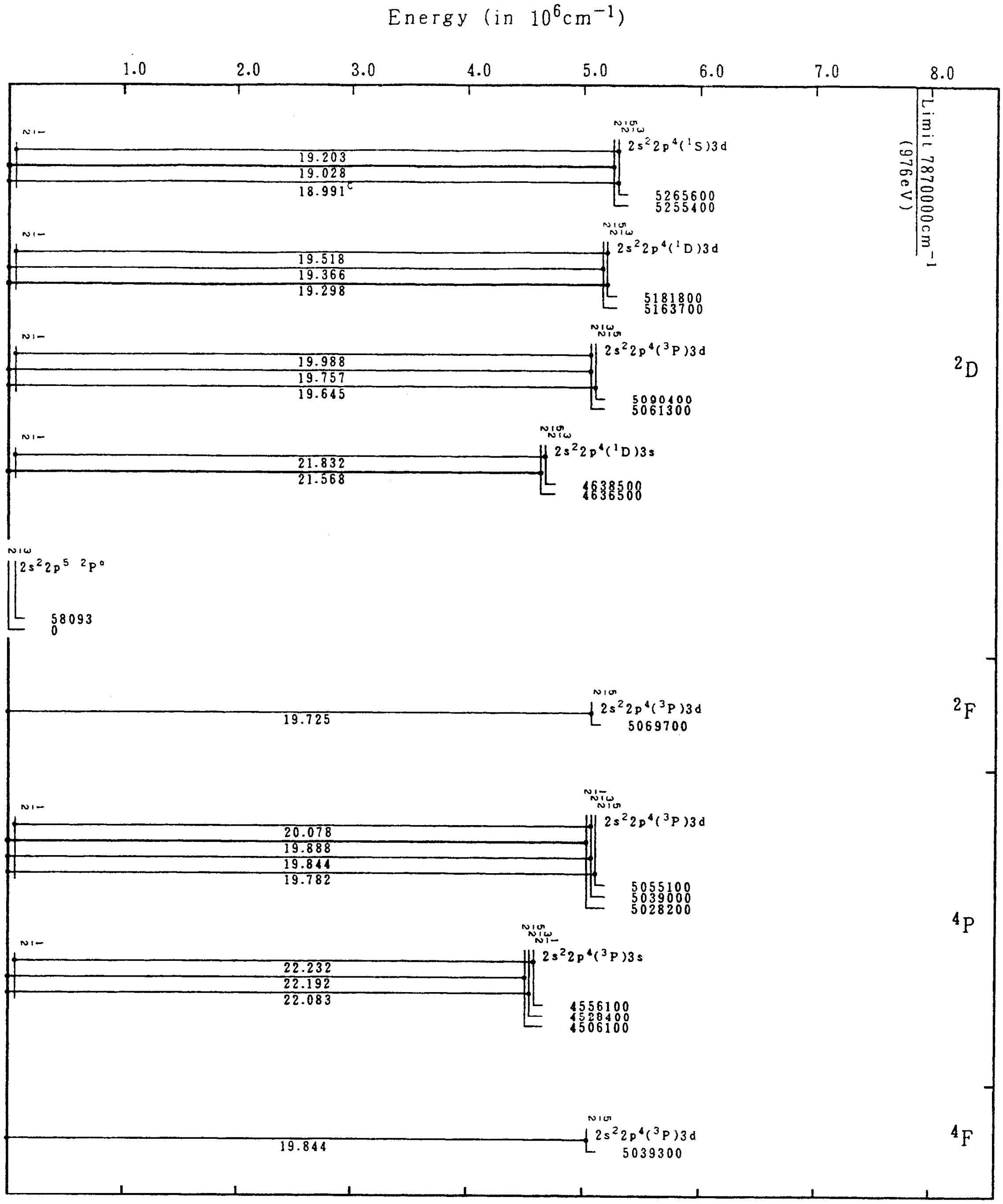

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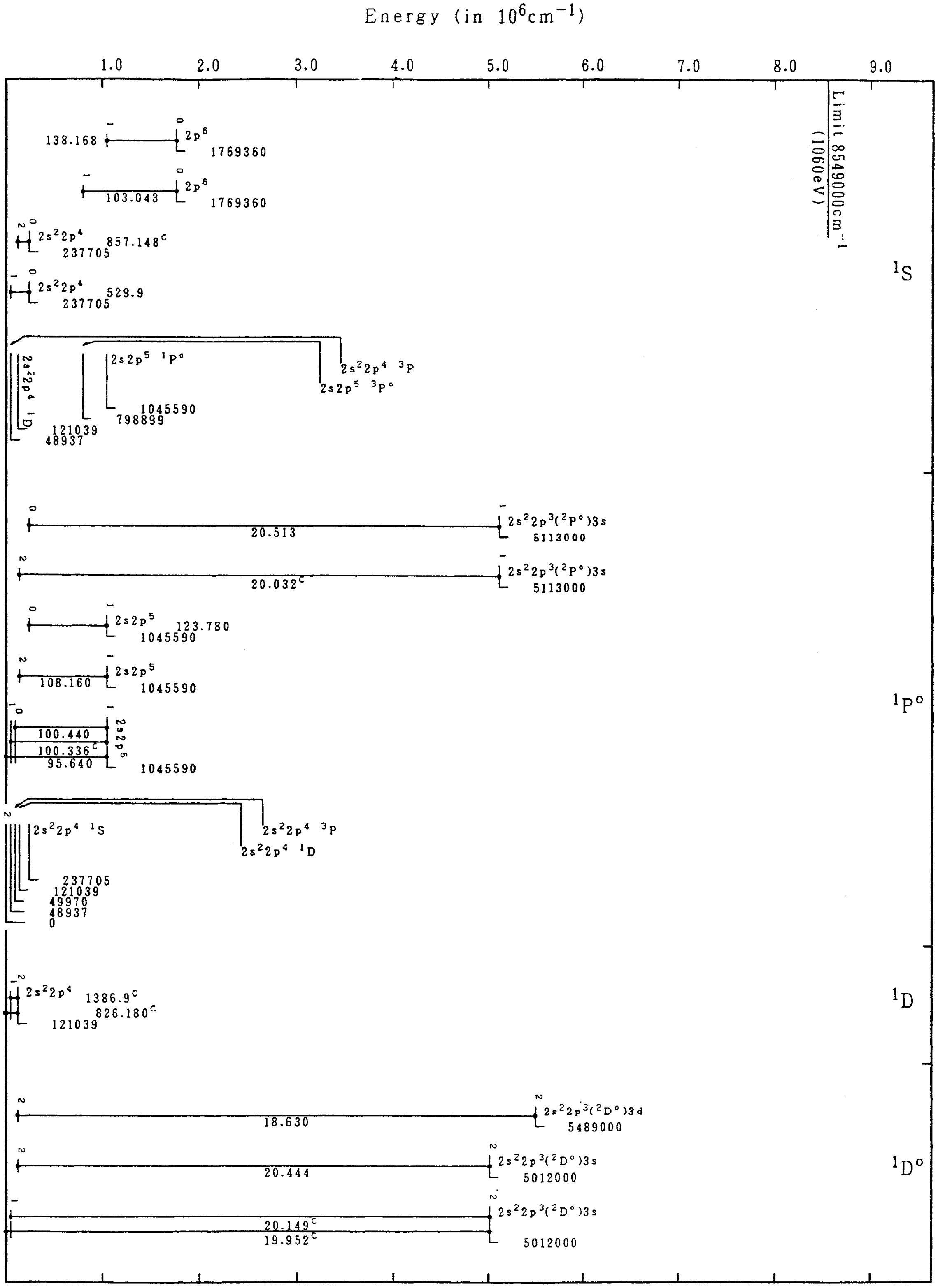

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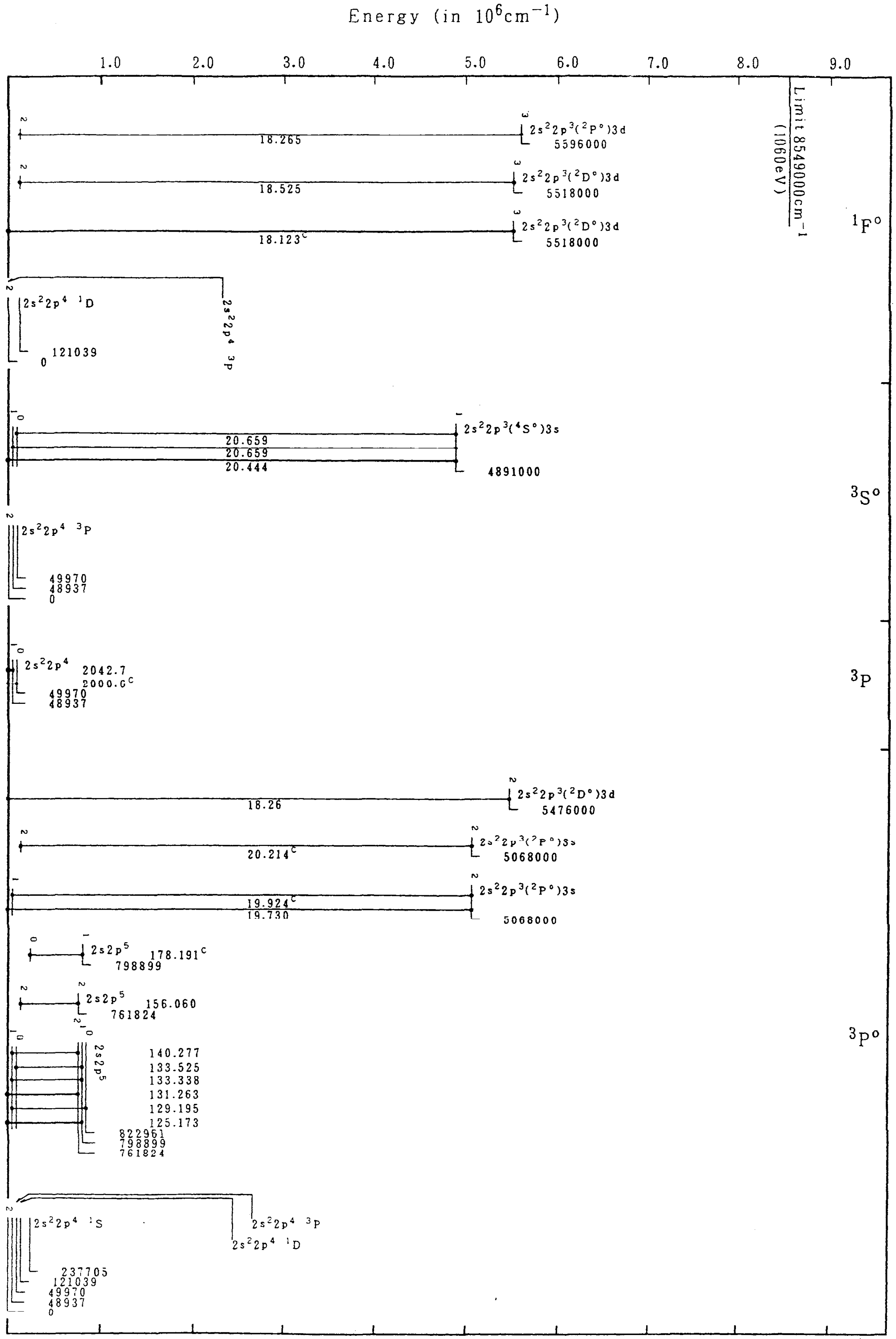

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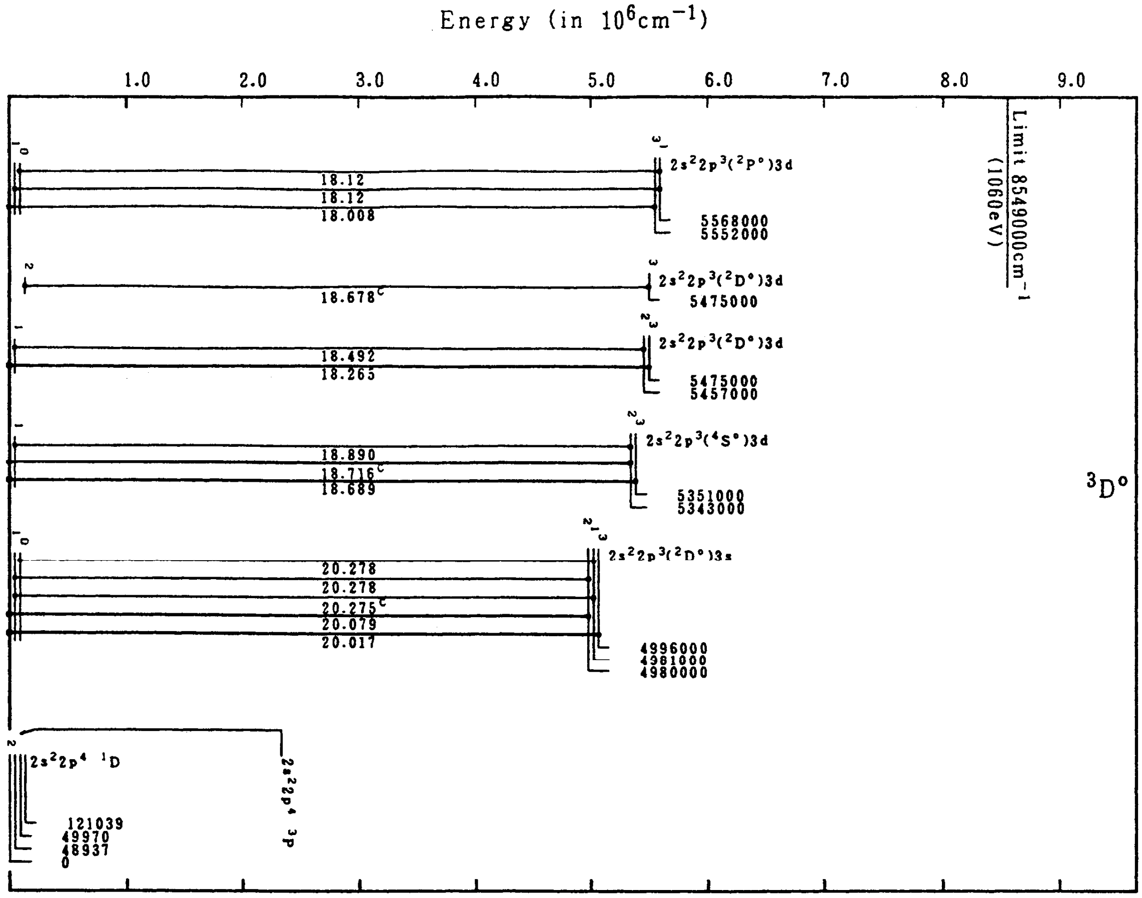

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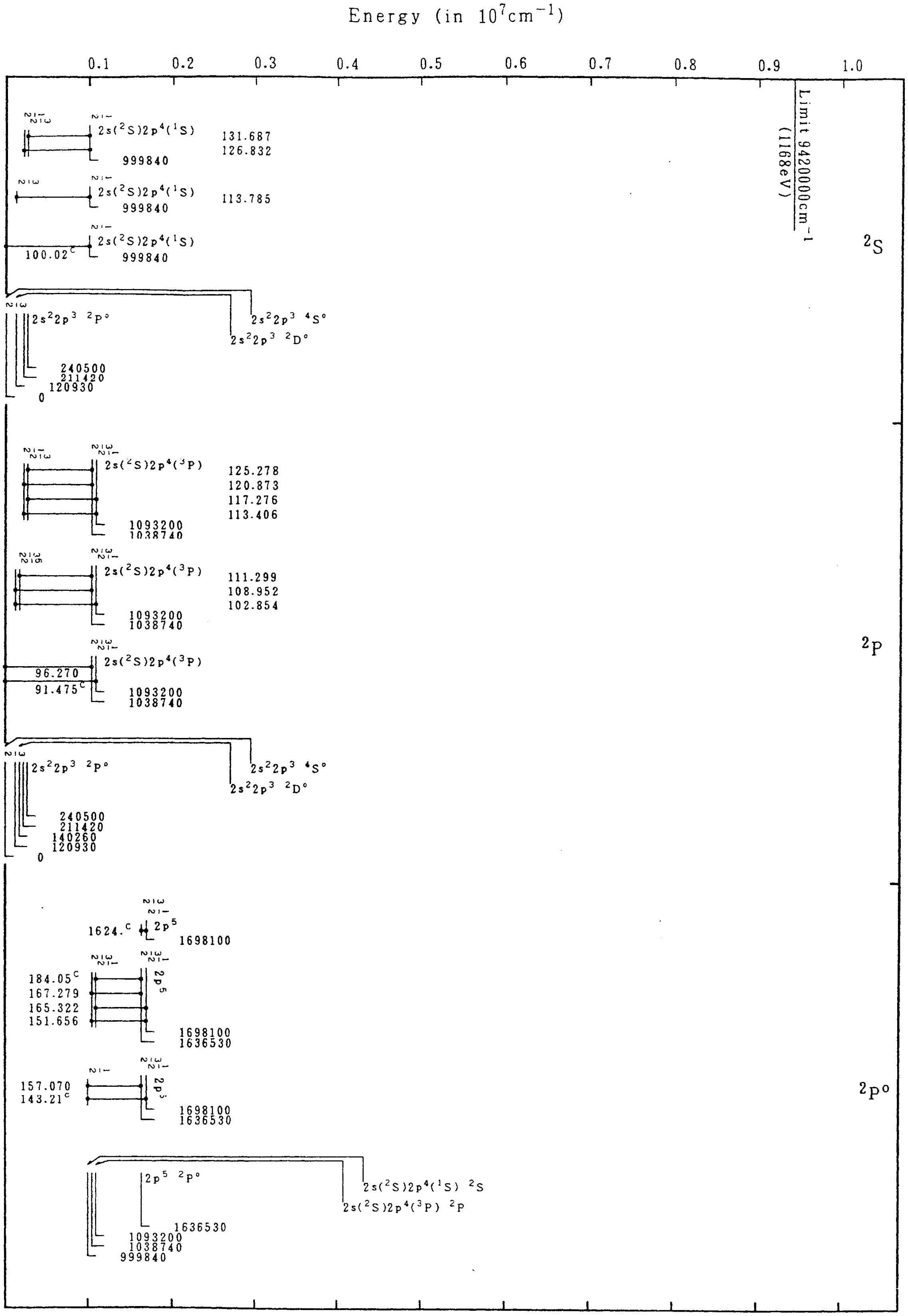

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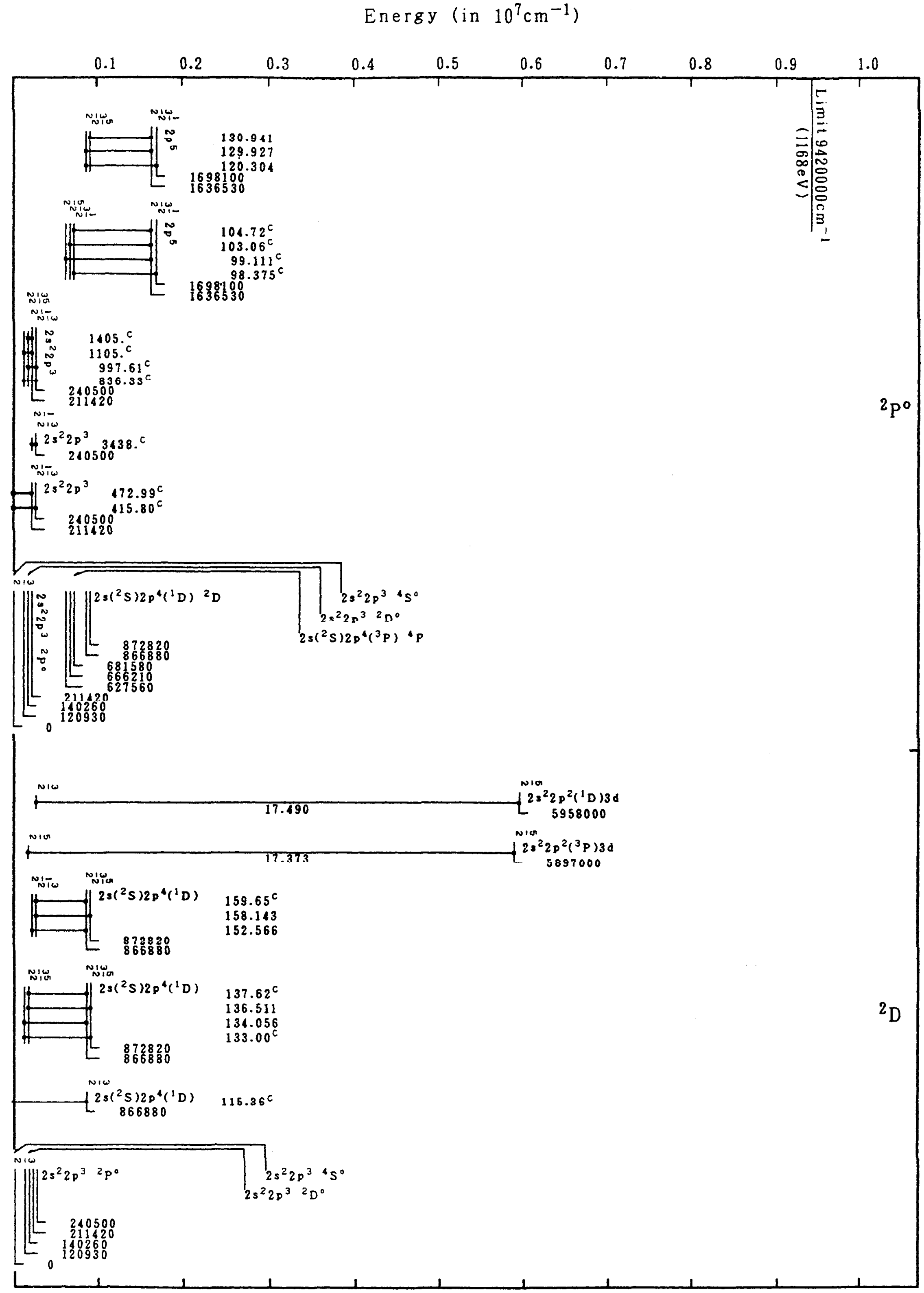

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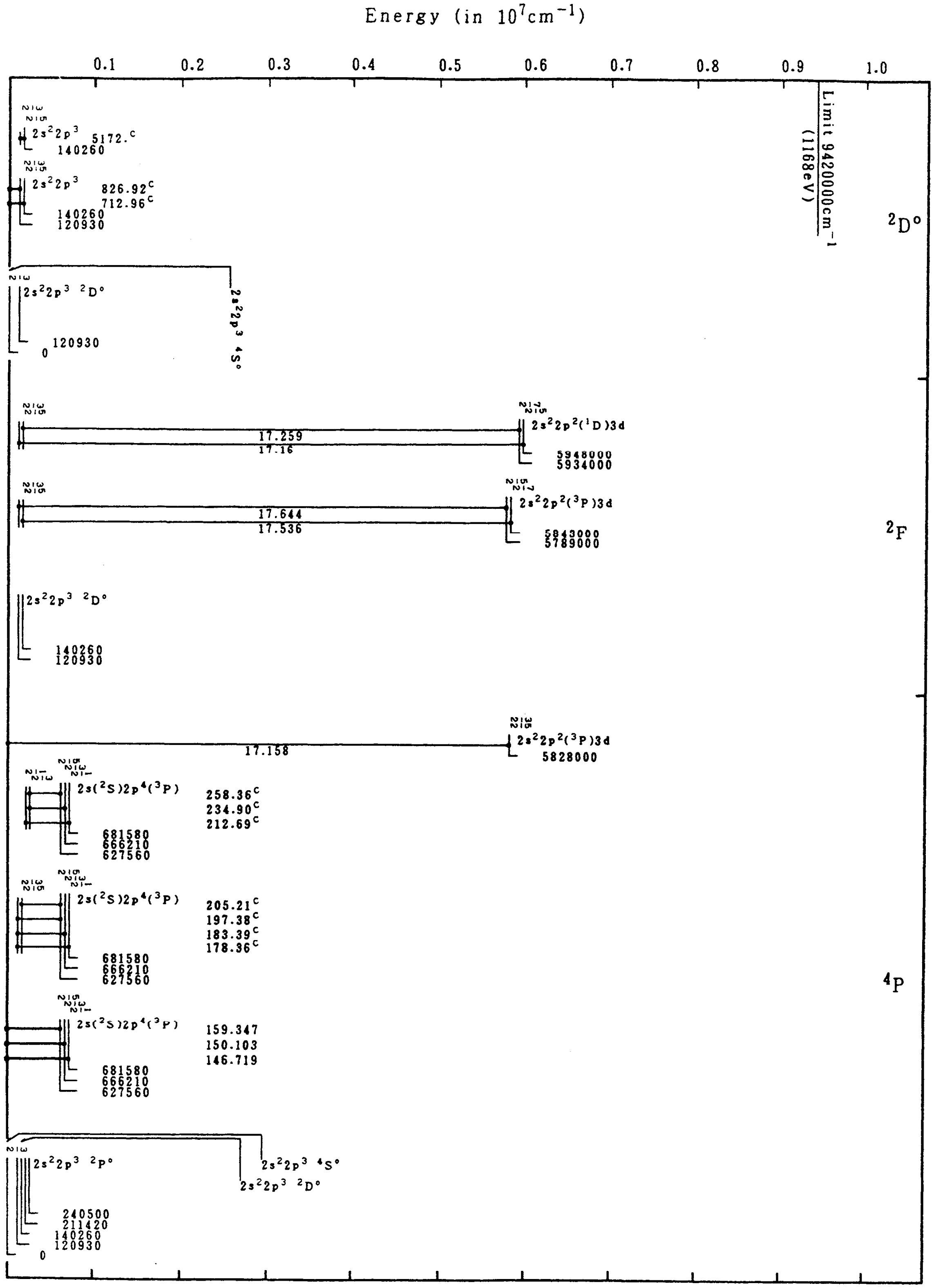

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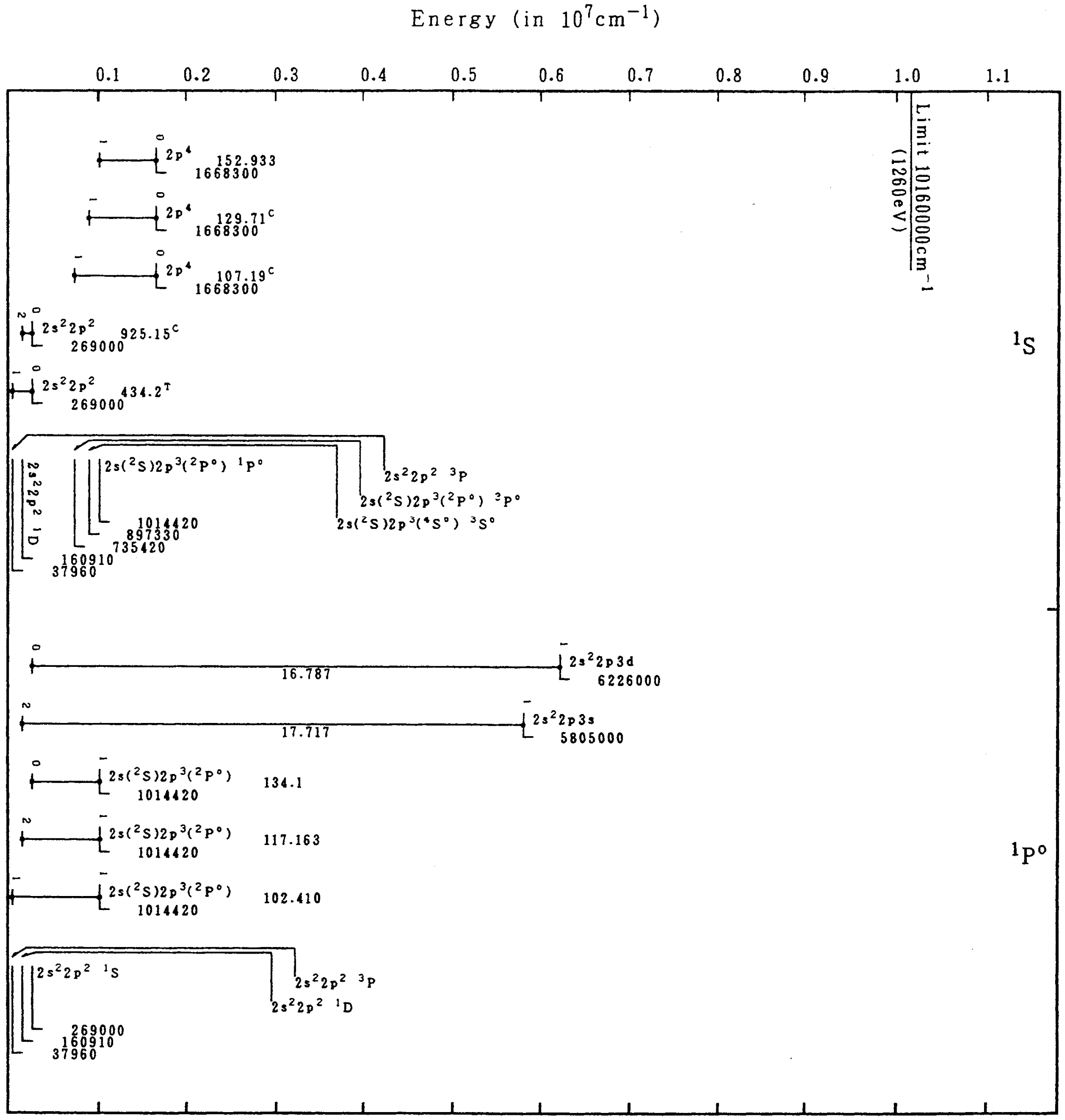

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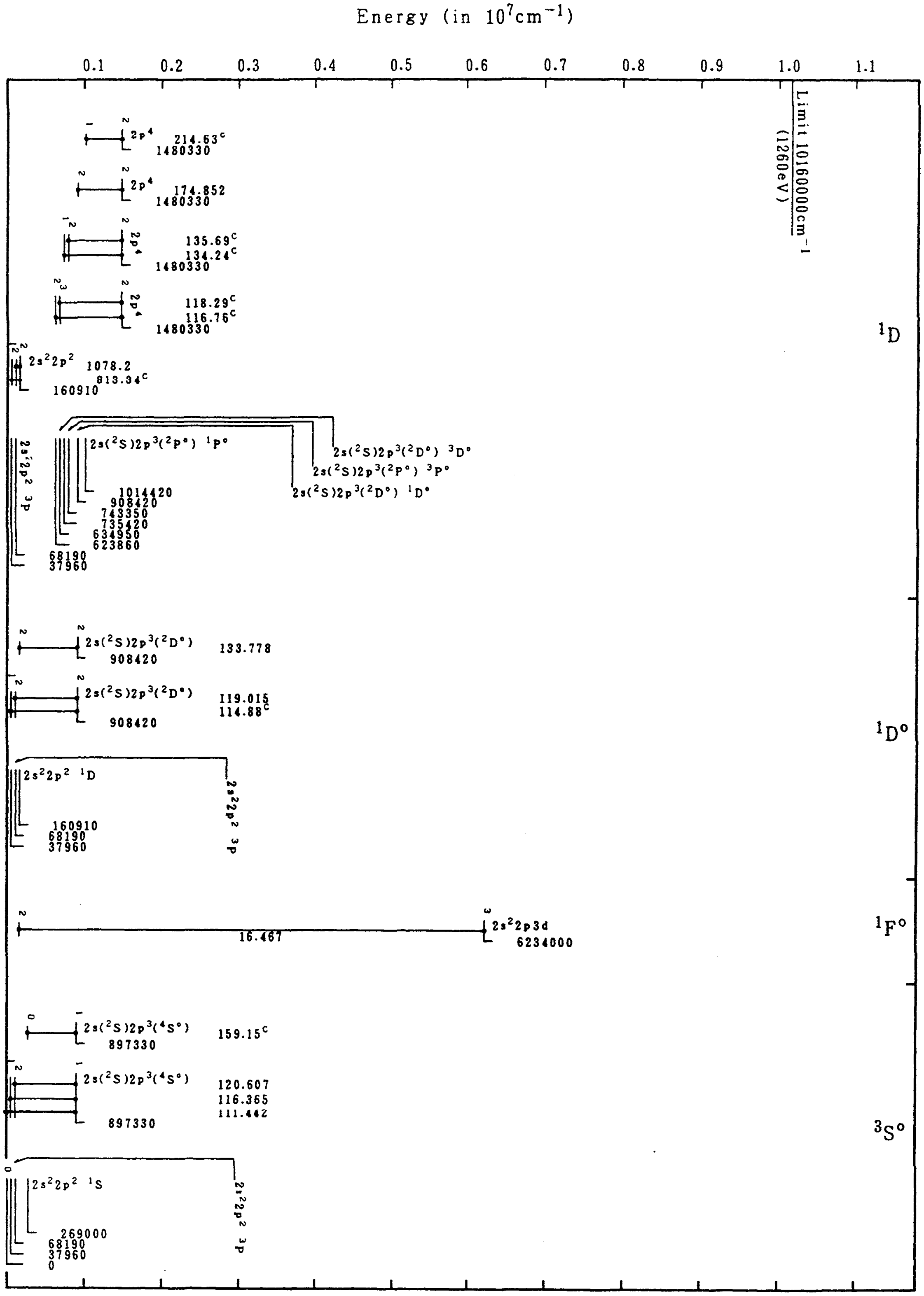

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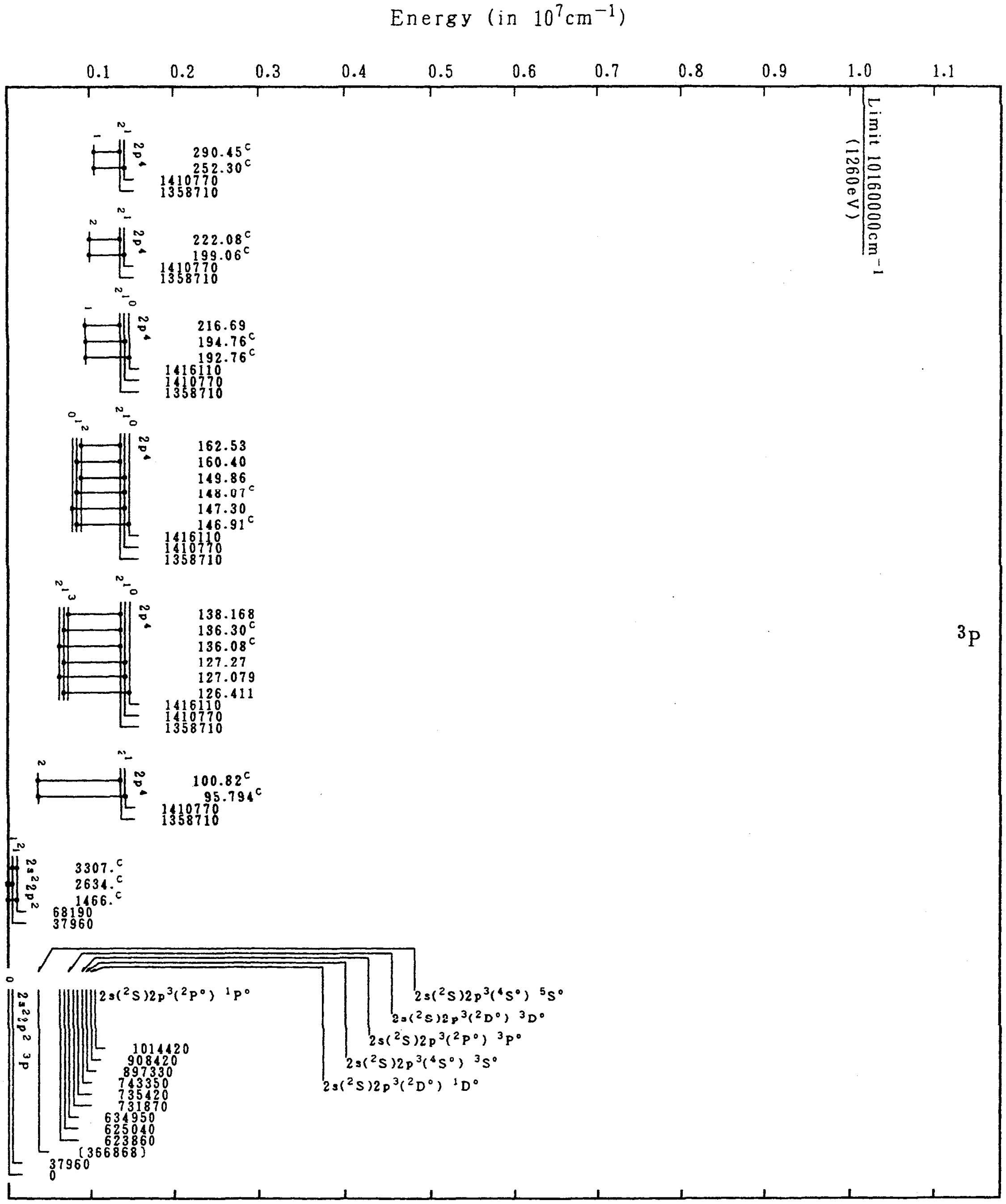

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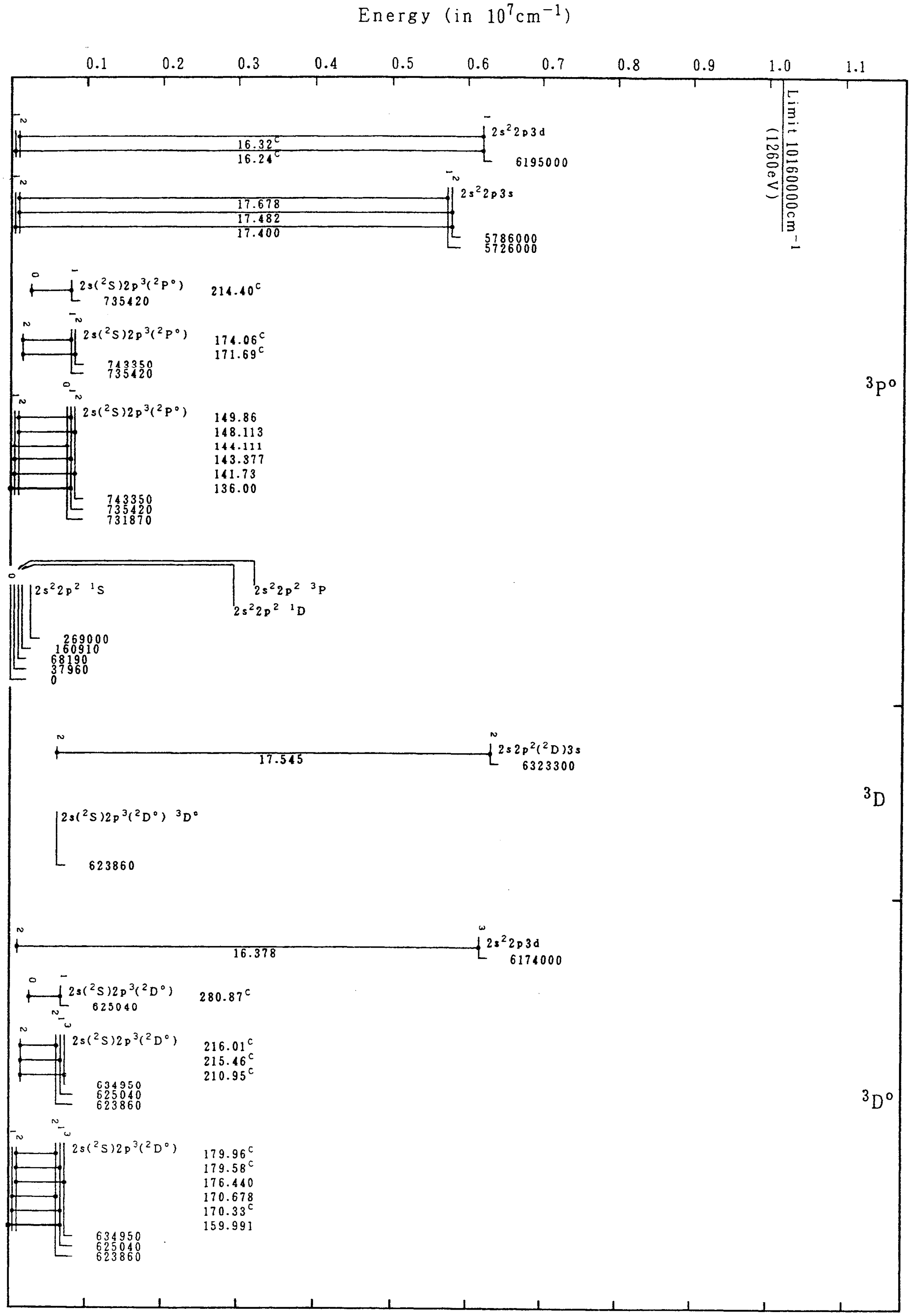

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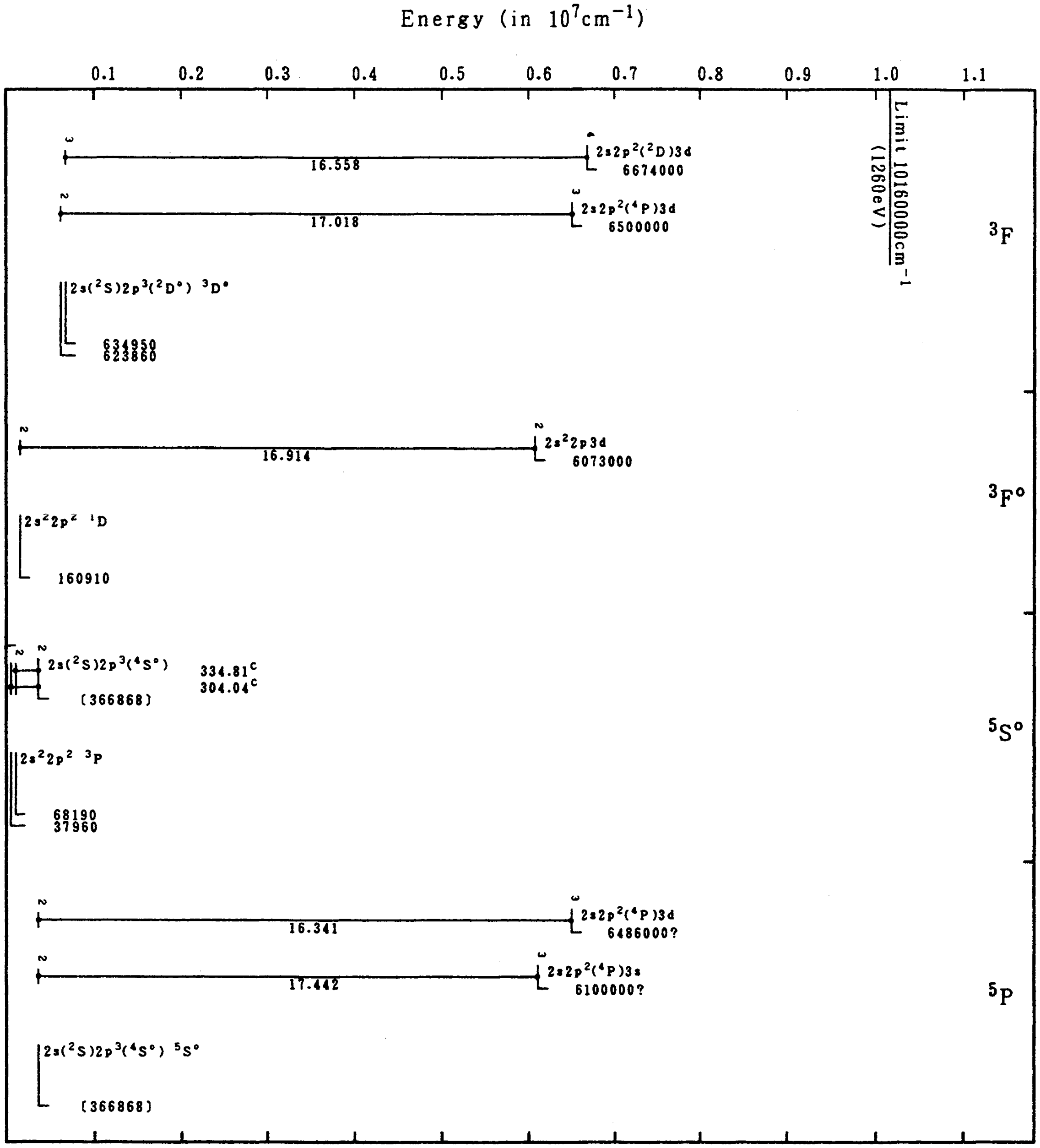

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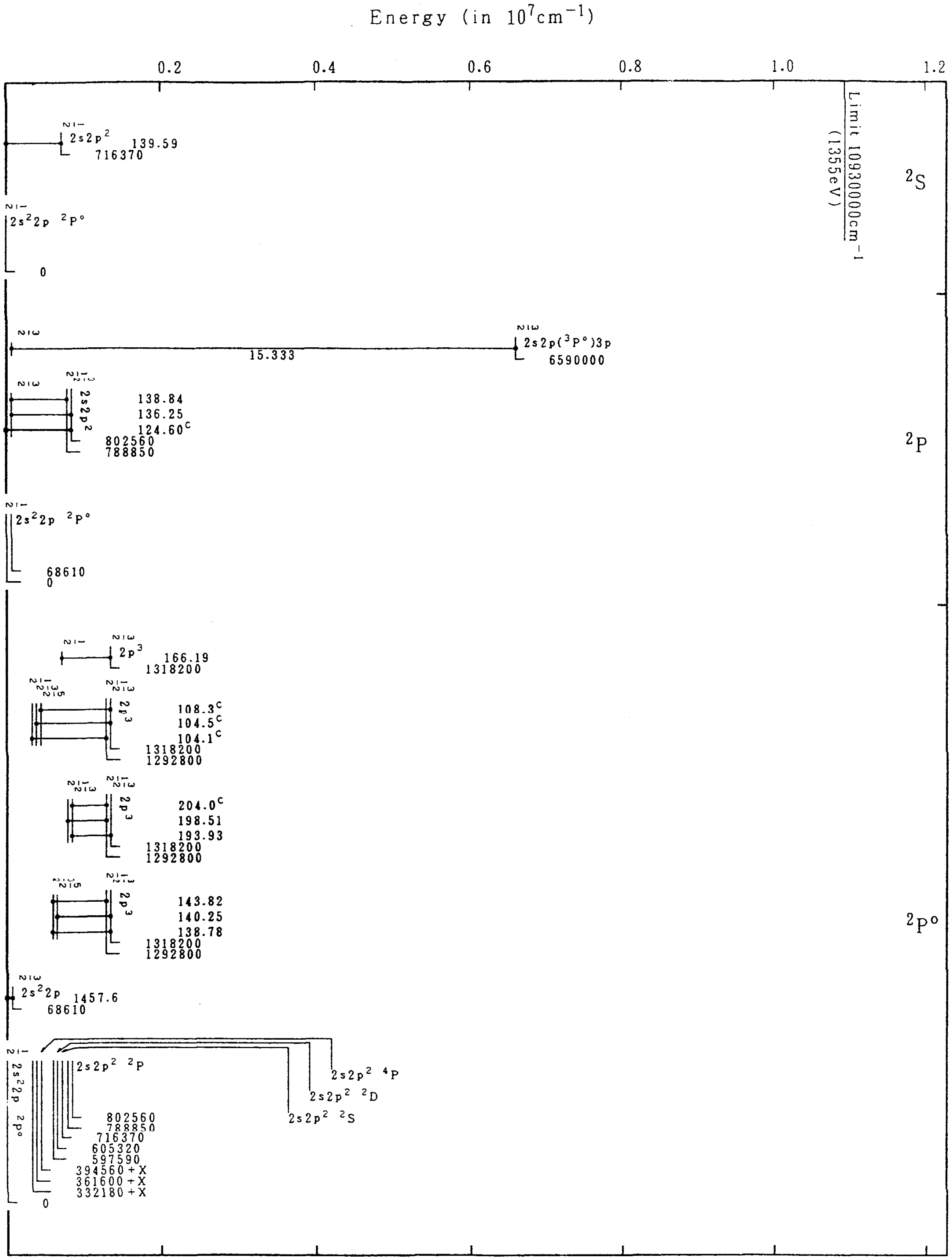

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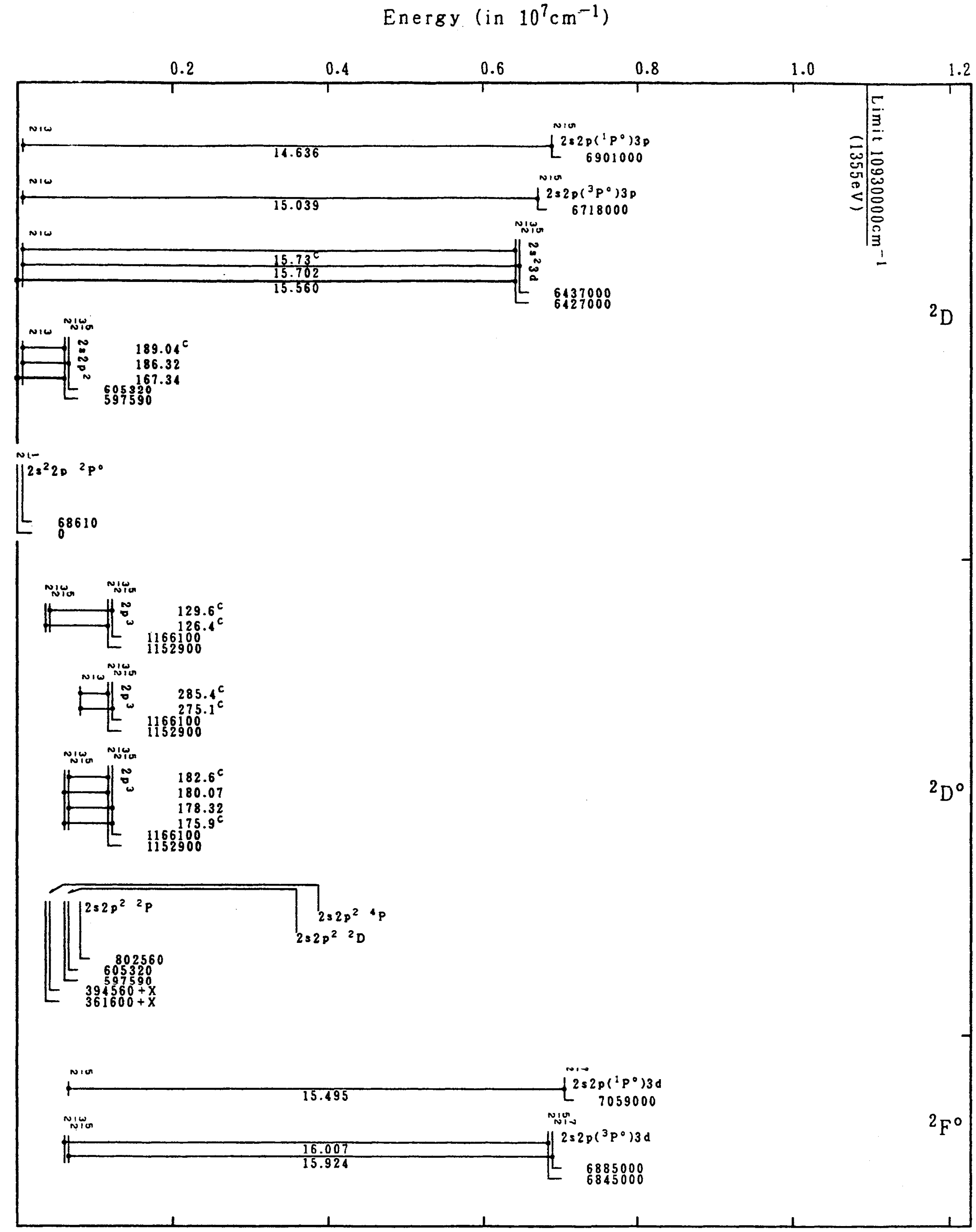

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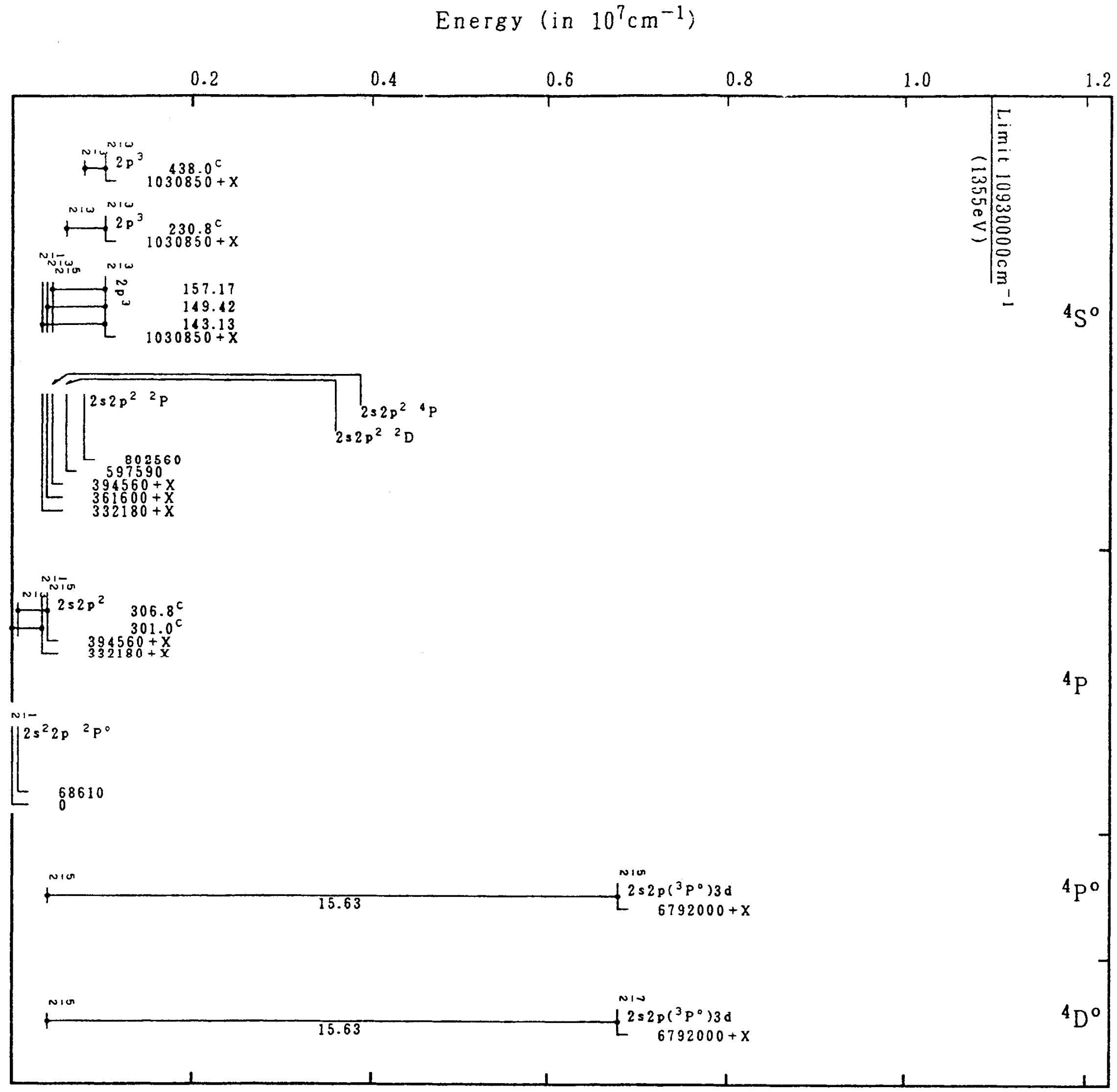

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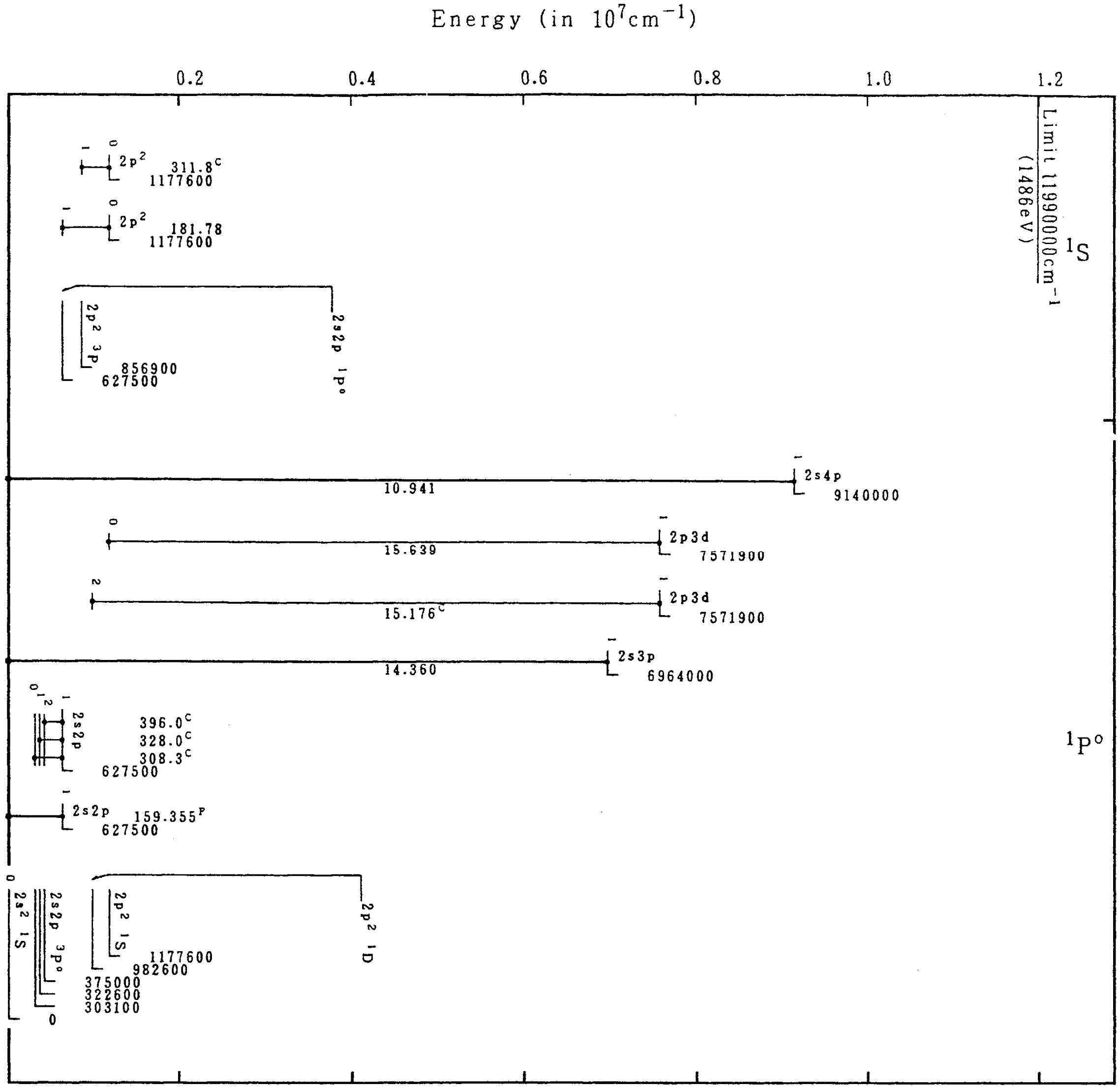

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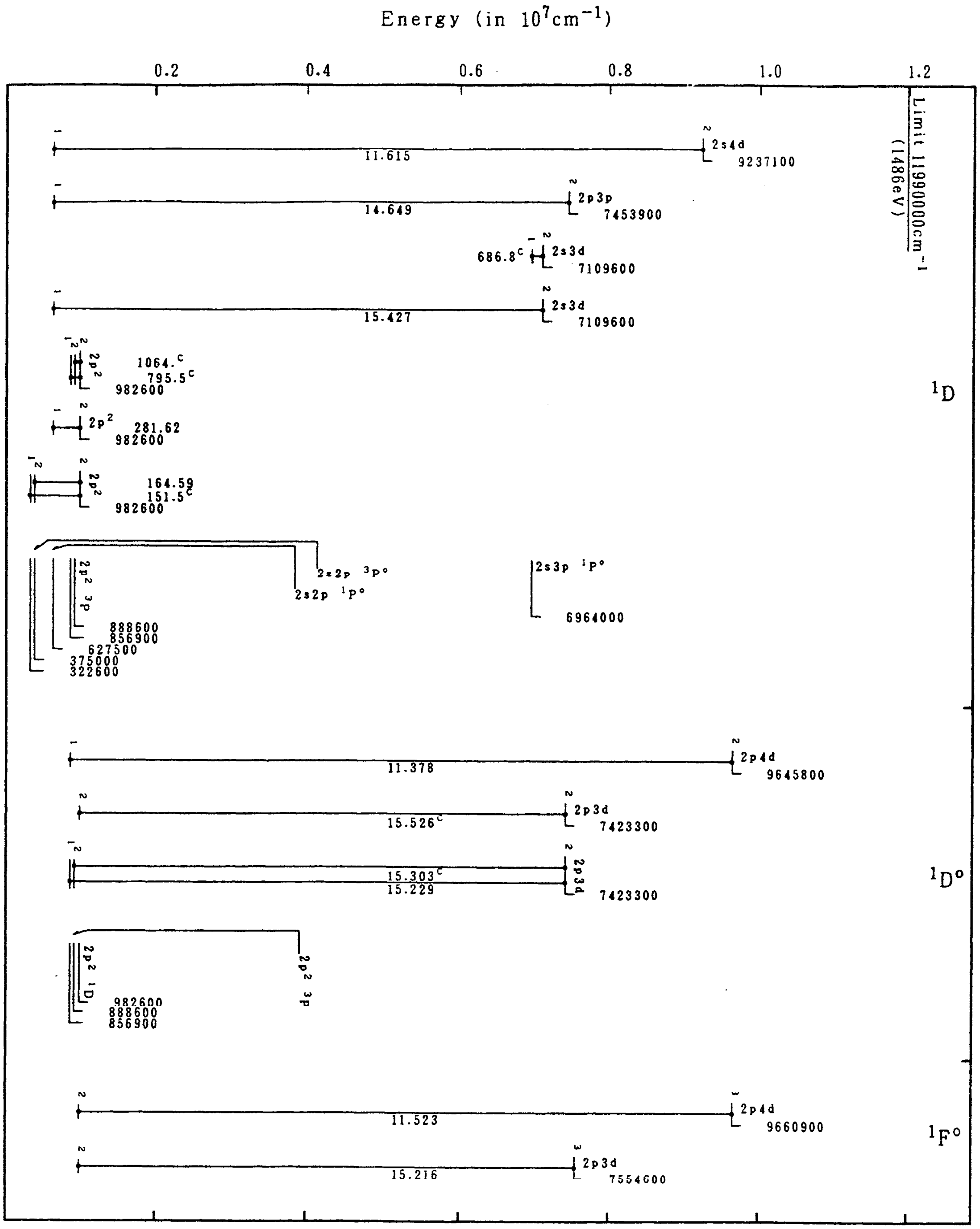

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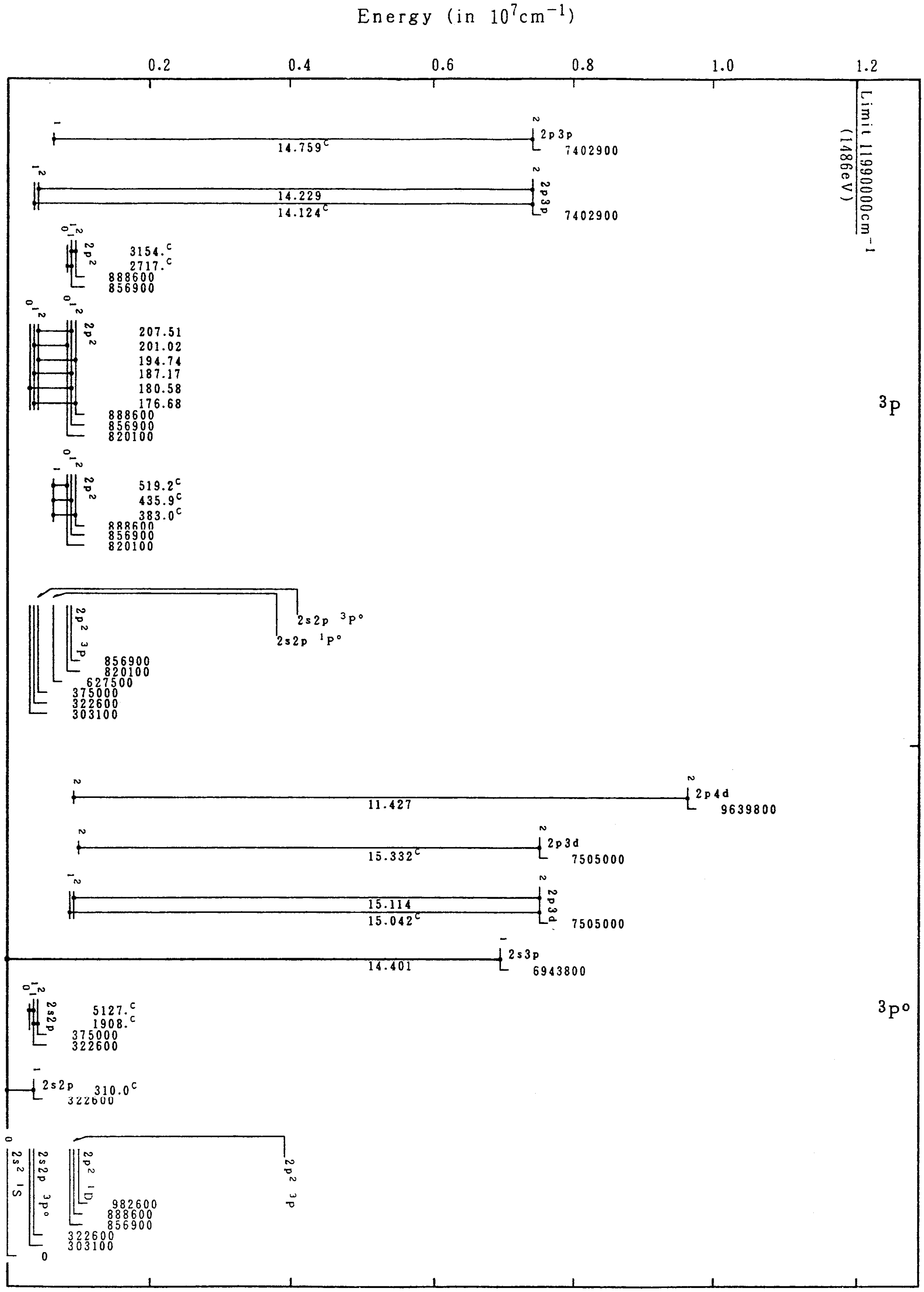

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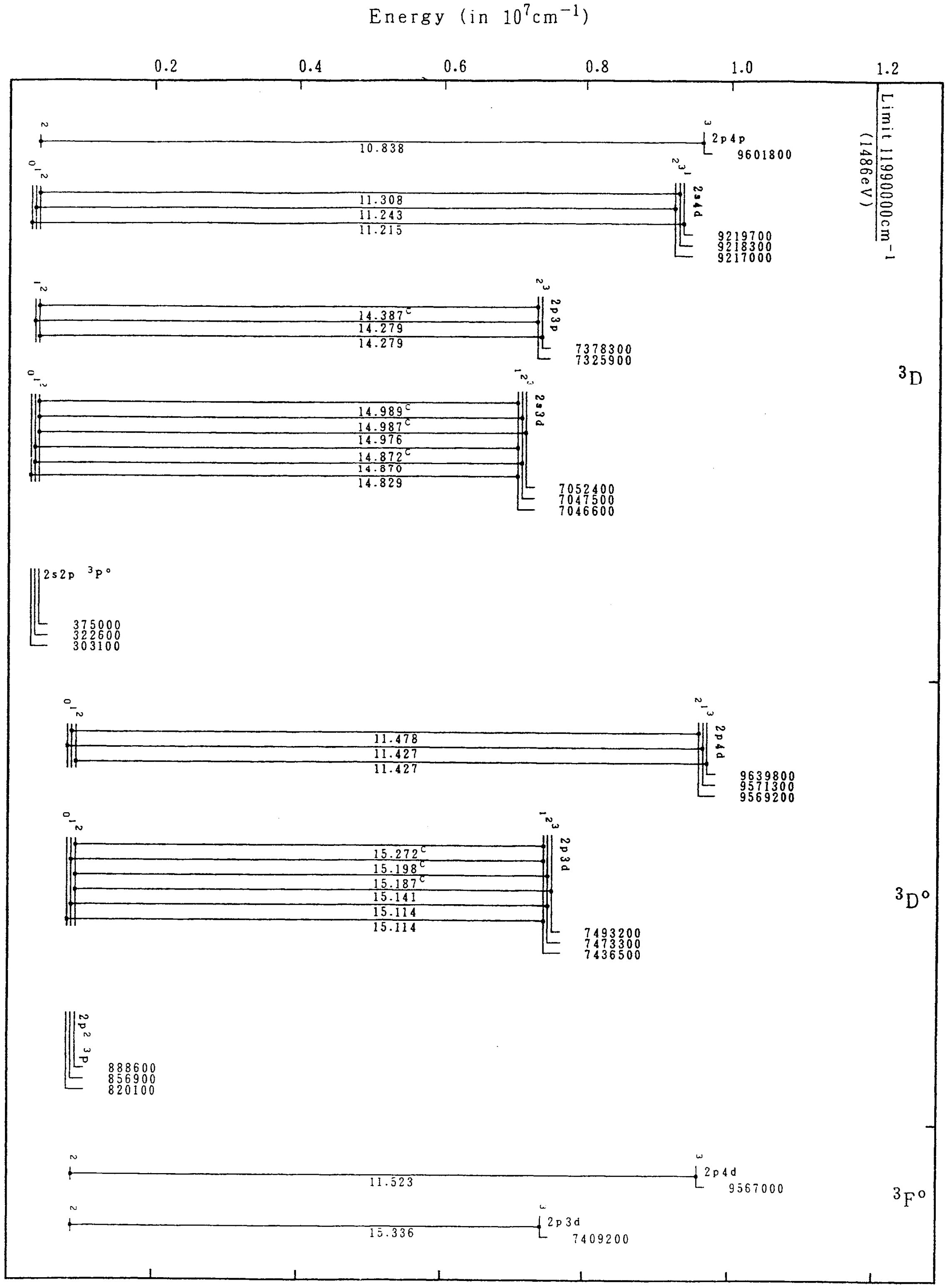

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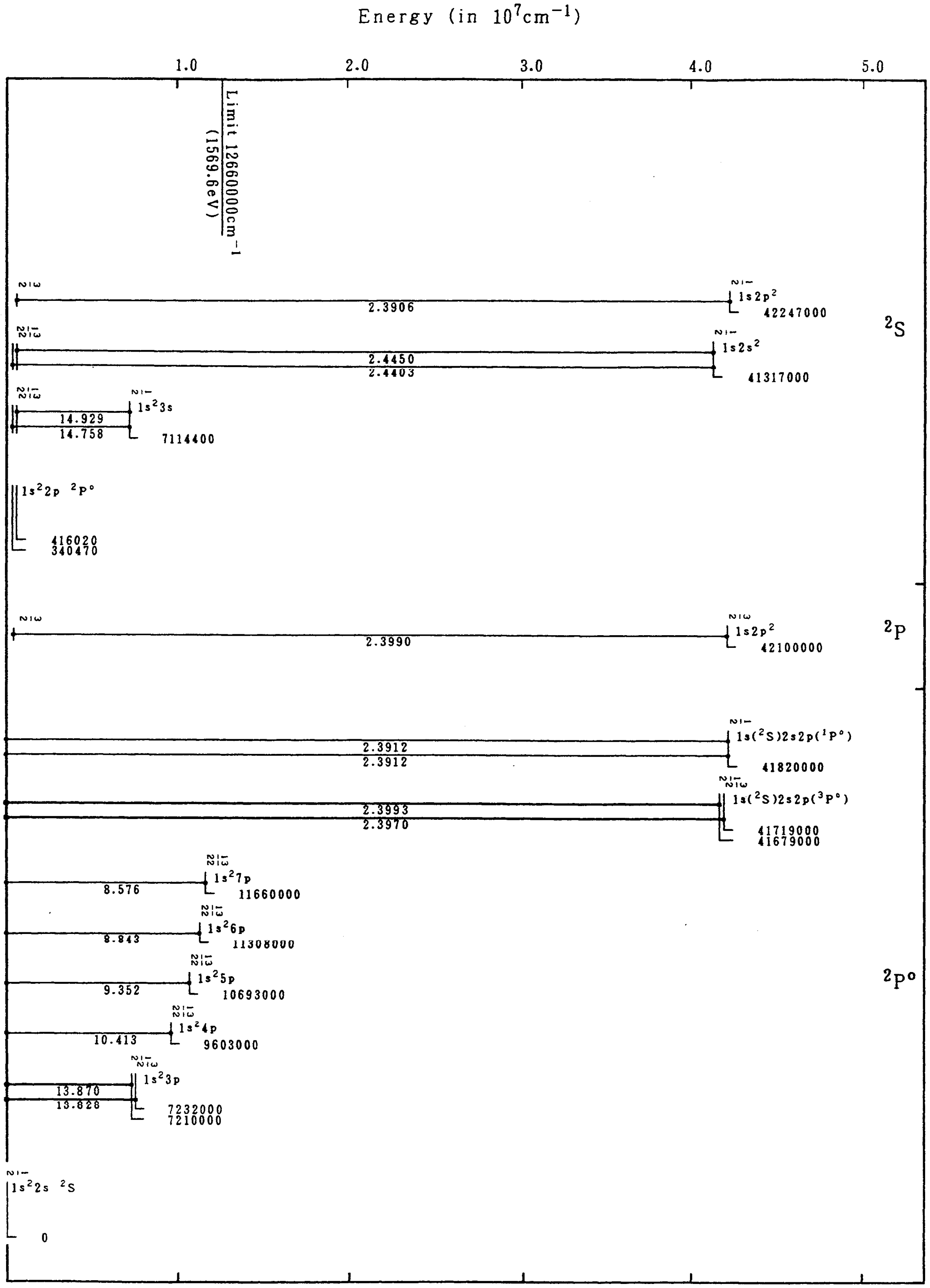

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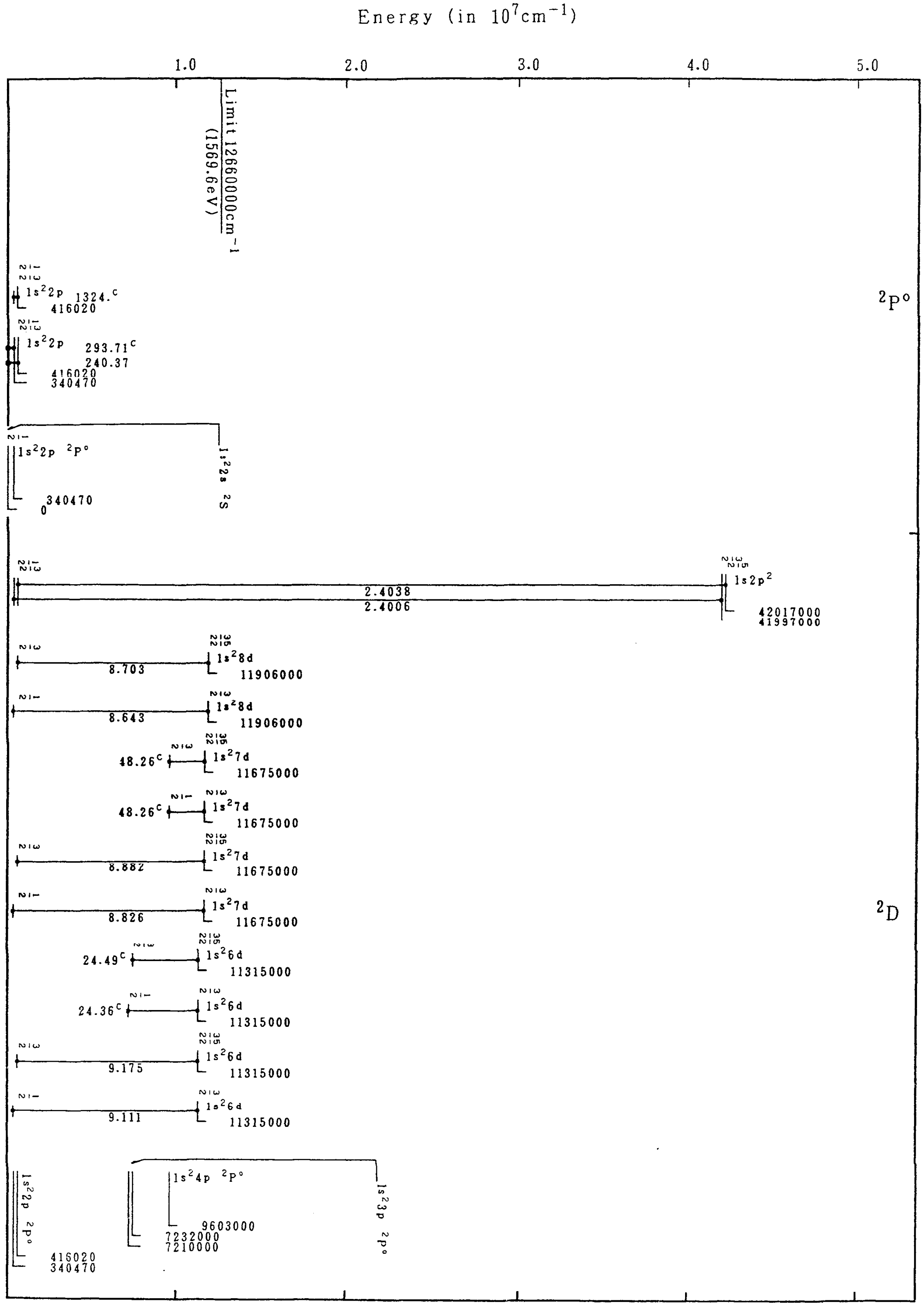

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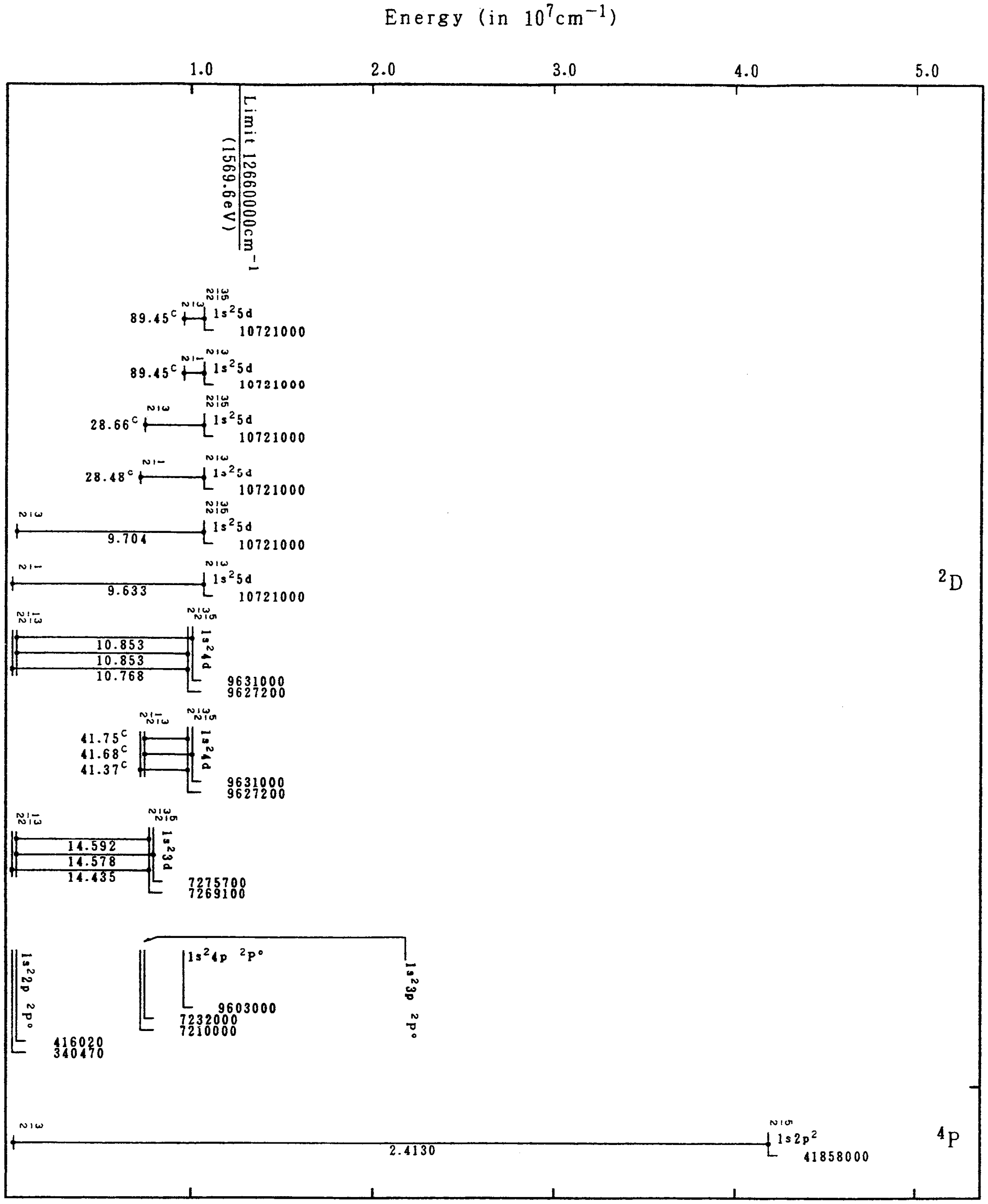

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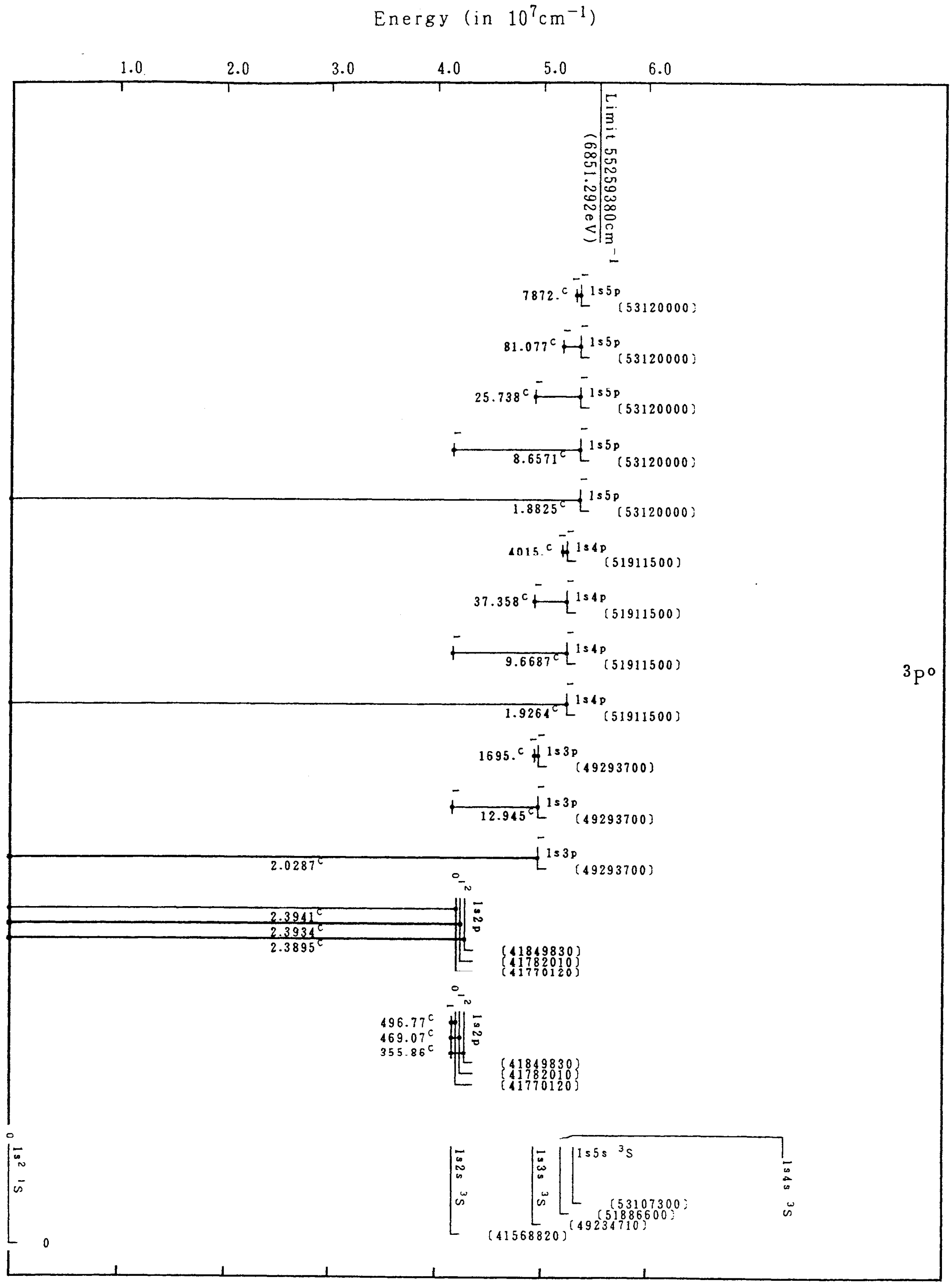

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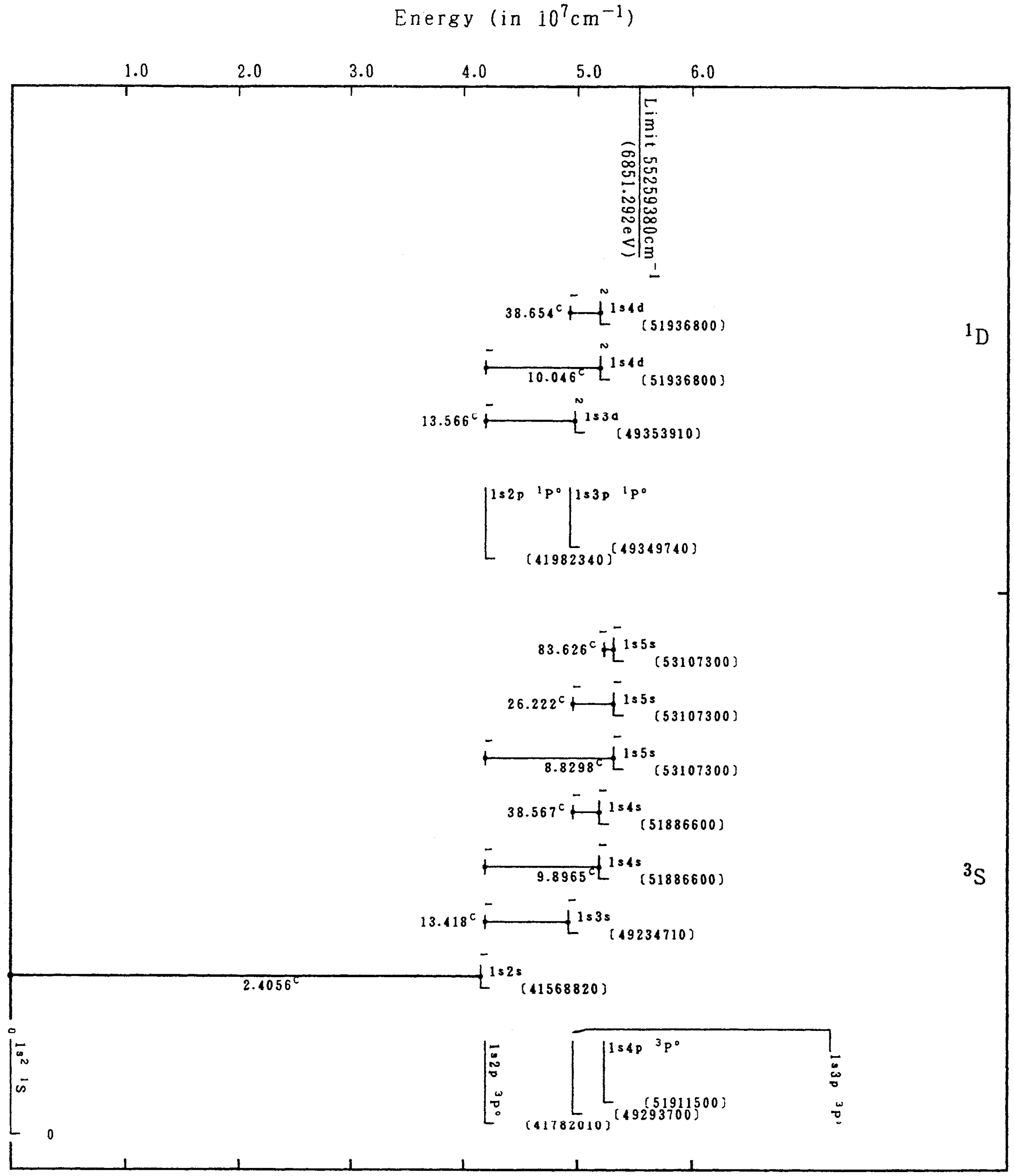

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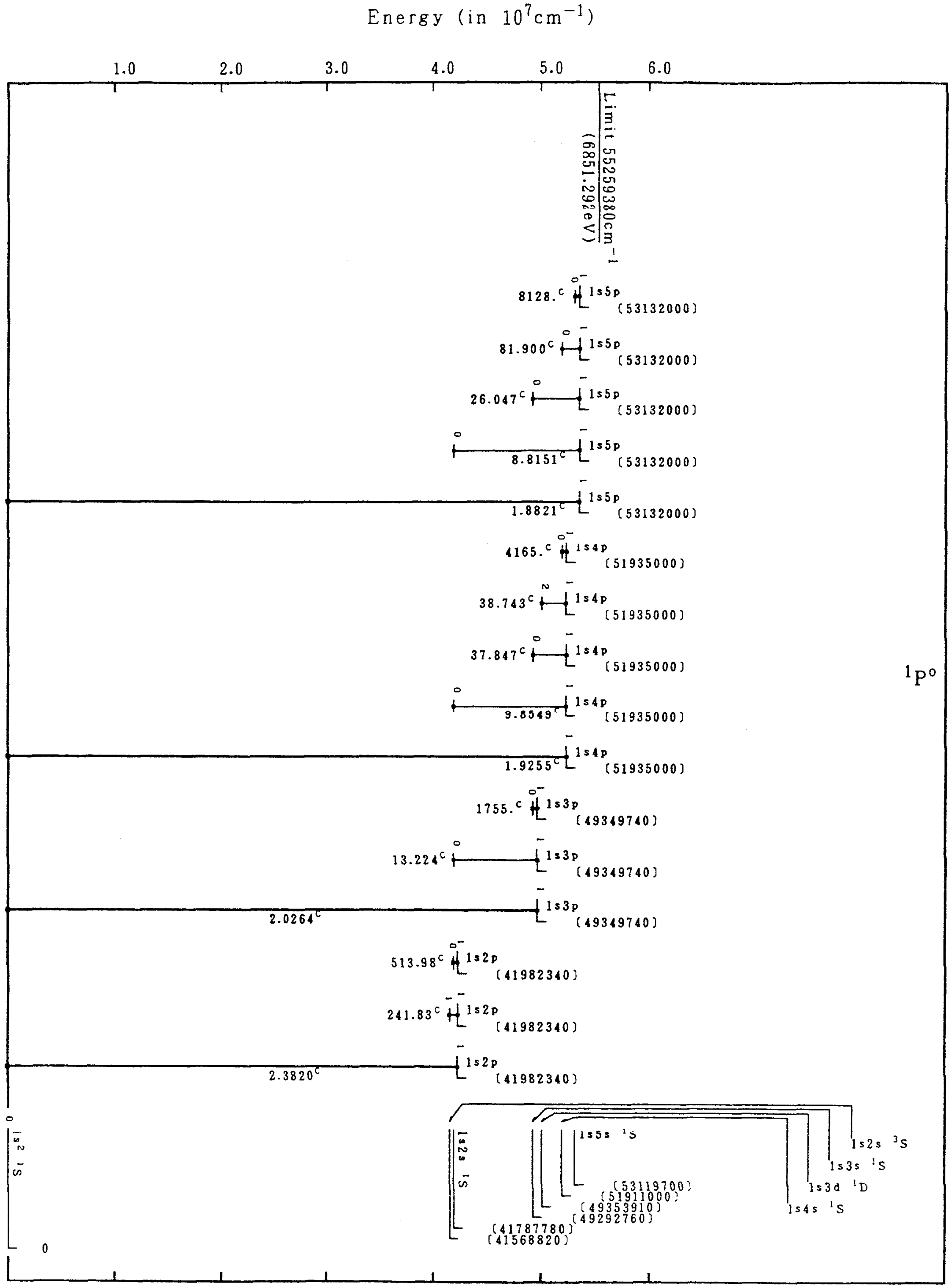

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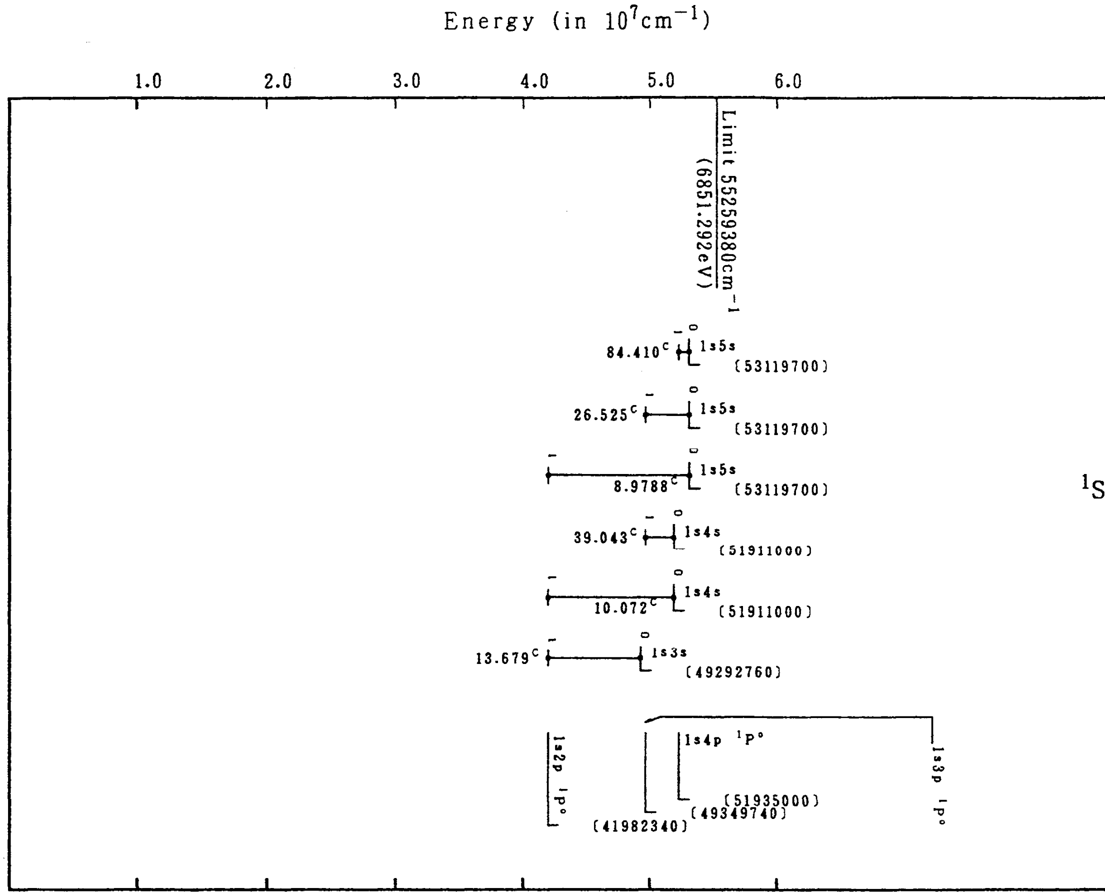

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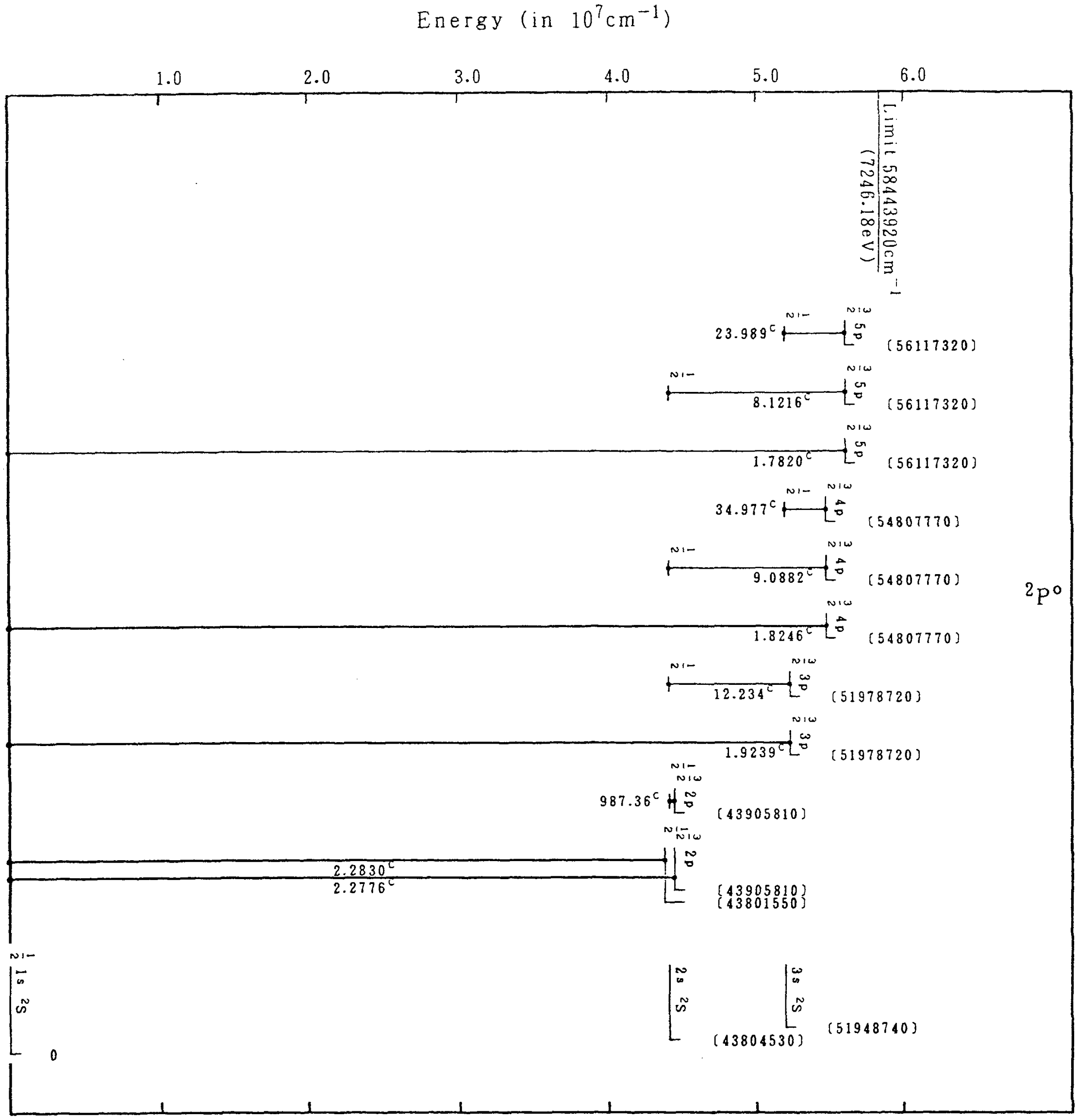

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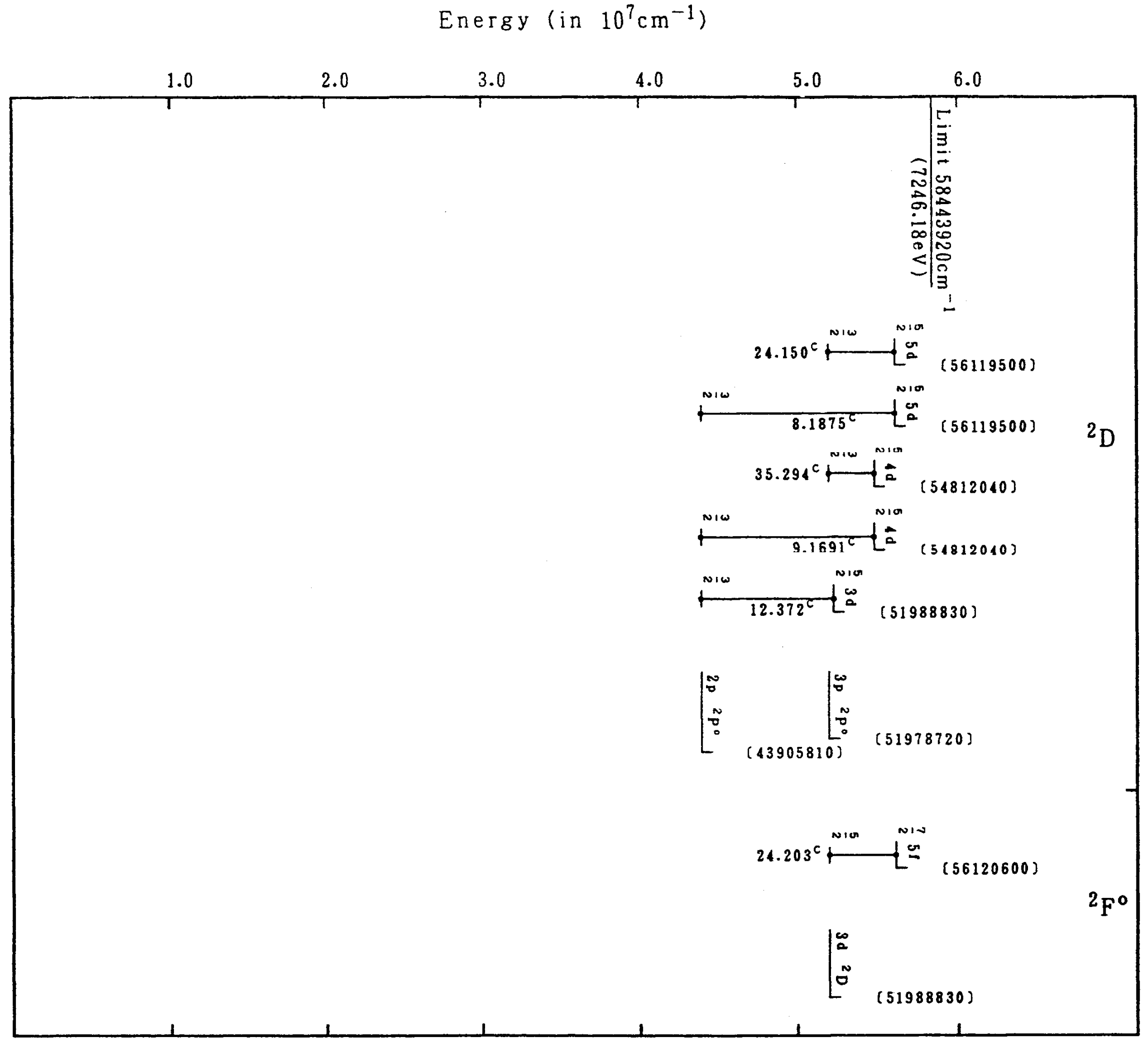

V XXIII(H–Sequence)

7. References for Tables and Comments

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