JAERI-M
82-078

GROTRIAN DIAGRAMS FOR HIGHLY IONIZED TITANIUM Ti V — Ti XXII

June 1982

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編集兼発行　日本原子力研究所
印　　刷　日立高速印刷株式会社

JAERI-M 82-078

Grotrian Diagrams for Highly Ionized Titanium
Ti V - Ti XXII

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(Received June 8, 1982)

Grotrian diagrams of Ti V - Ti XXII have been prepared. Data of wavelengths, energy levels, oscillator strengths and transition probabilities are updated for diagnostics of high temperature plasmas, and tabulated with references.

Keywords: Grotrian Diagram, Titanium, Highly Ionized Atom, Wavelength, Energy Level, Oscillator Strength, Transition Probability

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This work was supported by a research contact of Japan Atomic Energy Research Institute with Institute of Physical and Chemical Research in fiscal year 1980.

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JAERI－M 82－078

高電離チタン，Ti V－Ti XXII のグロトリアン図

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（1982年6月8日受理）

核融合プラズマに於ける不純物問題解明及びプラズマ診断を目的として，原子多価イオンの構造に関する原子分子データ収集を行っている。本報告は核融合開発研究の要請に合せたTi V（アルゴン様）からTi XXII（水素様）迄の高電離チタンのグロトリアン図とその波長表を収録したものである。

本図表の特長は垂直線方式をイオンの準位全体に採用し，図表を各イオンのエネルギー準位図であると共に，遷移の波長表としたことである。また付表中には波長，多重項，エネルギー準位値，強度，振動子強度，遷移確率，文献を収容した。

この報告書は昭和55年度に日本原子力研究所より理化学研究所に委託した調査報告書を改めてまとめたものである。

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1. Introduction

The wavelength tables and Grotrian diagrams of Ti V - Ti XXII have been prepared. They were originally compiled for our study on impurities in tokamak plasmas, because titanium is frequently used for the getter of the light impurities, such as oxygen, carbon and nitrogen, or the current aperture limiters in the tokamak machines.

We already published the similar data compilation for the iron ions of Fe VIII - Fe XXVI in 1979.[1] Iron is the component of the vacuum wall materials of tokamak. Since the completion of the iron compilation, we discussed whether we should extend this kind of work or not. The request from the diagnostics teams of the tokamak was on the side of continuing the work, at least, on titanium and nickel. Therefore, we started again the compilation of wavelengths on the titanium ions.

As for the structure data compilations of the highly ionized titanium atom, there have been several references; Kelly and Palumbo (1973)[2], Bashkin and Stoner (1975)[3], and Corliss and Sugar (1979)[4]. The energy level tables of Ti I - Ti XXII by Corliss et al.[4] is especially in connection with the present compilation.

The process of preparation of the present compilation was as follows: At first, the available data concerning the titanium spectra above Ti V have been collected from the published articles. Then, each wavelength was critically selected according to our judgement as the most reliable one among the collected data. The wavelength data have been

referred to the references cited at the end of the tables, but the values of energy levels have been, in principle, derived from the critical compilations by Corliss and Sugar (1979)[4]. Some of them, however, have been replaced by the improved ones with the more reliable observations appearing after the compilation by Corliss et al., or according to the consistency consideration of the Ritz combinations of the levels. The oscillator strengths and transition probabilities have been quoted from Wiese and Fuhr (1975)[5], Martin and Wiese (1976)[6], Fawcett (1978)[7], and Cheng, Kim, and Desclaux (1979)[8].

Diagrams showing transitions from one energy level to another are called "Grotrian Diagrams". Typical examples of such diagrams are found in the book published by Bashkin and Stoner[3]. In the usual diagrams such as Bashkin's, the line density is sometimes too large for each line to be drawn distinctly because most of the transition lines are connected obliquely to the common lower levels. In the present diagrams, all the lines are drawn in parallel and connected to the lines extended from the lower levels. As a result, dense packing of the lines and figures is avoided. Furthermore, the multiplet lines are accomodated as a whole. Our diagrams are, so to speak, combinations of tables of wavelengths and energy levels. Thus, the desired wavelengths and level energies are easily found. Also, the wavelength values are lined up in various groups, so that the characteristics of the transitions can be discerned at a glance.

New references after the bibliographies in the article by Corliss and Sugar[4] are as follows: Kastner, Swartz, Bhatia

and Lapides (1978)[9] for 3p - 4d, 3d - 4d transitions of Ti XI, Boiko, Faenov and Pikuz (1978)[10] for 1 - 2 and 2 - 3 transitions of Ti XIX, XX, XXI, Fawcett (1978)[7] on the HF calculations of 2 - 2 transitions, Fawcett, Bromage and Hayes (1979)[11] for 3 - 4, 5 transitions of Ti XIII, Hinnov (1979)[12] on the tokamak observations of the resonance transitions of Ti XIX and XX, Cheng, Kim and Desclaux (1979)[8] on the MCRHF calculations of the oscillator strengths and transition probabilities of 2s - 2p transitions, and Lawson, Peacock and Stamp (1981)[13] for the extensive data compilation and observation on 2 - 2 transitions of the iron group elements.

The previous general history of the compilations on atomic spectra of titanium was described by Corliss and Sugar (1979)[4]. Besides the titanium, the energy levels of the iron period elements are being extensively compiled at the NBS Atomic Energy Level Data Center. We heard that the compilation for nickel has recently been completed.

Acknowledgement

The author owes special thanks to Drs. K. Ozawa, Y. Nakai and T. Shirai of Japan Atomic Energy Research Institute for their arrangement of the publication of this compilation and for their valuable comments and cooperations on preparation of the tables and diagrams. The author is also thankful to Miss N. Komatsu for typing the manuscript and preparing the tables and diagrams.

The series of the present work including the compilation for iron[1] was originally started as one of the activities of

the Working Group on Atomic Processes in the Institute of Plasma Physics, Nagoya University. The author would like to thank Professors Y. Itikawa and M. Otsuka, and Dr. T. Kato of Nagoya University for their kind suggestions and supports on this work.

We gratefully acknowledge the valuable comments and discussions by Dr. W. L. Wiese of National Bureau of Standards, who have read our materials and given us many useful comments, especially on the compiled data of Ti XIV, XV, XVI, XVII, XVIII, XIX, XX. He provided us with most of the data of oscillator strengths and transition probabilities with their accuracies. Very recently Dr. Wiese gave us newly revised data[14)15)] on Ti XIV, XV, XVI, XVII, which were adopted in the present tables.

The present research was supported by the Science and Technology Agency under Japan Atomic Energy Research Institute.

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15. V. Kaufman, J. Sugar and D. Cooper: "F I and O I Isoelectronic Sequences: Observations of $2s^m2p^n$-$2s^{m-1}2p^{n+1}$ Intersystem Transitions and Improved Measurements for Cl, K, Ca, Sc, Ti and V", to be published.

2. Explanation of Tables

f Absorption oscillator strength

A Transition probability in sec^{-1}

The eighth column gives the numbers of the references. A ° indicates that the reference is for the adopted wavelength value. An * shows the reference to which the oscillator strength and/or the transition probability are referred.

Int Intensity of the spectral line to which the wavelength is assigned. The intensity here represents generally the estimated blackness of the photographic image of the spectral line on the plate. The intensity value is cited from the original paper, which is indicated by Δ on the reference figure.

Accuracy Accuracy is for the "uncertainties" of the data of the oscillator strengths and transition probabilities. The accuracy here is used in the meaning of "extent of possible error" or "possible deviation from the true value", which is determined by the NBS criterion.

- A: for uncertainties within 3 percent
- B: for uncertainties within 10 percent
- C: for uncertainties within 25 percent
- D: for uncertainties within 50 percent
- E: for uncertainties greater than 50 percent

C, P, T attached to the upper right of the wavelength values indicate the following meanings:

- C: the wavelength value was calculated from the values of energy levels which were determined by other transitions.
- P: the wavelength value was predicted by isoelectronic extrapolation.
- T: the wavelength value is given by theoretical calculation.

Forbidden lines are indicated by M1 and E2 in the type column of the table: M1: magnetic dipole, E2: electric quadrupole transition. f-values are normally not in use.

IP IP represents the ionization potential of the ion concerned in kayser and/or in electron volt.

3. Explanation of Diagrams

TiVII, TIXXI etc. Ion species of titanium, Ti^{+6}, Ti^{+20}, etc. According to conventional expression in spectroscopy, TiI indicates the first spectrum, that is, the spectrum of the neutral atom. TiII corresponds to the second spectrum belonging to the singly-ionized ion, and so on.

H-Sequence, C-Sequence, etc. The relevant ions have the same electronic configurations as those of the neutral hydrogen, the neutral carbon, etc.

Ordinate Energy of the levels in cm^{-1}. Transition wavelengths are shown in angstroms.

Limit The ionization limit in cm^{-1}.

Heavy holizontal lines: the energy levels, whose energy values are taken from Corliss and Sugar (1979)[19].

Heavy vertical lines: the resonance transitions with absorption oscillator strength $f \geq 0.01$. The choice $f \geq 0.01$ is rather arbitrary, but gives a fairly reasonable clue for estimating spectral line intensities.

x means that the level energy is measured from the x level, which is not yet absolutely determined in energy, because those groups of levels including x have no transitions connected to the ground level.

Parenthesis attached to the wavelength means that the wavelength value was calculated from the energy levels determined by other transitions. This corresponds to the one with C in the table.

Bracket attached to the wavelength means that the wavelength value was given by theoretical calculation. This corresponds to the one with T in the table.

P attached to the wavelength means that the wavelength value was predicted by isoelectronic extrapolation. This is the same as the one in the table.

4. Brief Histories on Each Titanium Ions

Ti V (A-Sequence)

The $3s^2 3p^6$ - $3p^5 3d$ transitions were identified by Gabriel, Fawcett and Jordan (1966)[67], Svensson (1971)[99] and Svensson (1976)[101]. The present compilation adopted the data of Svensson (1976)[101]. The $3s^2 3p^6$ - $3p^5 4s$, 5s, 6s transitions were taken from Svensson (1976)[101]. The $3s^2 3p^6$ - $3s 3p^6 4p \sim 11p$ $^1P°$, $3P°$ were observed by Kastner, Crooker, Behring and Cohen (1977)[79] as absorption lines from the ground state.

The transitions between higher levels were analyzed in detail by Svensson (1976)[101], a part of which are quoted in the present table and diagram.

Ti VI (Cl-Sequence)

The resonance $3s^2 3p^5\ ^2P^\circ$ - $3s3p^6\ ^2S$ transitions were first observed by Weissberg and Kruger[109]. They were remeasured by Svensson (1971)[99], which are adopted in the present table. The $3s^2 3p^5$ - $3p^4 3d$ transitions were observed by Fawcett and Gabriel (1966)[44], Svensson 1971)[99] and Fawcett, Cowan and Hayes (1972)[51]. The present compilation adopted the data from the compilation by Fawcett (1971)[49]. The $3s^2 3p^5$ - $3p^4 4s$, 4d, 5s, 5d transitions are from Svensson and Ekberg (1968)[97], and Fawcett, Peacock and Cowan (1968)[47]. The $3p^4 3d$ - $3p^4 4f$ transitions are reported by Fawcett, Cowan and Hayes (1972)[51].

The observed intercombination lines $3s^2 3p^5\ ^2P^\circ$ - $3p^4 3d\ ^4P$, $4s\ ^4P$, $4d\ ^4F$, $5s\ ^4P$ and $5d\ ^4F$ combine the doublet and quartet systems.

Ti VII (S-Sequence)

The resonance transitions $3s^2 3p^4$ - $3s3p^5$ were observed by Kruger and Pattin (1937)[108], Fawcett and Peacock (1967)[46], and Svensson (1971)[99]. The present wavelengths are from Svensson (1971)[99]. The $3s^2 3p^4$ - $3p^3 3d$ transitions were first identified by Fawcett and Gabriel (1966)[44] and Gabriel, Fawcett and Jordan (1966)[67], and new measurements were done by Svensson and Ekberg (1968)[97], which are adopted here.

The $3s^2 3p^4$ - $3p^3 4s$ transitions were originally identified by Edlén (1937)[31], and remeasured by Svensson and Ekberg (1968)[97], which are quoted in the present diagram. The $3s^2 3p^4$ - $3p^3 4d$ transitions were analyzed by Svensson and Ekberg (1968)[97]. The $3p^3 3d$ - $3p^3 4f$ transitions were reported by Fawcett, Cowan and Hayes (1972)[51].

The intersystem transitions of $3s^2 3p^4$ - $3p^3 3d$ (^1D - $^3P^\circ$, ^1D - $^3D^\circ$, ^3P - $^1P^\circ$, ^3P - $^1D^\circ$), $3s^2 3p^4$ - $3p^3 4s$ (^1D - $^3P^\circ$, ^3P - $^1D^\circ$), and $3s^2 3p^4\ ^1D$ - $3p^3 4d\ ^3D^\circ$ were observed by Svensson and Ekberg (1968)[97]. The position of $3s^2 3p^4\ ^1D_2$ was established, and, therefore, the $3s^2 3p^4\ ^1S_0$ and $^1P^\circ_1$ were determined through the singlet transitions.

Ti VIII (P-Sequence)

The $3s^2 3p^3$ - $3s3p^4$ transitions were observed by Fawcett and Peacock (1967)[46], Fawcett (1970)[48] and Smitt, Svensson and Outred (1976)[94]. The present wavelengths are from Smitt et al. (1976)[94]. The $3s^2 3p^3$ - $3p^2 3d$, $3d^2 4s$ transitions were extensively observed by Ekberg and Svensson (1970)[106]. The $3p^2 3d$ - $3p^2 4f$ transitions are due to Fawcett, Cowan and Hayes (1972)[51].

The intercombination transitions have not been observed, so all of the doublet levels have an added systematic error x.

Ti IX (Si-Sequence)

The $3s^2 3p^2$ - $3s3p^3$ transitions were first identified by Fawcett and Peacock (1967)[46] and Fawcett (1970)[48]. The present diagram adopted the more accurate data of Smitt, Svensson and Outred (1976)[94]. The $3s^2 3p^2$ - 3p3d transitions were analyzed by Fawcett, Gabriel and Saunders (1967)[45], Fawcett (1971)[49], and Ekberg and Svensson (1970)[106]. The present wavelengths are from Ekberg and Svensson (1970)[106]. The $3s^2 3p^2$ - 3p4s are also from Ekberg and Svensson (1970)[106]. The $3s^2 3p^2$ - 3p4d and 3p3d - 3p4f are observed by Fawcett, Cowan and Hayes (1972)[51].

The intercombination transitions $3s^2 3p^2\ {}^1D_2$ - $3s3p^3\ {}^3S^\circ_1$, ${}^3D^\circ_3$ and $3s^2 3p^2\ {}^3P_2$ - $3s3p^3\ {}^1D^\circ_2$ were reported by Smitt et al. (1976)[94].

Ti X (Al-Sequence)

The $3s^2 3p$ - $3s3p^2$ transitions were first identified by Fawcett and Peacock (1967)[46], and later measured by Fawcett (1970)[48]. The present compilations are from the more recent observation by Smitt, Svensson and Outred (1976)[94]. Fawcett (1970)[48] also reported the quartet $3s3p^2\ ^4P$ - $3p^3\ ^4S°$ and $3s^2 3p\ ^2P°$ - $3s^2 3d\ ^2D$ transitions. The $3s3p^2\ ^4P$ - $3s3p3d\ ^4D°$, $3s3p4s\ ^4P°$ were observed by Ekberg and Svensson (1970)[106]. The level of $3s3p^2\ ^4P$ has not been determined. The adopted values of that levels are the prediction by extrapolation along the isoelectronic sequence by Ekberg and Svensson (1970)[106].

The 3p - ns, 3d - np, and 3d - nf transitions were also measured by Ekberg and Svensson (1970)[106].

The transition probabilities are from Wiese and Fuhr (1975)[104].

Ti XI (Mg-Sequence)

The spectra of Ti XI were first observed by Edlén (1936)[30]. The resonance lines $3s^2$ - 3snp (up to 7p) were later analysed by Ekberg (1971)[39]. Fawcett (1970)[48] identified the 3s3p $^1P^\circ_1$ - $3p^2$ $^1S_0$, $^1D_2$ transitions. The 3s3p - $3p^2$, 3s3d, 3s4s, 3p4p, 3s4d, 3s5s, 3s5d, 3s6f were observed by Ekberg (1971)[39]. The $3p^2$ - 3p3d and 3s3d - 3p3d, 3s4f transitions were measured by Svensson and Ekberg (1969)[98] and Fawcett (1970)[48]. The 3p3d - 3p4f transitions are from Fawcett (1976)[55]. The $3p^2$ - 3p4s, 3s5f, and 3s3d - 3s5f were from Fawcett (1970)[48]. Kastner, Swartz, Bhatia and Lapides (1978)[80] identified recently the 3s3d $^1D_2$ - 3p4d $^1F^\circ_3$, $3p^2$ - 3p4d transitions.

The intercombination transitions 3s3p $^3P^\circ$ - $3p^2$ $^1D_2$ (Svensson and Ekberg (1969)[98]), and 3p3d $^1D_2$ - 3p4f $^3F_3$ (Fawcett (1976)[55]) are the uncertain identifications. The $3s^2$ $^1S_0$ - 3s3p $^3P^\circ_1$ transitions is a theoretical estimation by Kelly and Palumbo (1973)[82]. The energy level value of 3s3p $^3P^\circ_1$, 173827 cm^{-1} was estimated by Ekberg (1971)[39] with the isoelectronic interpolation.

The transition probabilities are from Wiese and Fuhr (1975)[104].

Ti XII (Na-Sequence)

The spectra of Ti XII were first observed by Edlén (1936)[29]. Ekberg and Svensson (1975)[40], and Cohen and Behring (1976)[18] extended the analysis of the series of transitions 3s - np, 3p - ns, 3p - nd and 3d - nf up to 11p, 7s, 10d and 8f. The wavelengths are mostly taken from Ekberg and Svensson (1975)[40].

The autoionization resonance lines 3s ^2S - $2p^5 3s^2$ $^2P^\circ$ are from Feldman and Cohen (1967)[60].

The transition probabilities are quoted from Wiese and Fuhr (1975)[104].

Ti XIII (Ne-Sequence)

The resonance transitions $2s^2 2p^6$ - $2p^5 3s$ and $2p^5 3d$ were identified by Edlén and Tyrén (1936)[107]. The resonance $2s^2 2p^6$ - 4s, 4d, 5d, $2s2p^6 3p$ transitions were observed by Fawcett (1965)[43], and Feldman and Cohen (1967)[60]. The present wavelengths are taken from the latter. The 3p - 4d transitions were first observed by Kastner, Behring and Cohen (1975)[77]. These and the 3s - 4p, 3p - 4s, 3p - 4s, 3d - 4f, 3d - 5f transitions have recently been extensively measured by Fawcett, Bromage and Hayes (1979)[57].

The transition probabilities are from Wiese and Fuhr (1975)[104].

Ti XIV (F-Sequence)

The $2s^2 2p^5$ - $2s^2 2p^4 3s$, 3d transitions were observed by Fawcett (1965)[43], Cohen, Feldman and Kastner (1968)[16], and Feldman, Doschek, Cowan and Cohen (1973)[62]. The wavelengths of these transitions are taken from Feldman et al. (1973)[62]. The $2s2p^6\ ^2S_{1/2}$ - $2s2p^5 3s\ ^2P^\circ_{1/2,3/2}$ transitions were also derived from Feldman et al. (1973)[62]. The resonance transitions $2s^2 2p^5\ ^2P^\circ$ - $2s2p^6\ ^2S$, 129.43 Å and 121.98 Å, were observed by Fawcett (1971)[49], which were given 129.433 Å and 121.980 Å by Edlén (1981)[38] as the recalculated wavelengths with the semi-empirical isoelectronic analysis.

The $2s^2 2p^5 (^2P^\circ_{3/2}$ - $^2P^\circ_{1/2})$ splitting was observed by Lawson, Peacock and Stamp (1981)[86] in DITE tokamak spectra. The transition probabilities for these transitions are from the theoretical calculations by Cheng, Kim and Desclaux (1979)[14].

Ti XV (O-Sequence)

The $2s^2 2p^4$ - $2s2p^5$ transitions were observed by Fawcett (1971)[50], Doschek, Feldman, Cowan and Cohen (1974)[24], and Kasyanov, Kononov, Korobkin, Koshelev, Ryablsev, Serov and Skokan (1974)[81]. The present wavelengths are adopted from Kasyanov et al. (1974)[81]. The $2s2p^5\ {}^1P^\circ_1$ - $2p^6\ {}^1S_0$ transition was observed by Kasyanov et al. (1974)[81], Fawcett, Galanti and Peacock (1974)[52], and Doschek, Feldman, Davis and Cowan (1975)[26]. The data by Kasyanov et al. (1974)[81] are quoted.

The $2s^2 2p^4$ - $2p^3 3s$ transitions are from Goldsmith, Feldman, and Cohen (1971)[68], and Doschek, Feldman and Cohen (1973)[23]. The wavelengths are taken from the latter.

The $2s^2 2p^4$ - $2p^3 3d$ transitions are from Goldsmith, Feldman and Cohen (1971)[68], Fawcett and Hayes (1975)[54] and Bromage and Fawcett (1977)[10]. Most of the wavelengths are adopted from Fawcett and Hayes (1975)[54].

The intercombination lines of Ti XV have not been observed. However, the singlet-triplet $2s^2 2p^4\ {}^3P_2$ - ${}^1D_2$ interval was recently estimated by Edlén (1981)[38], which was interpolated along the isoelectronic sequence, in which there have been several accurate experimental data on solar corona. The interval $2s^2 2p^4\ {}^1D_2$ - ${}^1S_0$ was predicted in the same way by Edlén (1981)[38]. The predicted values for the interval $2s^2 2p^4\ {}^3P_1$ - ${}^1S_0$ is less accurate than the above ones, because experimental data are few in this isoelectronic sequence.

The forbidden transitions within the $2s^2 2p^4$ ground configurations were reported by Kastner, Bhatia and Cohen (1977)[78]. Among them, the $2s^2 2p^4 ({}^3P_2 - {}^3P_1)$ transition, 2545.08 Å, was observed in DITE tokamak by Lawson, Peacock and Stamp (1981)[86].

The transition probabilities are form the theoretical calculation by Cheng, Kim and Desclaux (1979)[14].

Ti XVI (N-Sequence)

The transitions $2s^2 2p^3$ - $2s2p^4$ and $2s2p^4$ - $2p^5$ were identified by Fawcett (1971)[50] and more accurately measured by Kasyanov, Kononov, Korobkin, Koshelev, Ryabtsev, Sevov and Skokan (1974)[81]. The position of the doublets relative to the ground state is based on the estimated position of $2s^2 2p^3\ {}^2D^\circ_{3/2,5/2}$ by Lawson, Peacock, and Stamp (1981)[86].

The $2s^2 2p^3$ - $2p^2 3d$ transitions are taken from Fawcett and Hayes (1975)[54].

The intercombination lines and most of the forbidden lines were theoretically calculated by Fawcett (1978)[56], and by Cheng, Kim, and Desclaux (1979)[14].

Ti XVII (C-Sequence)

The $2s^2 2p^2$ - $2s2p^3$ transitions were classified by Fawcett, Galanti, and Peacock (1974)[52], and by Kasyanov, Kononov, Korobkin, Koshelev, Ryabtsev, Serov, and Skokan (1974)[81]. New measurements and some revised classifications were given by Fawcett and Hayes (1975)[54] and Fawcett (1975)[53], which are quoted in the present diagram. The $2s2p^3$ - $2p^4$ transitions are partially observed by Fawcett (1975)[53], but most of them cited in the present compilation are theoretical ones by Cheng, Kim and Desclaux (1979)[14], because the observation on them were uncertain.

The higher $2s^2 2p^2$ - 2p3s and $2s2p^3$ - $2s2p^2$3d wavelengths are from Goldsmith, Feldman, Crooker, and Cohen (1972)[70]. The transitions from 2p3d terms are taken from the observation by Bromage and Fawcett (1977)[11].

The intercombination $2s^2 2p^2\ ^3P_{1,2}$ - $2s2p^3\ ^5S_2$ transitions have not been observed. The present wavelengths are the predicted ones with the isoelectronic analyses by Lawson, Peacock, and Stamp (1981)[86]. Other intercombinations also have not been observed. Goldsmith, Feldman, Crooker, and Cohen (1972)[70] extrapolated the position of $2p^2\ ^1D_2$, which was later refined by Fawcett (1975)[53], and Feldman, Doschek, Cowan and Cohen (1975)[24].

Goldsmith et al. (1972)[70] identified two quintet transitions, but they are not connected to the triplet system.

The forbidden transitions within the $2s^2 2p^2$ ground configurations are the predicted values from Kastner, Bhatia and Cohen (1977)[78]. Among them, the $2s^2 2p^2 ({}^3P_{0,1} - {}^3P_{1,2})$ were observed in DITE tokamak by Lawson et al. (1981)[86].

The transition probabilities are from the theoretical calculation by Cheng, Kim and Desclaux (1979)[14].

Ti XVIII (B-Sequence)

The transition arrays $2s^2 2p$ - $2s2p^3$ were analyzed by Kasyanov, Kononov, Korobkin, Koshelev, Ryabtsev, Serov, and Skokan (1974)[81], and Fawcett and Hayes (1975)[54]. The present compilation is from the latter paper. The $2s2p^2$ - $2p^2$ transitions are derived from theoretical wavelengths by Chen, Kim and Desclaux (1979)[14]. The $2s^2 2p$ - 2s2p3p and $2s2p^2$ - 2s2p3d transitions are taken from Fawcett and Hayes (1975)[54].

The intersystem transitions have not been observed, so the present $2s^2 2p\ ^2P$ - $2s2p^2\ ^4P$ wavelengths are the predicted values by Edlén (1981)[38].

The forbidden $2s^2 2p(^2P^\circ_{1/2} - {}^2P^\circ_{3/2})$ transition was observed in DITE spectra by Lawson, Peacock and Stamp (1981)[86]. The other forbidden lines are calculated from the Ritz combination principle.

The transition probabilities are due to the theoretical wavelengths by Cheng, Kim and Desclaux (1979)[14].

Ti XIX (Be-Sequence)

The resonance transition $2s^2\ ^1S_0$ - $2s2p\ ^1P^\circ_1$ was initially identified by Goldsmith, Oren, Crooker and Cohen (1973)[71] and recently observed in a tokamak[75] and in a laser plasma[86]. The present wavelength is taken from the adjusted value along the isoelectronic interpolation by Edlén (1981)[38], rounded to five figures. The $2s2p$ - $2p^2$ transitions in singlet and triplet systems are quoted from Lawson, Peacock and Stamp (1981)[86], whose data were originally derived from the semiempirical analysis by Edlén (1981)[38].

The intersystem reasonance line, $2s^2\ ^1S_0$ - $2s2p\ ^3P^\circ_1$, has not been observed. The intercombination $2s2p\ ^3P^\circ_2$ - $2p^2\ ^1D_2$ was observed by Lawson et al. (1981)[86], from which the $2s2p\ ^3P^\circ_1$ level is deduced via the $2s2p\ ^1P^\circ_1$ - $2p^2\ ^1D_2$.

The higher transitions of n = 2 - 3 were observed by Fawcett and Hayes (1975)[54], Boiko, Pikuz, Safronova and Faenov (1977)[7], and recently by Boiko, Faenov and Pikuz (1978)[8]. The present compilations are adopted from Boiko et al. (1978)[8].

The magnetic dipole transition $2s2p(^3P^\circ_1$ - $^3P^\circ_2)$ was observed in the DITE tokamak by Lawson et al. (1981)[86].

The transition probabilities between 2 - 2 transitions are due to Cheng, Kim and Desclaux (1979)[14] by the multi-configuration relativistic Hartree-Fock calculation.

Ti XX (Li-Sequence)

The resonance transitions of $1s^2 2s\ ^2S_{1/2} - 1s^2 2p\ ^2P_{1/2,3/2}$ were previously predicted by solar flare observation by Sandlin, Brueckner, Scherrer and Tousey (1976)[93], and recently observed by Hinnov (1979)[75] in PLT tokamak, as 309.15 ±0.05 Å and 259.30 ±0.1 Å. Edlén's (1979)[37] isoelectronic extrapolation of this transitions shows good agreement with Hinnov's values.

The 2s - 3p, 2p - 3s, and 2p - 3d transitions were first reported by Goldsmith, Feldman, Oren and Cohen (1972)[69]. Boiko, Faenov and Pikuz (1978)[8] made detailed measurements on 2s -(3 - 9)p, 2p -(3 - 9)d transitions.

The transitions from the doubly excited levels, the satellite lines, are from Aglitskii, Boiko, Zakharov, Pikuz and Faenov (1974)[1], Feldman, Doschek, Nagel, Cowan and Whitelock (1974)[63], and Boiko, Faenov and Pikuz (1978)[8].

The transition probabilities are from Wiese's information.[103-106]

Ti XXI (He-Sequence)

The theoretical values of the energy levels calculated by Ermolaev and Jones (1974)[42] for the singlet and triplet systems are presented for the present compilation. The $1s^2$ - 1s2p transitions have been recently observed by Boiko, Faenov, and Pikuz (1978)[8]. The $1s^2$ - 1s3p transition is from Cohen, Feldman, Swartz and Underwood (1968)[17]. The 1s2s - 1s2p transitions are calculated by the Ritz combination principle.

The transition probabilities are taken from Wiese and Fuhr (1975)[104].

Ti XXII (H-Sequence)

The transitions of $1s\ ^2S_{1/2} - 2p\ ^2P_{1/2,3/2}$ were measured by Lie and Elton (1971)[88]. As Corliss and Sugar (1979) stated in their article (1979)[19], the theoretical values calculated by Erickson (1977)[41] for energy levels of the hydrogen-like ion are much more accurate than any observed values, so they are quoted in the present table.

The transition probability for $1s\ ^2S - 2p\ ^2P$ is derived from $(22)^4$ times that of the neutral hydrogen.

5. Wavelength Tables

Ti V (Ar-Sequence) IP=800900 cm^{-1} (99.300 eV)

λ (A)	Configuration		Energy level (cm^{-1})	Int	f/Type	A (s^{-1})	Acc	Reference
252.958	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,3d\ {}^1P_1^\circ$	0	395321	900	3.63-1	1.26+11 C	20, 49, 67, 82$^\Delta$, 99, 101°, 113*
363.145	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,3d\ {}^3P_1^\circ$	0	275372	1			20, 49, 82$^\Delta$, 101°
323.365	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,3d\ {}^3D_1^\circ$	0	309252	85	1.9-3	4.0+7 E	20, 49°, 82$^\Delta$, 101, 113*
225.347	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,4s\ {}^1P_1^\circ$	0	443753	400	3.3-1	1.4+10 E	82$^\Delta$, 101°, 113*
228.909	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,4s\ {}^3P_1^\circ$	0	436850	250	9.7-2	4.1+9 E	82$^\Delta$, 101°, 113*
162.984	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,5s\ {}^1P_1^\circ$	0	613558	20			82$^\Delta$, 85, 101°
164.446	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,5s\ {}^3P_1^\circ$	0	608101	35			82$^\Delta$, 85, 101°
146.897	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,6s\ {}^3P_1^\circ$	0	680748	3			82$^\Delta$, 101°
145.79	$3s^2 3p^6\ {}^1S_0$	$3p^5\,(^2P^\circ)\,6s\ {}^1P_1^\circ$	0	685940	1			82$^\Delta$, 101°
144.551	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 4p\ {}^1P_1^\circ$	0	691797	6			79, 82$^\Delta$, 101°
145.354	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 4p\ {}^3P_1^\circ$	0	687976	6			79$^\Delta$
120.824	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 5p\ {}^1P_1^\circ$	0	827650	12			79$^\Delta$
121.138	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 5p\ {}^3P_1^\circ$	0	825505	2			79$^\Delta$
112.495	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 6p\ {}^1P_1^\circ$	0	888928	10			79$^\Delta$

Ti V (Ar-Sequence) IP=800900 cm^{-1} (99.300 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
112.896	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 6p\ {}^3P^o_1$	0	885771	0			79△
108.443	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 7p\ {}^1P^o_1$	0	922143	6			79△
108.611	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 7p\ {}^3P^o_1$	0	920717	0			79△
106.154	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 8p\ {}^1P^o_1$	0	942028	3			79△
106.308	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 8p\ {}^3P^o_1$	0	940663	0			79△
104.711	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 9p\ {}^1P^o_1$	0	955100	0.8			79△
104.732	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 9p\ {}^3P^o_1$	0	954818	0.5			79△
103.733	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 10p\ {}^1P^o_1$	0	964013	0.8			79△
103.754	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 10p\ {}^3P^o_1$	0	963818	0.8			79△
103.059	$3s^2 3p^6\ {}^1S_0$	$3s3p^6 11p\ {}^1P^o$	0	970318	0			79△
557.115	$3d\ {}^3D^o_2$	$3s3p^6 3d\ {}^3D_1$	309433	488929	00			101△
556.562	1	1	309252	488929	0			101△
549.083	2	2	309433	491559	6			101△
548.533	1	2	309252	491559	4			101△
546.062	2	3	309433	492567	5			101△
543.103	3	2	307429	491559	7			101△
504.665	$3d\ {}^3F^o_2$	$3s3p^6 3d\ {}^3D_1$	290779	488929	12			101△
498.050	2	2	290779	491559				101
493.783	3	2	289050	491559	6			101△

Ti V (Ar-Sequence) IP=800900 cm^{-1} (99・300 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
491・358	3	3	289050	492567	1			101[Δ]
487・115	4	3	287277	492567	4			101[Δ]
468・257	3d $^3P^o_1$	3s3p^{6}3d $^3D_1$	275372	488929	3			101[Δ]
466・749	2	2	277311	491559	1			101[Δ]
466・224	0	1	274440	488929	4			101[Δ]
464・562	2	3	277311	492567	5			101[Δ]
462・565	1	2	275372	491559	3			101[Δ]
513・374	3d $^1F^o_3$	3s3p^{6}3d $^1D_2$	311434	506225	8			101[Δ]
501・631	3d $^1D^o_2$	3s3p^{6}3d $^1D_2$	306875	506225	2			101[Δ]
507・683	3d $^3D^o_1$	3s3p^{6}3d $^1D_2$	309252	506225	6			101[Δ]
503・031	3	2	307429	506225	3			101[Δ]
464・143	3d $^3F_2$	3s3p^{6}3d $^1D_2$	290779	506225	00			101[Δ]
901・692	3d $^1P^o_1$	3s3p^{6}3d $^1D_2$	395321	506225	1			101[Δ]
984・530	3d $^1P^o_1$	4p $^1P_1$	395321	496897	0			101[Δ]
834・315	3d $^1P^o_1$	4p $^1S_0$	395321	514609	3			101[Δ]
534・297	3d $^3F^o_2$	4p $^1D_2$	306875	494036	0			101[Δ]

Ti VI (Cl-Sequence) IP=964100 cm^{-1} (119・53 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
524・113	$3s^2 3p^5\ ^2P^o_{1/2}$	$3s3p^6\ ^2S_{1/2}$	5829	196628	900				49, 82△, 99○
508・575	3/2	1/2	0	196628	1000				49, 82△, 99○
353・877	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^3P)\ 3d\ ^2P_{1/2}$	5829	288412	6				49○, 82△
349・574	1/2	3/2	5829	291890	6				49○, 82△
346・728	3/2	1/2	0	288412	1				49○, 82△
342・595	3/2	3/2	0	291890	35				49○, 82△
341・109	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^3P)\ 3d\ ^2D_{3/2}$	5829	298991	20				49○, 82△
334・457	3/2	3/2	0	298991	20				49○, 82△
330・703	3/2	5/2	0	302386	60				49○, 82△
267・343	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1D)\ 3d\ ^2S_{1/2}$	5829	379874	200				44, 49○, 82△
263・246	3/2	1/2	0	379874	250				44, 49○, 82△
259・232	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1D)\ 3d\ ^2P_{3/2}$	5829	391583	250				44, 49○, 82△
257・855	1/2	1/2	5829	393644	250				44, 49○, 82△
255・375	3/2	3/2	0	391583	300				44, 49○, 67, 82△, 99
254・06	3/2	1/2	0	393644	200				44, 49○, 82△
251・071	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1D)\ 3d\ ^2D_{3/2}$	5829	404123	700				44, 49○, 67, 82△, 99
250・482	3/2	5/2	0	399231	1000				44, 49○, 67, 82△, 99
247・450	3/2	3/2	0	404123	250				44, 49○, 82△
301・913	$3s^2 3p^5\ ^2P^o_{3/2}$	$3p^4\ (^1D)\ 3d\ ^2F_{5/2}$	0	331221	20				82△, 97○
288・355	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1S)\ 3d\ ^2D_{3/2}$	5829	352625	60				49○, 82△
283・586	3/2	3/2	0	352625	20				49○, 82△
282・215	3/2	5/2	0	354340	1				49○, 82△

Ti VI (Cl-Sequence) IP=964100 cm^{-1} (119.53 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
331.767	$3s^2 3p^5\ ^2P^o_{3/2}$	$3p^4\ (^3P)\ 3d\ ^4P_{1/2}$	0	301417	6			82^{Δ}, 97^{O}
201.311	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^3P)\ 4s\ ^2P_{3/2}$	5829	502571	90			32^{O}, 82^{Δ}
199.759	1/2	1/2	5829	506432	200			32^{O}, 82^{Δ}
198.977	3/2	3/2	0	502571	400			32^{O}, 82^{Δ}
197.460	3/2	1/2	0	506432	200			32^{O}, 82^{Δ}
194.900	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1D)\ 4s\ ^2D_{3/2}$	5829	518914	200			32, 82^{Δ}, 97^{O}
192.754	3/2	5/2	0	518797	250			32, 82^{Δ}, 97^{O}
192.710	3/2	3/2	0	518914	20			32, 82^{Δ}, 97^{O}
184.106	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1S)\ 4s\ ^2S_{1/2}$	5829	548995	35			32^{O}, 82^{Δ}
182.151	3/2	1/2	0	548995	90			32^{O}, 82^{Δ}
203.434	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^3P)\ 4s\ ^4P_{1/2}$	5829	497389	3			82^{Δ}, 97^{O}
203.200	3/2	5/2	0	492126	6			82^{Δ}, 97^{O}
201.865	3/2	3/2	0	495380	125			32^{O}, 82^{Δ}
153.255	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^3P)\ 4d\ ^2P_{3/2}$	5829	658339	3			32^{O}, 82^{Δ}
151.897	3/2	3/2	0	658339	1			82^{Δ}, 97^{O}
154.768	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^3P)\ 4d\ ^2D_{3/2}$	5829	651960	6			47^{O}, 82^{Δ}
153.550	3/2	5/2	0	651255	35			47^{O}, 82^{Δ}
153.384	3/2	3/2	0	651960	3			47^{O}, 82^{Δ}
152.338	$3s^2 3p^5\ ^2P^o_{3/2}$	$3p^4\ (^3P)\ 4d\ ^2F_{5/2}$	0	656437	10			47^{O}, 82^{Δ}
149.560	$3s^2 3p^5\ ^2P^o_{3/2}$	$3p^4\ (^1D)\ 4d\ ^2S_{1/2}$	0	668630	10			47^{O}, 82^{Δ}
150.315	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\ (^1D)\ 4d\ ^2P_{3/2}$	5829	671096	3			47^{O}, 82^{Δ}

Ti VI (Cl-Sequence) IP=964100cm^{-1} (119・53eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
150・213	1/2	1/2	5829	671549	3				82$^{\Delta}$, 97°
149・010	3/2	3/2	0	671096	20				47°, 82$^{\Delta}$
149・392	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^1D)\ 4d\ {}^2D_{3/2}$	5829	675207	10				47°, 82$^{\Delta}$
148・303	3/2	5/2	0	674297	20				47°, 82$^{\Delta}$
148・104	3/2	3/2	0	675207	3				47°, 82$^{\Delta}$
143・176	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^1S)\ 4d\ {}^2D_{3/2}$	5829	704270	1				82$^{\Delta}$, 97°
141・988	3/2	5/2	0	704283	3				47°, 82$^{\Delta}$
154・161	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^3P)\ 4d\ {}^4F_{3/2}$	5829	654503	1				82$^{\Delta}$, 97°
152・960	3/2	5/2	0	653766	10				47°, 82$^{\Delta}$
141・061	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^3P)\ 5s\ {}^2P_{1/2}$	5829	714742	3				47°, 82$^{\Delta}$
140・443	3/2	3/2	0	712034	20				47°, 82$^{\Delta}$
139・911	3/2	1/2	0	714742	3				47°, 82$^{\Delta}$
137・813	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^1D)\ 5s\ {}^2D_{3/2}$	5829	731453	3				47°, 82$^{\Delta}$
136・714	3/2	5/2	0	731455	6				47°, 82$^{\Delta}$
136・67	3/2	3/2	0	731453					32°, 82$^{\Delta}$
141・113	$3s^2 3p^5\ {}^2P^{\circ}_{3/2}$	$3p^4\ (^3P)\ 5s\ {}^4P_{3/2}$	0	708652	10				47°, 82$^{\Delta}$
130・113	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^3P)\ 5d\ {}^2D_{3/2}$	5829	774306	3				47°, 82$^{\Delta}$
129・249	3/2	5/2	0	773702	6				47°, 82$^{\Delta}$
129・148	3/2	3/2	0	774306	3				47°, 82$^{\Delta}$
126・566	$3s^2 3p^5\ {}^2P^{\circ}_{1/2}$	$3p^4\ (^1D)\ 5d\ {}^2P_{3/2}$	5829	795615	1				82$^{\Delta}$, 98°
125・689	3/2	3/2	0	795615	6				82$^{\Delta}$, 97°

Ti VI (Cl-Sequence) IP=964100 cm^{-1} (119.53 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
126.330	$3s^2 3p^5\ ^2P^o_{1/2}$	$3p^4\,(^1D)\,5d\ ^2D_{3/2}$	5829	797406	3				82△, 97○
125.456	3/2	5/2	0	797092	10				82△, 97○
128.450	$3s^2 3p^5\ ^2P^o_{3/2}$	$3p^4\,(^3P)\,5d\ ^4F_{5/2}$	0	778513	1				47○, 82△
235.310	$3p^4\,(^1D)\,3d\ ^2G_{9/2}$	$3p^4\,(^1D)\,4f\ ^2H^o_{11/2}$							51
226.561	$3p^4\,(^3P)\,3d\ ^4D^o_{7/2}$	$3p^4\,(^3P)\,4f\ ^4F_{9/2}$							51
235.836	$3p^4\,(^3P)\,3d\ ^4F_{7/2}$	$3p^4\,(^3P)\,4f\ ^4G^o_{9/2}$							51
235.408	9/2	11/2							51
235.066	5/2	7/2							51

Ti VII (S-Sequence) IP=1136000 cm^{-1} (140.8 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
521.561	$3s^2 3p^4\ {}^3P_1$	$3s3p^5\ {}^3P^o_2$	4534	196266	250			46, 49, 82$^\Delta$, 99^O
515.008	0	1	5888	200059	125			46, 49, 82$^\Delta$, 99^O
511.442	1	1	4534	200059	125			46, 49, 82$^\Delta$, 99^O
509.511	2	2	0	196266	550			46, 49, 82$^\Delta$, 99^O
505.899	1	0	4534	202202	100			46, 49, 82$^\Delta$, 99^O
499.853	2	1	0	200059	125			46, 49, 82$^\Delta$, 99^O
509.127	$3s^2 3p^4\ {}^1S_0$	$3s3p^5\ {}^1P^o_1$	54801	251214	60			82$^\Delta$, 99^O
440.361	$3s^2 3p^4\ {}^1D_2$	$3s3p^5\ {}^1P^o_1$	24130	251214	125			28, 46, 49, 82$^\Delta$, 99^O
270.748	$3s^2 3p^4\ {}^3P_0$	$3p^3\ ({}^2D)\ 3d\ {}^3S^o_1$	5888	375235	10			49, 82$^\Delta$, 97^O
269.759	1	1	4534	375235	90			49, 82$^\Delta$, 97^O
266.502*	2	1	0	375235	200			49, 82$^\Delta$, 97^O
268.106	$3s^2 3p^4\ {}^3P_0$	$3p^3\ ({}^2D)\ 3d\ {}^3P^o_1$	5888	378872	35			49, 82$^\Delta$, 97^O
268.035	1	2	4534	377614	200			44, 49, 82$^\Delta$, 97^O
267.136	1	1	4534	378872	60			49, 82$^\Delta$, 97^O
265.059	1	0	4534	381808	90			49, 82$^\Delta$, 97^O
264.823	2	2	0	377614	250			44, 49, 82$^\Delta$, 97^O
263.944	2	1	0	378872	35			49, 82$^\Delta$, 97^O
255.076	$3s^2 3p^4\ {}^3P_1$	$3p^3\ ({}^2P)\ 3d\ {}^3D^o_2$	4534	396572	250			49, 67, 82$^\Delta$, 97^O
254.687	0	1	5888	398527	200			49, 67, 82$^\Delta$, 97^O
254.022	2	3	0	393667	800			49, 66, 67, 82$^\Delta$, 97^O
253.811	1	1	4534	398527	200			49, 82$^\Delta$, 97^O
252.162	2	2	0	396572	200			49, 82$^\Delta$, 97^O
250.913	2	1	0	398527	3			49, 82$^\Delta$, 97^O
305.730	$3s^2 3p^4\ {}^1S_0$	$3p^3\ ({}^2D)\ 3d\ {}^1P^o_1$	54801	381894	1			49, 82$^\Delta$, 97^O

Ti VII (S-Sequence) IP=1136000cm^{-1} (140.8eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
332.081	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 3d\ {}^1D_2^o$	24130	325261	6			49, 82$^\Delta$, 97°
296.056	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 3d\ {}^1F_3^o$	24130	361904	35			49, 82$^\Delta$, 97°
279.516	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 3d\ {}^1P_1^o$	24130	381894	200			49, 82$^\Delta$, 97°
260.704	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P^o)\ 3d\ {}^1D_2^o$	24130	407703	250			44, 49, 82$^\Delta$, 97°
252.571	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P^o)\ 3d\ {}^1P_1^o$	24130	450729	60			49, 82$^\Delta$, 97°
252.275	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P)\ 3d\ {}^1F_3^o$	24130	420522	800			49, 67, 82$^\Delta$, 97°
282.898	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 3d\ {}^3P_2^o$	24130	377614	1			82$^\Delta$, 97°
281.898	2	1	24130	378872	200			82$^\Delta$, 97°
268.493	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P)\ 3d\ {}^3D_2^o$	24130	396572	1			82$^\Delta$, 97°
265.951	$3s^2 3p^4\ {}^3P_0$	$3p^3\ (^2D)\ 3d\ {}^1P_1^o$	5888	381894	60			82$^\Delta$, 97°
264.997	1	1	4534	381894	35			82$^\Delta$, 97°
261.851	2	1	0	381894	60			82$^\Delta$, 97°
248.037	$3s^2 3p^4\ {}^3P_1$	$3p^3\ (^2P)\ 3d\ {}^1D_2^o$	4534	407703	3			82$^\Delta$, 97°
179.107	$3s^2 3p^4\ {}^3P_0$	$3p^3\ (^4S)\ 4s\ {}^3S_1^o$	5888	564217	10			31, 82$^\Delta$, 97°
178.673	1	1	4534	564217	20			31, 82$^\Delta$, 97°
177.238	2	1	0	564217	60			31, 82$^\Delta$, 97°
172.353	$3s^2 3p^4\ {}^3P_0$	$3p^3\ (^2D)\ 4s\ {}^3D_1^o$	5888	586092	6			31, 82$^\Delta$, 97°
171.952	1	1	4534	586092	6			31, 82$^\Delta$, 97°

Ti VII (S-Sequence) IP=1136000cm^{-1} (140・8eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
171・888	1	2	4534	586308	20			31, 82$^{\Delta}$, 97°
170・559	2	2	0	586308	20			31, 82$^{\Delta}$, 97°
170・358	2	3	0	586998	125			31, 82$^{\Delta}$, 97°
166・087	$3s^2 3p^4\ {}^3P_0$	$3p^3\ (^2P)\ 4s\ {}^3P_1^{\circ}$	5888	607982	10			31, 82$^{\Delta}$, 97°
165・836	1	0	4534	607538	3			31, 82$^{\Delta}$, 97°
165・716	1	1	4534	607982	1			31, 82$^{\Delta}$, 97°
165・403	1	2	4534	609116	6			31, 82$^{\Delta}$, 97°
164・478	2	1	0	607982	3			31, 82$^{\Delta}$, 97°
164・173	2	2	0	609116	10			31, 82$^{\Delta}$, 97°
178・572	$3s^2 3p^4\ {}^1S_0$	$3p^3\ (^2P)\ 4s\ {}^1P_1^{\circ}$	54801	614794	10			31, 82$^{\Delta}$, 97°
175・812	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 4s\ {}^1D_2^{\circ}$	24130	592918	90			31, 82$^{\Delta}$, 97°
171・276^{C}	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P)\ 4s\ {}^3P_1^{\circ}$	24130	607982	20			31, 82$^{\Delta}$, 97
170・938	2	2	24130	609116	3			31, 82$^{\Delta}$, 97°
168・652	$3s^2 3p^4\ {}^3P_2$	$3p^3\ (^2D)\ 4s\ {}^1D_2^{\circ}$	0	592918	10			31, 82$^{\Delta}$, 97°
138・814	$3s^2 3p^4\ {}^3P_0$	$3p^3\ (^4S)\ 4d\ {}^3D_1^{\circ}$	5888	726277	1			32, 47, 82$^{\Delta}$, 97°
138・548	1	2	4534	726303	10			32, 47, 82$^{\Delta}$, 97°
137・661	2	3	0	726424	20			32, 47, 82$^{\Delta}$, 97°
132・733	$3s^2 3p^4\ {}^3P_2$	$3p^3\ (^2D)\ 4d\ {}^3D_3^{\circ}$	0	753393	10			82$^{\Delta}$, 97°
132・522	2	2	0	754591	6			82$^{\Delta}$, 97°
133・633	$3s^2 3p^4\ {}^3P_1$	$3p^3\ (^2D)\ 4d\ {}^3P_2^{\circ}$	4534	752850	3			82$^{\Delta}$, 97°
132・322	2	1	0	755732	1			82$^{\Delta}$, 97°

Ti VII (S-Sequence) IP=1136000 cm^{-1} (140・8 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
132・982	$3s^2 3p^4\ {}^3P_1$	$3p^3\ (^2D)\ 4d\ {}^3S_1^\circ$	4534	756518	1			82$^\Delta$, 97°
129・722	$3s^2 3p^4\ {}^3P_1$	$3p^3\ (^2P)\ 4d\ {}^3D_2^\circ$	4534	775416	3			82$^\Delta$, 97°
129・603	1	1	4534	776122	1			82$^\Delta$, 97°
128・25	2	3	0	779699	1			82$^\Delta$, 97°
132・351	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P)\ 4d\ {}^3D_3^\circ$	24130	779699	1			82$^\Delta$, 97°
136・815	$3s^2 3p^4\ {}^1S_0$	$3p^3\ (^2P)\ 4d\ {}^1P_1^\circ$	54801	785716	3			32, 47, 82$^\Delta$, 97°
132・149	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P)\ 4d\ {}^1D_2^\circ$	24130	780853	3			82$^\Delta$, 97°
132・093	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2P)\ 4d\ {}^1F_3^\circ$	24130	781170	1			82$^\Delta$, 97°
136・267	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 4d\ {}^1D_2^\circ$	24130	757984	6			32, 47, 82$^\Delta$, 97°
135・801	$3s^2 3p^4\ {}^1D_2$	$3p^3\ (^2D)\ 4d\ {}^1F_3^\circ$	24130	760504	20			32, 47, 82$^\Delta$, 97°

Ti VIII (P Sequence) IP=1374000cm^{-1} (170・4eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
538・241	$3s^2 3p^3\ {}^2P^o_{3/2}$	$3s3p^4\ {}^2D_{5/2}$	55634+x	241426+x	4			94$^{\circ\Delta}$, 106
535・381	1/2	3/2	54189+x	240972+x	1			94$^{\circ\Delta}$, 106
481・428	$3s^2 3p^3\ {}^2D^o_{5/2}$	$3s3p^4\ {}^2D_{3/2}$	33256+x	240972+x	3			94$^{\circ\Delta}$, 106
480・376	5/2	5/2	33256+x	241426+x	11			94$^{\circ\Delta}$, 106
478・971	3/2	3/2	32191+x	240972+x	10			48, 49, 82, 94$^{\circ\Delta}$, 106
449・633	$3s^2 3p^3\ {}^2P^o_{3/2}$	$3s3p^4\ {}^2P_{3/2}$	55634+x	278038+x	1			48, 94$^{\circ\Delta}$
443・49	1/2	3/2	54189+x	278038+x				61
440・687	1/2	1/2	54189+x	281108+x	2			94$^{\Delta}$
426・258	$3s^2 3p^3\ {}^2P^o_{3/2}$	$3s3p^4\ {}^2S_{1/2}$	55634+x	290234+x	6			48, 94$^{\circ\Delta}$
423・649	1/2	1/2	54189+x	290234+x	3			48, 94$^{\circ\Delta}$
408・528	$3s^2 3p^3\ {}^2D^o_{5/2}$	$3s3p^4\ {}^2P_{3/2}$	33256+x	278038+x	7			48, 49, 82, 94$^{\circ\Delta}$
406・756	3/2	3/2	32191+x	278038+x	3			94$^{\Delta}$
401・739	3/2	1/2	32191+x	281108+x	6			48, 49, 82, 94$^{\circ\Delta}$
514・206	$3s^2 3p^3\ {}^4S^o_{3/2}$	$3s3p^4\ {}^4P_{5/2}$	0	194475	12			46, 48, 49, 82, 94$^{\circ\Delta}$, 106
504・801	3/2	3/2	0	198098	8			48, 49, 82, 94$^{\circ\Delta}$, 106
500・116	3/2	1/2	0	199954	5			48, 49, 82, 94$^{\circ\Delta}$, 106
324・207	$3s^2 3p^3\ {}^2P^o_{3/2}$	$3p^2\ ({}^3P)\ 3d\ {}^2P_{3/2}$	55634+x	364082+x	1			49, 82$^{\Delta}$, 106°
322・698	1/2	3/2	54189+x	364082+x	1			49, 82$^{\Delta}$, 106°
319・463	3/2	1/2	55634+x	368663+x	1			49, 82$^{\Delta}$, 106°
317・952	1/2	1/2	54189+x	368663+x	1			49, 82$^{\Delta}$, 106°
263・564	$3s^2 3p^3\ {}^2P^o_{3/2}$	$3p^2\ ({}^1S)\ 3d\ {}^2D_{5/2}$	55634+x	435049+x	120			49, 82$^{\Delta}$, 106°
262・718	3/2	3/2	55634+x	436270+x	10			49, 82$^{\Delta}$, 106°

Ti VIII (P-Sequence) IP=1374000cm^{-1} (170・4eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
261・725	1/2	3/2	54189+x	436270+x	60				49, 82$^{\Delta}$, 106°
302・272	$3s^2\ 3p^3\ {}^2D^{\circ}_{5/2}$	$3p^2\ ({}^3P)\ 3d\ {}^2P_{3/2}$	33256+x	364082+x	60				49, 82$^{\Delta}$, 106°
301・297	3/2	3/2	32191+x	364082+x	6				49, 82$^{\Delta}$, 106°
297・197	3/2	1/2	32191+x	368663+x	20				49, 82$^{\Delta}$, 106°
269・533	$3s^23p^3\ {}^4S^{\circ}_{3/2}$	$3p^2\ ({}^3P)\ 3d\ {}^4P_{5/2}$	0	371012	175	9・6−1	5・9+10	E	45*, 49, 82$^{\Delta}$, 106°
268・178	3/2	3/2	0	372887	120	6・2−1	5・8+10	E	45*, 49, 82$^{\Delta}$, 106°
267・401	3/2	1/2	0	373971	60	3・1−1	5・8+10	E	45*, 49, 82$^{\Delta}$, 106°
271・591	$3s^23p^3\ {}^2P^{\circ}_{3/2}$	$3p^2\ ({}^1D)\ 3d\ {}^2S_{1/2}$	55634+x	423834+x	3				49, 82$^{\Delta}$, 106°
270・530	1/2	1/2	54189+x	423834+x	1				49, 82$^{\Delta}$, 106°
297・940	$3s^23p^3\ {}^2P^{\circ}_{3/2}$	$3p^2\ ({}^1D)\ 3d\ {}^2P_{1/2}$	55634+x	412858+x	20				49, 82$^{\Delta}$, 106°
278・806	1/2	1/2	54189+x	412858+x	20				49, 82$^{\Delta}$, 106°
277・813	3/2	3/2	55634+x	415589+x	35				49, 82$^{\Delta}$, 106°
276・701	1/2	3/2	54189+x	415589+x	10				49, 82$^{\Delta}$, 106°
290・971	$3s^23p^3\ {}^2P^{\circ}_{3/2}$	$3p^2\ ({}^1D)\ 3d\ {}^2D_{5/2}$	55634+x	399323+x	35				49, 82$^{\Delta}$, 106°
289・375	1/2	3/2	54189+x	399772+x	1				49, 82$^{\Delta}$, 106°
273・178	$3s^23p^3\ {}^2D^{\circ}_{5/2}$	$3p^2\ ({}^1D)\ 3d\ {}^2D_{5/2}$	33256+x	399323+x	90				49, 82$^{\Delta}$, 106°
272・843	5/2	3/2	33256+x	399772+x	6				49, 82$^{\Delta}$, 106°
272・369	3/2	5/2	32191+x	399323+x	10				49, 82$^{\Delta}$, 106°
272・073	3/2	3/2	32191+x	399772+x	90				49, 82$^{\Delta}$, 106°
258・610	$3s^23p^3\ {}^2D^{\circ}_{5/2}$	$3p^2\ ({}^1D)\ 3d\ {}^2F_{7/2}$	33256+x	419939+x	700				49, 67, 82$^{\Delta}$, 99, 106°
162・401	$3s^23p^3\ {}^2P^{\circ}_{3/2}$	$3p^2\ ({}^3P)\ 4s\ {}^2P_{1/2}$	55634+x	671405+x	1				82$^{\Delta}$, 106°
162・016	1/2	1/2	54189+x	671405+x	1				82$^{\Delta}$, 106°

Ti VIII (P-Sequence) IP=1374000cm^{-1} (170・4eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
161・290	3/2	3/2	55634+x	675631+x	6			82$^{\Delta}$, 106°
160・914	1/2	3/2	54189+x	675631+x	1			82$^{\Delta}$, 106°
157・528	$3s^2 3p^3\ {}^2P^{\circ}_{3/2}$	$3p^2\,({}^3P)\,4s\ {}^2D_{5/2}$	55634+x	690446+x	3			82$^{\Delta}$, 106°
157・472	3/2	3/2	55634+x	690672+x	3			82$^{\Delta}$, 106°
157・112	1/2	3/2	54189+x	690672+x	3			82$^{\Delta}$, 106°
156・444	$3s^2 3p^3\ {}^2D^{\circ}_{3/2}$	$3p^2\,({}^3P)\,4s\ {}^2P_{1/2}$	32191+x	671405+x	10			82$^{\Delta}$, 106°
155・675	5/2	3/2	33256+x	675631+x	20			82$^{\Delta}$, 106°
155・456	3/2	3/2	32191+x	675631+x	1			82$^{\Delta}$, 106°
152・164	$3s^2 3p^3\ {}^2D^{\circ}_{5/2}$	$3p^2\,({}^3P)\,4s\ {}^2D_{5/2}$	33256+x	690446+x	20			82$^{\Delta}$, 106°
151・915	3/2	5/2	32191+x	690446+x	1			82$^{\Delta}$, 106°
151・864	3/2	3/2	32191+x	690672+x	10			82$^{\Delta}$, 106°
149・981	$3s^2 3p^3\ {}^2P^{\circ}_{3/2}$	$3p^2\,({}^1S)\,4s\ {}^2S_{1/2}$	55634+x	722394+x	1			82$^{\Delta}$, 106°
149・653	1/2	1/2	54189+x	722394+x	3			82$^{\Delta}$, 106°
151・484	$3s^2 3p^3\ {}^4S^{\circ}_{3/2}$	$3p^2\,({}^3P)\,4s\ {}^4P_{1/2}$	0	660135	10			82$^{\Delta}$, 106°
150・867	3/2	3/2	0	662835	35			82$^{\Delta}$, 106°
150・039	3/2	5/2	0	666493	60			82$^{\Delta}$, 106°
171・723	$3p^2 3d\ {}^2G_{9/2}$	$3p^2 4f\ {}^2H^{\circ}_{11/2}$						51
171・392	7/2	9/2						51
168・192	$3p^2 3d\ {}^4F_{9/2}$	$3p^2 4f\ {}^4G^{\circ}_{11/2}$						51
168・162	7/2	9/2						51

Ti IX (Si-Sequence)　IP=1549000 cm^{-1} (192・1eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
518・100	$3s^2 3p^2\ ^3P_2$	$3s3p^3\ ^3D^o_2$	7282	200293	0			94[△]
516・215	2	3	7282	201000	8			48, 49, 82, 94[○△]
507・365	1	1	3119	200209				94
507・174	1	2	3119	200293	6			48, 49, 82, 94[○△]
499・479	0	1	0	200293	2			48, 94[○△]
447・701	$3s^2 3p^2\ ^3P_2$	$3s3p^3\ ^3P^o_1$	7282	230645	1			49, 82, 94[○△]
447・484	2	2	7282	230754	6			46, 48, 49, 82, 94[○△]
439・745	1	0	3119	230524	3			49, 82, 94[○△]
439・513	1	1	3119	230645	3			46, 48, 49, 82, 94[○△]
439・302	1	2	3119	230754	2			48, 49, 82, 94[○△],
433・567	0	1	0	230645	1			46, 48, 49, 82, 94[○△]
341・691	$3s^2 3p^2\ ^3P_2$	$3s3p^3\ ^3S^o_1$	7282	299944	7			48, 49, 82, 94[○△]
336・895	1	1	3119	299944	6			48, 49, 82, 94[○△]
333・385	0	1	0	299944	5			48, 49, 82, 94[○△]
400・041	$3s^2 3p^2\ ^1S_0$	$3s3p^3\ ^1P^o_1$	61100	311087	7			48, 49, 82, 94[○△]
443・512	$3s^2 3p^2\ ^1D_2$	$3s3p^3\ ^1D^o_2$	28555	254028	10			94[△]
353・942	$3s^2 3p^2\ ^1D_2$	$3s3p^3\ ^1P^o_1$	28555	311087	4			48, 49, 82, 94[○△]
368・482	$3s^2 3p^2\ ^1D_2$	$3s3p^3\ ^3S^o_1$	28555	299944	0			94[△]
579・896	$3s^2 3p^2\ ^1D_2$	$3s3p^3\ ^3D^o_3$	28555	201000	0			94[△]
405・272	$3s^2 3p^2\ ^3P_2$	$3s3p^3\ ^1D^o_2$	7282	254028	0			94[△]
329・159	$3s^2 3p^2\ ^3P_2$	$3s3p^3\ ^1P^o_1$	7282	311087	2			94[△]

Ti IX (Si-Sequence) IP=1549000cm^{-1} (192・1eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
324・712	1	1	3119	311087	0			82, 94$^{\Box\Delta}$
289・579	$3s^2 3p^2\ ^3P_2$	$3p3d\ ^3P^\circ_2$	7282	352632	90			49, 82$^{\Delta}$, 106°
286・112	1	2	3119	352632	20			49, 82$^{\Delta}$, 106°
285・981	2	1	7282	356962				49, 82, 106°
282・613	1	1	3119	356962				49, 82, 106°
281・446	1	0	3119	358427	6			49, 82$^{\Delta}$, 106°
280・141	0	1	0	356962	3			49, 82$^{\Delta}$, 106°
280・027	$3s^2 3p^2\ ^3P_2$	$3p3d\ ^3D^\circ_1$	7282	364414	20			45, 49, 82$^{\Delta}$, 106°
279・074	2	2	7282	365611	20			45, 49, 82$^{\Delta}$, 106°
278・713	2	3	7282	366074	225			45, 49, 82$^{\Delta}$, 106°
276・785	1	1	3119	364414	20			45, 49, 82$^{\Delta}$, 106°
275・867	1	2	3119	365611	60			45, 49, 82$^{\Delta}$, 106°
274・411	0	1	0	364414	10			45, 49, 82$^{\Delta}$, 106°
285・128	$3s^2 3p^2\ ^1S_0$	$3p3d\ ^1P^\circ_1$	61100	411820	20			49, 82$^{\Delta}$, 106°
267・941	$3s^2 3p^2\ ^1D_2$	$3p3d\ ^1F^\circ_3$	28555	401771	120			45, 49, 82$^{\Delta}$, 106°
260・916	$3s^2 3p^2\ ^1D_2$	$3p3d\ ^1P^\circ_1$	28555	411820	6			49, 82$^{\Delta}$, 106°
308・568	$3s^2 3p^2\ ^1D_2$	$3p3d\ ^3P^\circ_2$	28555	352632	35			49, 82$^{\Delta}$, 106°
304・498	2	1	28555	356962	1			49, 82$^{\Delta}$, 106°
138・548	$3s^2 3p^2\ ^3P_2$	$3p4s\ ^3P^\circ_1$	7282	729111	10			49, 82$^{\Delta}$, 106°
137・991	1	0	3119	727806	3			49, 82$^{\Delta}$, 106°
137・743	1	1	3119	729111	1			49, 82$^{\Delta}$, 106°
137・377	2	2	7282	735208	20			49, 82$^{\Delta}$, 106°
137・153	0	1	0	729111	3			49, 82$^{\Delta}$, 106°

Ti IX (Si-Sequence)　IP=1549000 cm^{-1} (192・1 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
136・595	[1]	[2]	3119	735208	6				49, 82[△], 106[○]
147・157	$3s^2 3p^2\ {}^1S_0$	$3p4s\ {}^1P^o_1$	61100	740648	1				49, 82[△], 106[○]
140・443	$3s^2 3p^2\ {}^1D_2$	$3p4s\ {}^1P^o_1$	28555	740648	35				49, 82[△], 106[○]
110・283	$3s^2 3p^2\ {}^3P_2$	$3p4d\ {}^3D^o_3$	7282	914040					51
111・345	$3s^2 3p^2\ {}^1D_2$	$3p4d\ {}^1F^o_3$	28555	926660					51
149・560	$3p3d\ {}^3F_4$	$3p4f\ {}^3G^o_5$							51

Ti X (Al-Sequence) IP=1741500 cm^{-1} (215.92 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
488.971	$3s^2 3p\ ^2P^o_{3/2}$	$3s3p^2\ ^2D_{3/2}$	7543	212055	0	5.0-3	1.4+8	E	94^{OA}, 104*
487.654	3/2	5/2	7543	212606	6	4.5-2	8.4+8	D	46, 48, 82, 94^{OA}, 102, 104*
471.574	1/2	3/2	0	212055	5	5.2-2	7.7+8	D	46, 48, 82, 94^{OA}, 102, 104*
389.237	$3s^2 3p\ ^2P^o_{3/2}$	$3s3p^2\ ^2S_{1/2}$	7543	264456	6				46, 48, 82, 94^{OA}, 102
378.135	1/2	1/2	0	264456	5				46, 48, 82, 94^{OA}, 102
365.628	$3s^2 3p\ ^2P^o_{3/2}$	$3s3p^2\ ^2P_{1/2}$	7543	281045	5				46, 48, 82, 94^{OA}, 102
360.133	3/2	3/2	7543	285218	6				46, 48, 82, 94^{OA}, 102
355.815	1/2	1/2	0	281045	6				46, 48, 82, 94^{OA}, 102
350.610	1/2	3/2	0	285218	5				46, 48, 82, 94^{OA}, 102
389.99	$3s3p^2\ ^4P_{5/2}$	$3p^3\ ^4S^o_{3/2}$	164764+x	421188+x					46, 48, 49, 82^O
383.93	3/2	3/2	160655+x	421188+x					48, 49, 82^O
379.74	1/2	3/2	157850+x	421188+x					48, 49, 82^O
296.04[C]	$3s^2 3p\ ^2P^o_{3/2}$	$3s^2\ (^1S)\ 3d\ ^2D_{3/2}$	7543	345329		7.4-2	5.7+9	E	104*
295.584	3/2	5/2	7543	345857	35	6.7-1	3.4+10	D	48, 49^O, 82^A, 104*
289.579	1/2	3/2	0	345329	90	7.9-1	3.1+10	D	48, 49^O, 82^A, 104*
293.798	$3s3p^2\ ^4P_{5/2}$	$3s3p\ (^3P^o)\ 3d\ ^4D^o_{5/2}$	164764+x	505134+x	1				49, 82^A, 98, 106^O
293.684	5/2	7/2	164764+x	505266+x	10				49, 82^A, 98, 106^O
290.815	3/2	3/2	160655+x	504516+x	1				49, 82^A, 98, 106^O
290.294	3/2	5/2	160655+x	505134+x	1				49, 82^A, 98, 106^O
288.462	1/2	3/2	157850+x	504516+x	1				49, 82^A, 98, 106^O
142.687	$3d\ ^2D_{5/2}$	$4f\ ^2F^o_{7/2}$	345857	1046694	10				82^A, 98, 106^O
142.595	3/2	5/2	345329	1046622	3				82^A, 98, 106^O

Ti X (Al-Sequence) IP=1741500 cm^{-1} (215.92 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
126.651	$3p\ ^2P^o_{3/2}$	$4s\ ^2S_{1/2}$	7543	797113	20				82[Δ], 98, 106[○]
125.456	1/2	1/2	0	797113	10				82[Δ], 98, 106[○]
102.106	$3p\ ^2P^o_{3/2}$	$4d\ ^2D_{5/2}$	7543	986919	20				82[Δ], 98, 106[○]
101.353	1/2	3/2	0	986655	35				82[Δ], 98, 106[○]
124.391	$3s3p^2\ ^4P_{5/2}$	$3s3p(^3P^o)4s\ ^4P^o_{3/2}$	164764+x	968680+x	6				82[Δ], 98, 106[○]
124.143	3/2	1/2	160655+x	966176+x	3				82[Δ], 98, 106[○]
123.703	1/2	1/2	157850+x	966176+x	3				82[Δ], 98, 106[○]
123.657	5/2	5/2	164764+x	973441+x	6				82[Δ], 98, 106[○]
123.331	1/2	3/2	157850+x	968680+x	3				82[Δ], 98, 106[○]
123.036	3/2	5/2	160655+x	973441+x	6				82[Δ], 98, 106[○]
119.891	$3s3p^2\ ^2D_{5/2}$	$3s^24f\ ^2F^o_{7/2}$	212606	1046694	6				82[Δ], 98, 106[○]
119.822	3/2	5/2	212055	1046622	1				82[Δ], 98, 106[○]
104.568	$3d\ ^2D_{5/2}$	$5f\ ^2F^o_{7/2}$	345857	1302170	0				82[Δ], 98, 106[○]
104.516	3/2	5/2	345329	1302120	0				82[Δ], 98, 106[○]
85.262	$3p\ ^2P^o_{3/2}$	$5s\ ^2S_{1/2}$	7543	1180390	10				82[Δ], 98, 106[○]
84.711	1/2	1/2	0	1180390	6				82[Δ], 98, 106[○]
79.110	$3p\ ^2P^o_{3/2}$	$5d\ ^2D_{5/2}$	7543	1271680	3				82[Δ], 98, 106[○]
78.655	1/2	3/2	0	1271460	1				82[Δ], 98, 106[○]
91.855	$3d\ ^2D_{5/2}$	$6f\ ^2F^o_{7/2}$	345857	1434560	0				82[Δ], 98, 106[○]
91.806	3/2	5/2	345329	1434560	0				82[Δ], 98, 106[○]
70.625	$3p\ ^2P^o_{3/2}$	$6d\ ^2D_{5/2}$	7543	1415930	1				82[Δ], 98, 106[○]

Ti X (Al-Sequence) IP=1741500cm^{-1} (215・92eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
70・265	1/2	3/2	0	1423180	0				82[A], 98, 106[C]

Ti XI (Mg-Sequence) IP=2137400 cm^{-1} (265.0 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
386.140	$3s^2\ ^1S_0$	$3s3p\ ^1P^o_1$	0	258973	3	9.6-1	1.4+10	E	28, 39[O], 46, 49, 82[Δ], 98, 104[*]
568.44	$3s^2\ ^1S_0$	$3s3p\ ^3P^o_1$	0	173827+x					82
87.725	$3s^2\ ^1S_0$	$3s4p\ ^1P^o_1$	0	1139920	35				30, 39[O], 82[Δ], 98
65.403	$3s^2\ ^1S_0$	$3s5p\ ^1P^o_1$	0	1528980	1				39[O], 82[Δ], 98
57.891	$3s^2\ ^1S_0$	$3s6p\ ^1P^o_1$	0	1727380	1				39[O], 82[Δ], 98
54.322	$3s^2\ ^1S_0$	$3s7p\ ^1P^o_1$	0	1840880	1				39[O], 82[Δ], 98
446.69	$3s(^2S)3p\ ^1P^o_1$	$3p^2\ ^1S_0$	258973	482840		1.3-1	1.3+10	D	48[O], 49, 82, 104[*]
667.34[C]	$3s3p\ ^1P^o_1$	$3p^2\ ^1D_2$	258973	408820		1.3-1	1.2+9	C	48, 104[*]
429.60	$3s(^2S)3p\ ^3P^o_2$	$3p^2\ ^3P_1$	179473+x	412230+x		8.2-2	4.9+9	C	39[O], 46, 49, 82, 104[*]
425.74	1	0	173827+x	408710+x		1.1-1	1.2+10	C	39[O], 46, 49, 82, 104[*]
419.45	1	1	173827+x	412230+x		8.4-2	3.2+9	C	39[O], 46, 49, 82, 104[*]
417.85	2	2	179473+x	418780+x		2.6-1	1.0+10	C	39[O], 46, 49, 82, 104[*]
415.07	0	1	171274+x	412230+x		3.4-1	4.4+9	C	39[O], 46, 49, 82, 104[*]
408.28	1	2	173827+x	418780+x		1.4-1	3.5+9	C	46[O], 49, 61, 82, 104[*]
378.630	$3s3p\ ^3P^o_2$	$3p^2\ ^1D_2$	179473+x	408820	1				82[Δ], 98[O]
370.789	1	2	173827+x	408820	1				82[Δ], 98[O]
327.192	$3s3p\ ^1P^o_1$	$3s3d\ ^1D_2$	258973	564604		8.0-1	3.0+10	C	39[O], 98, 104[*]
314.03[C]	$3s(^2S)3p\ ^3P^o_2$	$3s3d\ ^3D_1$	179473+x	497918+x		4.3-3	4.8+8	D	104[*]

Ti XI (Mg-Sequence) IP-2137400cm^{-1} (265.0eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
313.710	2	2	179473+x	498239+x	1	6.4-2	4.3+9	C	39^{O}, 82$^{\Delta}$, 104*
313.229	2	3	179473+x	498728+x	10	3.5-1	1.7+10	C	39^{O}, 46, 48, 49, 82$^{\Delta}$, 104*
308.568	1	1	173827+x	497918+x	35	1.1-1	7.6+9	C	39^{O}, 82$^{\Delta}$, 104*
308.250	1	2	173827+x	498239+x	10	3.2-1	1.4+10	C	39^{O}, 82$^{\Delta}$, 104*
306.144	0	1	171274+x	497918+x	1	4.3-1	1.0+10	C	39^{O}, 82$^{\Delta}$, 104*
374.00	$3p^2\ ^1S_0$	$3p\ (^2P)\ 3d\ ^1P^o_1$	482840	750220					48^{O}, 49, 82
349.91	$3p^2\ ^1D_2$	$3p\ (^2P)\ 3d\ ^1D^o_2$	408820	694610					48^{O}, 82
327.22	$3p^2\ ^3P_2$	$3p\ (^2P)\ 3d\ ^3P^o_2$	418780+x	724385+x	3				48^{O}, 49, 82$^{\Delta}$
322.75	$3p^2\ ^3P_2$	$3p\ (^2P)\ 3d\ ^3D^o_3$	418780+x	728640+x					48^{O}, 49, 82
434.94	$3s\ (^2S)\ 3d\ ^3D_3$	$3p\ (^2P)\ 3d\ ^3D^o_3$	498728+x	728640+x					48^{O}, 49, 82
312.676^{C}	$3p^2\ ^1D_2$	$3p3d\ ^3D^o_3$	408820	728640+x	1				82$^{\Delta}$, 98
543.23	$3s\ (^2S)\ 3d\ ^3D_1$	$3p\ (^2P)\ 3d\ ^3F^o_2$	497918+x	682000+x					48^{O}, 49, 82
533.55	2	3	498239+x	685660+x					48^{O}, 49, 82
522.66	3	4	498728+x	690060+x					48^{O}, 49, 82
538.747^{C}	$3s3d\ ^1D_2$	$3p3d\ ^1P^o_1$	564604	750220	1				82$^{\Delta}$, 98
625.857^{C}	$3s3d\ ^1D_2$	$3p3d\ ^3P^o_2$	564604	724385+x	3				82$^{\Delta}$, 98
123.946	$3s3p\ ^1P^o_1$	$3s4s\ ^1S_0$	258973	1065780					39^{O}, 98
115.015	$3s3p\ ^3P^o_2$	$3s4s\ ^3S_1$	179473+x	1048930+x	20				30, 39^{O}, 82$^{\Delta}$

Ti XI (Mg-Sequence) IP=2137400cm^{-1} (265.0eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1}) Acc	Reference
114.272	1	1	173827+x	1048930+x	10			30, 39°, 82$^{\triangle}$
113.940	0	1	171274+x	1048930+x	6			30, 39°, 82$^{\triangle}$, 98
110.019	3s3d $^1D_2$	3p4d $^1F^{\circ}_3$	564604	1473538				80
135.179	3s3d $^1D_2$	3s4f $^1F^{\circ}_3$	564604	1304360				39°, 98
126.042	3s3d $^3D_3$	3s4f $^3F^{\circ}_4$	498728+x	1292120+x	35			30, 39°, 82$^{\triangle}$
125.979	2	3	498239+x	1292020+x	20			30, 39°, 82$^{\triangle}$
125.940	1	2	497918+x	1291950+x	6			30, 39°, 82$^{\triangle}$
137.473^{c}	3s3d $^1D_2$	3s4f $^3F^{\circ}_3$	564604	1292020+x	3			82$^{\triangle}$, 98
84.711	3s3p $^3P^{\circ}_2$	3p4p $^3S_1$	179473+x	1359860+x				39°, 98
84.321	1	1	173827+x	1359860+x				39
85.290	3s3p $^3P^{\circ}_{2,1,0}$	3p4p $^3D_{3,2,1}$	171274+x	1351940+x	3			39°, 82$^{\triangle}$, 98
85.114	3s3p $^3P^{\circ}_2$	3p4p $^3P_1$	179473+x	1354360+x				39
84.876	1	0	173827+x	1352020+x				39
84.835	2	2	179473+x	1358220+x				39°, 82
84.525	0	1	171274+x	1354360+x				39
84.433	1	2	173827+x	1358220+x				39
100.591	3s3p $^1P^{\circ}_1$	3s4d $^1D_2$	258973	1253100				39
94.085	3s3p $^3P^{\circ}_2$	3s4d $^3D_2$	179473+x	1242340+x	3			30, 39°, 82$^{\triangle}$, 98
94.053	2	3	179473+x	1242710+x	35			30, 39°, 82$^{\triangle}$, 98
93.626	1	1	173827+x	1242000+x	10			30, 39°, 82$^{\triangle}$, 98
93.589	1	2	173827+x	1242340+x	20			30, 39°, 82$^{\triangle}$, 98

Ti XI (Mg-Sequence) IP=2137400 cm^{-1} (265・0 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
93・395	0	1	171274+x	1242000+x	6				30, 39°, 82△, 98
134・704	$3p\,(^2P)\,3d\ ^1F^o_3$	$3p\,(^2P)\,4f\ ^1G_4$							55
127・268	$3p\,(^2P)\,3d\ ^3D^o_2$	$3p\,(^2P)\,4f\ ^3D_2$	728640+x	1515483+x					55
129・055	$3p\,(^2P)\,3d\ ^3D^o_3$	$3p\,(^2P)\,4f\ ^3F_4$	728640+x	1503500+x					55
123・070	$3p\,(^2P)\,3d\ ^3F^o_3$	$3p\,(^2P)\,4f\ ^3G_4$	685660+x	1498210+x					55
122・905	4	5	690060+x	1503700+x					55
124・138	$3p\,(^2P)\,3d\ ^1D^o_2$	$3p\,(^2P)\,4f\ ^3F_3$	694610	1500170+x					55
117・171	$3p^2\ ^3P_1$	$3p4s\ ^3P^o_0$	412230+x	1265680+x					39
116・910	2	2	418780+x	1274120+x					39
116・387	0	1	408710+x	1267920+x					39
116・028	1	2	412230+x	1274120+x					39
100・835	$3p^2\ ^1S_0$	$3p4d\ ^1P^o_1$	482840	1474559					80
93・909	$3p^2\ ^1D_2$	$3p4d\ ^1F^o_3$	408820	1473538					80
96・246	$3p^2\ ^3P_1$	$3p4d\ ^3D^o_1$	412230+x	1451200+x					80
95・929	0	1	408710+x	1451200+x					80
111・664	$3p^2\ ^1D_2$	$3s4f\ ^1F^o_3$	408820	1304360					39°, 98
90・966	$3s3d\ ^3D_3$	$3s5f\ ^3F^o_4$	498728+x	1598040+x	3				29, 39°, 82△, 98
90・927	2	3	498239+x	1598020+x	3				39°, 82△, 98
90・908	1	2	497918+x	1597930+x	1				39°, 82△, 98

Ti XI (Mg−Sequence) IP=2137400 cm^{-1} (265・0 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
96・288	$3s3d\ ^1D_2$	$3s5f\ ^1F^o_3$	564604	1603140					39
83・732	$3p^2\ ^1D_2$	$3s5f\ ^1F^o_3$	408820	1603140					39
81・119	$3s3p\ ^1P^o_1$	$3s5s\ ^1S_0$	258973	1491740	1				39°, 82△, 98
76・731	$3s3p\ ^3P^o_2$	$3s5s\ ^3S_1$	179473+x	1482700+x	1				39°, 82△, 98
76・403	1	1	173827+x	1482700+x	1				39°, 82△, 98
75・415	$3s3p\ ^1P^o_1$	$3s5d\ ^1D_2$	258973	1584970	1				39°, 82△, 98
71・603	$3s3p\ ^3P^o_2$	$3s5d\ ^3D_3$	179473+x	1576060+x	6				30, 39°, 82△, 98
71・323	1	2	173827+x	1575900+x	3				39°, 82△, 98
71・202	0	1	171274+x	1575750+x	1				39°, 82△, 98
79・076	$3s3d\ ^3D_3$	$3s6f\ ^3F^o_4$	498728+x	1763340+x	1				39°, 82△, 98
79・027	2, 1	3, 2	498239+x		1				39°, 82△, 98

Ti XII (Na-Sequence) IP=2351100cm^{-1} (291.502eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
479.881	3s $^2S_{1/2}$	3p $^2P^o_{1/2}$	0	208385		1.55-1	4.49+9	B	18, 28, 35, 40°, 46, 49, 82, 104*
460.741	1/2	3/2	0	217042		3.23-1	5.08+9	B	18, 28, 35, 40°, 46, 49, 82, 104*
351.024	3p $^2P^o_{3/2}$	3d $^2D_{3/2}$	217042	501922		3.7-2	2.0+9	D	18, 40°, 46, 49, 82, 104*
349.929	3/2	5/2	217042	502814		3.3-1	1.2+10	C	18, 28, 35, 40°, 46, 49, 82, 104*
340.672	1/2	3/2	208385	501922		3.7-1	1.1+10	C	18, 28, 35, 40°, 46, 49, 82, 104*
140.361	3d $^2D_{3/2}$	4p $^2P^o_{1/2}$	501922	1214390	1	4.60-2	3.11+10	C	18$^{\Delta}$, 40°, 82, 104*
139.884	5/2	3/2	502814	1217700	3	5.5-2	2.81+10	C	18$^{\Delta}$, 40°, 82, 104*
116.597	3d $^2D_{5/2}$	4f $^2F^o_{7/2}$	502814	1360470	90	9.1-1	3.36+11	C	18$^{\Delta}$, 29, 35, 40°, 82, 104*
116.497	3/2	5/2	501922	1360310	60	9.1-1	2.99+11	C	18$^{\Delta}$, 29, 35, 40°, 82, 104*
109.107	3p $^2P^o_{3/2}$	4s $^2S_{1/2}$	217042	1133573	35	8.4-2	9.4+10	D	18$^{\Delta}$, 29, 40°, 82, 104*
108.086	1/2	1/2	208385	1133573	10	8.4-2	4.8+10	D	18$^{\Delta}$, 29, 40°, 82, 104*
90.547	3p $^2P^o_{3/2}$	4d $^2D_{3/2}$	217042	1321430	6	2.3-2	1.8+10	E	18$^{\Delta}$, 29, 40°, 82, 104*
90.512	3/2	5/2	217042	1321870	90	2.1-1	1.1+11	D	18$^{\Delta}$, 29, 40°, 82, 104*
89.844	1/2	3/2	208385	1321430	60	2.4-1	9.8+10	D	18$^{\Delta}$, 29, 40°, 82,

Ti XII (Na-Sequence) IP=2351100cm^{-1} (291.502eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
									104*
82.344	3s $^2S_{1/2}$	4p $^2P^o_{1/2}$	0	1214390	20	5.88-2	5.79+10	C	18$^\Delta$, 29, 40°, 82, 104*
82.121	1/2	3/2	0	1217700	90	1.18-1	5.84+10	C	18$^\Delta$, 29, 40°, 82, 104*
87.426	3d $^2D_{3/2}$	5p $^2P^o_{1/2}$	501922	1645760					40
87.364	5/2	3/2	502814	1647440	2				18$^\Delta$, 40°
82.368	3d $^2D_{5/2}$	5f $^2F^o_{7/2}$	502814	1716920	6	1.5-1	1.1+11	D	18$^\Delta$, 29, 35, 40°, 82, 104*
82.307	3/2	5/2	501922	1716840	6	1.6-1	1.0+11	D	18$^\Delta$, 29, 35, 40°, 82, 104*
71.987	3p $^2P^o_{3/2}$	5s $^2S_{1/2}$	217042	1606160	3	1.5-2	3.8+10	D	18$^\Delta$, 40°, 82, 104*
71.545	1/2	1/2	208385	1606160	1	1.5-2	1.9+10	D	18$^\Delta$, 40°, 82
67.555	3p $^2P^o_{3/2}$	5d $^2D_{5/2}$	217042	1697320	35				18$^\Delta$, 28, 40°, 82
67.171	1/2	3/2	208385	1697110	10				18$^\Delta$, 29, 40°, 82
60.762	3s $^2S_{1/2}$	5p $^2P^o_{1/2}$	0	1645760	3	1.8-2	3.3+10	D	18$^\Delta$, 29, 40°, 82, 104*
60.701	1/2	3/2	0	1647440	10	3.8-2	3.4+10	D	18$^\Delta$, 29, 40°, 82, 104*
71.031	3d $^2D_{5/2}$	6f $^2F^o_{7/2}$	502814	1910680	1	5.7-2	5.7+10	D	18$^\Delta$, 35, 40°, 104*
70.986	3/2	5/2	501922	1910630	6	6.0-2	5.3+10	D	18$^\Delta$, 29, 35, 40°, 82, 104*

Ti XII (Na-Sequence) IP=2351100cm^{-1} (291.502eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
61.286	3p $^2P_{3/2}$	6s $^2S_{1/2}$	217042	1848640	1	5.3-3	1.9+10	D	18$^{\Delta}$, 40°, 82, 104*
60.971	1/2	1/2	208385	1848640	1	5.2-3	9.4+9	D	18$^{\Delta}$, 40°, 82, 104*
59.435	3p $^2P^{\circ}_{3/2}$	6d $^2D_{5/2}$	217042	1899540	10				18$^{\Delta}$, 40°
59.133	1/2	3/2	208385	1899500	6				18$^{\Delta}$, 40°
53.457	3s $^2S_{1/2}$	6p $^2P^{\circ}_{1/2}$	0	1870660	1				18$^{\Delta}$, 40°, 82
53.433	1/2	3/2	0	1871490	3				18$^{\Delta}$, 40°, 82
65.577	3d $^2D_{5/2}$	7f $^2F^{\circ}_{7/2}$	502814	2027730	3				18$^{\Delta}$, 35, 40°
65.540	3/2	5/2	501922	2027700	1				18$^{\Delta}$, 35, 40°
56.431	3p $^2P^{\circ}_{3/2}$	7s $^2S_{1/2}$	217042	1989000	3				18$^{\Delta}$
56.161	1/2	1/2	208385	1989000	2				18$^{\Delta}$
55.443	3p $^2P^{\circ}_{3/2}$	7d $^2D_{5/2}$	217042	2020690	3				18$^{\Delta}$, 40°
55.181	1/2	3/2	208385	2020620	1				18$^{\Delta}$, 40°
49.912	3s $^2S_{1/2}$	7p $^2P^{\circ}_{1/2, 3/2}$	0	2003500					18
62.470	3d $^2D_{5/2}$	8f $^2F^{\circ}_{7/2}$	502814	2103582	1				18$^{\Delta}$, 40°
62.433	3/2	5/2	501922	2103639	1				18$^{\Delta}$, 40°
53.140	3p $^2P^{\circ}_{3/2}$	8d $^2D_{5/2}$	217042	2098880	1				18$^{\Delta}$, 40°
52.896	1/2	3/2	208385	2098875					18$^{\Delta}$, 40°
47.906	3s $^2S_{1/2}$	8p $^2P^{\circ}_{1/2, 3/2}$	0	2087400					18
51.669	3p $^2P^{\circ}_{3/2}$	9d $^2D_{5/2}$	217042	2152438					18
51.446	1/2	3/2	208385	2152170					18

Ti XII (Na-Sequence) IP=2351100 cm^{-1} (291.502 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
46.641	$3s\ ^2S_{1/2}$	$9p\ ^2P^o_{1/2,3/2}$	0	2144000					18
50.674	$3p\ ^2P^o_{3/2}$	$10d\ ^2D_{5/2}$	217042	2190624					18
50.448	1/2	3/2	208385	2190440					18
45.783	$3s\ ^2S_{1/2}$	$10p\ ^2P^o_{1/2,3/2}$	0	2184200					18
45.167	$3s\ ^2S_{1/2}$	$11p\ ^2P^o_{1/2,3/2}$	0	2214000					18
959.945	$4p\ ^2P^o_{3/2}$	$4d\ ^2D_{5/2}$	1217700	1321870					40
260.145	$4p\ ^2P^o_{3/2}$	$5s\ ^2S_{1/2}$	1217700	1606160		1.4-1	2.8+10		82°, 98, 105*
253.142	$4d\ ^2D_{5/2}$	$5f\ ^2F^o_{7/2}$	1321870	1716920					82°, 98
27.818	$3s\ ^2S_{1/2}$	$2p^5 3s^2\ ^2P^o_{3/2}$	0	3594700					61
27.480	1/2	1/2	0	3637900					61

Ti XIII (Ne-Sequence) IP=6354300 cm^{-1} (787.84 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
26.960	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{3/2})\ 3s\ (\frac{3}{2}, \frac{1}{2})^o\ {}^3P^o_1$	0	3709200		6.3−2	1.9+11	D	82, 104*, 107○
26.641	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{1/2})\ 3s\ (\frac{1}{2}, \frac{1}{2})^o\ {}^1P^o_1$	0	3753600		7.5−2	2.3+11	D	82, 104*, 107○
23.991	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{3/2})\ 3d\ [\frac{1}{2}]^o\ {}^3P^o_1$	0	4168200					82, 107○
23.698	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{3/2})\ 3d\ [\frac{3}{2}]^o\ {}^1P^o_1$	0	4219800		3.3−1	1.3+12	D	82, 104*, 107○
23.356	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{1/2})\ 3d\ [\frac{3}{2}]^o\ {}^3D^o_1$	0	4281600		2.4−1	9.7+12	D	82, 104*, 107○
19.943	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{1/2})\ 4s\ (\frac{1}{2}, \frac{1}{2})^o\ {}^3P^o_1$	0	5014300	50	1.1−2	6.3+10	D	60○, 82△, 104*
20.135	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{3/2})\ 4s\ (\frac{3}{2}, \frac{1}{2})^o\ {}^1P^o_1$	0	4966500	50	1.7−2	9.3+10	D	60○, 82△, 104*
19.204	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{1/2})\ 4d\ [\frac{3}{2}]^o\ {}^1P^o_1$	0	5207200	250	4.5−1	2.7+12	D	43, 60○, 82△, 104*
19.366	$2s^2 2p^6\ {}^1S_0$	$2p^5\,(^2P^o_{3/2})\ 4d\ [\frac{3}{2}]^o\ {}^3D^o_1$	0	5148500	200	2.8−1	1.7+12	D	43, 60○, 82△, 104*
17.727	$2s^2 2p^6\ {}^1S_0$	$5d\ {}^1P^o_1$	0	5641100	100	1.6−1	1.1+12	D	60○, 82△, 104*
17.869	$2s^2 2p^6\ {}^1S_0$	$5d\ {}^3D^o_1$	0	5596300	50	1.4−1	9.7+11	D	60○, 82△, 104*
21.035	$2s^2 2p^6\ {}^1S_0$	$2s2p^6 3p\ {}^1P^o_1$	0	4754000	350				43, 60○, 82△
21.127	$2s^2 2p^6\ {}^1S_0$	$2s2p^6 3p\ {}^3P^o_1$	0	4733300	100				60○, 82△
81.153	$3p\ {}^3P_1\ (\frac{1}{2}, \frac{3}{2})$	$4d\ {}^3F^o_2\ (\frac{1}{2}, \frac{5}{2})^o$	3921900	5143100					57, 77○
80.290	$3p\ {}^3D_3\ (\frac{3}{2}, \frac{5}{2})$	$4d\ {}^3F^o_4\ (\frac{3}{2}, \frac{7}{2})^o$	3900700	5141100					57, 77○

Ti XIII (Ne Sequence) IP=6354300cm^{-1} (787.84eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
81.611	3p $^3P_2$ ($\frac{1}{2}$, $\frac{3}{2}$)	4d $^3F_3^o$ ($\frac{1}{2}$, $\frac{5}{2}$) ^{o}	3964800	5201000					50, 77^o
81.318	3p $^3D_1$ ($\frac{3}{2}$, $\frac{3}{2}$)	4d $^3D_2^o$ ($\frac{3}{2}$) ^{o}	3950200	5163700					77
80.602	2	3	3904000	5177500					57, 77^o
81.255	3p $^1D_2$	4d $^1F_3^o$ ($\frac{3}{2}$, $\frac{7}{2}$) ^{o}	3965800	5197200					77
80.494	3p $^1P_1$	4d $^1D_2^o$ ($\frac{1}{2}$, $\frac{3}{2}$) ^{o}	3912900	5170000					77
299.67^T	3s $^1P_1^o$	3p $^1S_0$	3753600	4087300		4.9−2	1.10+10	D	104*
264.48^T	3s $^3P_1^o$	3p $^1S_0$	3709200	4087300		2.8−2	8.1+9	E	104*
596.66^T	3s $^3P_0^o$	3p $^1P_1$	3745300	3912900		4.0−3	2.5+7	E	104*
490.92^T	1	1	3709200	3912900		1.3−1	3.7+9	D	104*
455.37^T	2	1	3693300	3912900		6.7−3	3.6+8	E	104*
471.25^T	3s $^1P_1^o$	3p $^1D_2$	3753600	3965800		2.3−1	4.2+9	D	104*
389.71^T	3s $^3P_1$	3p $^1D_2$	3709200	3965800		4.9−3	1.3+8	E	104*
366.97^T	2	2	3693300	3965800		2.0−3	1.0+8	E	104*
791.14^T	3s $^1P_1^o$	3p $^3S_1$	3753600	3880000		2.2−3	2.3+7	E	104*
742.39^T	3s $^3P_0^o$	3p $^3S_1$	3745300	3880000		6.7−3	2.7+7	E	104*
585.48^T	1	1	3709200	3880000		1.0−2	2.0+8	E	104*
535.62^T	2	1	3693300	3880000		6.7−2	2.6+9	D	104*
594.18^T	3s $^1P_1^o$	3p $^3P_2$	3753600	3921900		5.1−3	5.8+7	E	104*
516.26^T	1	0	3753600	3947300		1.5−2	1.1+9	E	104*

Ti XIII (Ne-Sequence) IP=6354300 cm^{-1} (787.84 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
473.48^{T}	1	1	3753600	3964800		6.0-2	1.8+9	D	104*
470.15^{T}	3s $^{3}P^{o}_{1}$	3p $^{3}P_{2}$	3709200	3921900		1.2-1	2.1+9	D	104*
455.58^{T}	0	1	3745300	3964800		2.2-1	2.4+9	D	104*
437.45^{T}	2	2	3693300	3921900		8.0-2	2.8+9	D	104*
419.99^{T}	1	0	3709200	3947300		3.8-2	4.3+9	D	104*
368.32^{T}	2	1	3693300	3964800		6.5-3	5.3+8	E	104*
508.65^{T}	3s $^{1}P^{o}_{1}$	3p $^{3}D_{1}$	3753600	3950200		7.4-2	1.9+9	D	104*
522.19^{T}	3s $^{3}P^{o}_{1}$	3p $^{3}D_{2}$	3709200	3900700		1.2-1	1.8+9	D	104*
488.04^{T}	0	1	3745300	3950200		1.9-1	1.8+9	D	104*
482.16^{T}	2	2	3693300	3900700		6.6-2	1.9+9	D	104*
474.61^{T}	2	3	3693300	3904000		2.0-1	4.2+9	D	104*
414.94^{T}	1	1	3709200	3950200		5.2-4	2.0+7	E	104*

Ti XIV (F-Sequence) IP=6961000 cm^{-1} (863.1 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
129.440	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2s2p^6\ {}^2S_{1/2}$	47207	819766		6.5-2	2.58+10	C	14*, 38, 50, 53, 82, 86, 104, 123°
121.986	3/2	1/2	0	819766		7.0-2	6.3+10	C	14*, 24, 38, 50, 53, 82, 86, 104, 123°
25.025	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2p^4\ ({}^3P)\ 3s\ {}^2P_{3/2}$	47207	4043800	50				62$^{\Delta}$
24.891	1/2	1/2	47207	4065100	60				62$^{\Delta}$
24.728	3/2	3/2	0	4043800	70				16, 43, 62$^{\circ\Delta}$, 82
24.592	3/2	1/2	0	4065100	75				62$^{\Delta}$
25.206	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2p^4\ ({}^3P)\ 3s\ {}^4P_{3/2}$	47207	4014900	6				62$^{\Delta}$
25.071	1/2	1/2	47207	4036300	4				62$^{\Delta}$
25.025	3/2	5/2	0	3996000	50				16, 43, 62$^{\circ\Delta}$
24.907	3/2	3/2	0	4014900	70				16, 43, 62$^{\circ\Delta}$
23.960	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2p^4\ ({}^1S)\ 3s\ {}^2S_{1/2}$	47207	4221200	20				62$^{\Delta}$
23.690	3/2	1/2	0	4221200	90				62$^{\Delta}$
24.592	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2p^4\ ({}^1D)\ 3s\ {}^2D_{3/2}$	47207	4114000	75				16, 43, 62$^{\circ\Delta}$
24.315	3/2	5/2	0	4112700	60				16, 43, 62$^{\circ\Delta}$, 82
22.486	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2p^4\ ({}^3P)\ 3d\ {}^2P_{1/2}$	47207	4494800	15				16, 62$^{\circ\Delta}$
22.328	1/2	3/2	47207	4525100	30				16, 62$^{\circ\Delta}$
22.248	3/2	1/2	0	4494800	10				16, 62$^{\circ\Delta}$, 82
22.099	3/2	3/2	0	4525100	20				16, 62$^{\circ\Delta}$
22.426	$2s^2 2p^5\ {}^2P^o_{1/2}$	$2p^4\ ({}^3P)\ 3d\ {}^2D_{3/2}$	47207	4506600	40				62$^{\Delta}$
22.190	3/2	3/2	0	4506600	30				16, 62$^{\circ\Delta}$
22.066	3/2	5/2	0	4531900	60				16, 62$^{\circ\Delta}$

Ti XIV (F-Sequence) IP=6961000 cm^{-1} (863.1 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
22.162	$2s^2 2p^5\ ^2P^o_{3/2}$	$2p^4\ (^3P)\ 3d\ ^2F_{5/2}$	0	4512200	30				62[△]
22.518	$2s^2 2p^5\ ^2P^o_{1/2}$	$2p^4\ (^3P)\ 3d\ ^4P_{3/2}$	47207	4488500	20				62[△]
22.328	3/2	1/2	0	4478700	30				62[△]
22.279	3/2	3/2	0	4488500	40				62[△]
22.215	3/2	5/2	0	4501500	30				62[△]
22.279	$2s^2 2p^5\ ^2P^o_{3/2}$	$2p^4\ (^3P)\ 3d\ ^4F_{5/2}$	0	4488500	40				62[△]
21.82	$2s^2 2p^5\ ^2P^o_{3/2}$	$2p^4\ (^1D)\ 3d\ ^2S_{1/2}$	0	4583000	60				62[△]
21.958	$2s^2 2p^5\ ^2P^o_{1/2}$	$2p^4\ (^1D)\ 3d\ ^2P_{3/2}$	47207	4601700	50				62[△]
21.883	$2s^2 2p^5\ ^2P^o_{1/2}$	$2p^4\ (^1D)\ 3d\ ^2D_{3/2}$	47207	4617400	70				62[△]
21.732	3/2	5/2	0	4601500	70				62[△]
21.657	3/2	3/2	0	4617400	70				62[△]
21.522	$2s^2 2p^5\ ^2P^o_{1/2}$	$2p^4\ (^1S)\ 3d\ ^2D_{3/2}$	47207	4694000	50				16, 62[○△]
21.341	3/2	5/2	0	4685800	40				16, 62[○△]
21.304	3/2	3/2	0	4694000	6				62[△]
25.260	$2s2p^6\ ^2S_{1/2}$	$2s2p^5\ (^3P)\ 3s\ ^2P^o_{3/2}$	819766	4778800	30				16, 43, 62[○△]
25.086	1/2	1/2	819766	4806300	20				62[△]
2117.07	$2s^2 2p^5\ ^2P^o_{3/2}$	$2s^2 2p^5\ ^2P^o_{1/2}$	0	47207		M1	1.87+3	C	86*

Ti XV (O-Sequence) IP=7597000 cm^{-1} (941.9 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
148.588	$2s^2 2p^4\ {}^3P_1$	$2s2p^5\ {}^3P_2^o$	39292	712285	500	4.52-2	8.2+9	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 91, 104, 123°
142.750	0	1	42345	742882	250	1.08-1	1.18+10	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 104, 123°
142.130	1	1	39292	742882	200	2.82-2	9.3+9	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 104, 123°
140.395	2	2	0	712285	800	8.3-2	2.81+10	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 104, 123°
138.357	1	0	39292	762060	300	3.92-2	4.10+10	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 104, 123°
134.609	2	1	0	742882	400	3.11-2	1.91+10	C	14*, 38, 81$^\Delta$, 86, 104, 123°
189.62^c	$2s^2 2p^4\ {}^1S_0$	$2s2p^5\ {}^3P_1^o$	215521	742882		4.3-3	2.7+8	D	86*
131.146	$2s^2 2p^4\ {}^1S_0$	$2s2p^5\ {}^1P_1^o$	215521	978030	60	6.5-2	8.4+9	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 91, 104, 123°
165.690	$2s^2 2p^4\ {}^1D_2$	$2s2p^5\ {}^3P_2^o$	108720	712285		3.5-3	8.5+8	D	86*, 123°
115.031	$2s^2 2p^4\ {}^1D_2$	$2s2p^5\ {}^1P_1^o$	108720	978030	350	1.37-1	1.15+11	C	14*, 24, 38, 50, 53, 56, 81$^\Delta$, 82, 86, 104, 123°

Ti XV (O-Sequence) IP=7597000 cm^{-1} (941.9 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
106.874	$2s^22p^4\ ^3P_0$	$2s2p^5\ ^1P^o_1$	42345	978030		2.6−3	5.1+8	D	14*, 56, 123°
106.52[C]	1	1	39292	978030		3.8−4	2.2+8	E	14*, 56, 82
102.247	2	1	0	978030		4.8−3	5.1+9	D	14*, 38, 56, 86, 123°
147.436	$2s2p^5\ ^1P^o_1$	$2p^6\ ^1S_0$	978030	1656290	50	1.30−1	1.20+11	C	14*, 26, 38, 52, 53, 56, 81△, 91, 123°
23.193	$2s^22p^4\ ^3P_0$	$2p^3\ (^4S^o)\ 3s\ ^3S^o_1$	42345	4354000					23
23.177	1	1	39292	4354000	200				23°, 68, 82△
22.967	2	1	0	4354000	200				23°, 68, 82△
22.109	$2s^22p^4\ ^3P_2$	$2p^3\ (^2P^o)\ 3s\ ^3P^o_2$	0	4523000	100				68°, 82△
22.739	$2s^22p^4\ ^3P_0$	$2p^3\ (^2D^o)\ 3s\ ^3D^o_1$	42345	4440100					23
22.724	1	2	39292	4440400	200				23°, 82△
22.518	2	2	0	4440400					23
22.464	2	3	0	4451600	350				23°, 82△
23.034	$2s^22p^4\ ^1S_0$	$2p^3\ (^2P^o)\ 3s\ ^1P^o_1$	215521	4556800	150				23°, 68, 82△
22.482	$2s^22p^4\ ^1D_2$	$2p^3\ (^2P^o)\ 3s\ ^1P^o_1$	108720	4556800					23
22.936	$2s^22p^4\ ^1D_2$	$2p^3\ (^2D^o)\ 3s\ ^1D^o_2$	108720	4468700	300				23°, 68, 82△
23.41[P]	$2s^22p^4\ ^3P_1$	$2p^3 3s\ ^5S^o_2$	39292	4310000		8.6−5	6.3+8		78*
23.20[P]	2	2	0	4310000		3.9−4	4.8+9		78*
20.364	$2s^22p^4\ ^3P_1$	$2p^3\ (^2P)\ 3d\ ^3P^o_2$	39292	4936000					54
20.317	2	2	0	4936000	300				68°, 82△
20.313	0	1	42345	4965000					10

Ti XV (O-Sequence) IP=7597000cm^{-1} (941・9eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
20・538	$2s^2 2p^4\ {}^3P_1$	$2p^3\,(^2D)\,3d\ {}^3P^o_1$	39292	4908000					10
20・422	2	2	0	4896700	450				10, 68°, 82$^{\Delta}$
21・094	$2s^2 2p^4\ {}^3P_1$	$2p^3\,(^4S)\,3d\ {}^3D^o_2$	39292	4780000	50				68°, 82$^{\Delta}$
20・897	2	3	0	4785000	150				54°, 68, 82$^{\Delta}$
20・31	$2s^2 2p^4\ {}^3P_0$	$2p^3\,(^2P)\,3d\ {}^3D^o_1$	42345	4974000					50, 54°
20・23	1	1	39292	4974000					10°, 91
20・133	1	2	39292	5006000					50, 54°
20・051	2	3	0	4987000	100				50, 54°, 68, 82$^{\Delta}$
20・70	$2s^2 2p^4\ {}^3P_0$	$2p^3\,(^2D)\,3d\ {}^3D^o_1$	42345	4873000					54
20・611	1	2	39292	4891000					54
20・418	2	3	0	4898000					50, 54°
20・701	$2s^2 2p^4\ {}^1S_0$	$2p^3\,(^2P)\,3d\ {}^1P^o_1$	215521	5046000					10
20・823	$2s^2 2p^4\ {}^1D_2$	$2p^3\,(^2D^o)\,3d\ {}^1D^o_2$	108720	4911000	300				54°, 68, 82$^{\Delta}$
20・389	$2s^2 2p^4\ {}^1D_2$	$2p^3\,(^2P)\,3d\ {}^1F^o_3$	108720	5013000					10, 54°
20・700	$2s^2 2p^4\ {}^1D_2$	$2p^3\,(^2D)\,3d\ {}^1F^o_3$	108720	4940000	200				54°, 68, 82$^{\Delta}$
20・312	$2s^2 2p^4\ {}^3P_1$	$2p^3\,(^2P)\,3d\ {}^1D^o_2$	39292	4963000					10
2545・08	$2s^2 2p^4\ {}^3P_2$	$2s^2 2p^4\ {}^3P_1$	0	39292		M1	1・27+3	C	14*, 78°, 86
936・30^{c}	$2s^2 2p^4\ {}^1D_2$	$2s^2 2p^4\ {}^1S_0$	108720	215521		E2	1・4+1	D	14*

Ti XV (O-Sequence) IP=7597000cm^{-1} (941・9eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
1440・3^{C}	$2s^2 2p^4\ {}^3P_1$	$2s^2 2p^4\ {}^1D_2$	39292	108720		M1	2・44+2	C	14*, 78, 86
919・8^{C}	2	2	0	108720		M1	2・55+3	C	14*, 78, 86
567・44^{C}	$2s^2 2p^4\ {}^3P_1$	$2s^2 2p^4\ {}^1S_0$	39292	215521		M1	2・41+4	C	14*, 78°, 86
2・721	K_α		0	36751194					88

Ti XVI (N-Sequence) IP=8420000 (cm^{-1}) (1044eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
169·740	$2s^2 2p^3\ {}^4S^o_{3/2}$	$2s2p^4\ {}^4P_{5/2}$	0	589140	400	6·6−2	1·02+10	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
161·168	3/2	3/2	0	620470	250	4·69−2	1·20+10	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
157·812	3/2	1/2	0	633660	150	2·46−2	1·32+10	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
168·38^C	$2s^2 2p^3\ {}^2P^o_{3/2}$	$2ssp^4\ {}^2D_{3/2}$	219180	813080		1·80−3	4·2+8	D	14*, 86
167·242	3/2	5/2	219180	817160	200	2·92−2	4·64+9	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
162·503	1/2	3/2	197700	813080	60	2·07−2	2·61+9	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
146·57	$2s^2 2p^3\ {}^2D^o_{5/2}$	$2s2p^4\ {}^2D_{3/2}$	130720	813080	30	1·30−3	6·1+8	D	14*, 56, 81^○Δ, 86, 104
145·665	5/2	5/2	130720	817160	600	7·4−2	2·33+10	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
143·459	3/2	3/2	116030	813080	400	8·5−2	2·75+10	C	14*, 24, 50, 53, 56, 81^Δ, 82, 86, 104, 122^○
142·57	3/2	5/2	116030	817160	100	1·2−4	2·6+7	E	14*, 56, 81^○Δ, 104
138·760	$2s^2 2p^3\ {}^2P^o_{3/2}$	$2s2p^4\ {}^2S_{1/2}$	219180	939900	20	1·21−2	8·4+9	C	14*, 25, 50, 53, 56, 81^Δ, 82, 86, 104.

Ti XVI (N-Sequence) IP=8420000 (cm^{-1}) (1044eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
134・724	1/2	1/2	197700	939900	200	7・1−2	2・61+10	C	122[○] 14[*], 53, 64, 81[△], 82, 86, 104, 122[○]
132・022	$2p^2 2p^3\ ^2P^o_{3/2}$	$2s2p^4\ ^2P_{3/2}$	219180	976630	150	2・28−2	8・7+9	C	14[*], 24, 50, 53, 56, 81[△], 82, 86, 104, 122[○]
128・381	1/2	3/2	197700	976630	60	2・69−2	5・4+9	C	14[*], 24, 50, 53, 56, 81[△], 82, 86, 104, 122[○]
124・793	3/2	1/2	219180	1020510	350	7・1−2	6・1+10	C	14[*], 24, 50, 53, 56, 81[△], 82, 86, 104, 122[○]
121・534	1/2	1/2	197700	1020510	20	1・23−2	5・6+9	C	14[*], 24, 53, 56, 81[△], 86, 104, 122[○]
121・382	$2s^2 2p^3\ ^2D^o_{3/2}$	$2s2p^4\ ^2S_{1/2}$	116030	939900	150	2・65−2	2・40+10	C	14[*], 56, 64, 81[△], 86, 122[○]
118・215	$2s^2 2p^3\ ^2D^o_{5/2}$	$2s2p^4\ ^2P_{3/2}$	130720	976630	600	1・04−1	7・4+10	C	14[*], 24, 50, 53, 56, 81[△], 82, 86, 104, 122[○]
116・198	3/2	3/2	116030	976630	100	2・94−2	1・45+10	C	14[*], 24, 50, 53, 56, 81[△], 82, 86, 104, 122[○]
110・561	3/2	1/2	116030	1020510	150	3・08−2	3・36+10	C	14[*], 24, 50, 53, 56, 81[△], 82, 86, 104, 122[○]
106・39[C]	$2p^2 2p^3\ ^4S^o_{3/2}$	$2s2p^4\ ^2S_{1/2}$	0	939900		3・5−4	4・1+8	E	14[*], 56

Ti XVI (N-Sequence) IP=8420000 (cm^{-1}) (1044eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
102·393	$2s^2 2p^3\ {}^4S^o_{3/2}$	$2s2p^4\ {}^2P_{3/2}$	0	976630		1·9−3	1·2+9	E	14*, 56, 86, 122°
97·99[C]	3/2	1/2	0	1020510		1·1−4	1·5+8	E	14*, 56
193·37[C]	$2s2p^4\ {}^2P_{1/2}$	$2p^5\ {}^2P^o_{3/2}$	1020510	1537640		2·55−2	2·27+9	C	14*, 56, 86
178·240	3/2	3/2	976630	1537640		1·20−1	2·52+10	C	14*, 50, 53, 54, 56, 81, 122°
176·267	1/2	1/2	1020510	1587830		1·14−1	2·45+10	C	14*, 56, 86, 122°
163·610	3/2	1/2	976630	1587830		3·86−2	1·83+10	C	14*, 56, 86, 122°
167·297	$2s2p^4\ {}^2S_{1/2}$	$2p^5\ {}^2P^o_{3/2}$	939900	1537640		4·60−2	5·5+9	C	14*, 53, 56, 81, 122°
154·34[C]	1/2	1/2	939900	1587830		6·6−4	1·8+8	E	14*, 53, 56
138·800	$2s2p^4\ {}^2D_{5/2}$	$2p^5\ {}^2P^o_{3/2}$	817160	1537640	20	6·7−2	3·48+10	C	14*, 26, 50, 53, 54, 56, 81△, 82, 122°
138·020	3/2	3/2	813080	1537640		2·51−2	8·8+9	C	14*, 26, 56, 82, 122°
129·075	3/2	1/2	813080	1587830	10	4·76−2	3·81+10	C	14*, 26, 50, 53, 54, 56, 81△, 82, 122°
20·101	$2s^2 2p^3\ {}^2P^o_{3/2}$	$2p^2\ ({}^3P)\ 3d\ {}^2P_{3/2}$	219180	5193000					54
19·551	$2s^2 2p^3\ {}^2D^o_{5/2}$	$2p^2\ ({}^3P)\ 3d\ {}^2F_{7/2}$	130720	5246000					54
19·370	$2s^2 2p^3\ {}^2D^o_{5/2}$	$2p^2\ ({}^3P)\ 3d\ {}^2D_{5/2}$	130720	5293000					50, 54°
19·71	$2s^2 2p^3\ {}^2P^o_{3/2}$	$2p^2\ ({}^3P)\ 3d\ {}^2D_{5/2}$	219180	5293000					54
19·112	$2s^2 2p^3\ {}^4S^o_{3/2}$	$2p^2\ ({}^3P)\ 3d\ {}^4P_{5/2}$	0	5232000					50, 54°, 82
19·089	3/2	3/2	0	5239000					54

Ti XVI (N-Sequence) IP=8420000 (cm^{-1}) (1044eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
19·210	$2s^2 2p^3\ ^2D^o_{5/2}$	$2p^2\ (^1D)\ 3d\ ^2F_{7/2}$	130720	5336000					50, 54°, 82
19·110	3/2	5/2	116030	5349000					54
270·3[C]	$2s^2 2p^3\ ^2P^o_{3/2}$	$2s2p^4\ ^4P_{5/2}$	219180	589140		2·8−4	1·7+7	E	14*
249·2[C]	3/2	3/2	219180	620470		5·9−4	6·3+7	E	14*, 88
241·3[C]	3/2	1/2	219180	633660		1·6−7	3·7+4	E	14*
236·5[C]	1/2	3/2	197700	620470		9·9−6	5·9+5	E	14*
229·4[C]	1/2	1/2	197700	633660		3·2−4	4·1+7	E	14*
218·1[C]	$2s^2 2p^3\ ^2D^o_{5/2}$	$2s2p^4\ ^4P_{5/2}$	130720	589140		5·2−4	7·3+7	E	14*, 88
211·4[C]	3/2	5/2	116030	589140		9·6−4	9·6+7	E	14*, 88
204·2[C]	5/2	3/2	130720	620470		3·0−5	7·2+6	E	14*
198·2[C]	3/2	3/2	116030	620470		5·6−5	9·5+6	E	14*
193·2[C]	3/2	1/2	116030	633660		1·2−4	4·3+7	E	14*
123·0[C]	$2s^2 2p^3\ ^4S^o_{3/2}$	$2s2p^4\ ^2D_{3/2}$	0	813080		3·8−4	1·7+8	E	14*, 88
122·4[C]	3/2	5/2	0	817160		1·1−5	3·3+6	E	14*
110·6[C]	$2s2p^4\ ^4P_{1/2}$	$2p^5\ ^2P^o_{3/2}$	633660	1537640		3·9−4	1·1+8	E	14*
109·0[C]	3/2	3/2	620470	1537640		5·8−4	3·3+8	E	14*
105·4[C]	5/2	3/2	589140	1537640		9·7−4	8·7+8	E	14*
104·8[C]	1/2	1/2	633660	1587830		4·8−4	2·9+8	E	14*
103·4[C]	3/2	1/2	620470	1587830		4·3−5	5·4+7	E	14*
1493·0[C]	$2s^2 2p^3\ ^2D^o_{5/2}$	$2s^2 2p^3\ ^2P^o_{1/2}$	130720	197700		E2	4·0−1	D	14*
1224·4[C]	3/2	1/2	116030	197700		M1	1·38+3	C	14*, 86
1130·5[C]	5/2	3/2	130720	219180		M1	1·80+3	C	14*, 86
969·5[C]	3/2	3/2	116030	219180		M1	4·69+3	C	14*, 86
861·8[C]	$2s^2 2p^3\ ^4S^o_{3/2}$	$2s^2 2p^3\ ^2D^o_{3/2}$	0	116030		M1	2·23+3	C	14*, 86

Ti XVI (N-Sequence) IP=8420000 (cm^{-1}) (1044eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
765·0[C]	3/2	5/2	0	130720			7·7+1	C	14*, 86
505·8[C]	$2s^2 2p^3\ {}^4S^o_{3/2}$	$2s^2 2p^3\ {}^2P^o_{1/2}$	0	197700		M1	4·98+3	C	14*, 86
456·2[C]	3/2	3/2	0	219180		M1	7·8+3	C	14*, 86
6810·[C]	$2s^2 2p^3\ {}^2D^o_{3/2}$	$2s^2 2p^3\ {}^2D^o_{5/2}$	116030	130720		M1	2·60+1	C	14*
4660·[C]	$2s^2 2p^3\ {}^2P^o_{1/2}$	$2s^2 2p^3\ {}^2P^o_{3/2}$	197700	219180		M1	7·8+1	C	14*
2·704	K_α		0	36982000					88

Ti XVII (C-Sequence) IP=9120000 cm^{-1} (1131 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
191·16[C]	$2s^2 2p^2\ ^3P_2$	$2s2p^3\ ^3D^o_2$	55761	578878		4·8−4	8·8+7	E	14*, 53, 56, 82, 86, 104
190·71[C]	2	1	55761	580114		5·0−5	1·5+7	E	14*, 56, 82, 104
188·312	2	3	55761	586795	250	3·90−2	5·2+9	C	14*, 52, 53, 54, 56, 81△, 82, 86, 104, 121○
182·072	1	2	29664	578878		5·5−2	6·6+9	C	14*, 52, 53, 54, 56, 82, 86, 104, 121○
181·67[C]	1	1	29664	580114		6·3−3	1·3+9	D	14*, 53, 56, 86, 104
172·380	0	1	0	580114	150	8·6−2	6·4+9	C	14*, 52, 53, 54, 56, 81△, 86, 104, 121○
159·955	$2s^2 2p^2\ ^3P_2$	$2s2p^3\ ^3P^o_1$	55761	680926	20	8·5−3	3·7+9	D	14*, 53, 56, 81△, 86, 104, 121○
158·469	2	2	55761	686803	100	5·1−2	1·35+10	C	14*, 52, 53, 54, 56, 64, 81△, 86, 121○
154·133	1	0	29664	678454		1·94−2	1·63+10	C	14*, 52, 56, 86, 104, 121○
153·554	1	1	29664	680926	30	3·00−2	8·5+9	C	14*, 52, 53, 56, 81△, 84, 104, 121○
152·174	1	2	29664	686803		6·0−3	1·0+9	D	14*, 52, 56, 86, 104, 121○
146·856	0	1	0	680926		3·68−2	3·80+9	C	14*, 56, 86, 104, 121○
127·782	$2s^2 2p^2\ ^3P_2$	$2s2p^3\ ^3S^o_1$	55761	838350	250	6·8−2	4·63+10	C	14*, 52, 53, 54, 56, 64, 81△, 82, 86, 104, 121○
123·654	1	1	29664	838350	100	5·2−2	2·27+10	C	14*, 52, 53, 54, 56, 64, 81△, 86, 104,

Ti XVII (C-Sequence) IP=9120000cm^{-1} (1131eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
119·284	^{0}	^{1}	0	838350	20	5·1−2	8·0+9	C	121° 14*, 52, 53, 54, 56, 64, 81$^{\Delta}$, 86, 104, 121°
142·589	$2s^2 2p^2\ ^1S_0$	$2s2p^3\ ^1P_1^{\circ}$	242204	943520		1·23−1	1·35+10	C	14*, 52, 53, 54, 56, 81, 82, 86, 104, 121°
141·948	$2s^2 2p^2\ ^1D_2$	$2s2p^3\ ^1D_2^{\circ}$	140693	845180	400	1·17−1	3·87+10	C	14*, 52, 53, 54°, 56, 64, 81$^{\Delta}$, 82, 86, 104, 121°
124·553	$2s^2 2p^2\ ^1D_2$	$2s2p^3\ ^1P_1^{\circ}$	140693	943520	350	7·2−2	5·2+10	C	14*, 52, 53, 54, 56, 64, 81$^{\Delta}$, 82, 86, 104, 121°
227·57^{C}	$2s^2 2p^2\ ^1D_2$	$2s2p^3\ ^3D_1^{\circ}$	140693	580114		2·9−4	6·2+7	E	86*
224·16^{C}	$_{2}$	$_{3}$	140693	586795		3·4−3	3·2+8	D	86*
185·1^{C}	$2s^2 2p^2\ ^1D_2$	$2s2p^3\ ^3P_1^{\circ}$	140693	680926		6·0−4	1·9+8	E	86*
183·11^{C}	$_{2}$	$_{2}$	140693	686803		5·6−4	1·1+8	E	86*
126·676	$2s^2 2p^2\ ^3P_2$	$2s2p^3\ ^1D_2^{\circ}$	55761	845180		7·2−3	3·0+9	D	86*, 121°
109·432	$2s^2 2p^2\ ^3P_1$	$2s2p^3\ ^1P_1^{\circ}$	29664	943520		3·9−3	2·2+9	D	86*, 121°
364·0^{C}	$2s^2 2p^2\ ^3P_2$	$2s2p^3\ ^5S_2^{\circ}$	55761	330500		1·6−4	8·1+6	D	14*, 78, 86
332·4^{C}	$_{1}$	$_{2}$	29664	330500		1·6−4	5·8+6	D	14*, 78, 86
230·9^{C}	$2s2p^3\ ^3S_1^{\circ}$	$2p^4\ ^3P_2$	838350	1271390		7·5−2	5·6+9	C	14*, 53, 56

Ti XVII (C-Sequence) IP=9120000 cm^{-1} (1131 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
210·5[C]	1	1	838350	1313300		5·8−2	8·7+9	C	14*, 53, 56
207·7[C]	1	0	838350	1319750		2·31−2	1·07+10	C	14*, 56
171·06[C]	$2s2p^3\ ^3P^o_2$	$2p^4\ ^3P_2$	686803	1271390		1·54−2	3·51+9	C	14*, 53, 56
169·36[C]	1	2	680926	1271390		1·97−2	2·75+9	C	14*, 53, 56
159·62[C]	2	1	686803	1313300		2·36−2	1·03+10	C	14*, 53, 56
158·13[C]	1	1	680926	1313300		5·4−4	1·4+8	D	14*, 53, 56
157·52[C]	0	1	678454	1313300		3·78−2	3·39+9	C	14*, 56
156·54[C]	1	0	680926	1319750		1·76−2	1·44+10	C	14*, 56
146·067	$2s2p^3\ ^3D^o_3$	$2p^4\ ^3P_2$	586795	1271390		5·9−2	2·58+10	C	14*, 53, 54, 56, 121°
144·66[C]	1	2	580114	1271390		7·6−3	1·5+9	D	14*, 53, 56
144·405	2	2	578878	1271390		2·95−2	9·4+9	C	14*, 53, 56, 121°
136·393	1	1	580114	1313300		3·17−2	1·14+10	C	14*, 53, 56, 121°
136·160	2	1	578878	1313300		3·26−2	1·95+10	C	14*, 53, 54, 56, 121°
135·202	1	0	580114	1319750		2·68−2	2·93+10	C	14*, 53, 54, 56, 121°
163·049	$2s2p^3\ ^1P^o_1$	$2p^4\ ^1S_0$	943520	1556830		8·3−2	6·2+10	C	14*, 56, 121°
228·93[C]	$2s2p^3\ ^1P^o_1$	$2p^4\ ^1D_2$	943520	1380330		4·49−2	3·43+9	C	14*, 56
186·863	$2s2p^3\ ^1D^o_2$	$2p^4\ ^1D_2$	845180	1380330		1·39−1	2·66+10	C	14*, 56, 121°
126·004	$2s2p^3\ ^3D^o_3$	$2p^4\ ^1D_2$	586795	1380330					121
20·183	$2s^22p^2\ ^1S_0$	$2p3s\ ^1P^o_1$	242204	5197000	20				70°, 82△
19·718	$2s^22p^2\ ^1D_2$	$2p3s\ ^1P^o_1$	140693	5197000	40	4·2−2	1·2+4	C	70°, 82△, 104*
19·651	$2s^22p^2\ ^3P_2$	$2p3s\ ^3P^o_1$	55761	5145000	20				70°, 82△, 104

Ti XVII (C-Sequence) IP=9120000cm^{-1} (1131eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
19·459	2	2	55761	5194000	60				70°, 82△, 104
19·369	1	2	29664	5194000	180				70°, 82△, 104
18·665	$2s^22p^2\ ^1S_0$	$2p3d\ ^1P^o_1$	242204	5600000	20				11, 70°, 82△
18·651	$2s^22p^2\ ^1D_2$	$2p3d\ ^1D^o_2$	140693	5502000					11
18·269	$2s^22p^2\ ^1D_2$	$2p3d\ ^1F^o_3$	140693	5615000	100				11, 54°, 70, 82△
18·141	$2s^22p^2\ ^3P_2$	$2p3d\ ^3P^o_2$	55761	5568000	40				11, 54°, 70, 82△
18·091	1	2	29664	5568000	80				70°, 82△
18·218	$2s^22p^2\ ^3P_1$	$2p3d\ ^3D^o_1$	29664	5516600					11
18·176	2	3	55761	5557000	40				11, 54°, 70, 82△
18·141	1	2	29664	5546000					11
18·757	$2s^22p^2\ ^1D_2$	$2p3d\ ^3F^o_2$	140693	5494900					11
18·350	$2s^22p^2\ ^3P_2$	$2p3d\ ^1D^o_2$	55761	5502000					11
19·501	$2s2p^3\ ^3D^o_2$	$2s2p^2\ (^2D)\ 3s\ ^3D_2$	578878	5707000	60				70°, 82△
19·415	$2s2p^3\ ^5S^o_2$	$2s2p^2\ (^4P)\ 3s\ ^5P_3$	330500	5453000	40				70°, 82△
18·939	$2s2p^3\ ^3D^o_2$	$2s2p^2\ (^4P)\ 3d\ ^3F_3$	578878	5859000					70
18·799	3	4	586795	5906000					54
18·387	$2s2p^3\ ^3D^o_3$	$2s2p^2\ (^2D)\ 3d\ ^3F_4$	586795	6025000	60				70°, 82△
18·154	$2s2p^3\ ^5S^o_2$	$2s2p^2\ (^4P)\ 3d\ ^5P_3$	330500	5811000	60				70°, 82△

Ti XVII (C-Sequence) IP=9120000cm^{-1} (1131eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
3834·6	$2s^2 2p^2\ ^3P_1$	$2s^2 2p^2\ ^3P_2$	29664	55761		M1	2·20+2	C	14*, 86°
3370·6	0	1	0	29664		M1	4·47+2	C	14*, 86°
990·3	$2s^2 2p^2\ ^1D_2$	$2s^2 2p^2\ ^1S_0$	140693	242204		E2	8·6+0	D	14*
1172·P	$2s^2 2p^2\ ^3P_2$	$2s^2 2p^2\ ^1D_2$	55761	140693		M1	2·43+3	C	14*, 86°
898·P	1	2	29664	140693		M1	1·96+3	C	14*, 86°
470·2P	$2s^2 2p^2\ ^3P_1$	$2s^2 2p^2\ ^1S_0$	29664	242204		M1	2·53+4	C	78*, 86°
2·686	K_α		0	37230000					88

Ti XVIII (B-Sequence) IP=9850000 cm^{-1} (1221 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
200·18[C]	$2s^2 2p\ ^2P^o_{3/2}$	$2s2p^2\ ^2D_{3/2}$	56300	555860		1·2−3	2·0+8	D	14*, 19, 53, 56, 86, 104
197·838	3/2	5/2	56300	561760		4·01−2	4·56+9	C	14*, 53, 54, 56, 86, 104, 124°
179·902	1/2	3/2	0	555860		6·11−2	6·43+9	C	14*, 53, 54, 56, 81, 86, 104, 124°
161·97[C]	$2s^2 2p\ ^2P^o_{3/2}$	$2s2p^2\ ^2S_{1/2}$	56300	673680		1·21−3	6·29+8	D	14*, 19, 53, 56, 83, 86, 104
148·438	1/2	1/2	0	673680	20	8·37−2	2·60+10	D	14*, 53, 54, 56, 81△, 82, 86, 104, 124°
147·607	$2s^2 2p\ ^2P^o_{3/2}$	$2s2p^2\ ^2P_{1/2}$	56300	733780	20	4·07−2	2·56+10	C	14*, 53, 54, 56, 81△, 86, 104, 124°
144·759	3/2	3/2	56300	747100	30	9·89−2	3·25+10	C	14*, 25, 53, 54, 56, 81△, 86, 104, 124°
136·280	1/2	1/2	0	733780		1·41−2	5·19+9	C	14*, 53, 54, 56, 86, 104, 124°
133·852	1/2	3/2	0	747100	20	2·77−2	5·32+9	C	14*, 25, 53, 54, 56, 81△, 86, 104, 124°
397·6[P]	$2s^2 2p\ ^2P^o_{3/2}$	$2s2p^2\ ^4P_{1/2}$	56300	307770		7·7−5	6·5+6	E	14*, 56, 86°
363·7[P]	3/2	3/2	56300	331220		4·7−5	2·4+6	E	14*, 56, 86°
330·6[P]	3/2	5/2	56300	360800+x		3·5−4	1·4+7	E	14*, 56, 86°
324·9[P]	1/2	1/2	0	307770		3·0−4	1·9+7	E	14*, 56, 86°
301·9[P]	1/2	3/2	0	331220		1·2−5	4·4+5	E	14*, 56, 86°
166·225	$2s2p^2\ ^4P_{5/2}$	$2p^3\ ^4S^o_{3/2}$	360800+x	962390+x	60	4·26−2	1·56+10	C	14*, 53, 54, 56, 81△, 104, 124°
158·94	3/2	3/2	331220	962390+x	70	4·41−2	1·18+10	C	14*, 53, 54°, 56, 81△,

Ti XVIII (B-Sequence) IP=9850000cm^{-1} (1221eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
153·23	1/2	3/2	307770	962390+x		4·70−2	5·76+9	C	104, 124 14*, 53, 54°, 56, 81, 104, 124
153·15[T]	$2s2p^2\ ^2D_{3/2}$	$2p^3\ ^2P^o_{1/2}$	555860	1208900		3·46−2	2·00+10	C	14*, 56, 58°
150·15[T]	5/2	3/2	561760	1227700		2·59−2	1·17+10	C	14*, 56, 58°
148·83[T]	3/2	3/2	555860	1227700		1·13−2	3·46+9	C	14*, 56, 58°
193·36[P]	$2s2p^2\ ^2D_{5/2}$	$2p^3\ ^2D^o_{3/2}$	561760	1078890		1·14−2	3·05+9	C	14*, 56, 58°, 104
191·23[P]	3/2	3/2	555860	1078890		3·62−2	6·6+9	C	14*, 56, 58°, 104
189·663	5/2	5/2	561760	1089010		5·20−2	9·6+9	C	14*, 56, 58, 104, 124°
187·55[P]	3/2	5/2	555860	1089010		1·30−2	1·64+9	C	14*, 56, 58°, 104
301·40[C]	$2s2p^2\ ^2P_{3/2}$	$2p^3\ ^2D^o_{3/2}$	747100	1078890		1·1−3	8·7+7	D	14*
292·47[C]	3/2	5/2	747100	1089010		5·0−2	2·6+9	C	14*, 56, 104
289·76[C]	1/2	3/2	733780	1078890		3·44−2	1·37+9	C	14*, 56, 104
216·54[C]	$2s2p^2\ ^2P_{3/2}$	$2p^3\ ^2P^o_{1/2}$	747100	1208900		8·2−3	2·3+9	D	14*, 56
210·51[T]	1/2	1/2	733780	1208900		6·6−2	9·9+9	C	14*, 56, 58°
208·07[T]	3/2	3/2	747100	1227700		7·9−2	1·2+10	C	14*, 56, 58°
202·46[C]	1/2	3/2	733780	1227700		4·0−3	3·3+8	D	14*, 56
186·84[C]	$2s2p^2\ ^2S_{1/2}$	$2p^3\ ^2P^o_{1/2}$	673680	1208900		1·77−3	3·38+8	D	14*, 56
180·50[C]	1/2	3/2	673680	1227700		3·78−2	3·84+9	C	14*, 56, 58
246·79[C]	$2s2p^2\ ^2S_{1/2}$	$2p^3\ ^2D^o_{3/2}$	673680	1078890		5·12−2	2·83+9		14*, 56
16·939	$2s^22p\ ^2P^o_{3/2}$	$2s2p\ (^3P)\ 3p\ ^2P_{3/2}$	56300	5960000					54
16·90	1/2	1/2	0	5917000					54

Ti XVIII (B-Sequence) IP=9850000 cm^{-1} (1221 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
16・624	$2s^2 2p\ ^2P^o_{3/2}$	$2s2p(^3P)\,3p\ ^2D_{5/2}$	56300	6072000					54C, 82
16・561	1/2	3/2	0	6038000					54
17・920	$2s2p^2\ ^2D_{5/2}$	$2s2p(^3P)\,3d\ ^2D^o_{5/2}$	561760	6142000					54
17・715	$2s2p^2\ ^2D_{3/2}$	$2s2p(^3P)\,3d\ ^2F^o_{5/2}$	555860	6201000					54
17・630	5/2	7/2	561760	6234000					54
17・28	$2s2p^2\ ^4P_{5/2}$	$2s2p(^3P)\,3d\ ^4P^o_{5/2}$	360800	6149000					54
17・30	$2s2p^2\ ^4P_{5/2}$	$2s2p(^3P)\,3d\ ^4D^o_{7/2}$	360800	6142000					54
17・587	$2s2p^2\ ^2P_{3/2}$	$2s2p(^1P)\,3d\ ^2D^o_{5/2}$	747100	6433000					54
17・150	$2s2p^2\ ^2D_{5/2}$	$2s2p(^1P)\,3d\ ^2F^o_{7/2}$	561760	6393000					54
18・38C	$2s^2 2p\ ^2P^o_{3/2}$	$2s^2 3s\ ^2S_{1/2}$	56300	5497000		2・0−2	7・8+11	D	113*
18・19C	1/2	1/2	0	5497000		2・0−2	4・0+11	D	113*
17・39C	$2s^2 2p\ ^2P^o_{3/2}$	$2s^2 3d\ ^2D_{3/2}$	56300	5807000		6・4−2	1・41+12	D	113*
17・36C	3/2	5/2	56300	5815000		5・8−1	8・6+12	D	19, 113*
17・22C	1/2	3/2	0	5807000		6・5−1	7・3+12	D	19, 113*
13・45C	$2s^2 2p\ ^2P^o_{3/2}$	$2s^2 4s\ ^2S_{1/2}$	56300	7491300		4・3−3	3・2+11	E	113*
13・35C	1/2	1/2	0	7491300		4・5−3	1・6+11	E	84, 113*
1777・95	$2s^2 2p\ ^2P^o_{1/2}$	$2s^2 2p\ ^2P^o_{3/2}$	0	56300		M1	1・6+3	C	14*, 86
2・667	K_α		0	37490000					88

Ti XIX (Be-Sequence) IP=10860000 cm^{-1} (1346 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
169·59	$1s^2 2s^2\ ^1S_0$	$1s^2 2s2p\ ^1P^o_1$	0	589660	250	1·75−1	1·42+10	B	14*, 36, 38, 53, 54, 56, 58, 71, 75, 81$^{O\Delta}$, 82, 83, 86, 104
328·36^C	$2s^2\ ^1S_0$	$2s2p\ ^3P^o_1$	0	304540+x		6·6−4	1·4+7	E	14*, 36, 38, 56, 82, 83, 86
305·01	$2s2p\ ^1P^o_1$	$2p^2\ ^1D_2$	589660	917540		6·78−2	2·92+9	B	14*, 36, 38, 53, 56, 58^O, 71, 86, 104
194·37	$2s2p\ ^1P^o_1$	$2p^2\ ^1S_0$	589660	1104170		4·28−2	2·27+10		14*, 36, 38, 53, 56, 58^O, 86, 104
218·50	$2s2p\ ^3P^o_2$	$2p^2\ ^3P_1$	347190+x	804850+x	150	1·55−2	3·61+9	B	14*, 36, 38, 53, 56, 58^O, 71, 81$^\Delta$, 86, 104
212·22	1	0	304540+x	775800+x		2·16−2	9·60+9	B	14*, 38, 53, 56, 58^O, 104
206·10	2	2	347190+x	832360+x	150	4·42−2	7·03+9	B	14*, 36, 38, 53, 56, 58^O, 71, 81$^\Delta$, 86, 104
199·89	1	1	304540+x	804850+x		1·69−2	2·82+9	B	14*, 38, 53, 56, 58^O, 71, 81, 86, 104
193·54	0	1	288130+x	804850+x	50	8·8−2	4·24+9	B	14*, 36, 38, 53, 56, 58^O, 71, 81$^\Delta$, 86, 104
189·47	1	2	304540+x	832360+x	100	3·06−2	3·41+9	B	14*, 36, 38, 53, 56, 58^O, 71, 81$^\Delta$, 86, 104
175·33	$2s2p\ ^3P^o_2$	$2p^2\ ^1D_2$	347190+x	917540		6·8−3	1·5+9	D	14*, 58^O, 86
163·1^C	1	2	304540+x	917540		7·7−4	1·2+8	E	14*
17·181	$2p^2\ ^1D_2$	$2p3d\ ^1D^o_2$	917540	6737900					7, 8^O

Ti XIX (Be-Sequence) IP=10860000 cm^{-1} (1346 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
17·076	$2s2p\ ^1P^o_1$	$2s3d\ ^1D_2$	589660	6445800		5·3−1	7·2+12	D	7, 8°, 54, 115*
16·514	$2s2p\ ^3P^o_2$	$2s3d\ ^3D_3$	347190+x	6402700+x		6·3−1	1·1+13	D	8°, 54, 115*
16·43	1	2	304540+x	6391000+x		5·5−1	8·1+12	D	7, 8, 54°, 115*
16·414	0	1	288130+x	6380500+x		7·5−1	6·2+12	D	7, 8°, 115*
16·802	$2p^2\ ^1D_2$	$2p3d\ ^1F^o_3$	917540	6869200					7, 8°, 54
16·811	$2p^2\ ^1D_2$	$2p3d\ ^1P^o_1$	917540	6866000					7, 8°
16·736	$2p^2\ ^3P_2$	$2p3d\ ^3D^o_3$	832360+x	6807500+x		7·1−1	1·2+13		7, 8°, 54, 115*
16·719	2	1	832360+x	6813600+x					7, 8°
16·71	1	2	804850+x	6789300+x					7, 8°, 54
17·076	$2s2p\ ^3P^o_1$	$2s3s\ ^3S_1$	304540+x	6160700+x					7, 8°
16·178	$2s2p\ ^1P^o_1$	$2p3p\ ^1D_2$	589660	6770900		2·2−1	3·4+12	D	7, 8°, 115*
15·742	$2s2p\ ^3P^o_2$	$2p3p\ ^3D_3$	347190+x	6699600+x		1·1−1	2·1+12	D	7, 8°, 54, 115*
15·671	$2s2p\ ^3P^o_1$	$2p3p\ ^3P_2$	304540+x	6685800+x					7, 8°
15·738	$2s2p\ ^3P^o_2$	$2p3p\ ^3S_1$	347190+x	6701200+x					7, 8°
15·866	$2s^2\ ^1S_0$	$2s3p\ ^1P^o_1$	0	6302800		6·4−1	5·7+12	C	7, 8°, 54, 114*
2344·6	$2s2p\ ^3P^o_1$	$2s2p\ ^3P^o_2$	304540+x	347190+x		M1	1·00+3	C	86*

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Ti XX (Li-Sequence) IP=11501000cm^{-1} (1425・9eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
309・15	$1s^2 2s\ ^2S_{1/2}$	$1s^2 2p\ ^2P^o_{1/2}$	0	323470		2・12−2	1・49+9	B	14*, 37, 65, 75°, 82, 93, 104
259・30	1/2	3/2	0	385650		5・86−2	2・54+9	B	14*, 37, 65, 75°, 82, 93, 104
101・9C	4d $^2D_{5/2}$	5p $^2P^o_{3/2}$	8748300	9729500		3・1−2	3・00+10	C	110*
101・8C	3/2	1/2	8746700	9729500		2・61−2	3・36+10	C	110*
101・8C	3/2	3/2	8746700	9729500		5・2−3	3・4+9	D	110*
99・246C	4p $^2P^o_{1/2}$	5d $^2D_{3/2}$	8732100	9739700		5・82−1	1・97+11	C	111*
99・246C	3/2	3/2	8732100	9739700		5・8−2	3・9+10	D	111*
99・197C	3/2	5/2	8732100	9740200		5・24−1	2・37+11	C	111*
64・700C	4p $^2P^o_{1/2}$	6d $^2D_{3/2}$	8732100	10277700		1・41−1	1・12+11	C	111*
64・700C	3/2	3/2	8732100	10277700		1・4−2	2・2+10	D	111*
64・691C	3/2	5/2	8732100	10277900		1・27−1	1・35+11	C	111*
53・8T	4p $^2P^o_{1/2}$	7d $^2D_{3/2}$	8732100	10590000		6・13−2	7・1+11	C	111*
53・8T	3/2	3/2	8732100	10590000		6・1−3	1・4+10	D	111*
53・2T	3/2	5/2	8732100	10610000		5・57−2	8・8+11	C	111*
48・1T	4p $^2P^o_{1/2}$	8d $^2D_{3/2}$	8732100	10810000		3・28−2	4・73+10	C	110*
48・1T	3/2	3/2	8732100	10810000		3・3−3	9・6+9	D	110*
47・8T	3/2	5/2	8732100	10820000		2・97−2	5・8+10	C	110*
47・270C	3d $^2D_{5/2}$	4p $^2P^o_{3/2}$	6616600	8732100		1・24−2	5・6+10	C	110*
47・123C	3/2	1/2	6610000	8732100		1・0−2	6・3+10	C	110*
47・123C	3/2	3/2	6610000	8732100		2・1−3	6・3+9	D	110*
46・030C	3p $^2P^o_{3/2}$	4d $^2D_{3/2}$	6574200	8746700		5・8−2	1・8+11	C	111*

Ti XX (Li-Sequence) IP=11501000 cm^{-1} (1425・9eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
45・996[C]	3/2	5/2	6574200	8748300		5・3−1	1・1+12	B	111*
45・650[C]	1/2	3/2	6556100	8746700		6・0−1	9・6+11	B	111*
44・601[C]	3s $^2S_{1/2}$	4p $^2P^o_{1/2,\,3/2}$	6490000	8732100		4・2−1	4・8+11	C	111*
32・124[C]	3d $^2D_{5/2}$	5p $^2P^o_{3/2}$	6616600	9729500		2・5−3	2・4+10	D	110*
32・056[C]	3/2	1/2	6610000	9729500		2・1−3	2・7+10	D	110*
32・056[C]	3/2	3/2	6610000	9729500		4・0−4	2・6+9	E	110*
31・591[C]	3p $^2P^o_{3/2}$	5d $^2D_{3/2}$	6574200	9739700		1・4−2	9・2+10	D	111*
31・586[C]	3/2	5/2	6574200	9740200		1・23−1	5・49+11	C	111*
31・411[C]	1/2	3/2	6556100	9739700		1・37−1	4・64+11	C	111*
30・868[C]	3s $^2S_{1/2}$	5p $^2P^o_{1/2,\,3/2}$	6490000	9729500		1・07−1	2・54+11	C	111*
27・4[T]	3d $^2D_{5/2}$	6p $^2P^o_{3/2}$	6616600	10270000		9・2−4	1・20+10	D	110*
27・3[T]	3/2	1/2	6610000	10270000		7・8−4	1・40+10	D	110*
27・3[T]	3/2	3/2	6610000	10270000		1・6−4	1・4+9	E	110*
27・001[C]	3p $^2P^o_{3/2}$	6d $^2D_{3/2}$	6574200	10277700		5・6−3	5・1+10	D	111*
27・000[C]	3/2	5/2	6574200	10277900		5・01−2	3・05+11	C	111*
26・870[C]	1/2	3/2	6556100	10277700		5・60−2	2・58+11	C	111*
26・2[T]	3s $^2S_{1/2}$	6p $^2P^o_{1/2,\,3/2}$	6490000	10270000		4・7−2	1・5+11	C	111*
24・9[T]	3p $^2P^o_{3/2}$	7d $^2D_{3/2}$	6574200	10590000		2・9−3	3・1+10	D	111*
24・8[T]	1/2	3/2	6556100	10590000		2・9−2	1・57+11	C	111*
24・8[T]	3/2	5/2	6574200	10610000		2・61−2	1・89+11	C	111*
24・2[T]	3s $^2S_{1/2}$	7p $^2P^o_{1/2,\,3/2}$	6490000	10600000		2・48−2	9・4+10	C	111*

Ti XX (Li-Sequence) IP=11501000cm^{-1} (1425・9eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
23・6^{T}	3p $^{2}P^{o}_{3/2}$	8d $^{2}D_{3/2}$	6574200	10810000		1・7−3	2・0+10	D	110*
23・5^{T}	1/2	3/2	6556100	10810000		1・7−2	1・1+11	C	110*
23・5^{T}	3/2	5/2	6574200	10820000		1・6−2	1・2+11	C	110*
22・9^{T}	3s $^{2}S_{1/2}$	8p $^{2}P^{o}_{1/2, 3/2}$	6490000	10820000		1・54−2	6・5+10	C	110*
16・379	2p $^{2}P^{o}_{3/2}$	3s $^{2}S_{1/2}$	385650	6490000		1・76−2	8・7+11	C	1, 8, 37, 69°, 82, 104*
16・218	1/2	1/2	323470	6490000		1・77−2	4・5+11	C	1, 8, 37, 69°, 82, 104*
16・067	2p $^{2}P^{o}_{3/2}$	3d $^{2}D_{3/2}$	385650	6610000		6・8−2	1・8+12	B	8°, 37, 84*, 104, 111*
16・049	3/2	5/2	385650	6616600		6・1−1	1・05+13	B	8°, 37, 69, 82, 84*, 104, 111*
15・907	1/2	3/2	323470	6610000		6・71−1	8・84+12	B	8°, 37, 69, 82, 84*, 104, 111*
15・253	2s $^{2}S_{1/2}$	3p $^{2}P^{o}_{1/2}$	0	6556100		1・25−1	3・58+12	B	8°, 37, 69, 82, 104, 111*
15・211	1/2	3/2	0	6574200		2・43−1	3・50+12	B	8°, 37, 69, 82, 104, 111*
11・958	2p $^{2}P^{o}_{3/2}$	4d $^{2}D_{3/2}$	385650	8746700		1・2−2	5・6+11	C	111*
11・958	3/2	5/2	385650	8748300		1・1−1	3・4+12	B	8°, 69, 82, 104, 111*
11・872	1/2	3/2	323470	8746700		1・2−1	2・8+12	B	8°, 69, 82, 104, 111*
11・452	2s $^{2}S_{1/2}$	4p $^{2}P^{o}_{1/2, 3/2}$	0	8732100		9・9−2		C	8°, 69, 82, 104*

Ti XX (Li-Sequence) IP=11501000 cm^{-1} (1425.9 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
10.690	$2p\ ^2P^o_{3/2}$	$5d\ ^2D_{3/2}$	385650	9739700		4.5-3	2.6+11	D	111*
10.690	3/2	5/2	385650	9740200		4.05-2	1.58+12	C	8°, 69, 82, 111*
10.620	1/2	3/2	323470	9739700		4.53-2	1.34+12	C	8°, 69, 82, 111*
10.278	$2s\ ^2S_{1/2}$	$5p\ ^2P^o_{1/2, 3/2}$	0	9729500		4.0-2	8.4+11	C	8°, 69, 82, 104, 111*
10.109	$2p\ ^2P^o_{3/2}$	$6d\ ^2D_{3/2}$	385650	10277700		2.2-3	1.4+11	D	111*
10.109	3/2	5/2	385650	10277900		1.98-2	8.6+11	C	8°, 69, 82, 111*
10.046	1/2	3/2	323470	10277700		2.21-2	7.3+11	C	8°, 69, 82, 111*
9.733	$2s\ ^2S_{1/2}$	$6p\ ^2P^o_{1/2, 3/2}$	0	10270000		2.11-2	4.95+11	C	8°, 104, 111*
9.434	$2s\ ^2S_{1/2}$	$7p\ ^2P^o_{1/2, 3/2}$	0	10600000		1.24-2	3.1+11	C	8°, 104, 111*
9.246	$2s\ ^2S_{1/2}$	$8p\ ^2P^o_{1/2, 3/2}$	0	10820000		7.7-3	2.0+11	D	8°, 110*
9.788	$2p\ ^2P^o_{3/2}$	$7d\ ^2D_{3/2}$	385650	10590000		1.2-2	8.6+10	D	111*
9.788	3/2	5/2	385650	10610000		1.13-2	5.26+11	C	111*
9.733	1/2	3/2	323470	10590000		1.26-2	4.45+11	C	111*
9.591	$2p\ ^2P^o_{3/2}$	$8d\ ^2D_{3/2}$	385650	10810000		7.9-4	5.7+10	E	110*
9.591	3/2	5/2	385650	10820000		7.1-3	3.4+11	D	8°, 110*
9.534	1/2	3/2	323470	10810000		8.0-3	2.9+11	D	8°, 110*
9.128	$2s\ ^2S_{1/2}$	$9p\ ^2P^o_{1/2, 3/2}$	0	10955000					8
9.549	$2p\ ^2P^o_{3/2}$	$9d\ ^2D_{3/2, 5/2}$	385650	10960000					8
2.6355	$2p\ ^2P^o_{3/2}$	$1s2p^2\ ^2D_{5/2}$	385650	38329000		1.9-1	1.2+14	D	1°, 8, 63, 112*

Ti XX (Li-Sequence) IP=11501000 cm^{-1} (1425.9 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
2.630[C]	2p $^2P^o_{1/2}$	$1s2p^2$ $^2P_{1/2}$	323470	38334000		2.8-1	2.7+14	D	63, 113*
2.6295	$_{3/2}$	$_{3/2}$	385650	38416000		3.3-1	3.2+14	D	1, 8, 63[O], 88, 113*

Ti XXI (He-Sequence) IP=50404600 cm^{-1} (6249.42 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
2.6101	$1s^2\ ^1S_0$	$1s2p\ ^1P^o_1$	0	38311600		7.35-1	2.40+14	B	1, 8°, 63, 82, 88, 117*
2.6204	$1s^2\ ^1S_0$	$1s2p\ ^3P^o_1$	0	38129200		3.46-2	1.12+13	B	1, 8°, 63, 82, 88, 117*
2.23	$1s^2\ ^1S_0$	$1s3p\ ^1P^o_1$	0	45021900		1.41-1	6.35+13	C+	17°, 82, 113*
556.25[C]	$1s2s\ ^1S_0$	$1s2p\ ^1P^o_1$	38135000	38311600		3.29-2	2.28+8	B	19, 118*
523.01[C]	$1s2s\ ^3S_1$	$1s2p\ ^3P^o_0$	37927500	38118700		4.01-3	2.93+8	B	19, 118*
495.79[C]	1	1	37927500	38129200		1.22-2	3.31+8	B	19, 118*
390.47[C]	1	2	37927500	38183600		2.69-2	7.07+8	B	19, 118*
14.520[C]	$1s2s\ ^1S_0$	$1s3p\ ^1P^o_1$	38135000	45021900		3.73-1	3.93+12	C	19, 113*
14.204[C]	$1s2s\ ^3S_1$	$1s3p\ ^3P^o_0$	37927500	44967900					19, 113*
14.198[C]	1	1	37927500	44970800		1.24-1	4.10+12	C	19, 113*
14.165[C]	1	2	37927500	44987200					19, 113*
	$1s2p\ ^1P^o_1$	$1s3d\ ^1D_2$	38311600			7.0-1		C	113*
	$1s2p\ ^3P^o_{0,1,2}$	$1s3d\ ^3D_{1,2,3}$				6.8-1		C	113*
	$1s3p\ ^3P^o_{0,1,2}$	$1s3d\ ^3D_{1,2,3}$				1.3-2		D	113*

Ti XXII (H-Sequence) IP=53440400 cm^{-1} (6625.82 eV)

λ (A)	Configuration		Energy level (cm^{-1})		Int	f/Type	A (s^{-1})	Acc	Reference
2.510	1s $^2S_{1/2}$	2p $^2P^o_{1/2}$	0	39984000		4-16-1			19*, 82, 88°
2.496	1/2	3/2	0	40064100					19*, 88°
	2p $^2P^o_{1/2}$		40053800						19
	3/2		40141000						19
	2s $^2S_{1/2}$		40056500						19
	3p $^2P^o_{1/2}$		47500500						19
	3/2		47526400						19
	3s $^2S_{1/2}$		47501300						19
	3d $^2D_{3/2}$		47526300						19
	5/2		47534800						19
	4p $^2P^o_{1/2}$		50103300						19
	3/2		50114200						19
	4s $^2S_{1/2}$		50103600						19
	4d $^2D_{3/2}$		50114200						19
	5/2		50117800						19
	4f $^2F^o_{5/2}$		50117800						19
	7/2		50119500						19

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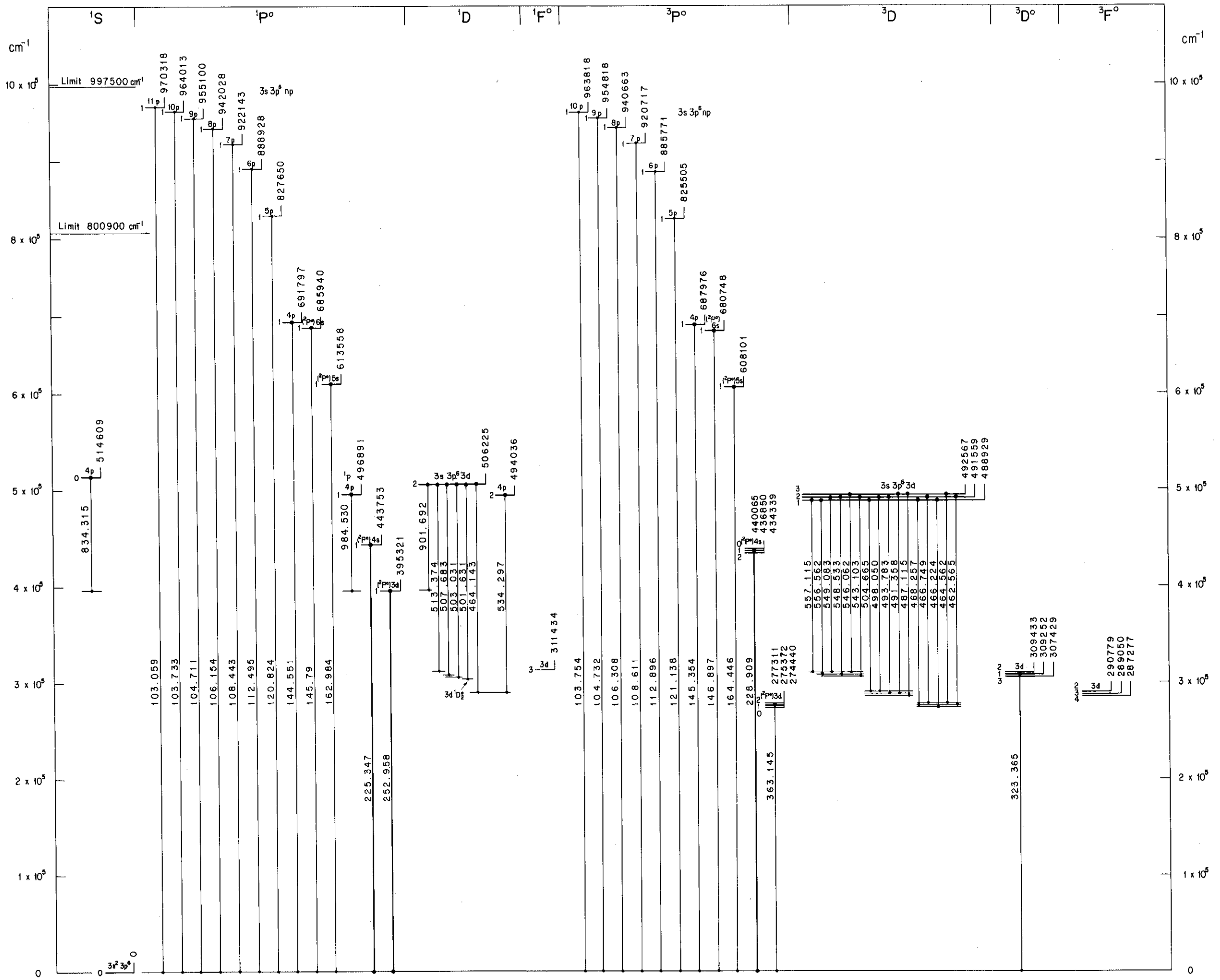
7. Grotrian Diagrams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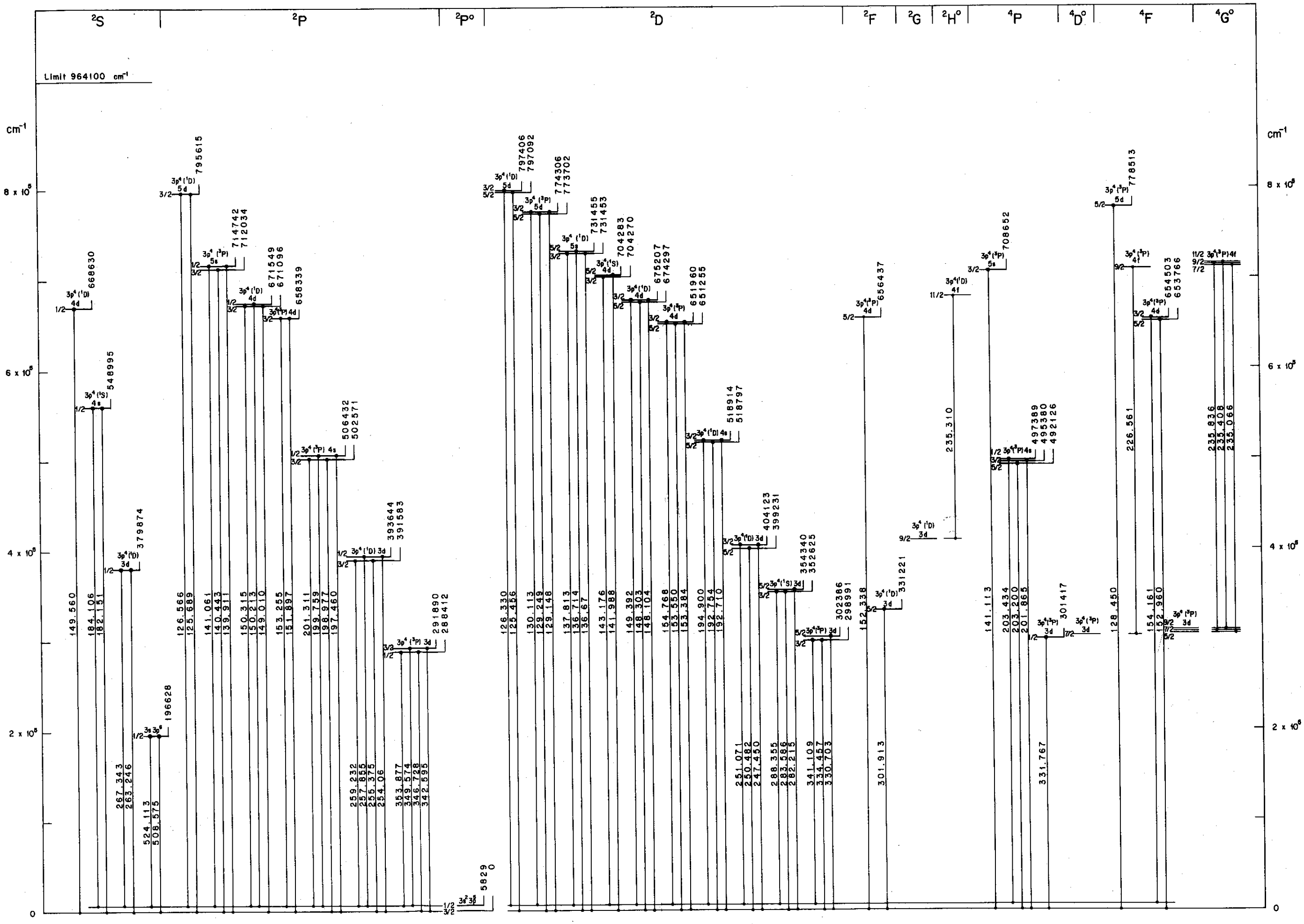
Ti V (A-Sequence)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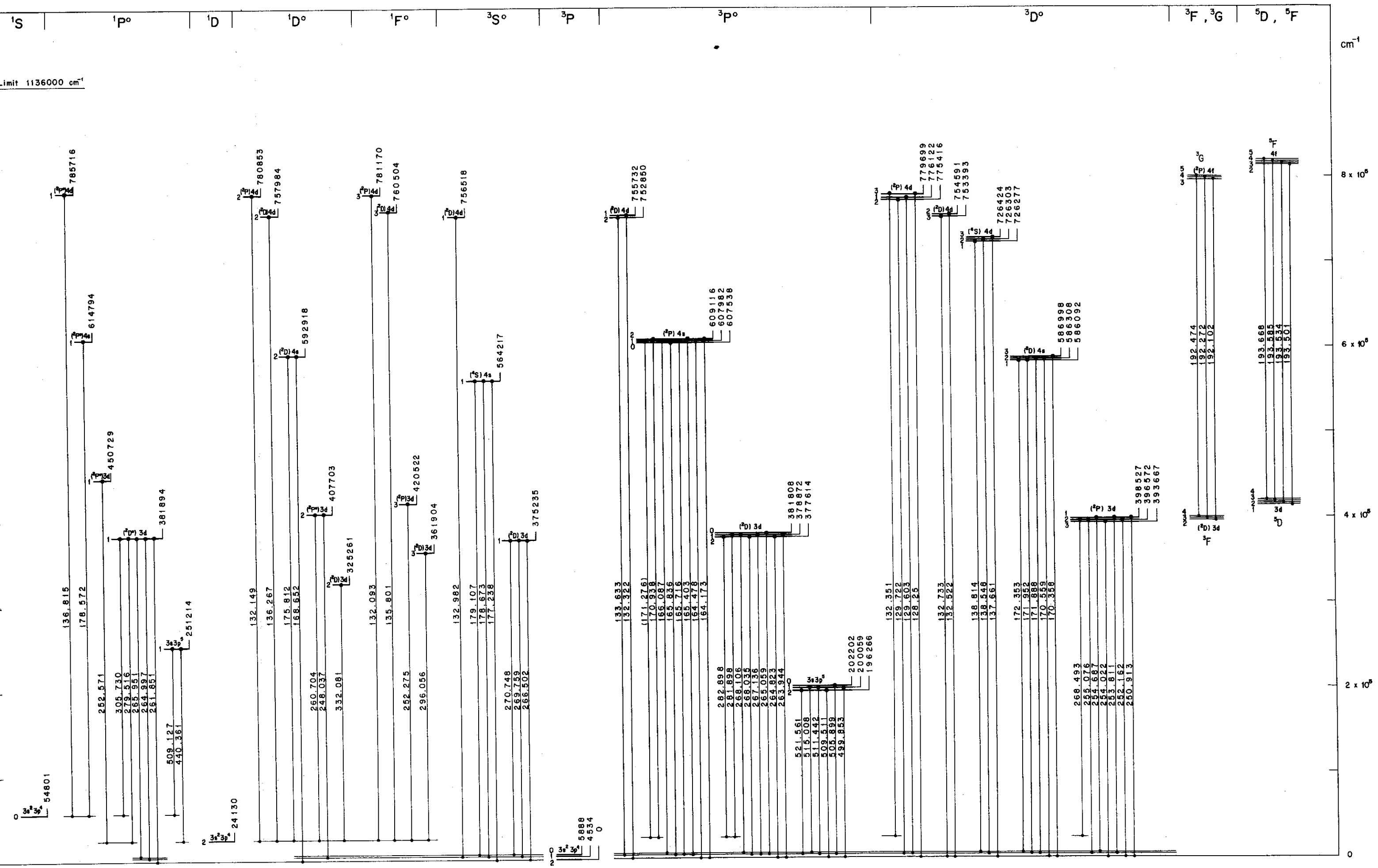

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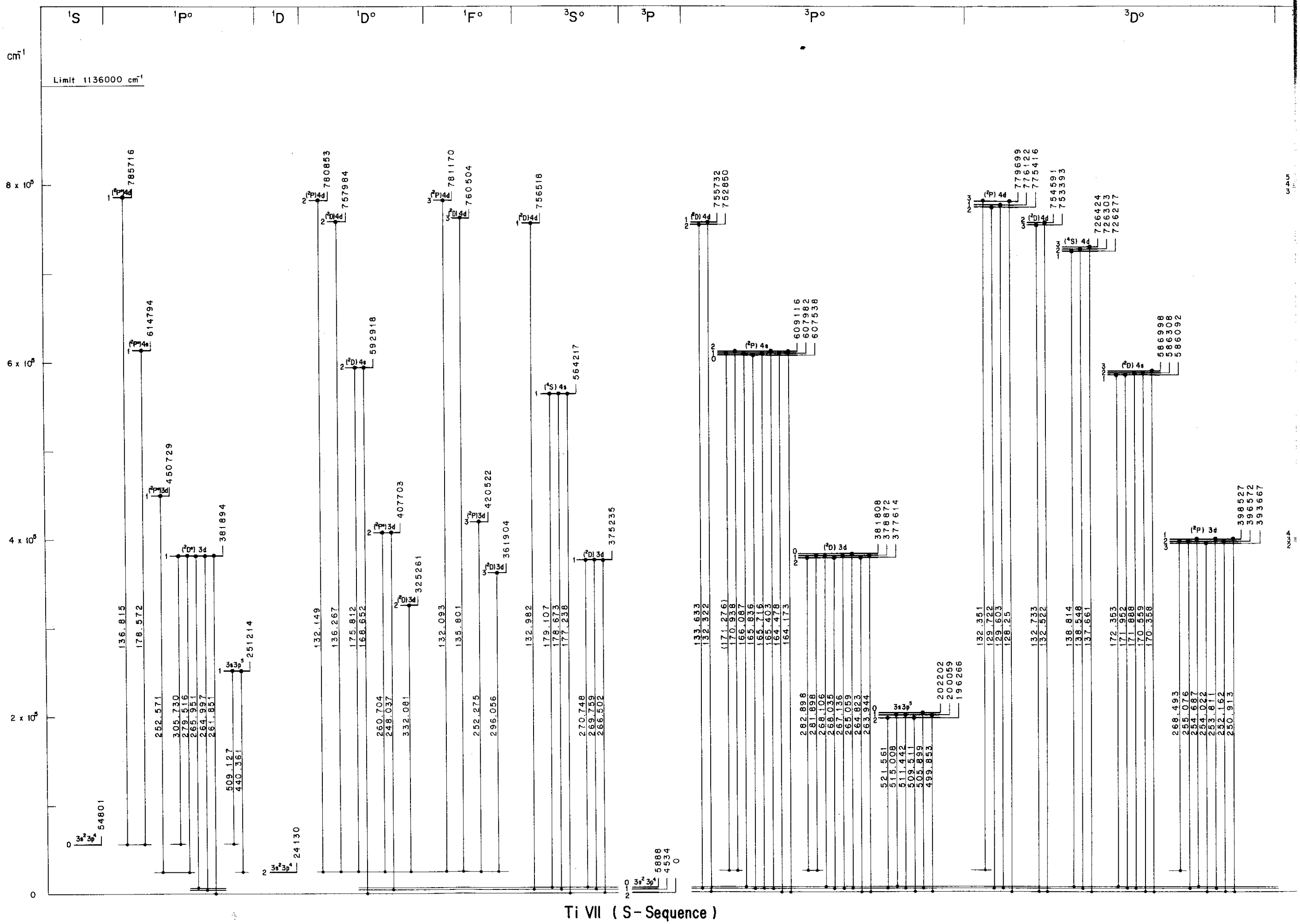

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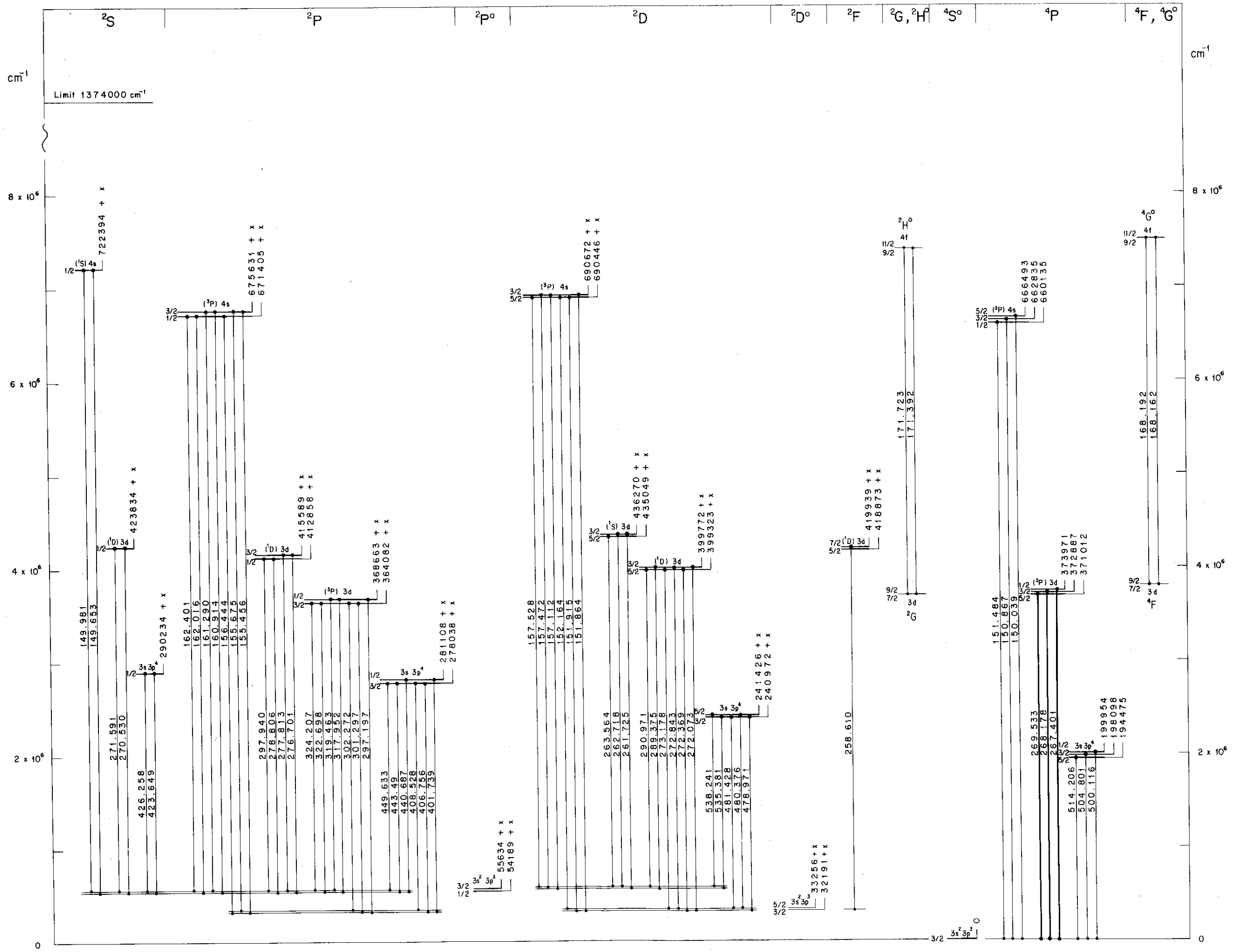

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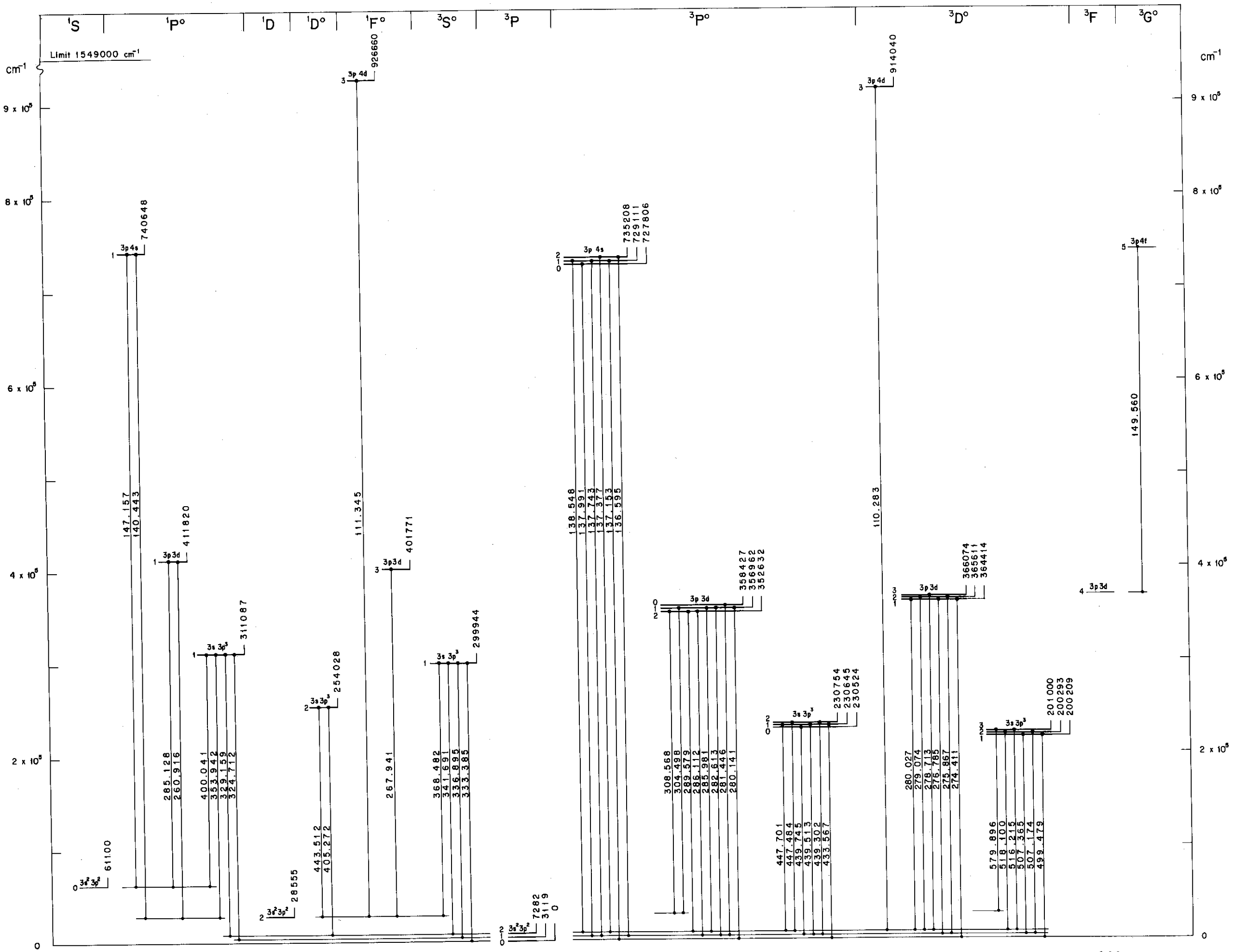

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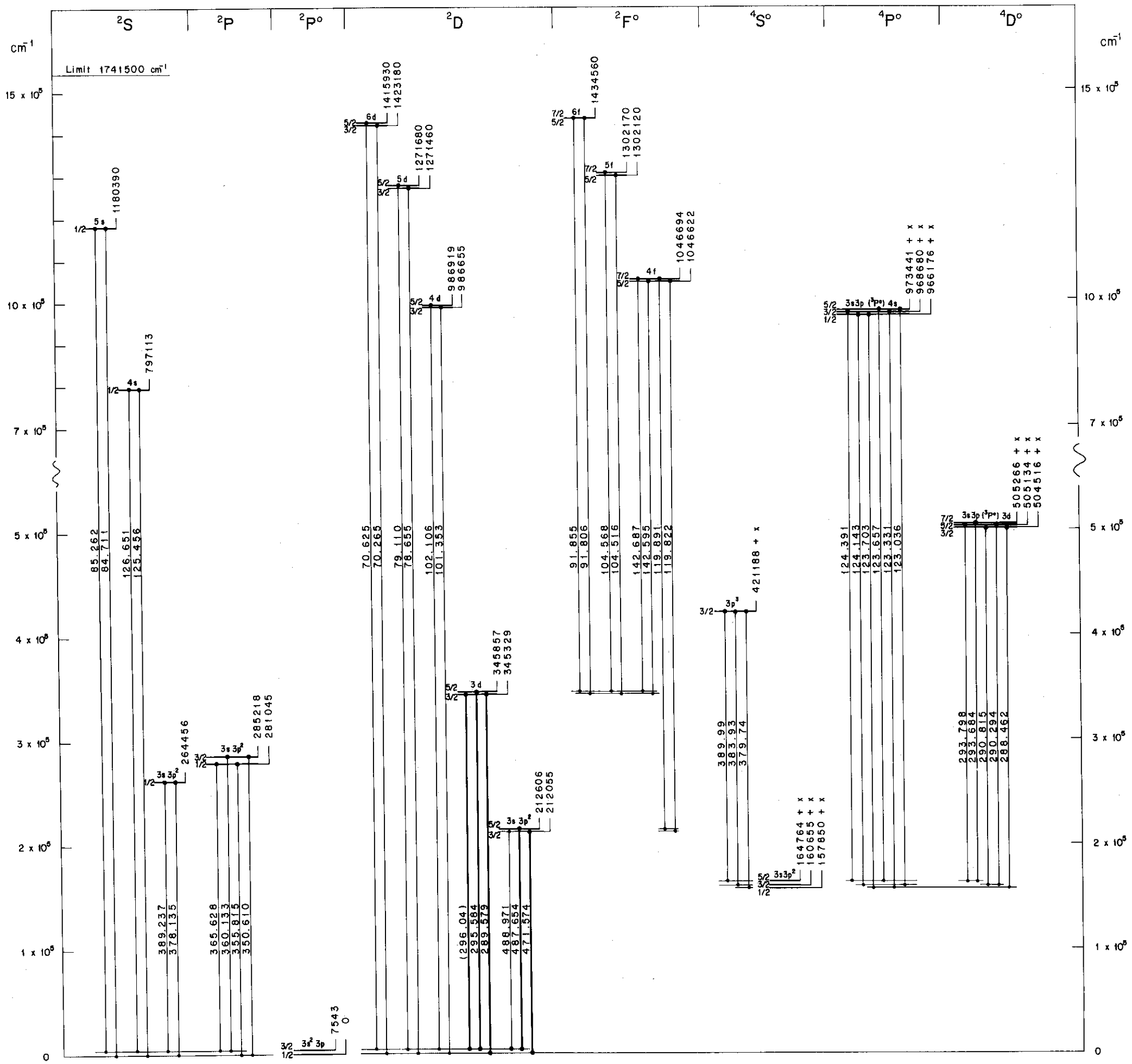
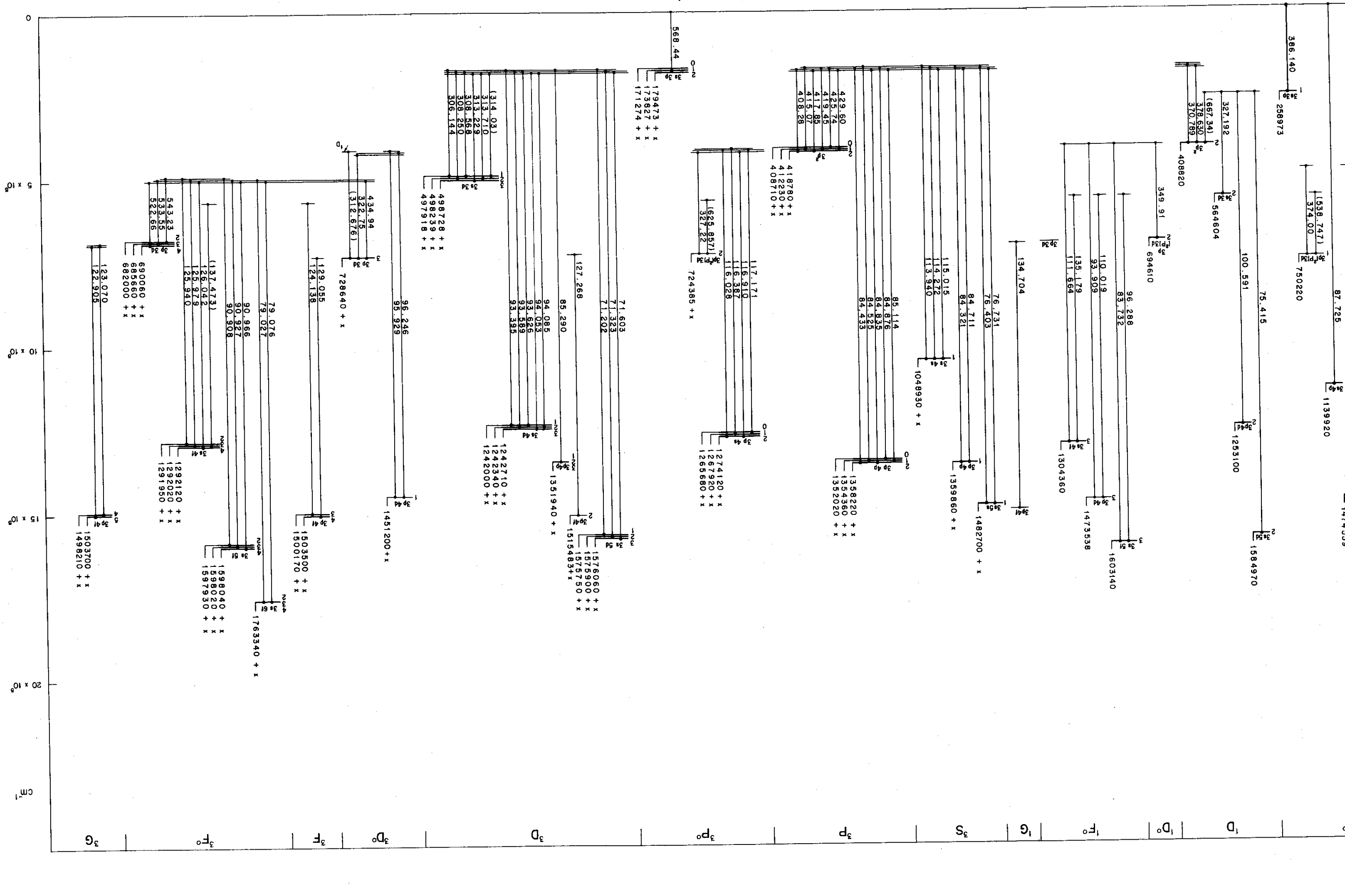


Ti X (Aℓ - Sequence)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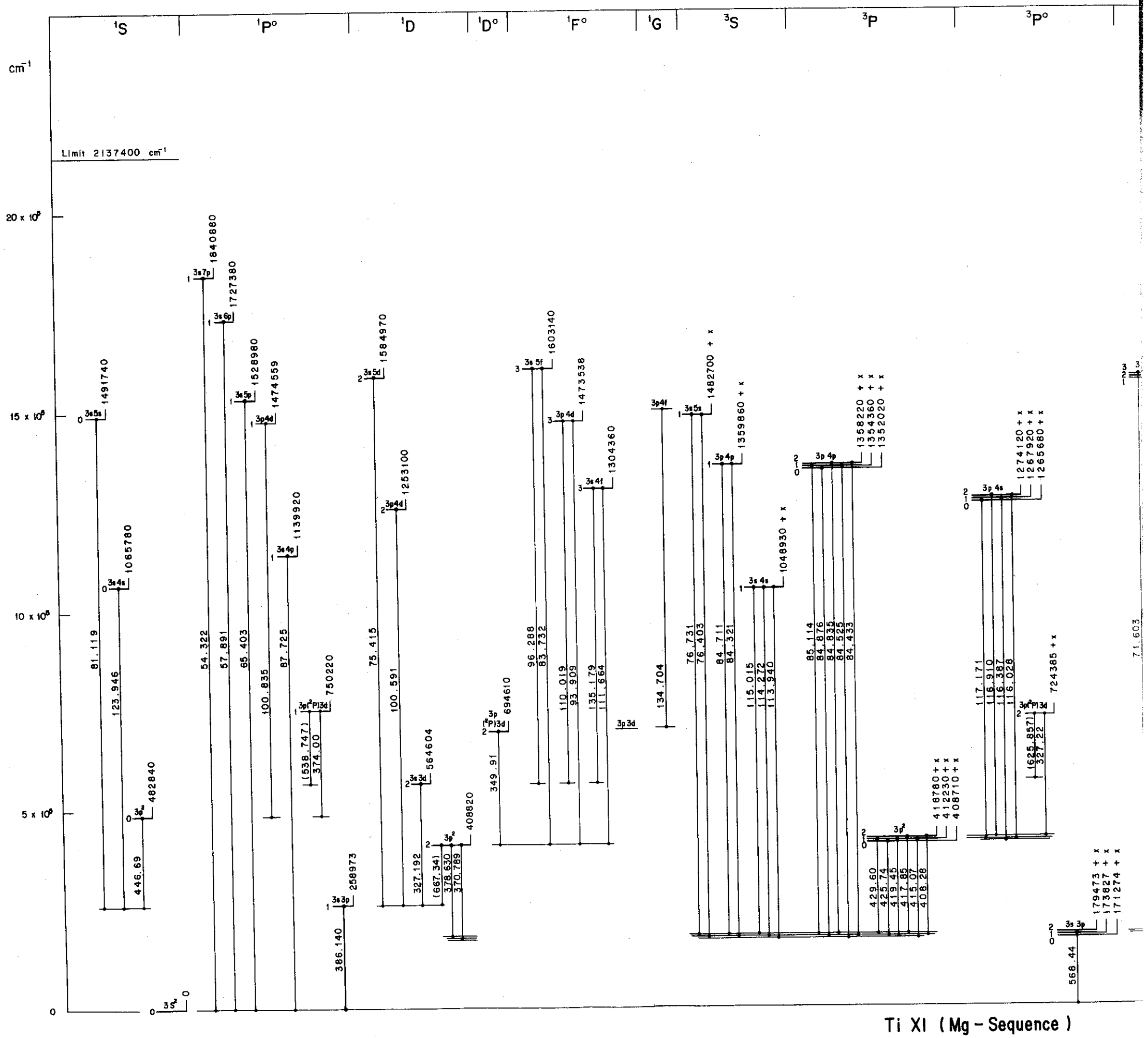
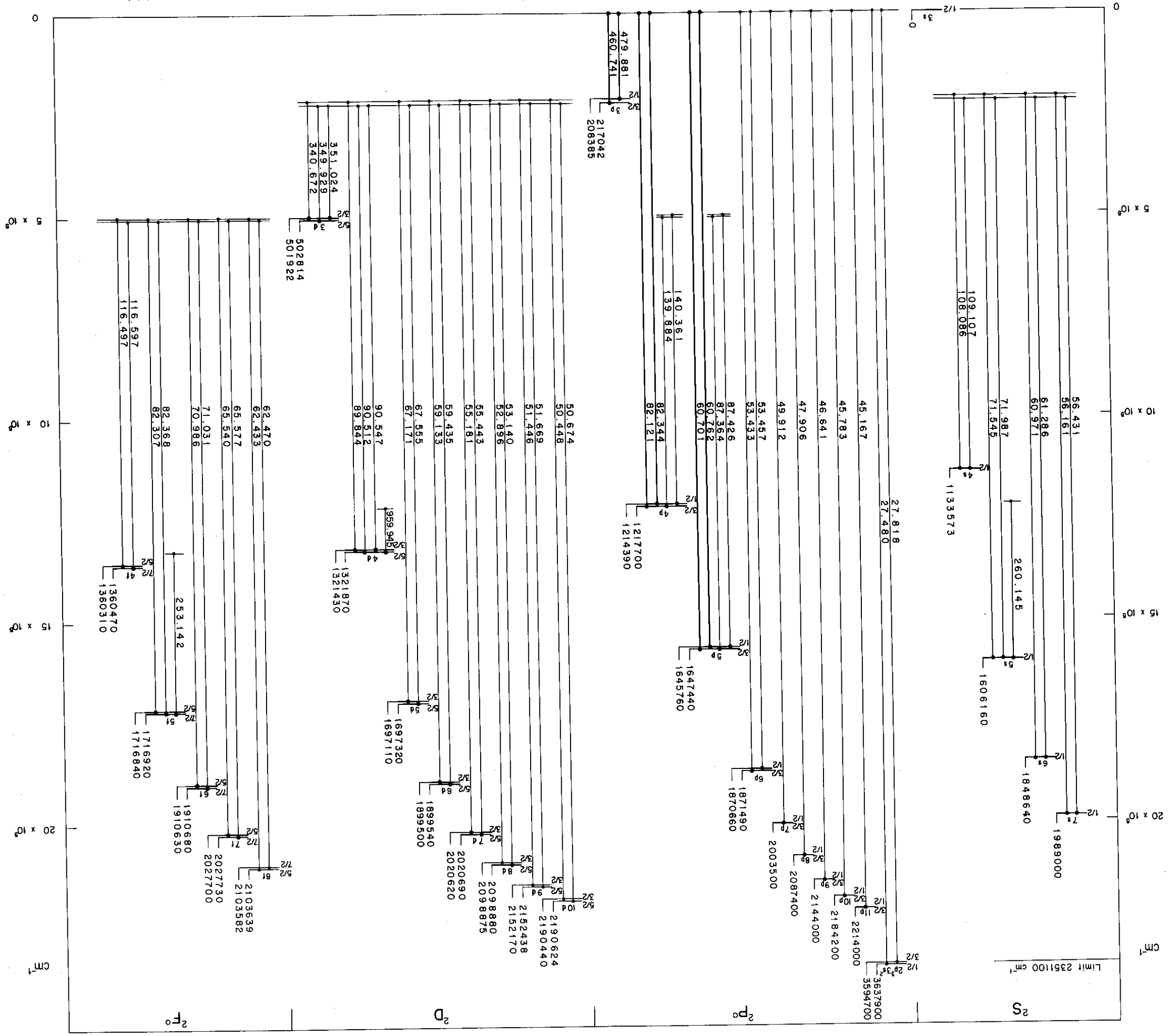
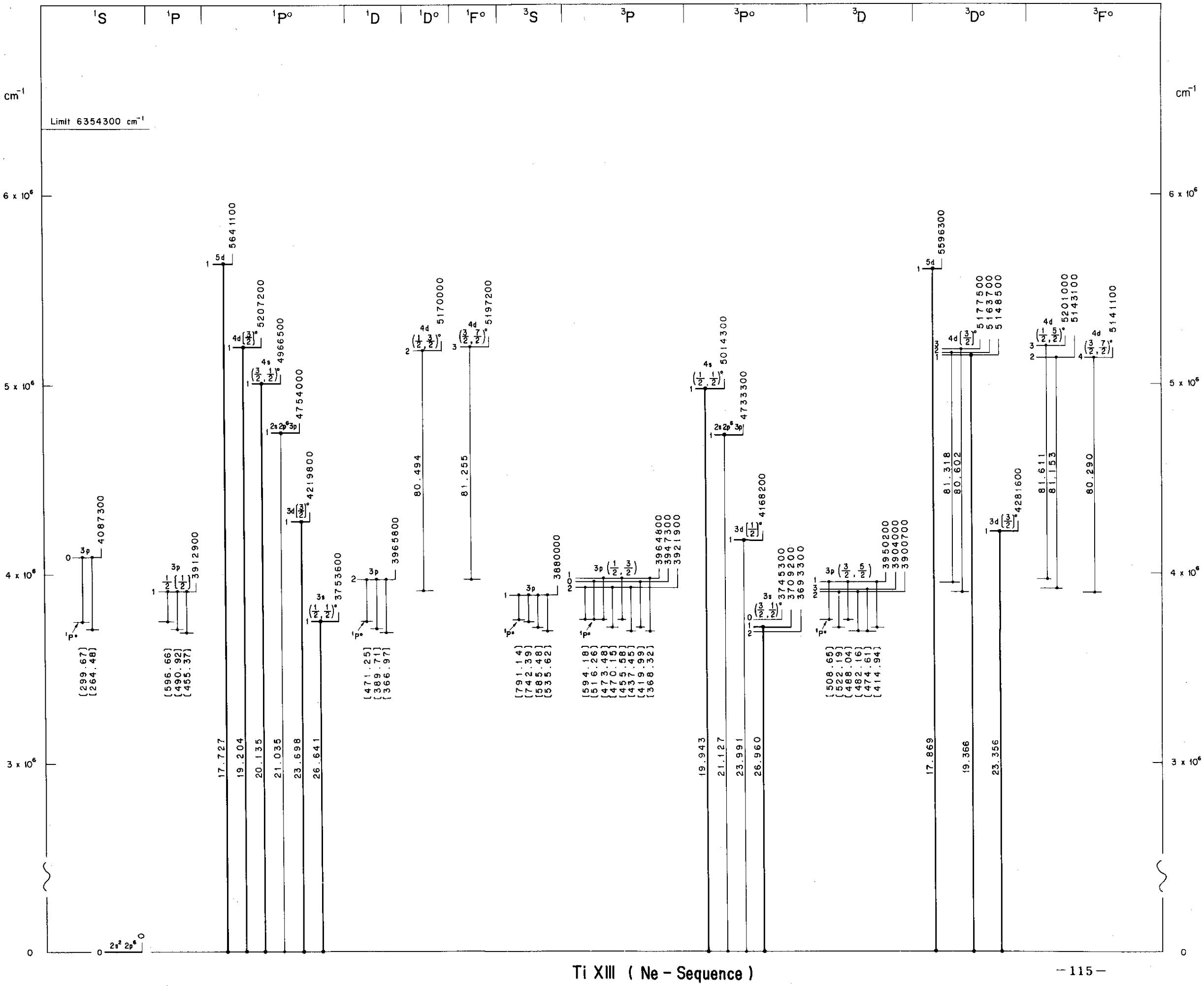


Ti XI (Mg – Sequence)

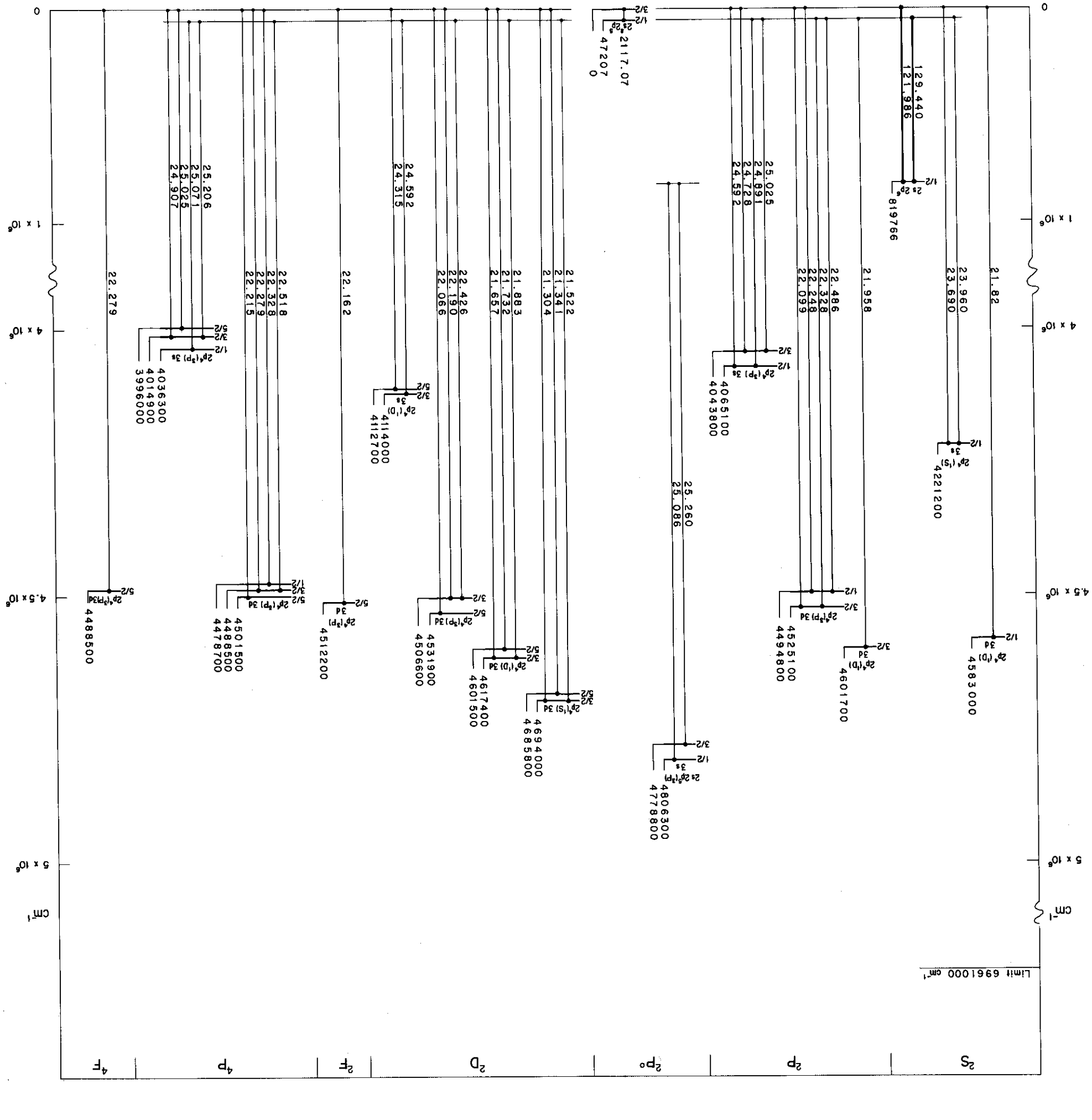
Ti XII (Na - Sequence)

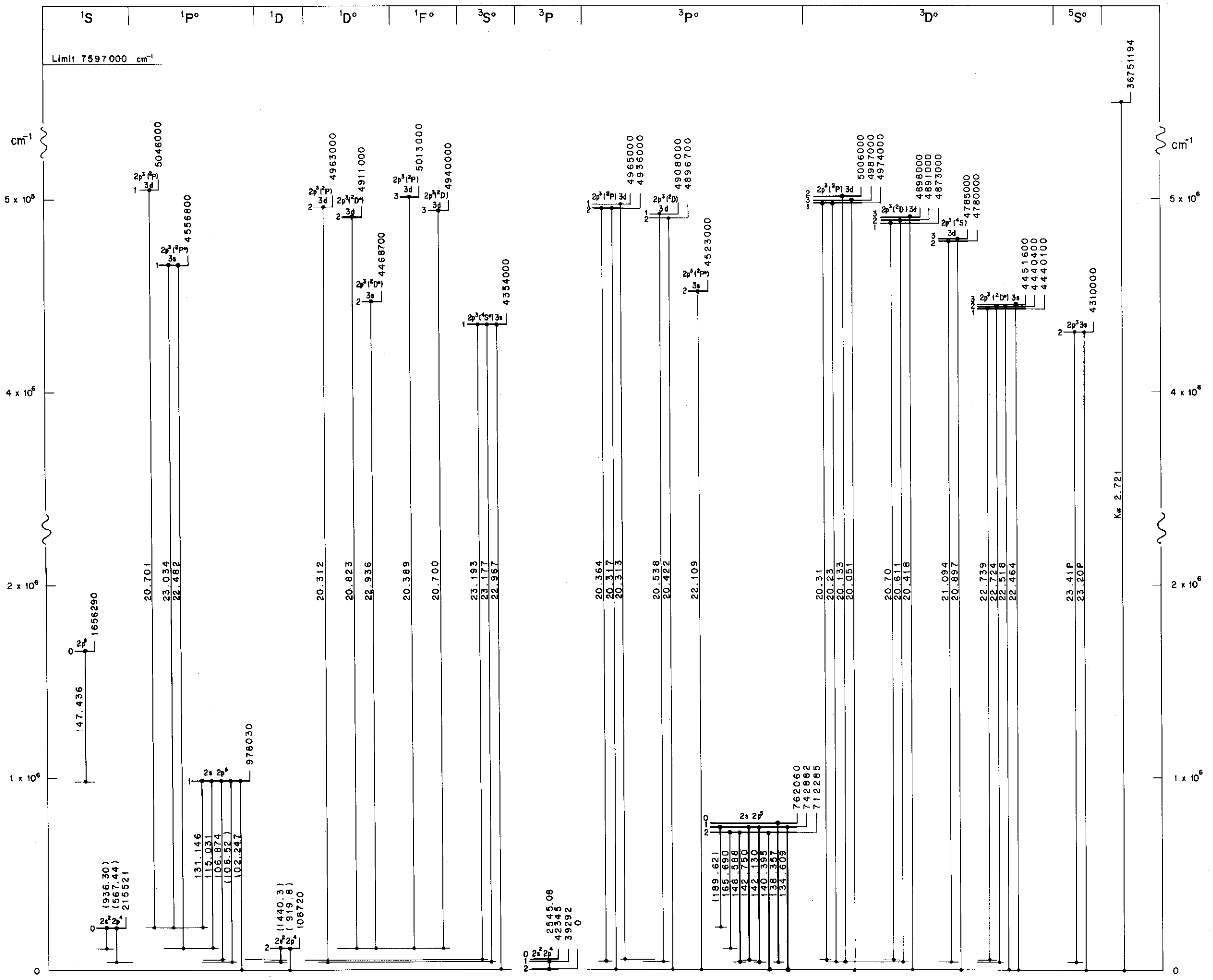




Ti XIII (Ne - Sequence)

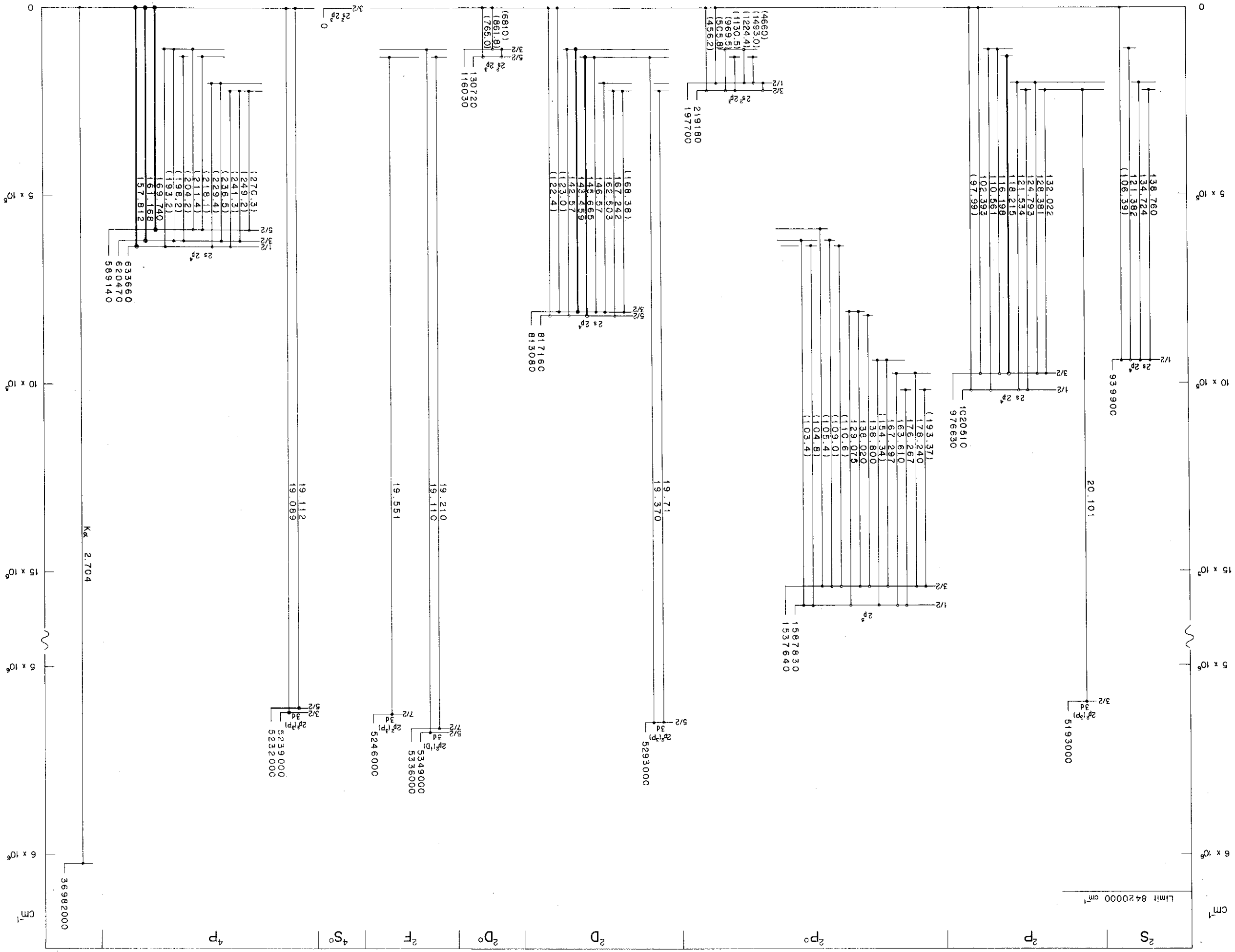
Ti XIV (F – Sequence)



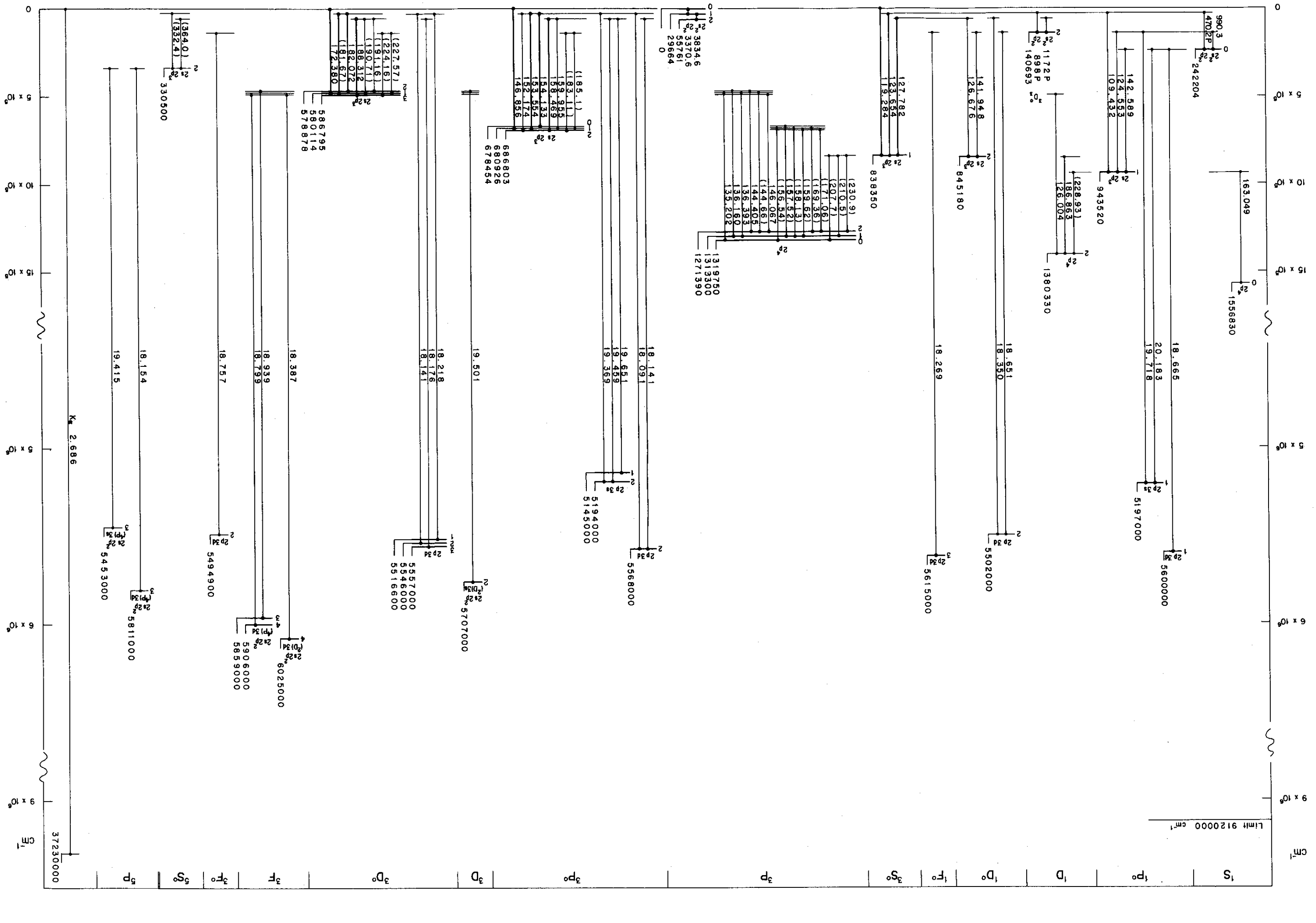


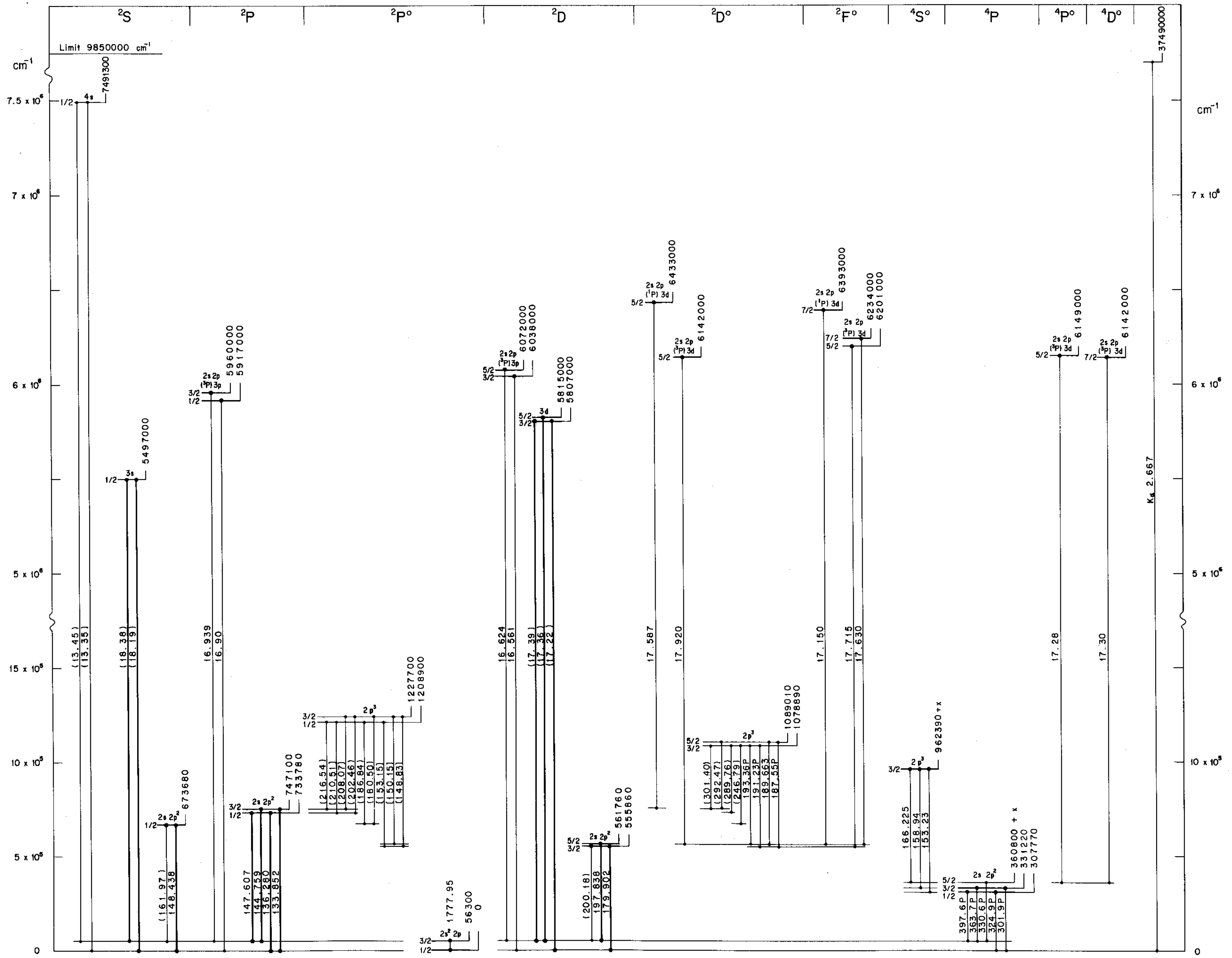
Ti XV (O- Sequence)

Ti XVI (N - Sequence)

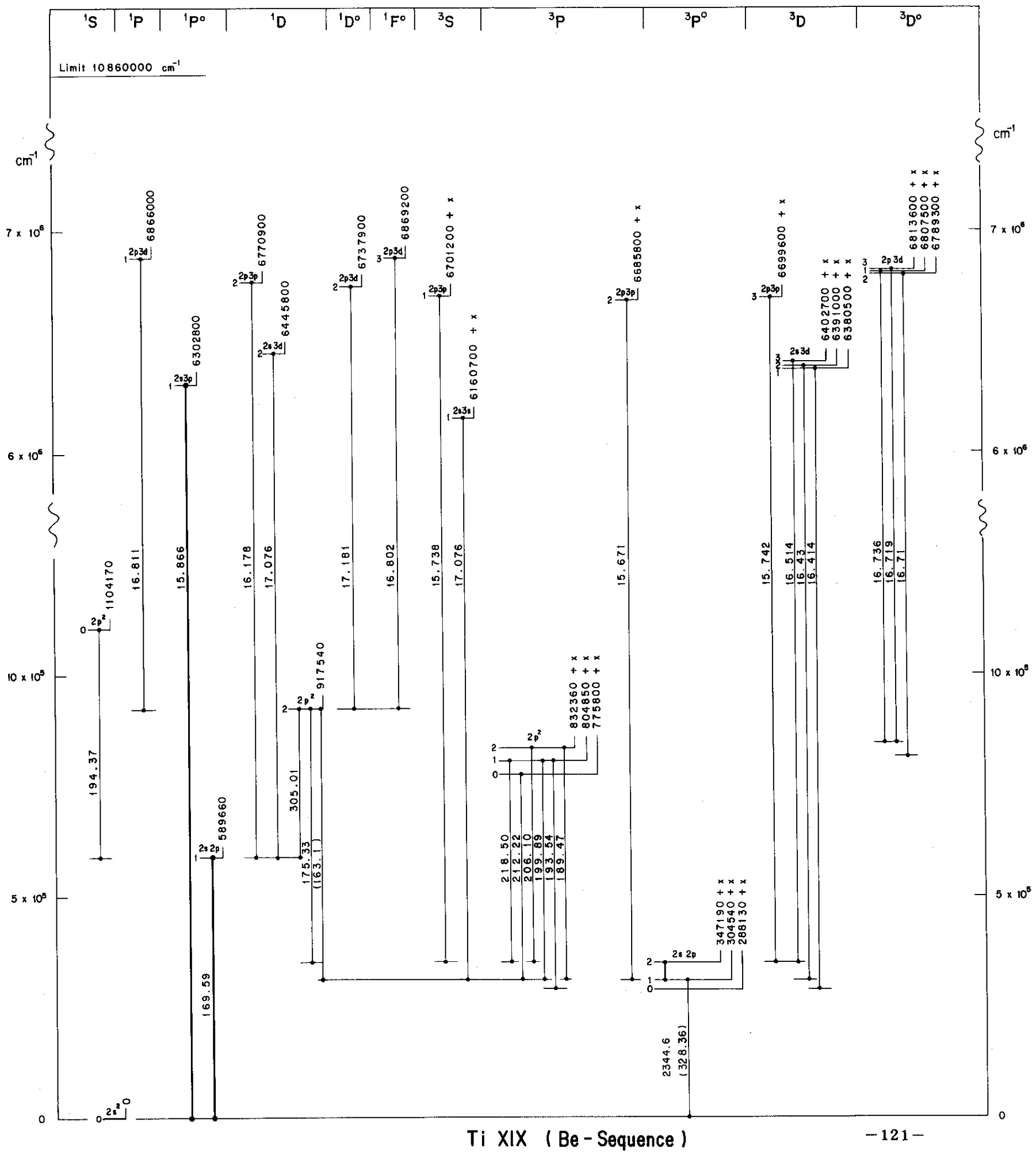


Ti XVII (C - Sequence)

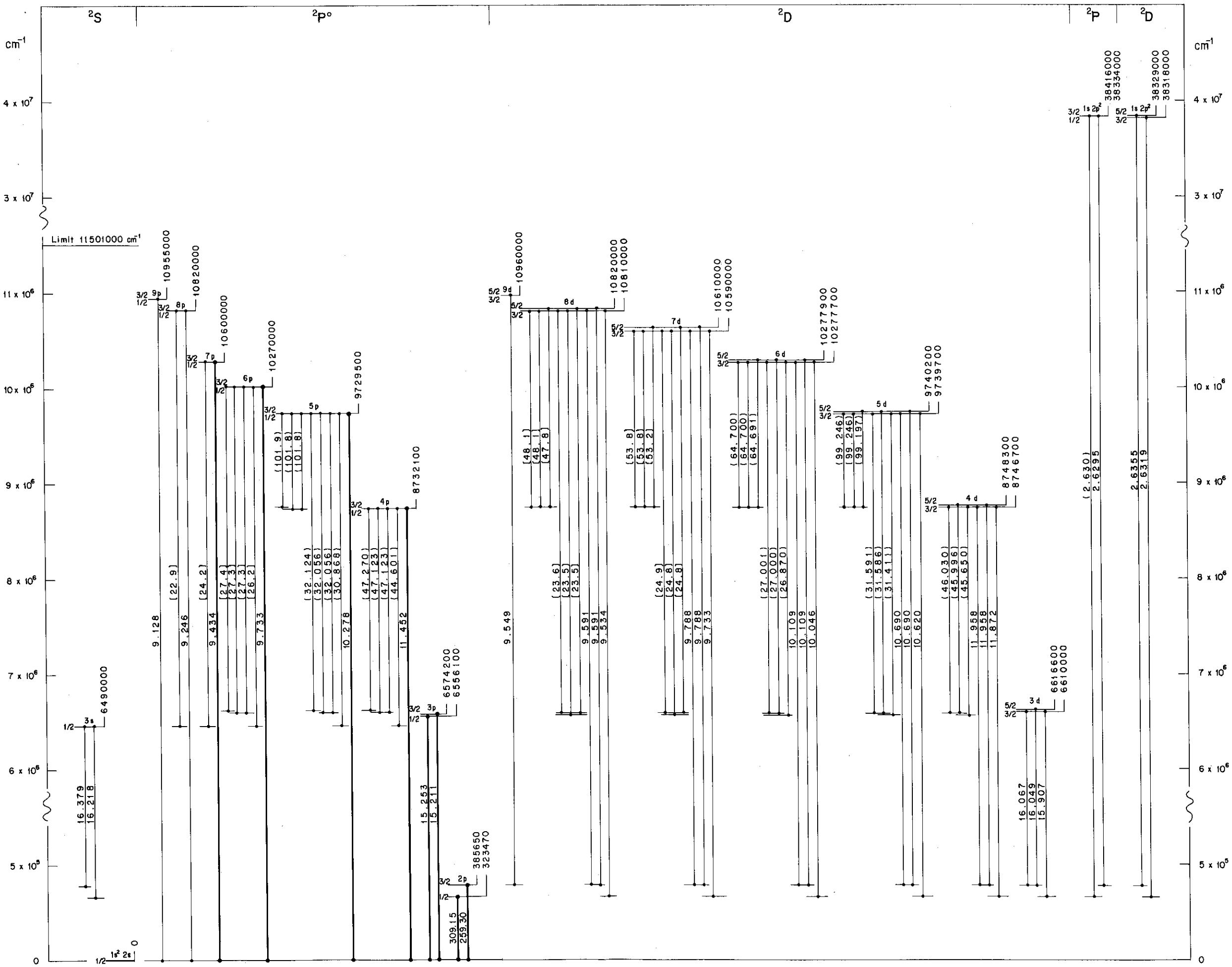




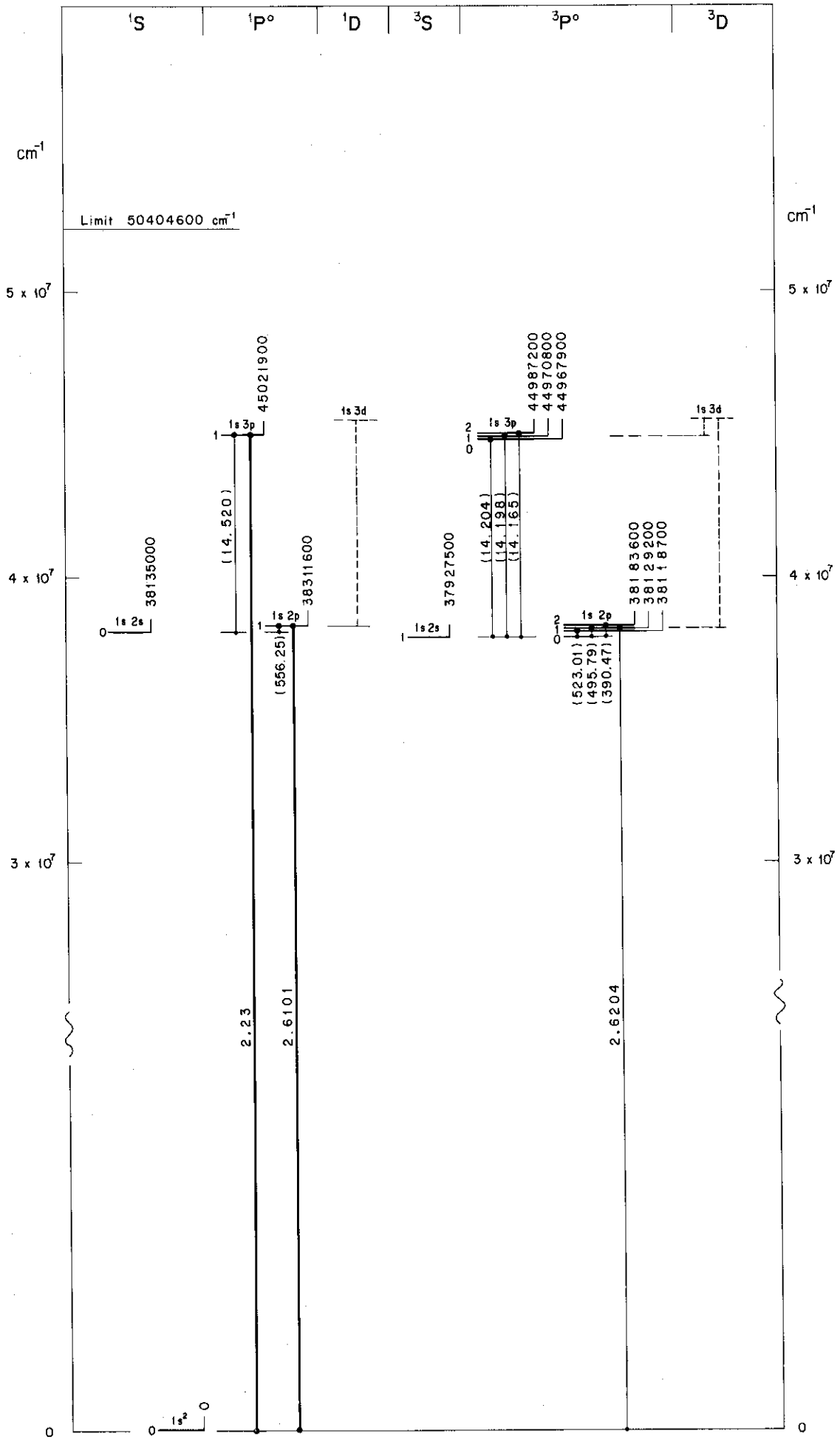
Ti XVIII (B - Sequence)



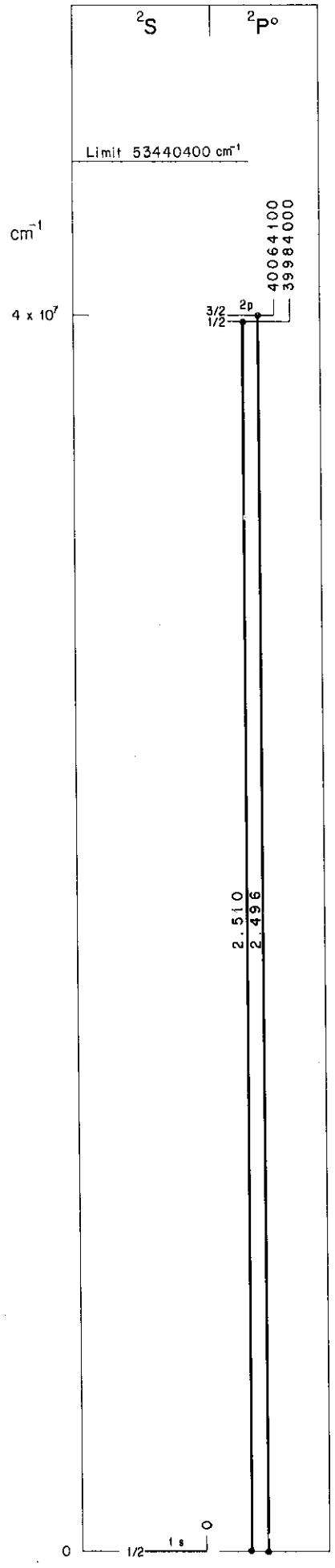
Ti XIX (Be - Sequence)



Ti XX (Li - Sequence)



Ti XXI (He-Sequence)



Ti XXII (H-Sequence)