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IDENTIFICATION OF SUN'S EMISSION LINES IN THE SHORTWAVE REGION OF THE SPECTRUM ($\lambda \leqslant 1100$ Å)

by

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IDENTIFICATION OF SUN'S EMISSION LINES IN THE SHORTWAVE REGION OF THE SPECTRUM ($\lambda \leqslant 1100$ Å)

(Otozhdestvleniye liniy izlucheniya Sólntsa v korotkovolnoy oblasti spektra ($\lambda \leqslant 1100$ A)

Geomagnetizm i Aeronomiya, *)
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by G. S. Ivanov-Kholodnyy
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ABSTRACT.

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Conducted is the investigation of 180 out of more or less 225 emission lines of the Sun observed with the aid of rockets in the region from 60 to 1100 Å. The anticipated line intensity was taken into account, and a critical analysis was given of the identifications made earlier.

The spectral distribution of Sun's shortwave energy was constructed. Maxima were detected in the 60 – 100 Å wavelength region (corona), the 200 – 450 Å region (upper part of transition region), and also in the regions of 550 – 650, 750 – 850, 950– 1o50 Å

The total energy of line emission, constituting near the Earth not less than 15 erg/cm^2 sec, is estimated for $\lambda \leqslant 1100$ Å.

It is shown that the relative nitrogen content in the Sun is $[N] / [H] = 3 \cdot 10^{-5}$.

The compilation of lines proposed in the Table at the end of the current paper, constitutes at present the most complete theoretical list of wavelengths and intensities of bright lines in the shortwave spectrum of the Sun. The results of comparison of the theoretical data of the forecast with the experimental data are also brought out.

*) also presented at the Cospar Space Science Symposium, Washington in May 1962.

COVER-TO-COVER TRANSLATION

In reference [1] a list of nearly 500 spectral lines, observable in the shortwave spectrum of the Sun with an intensity fundamentally greater than $3.10^{-4} \div 10^{-3}$ erg/cm^2 sec, has been presented. In the current paper we draw the comparison of that prediction with the available experimental data, and the results of spectrum identification are analyzed.

Beginning with 1958, a number of spectral rocket measurements of solar radiation in the $\lambda \leq 1100$ Å region were conducted and nearly 200 emission lines were registered. The understanding of the solar extreme ultraviolet spectrum constitutes one of the most interesting problems set up before astrophysics as a result of the newest rocket investigations. Though many attempts have been made to identify the observed lines, less than one half of them permitted a successful conclusion, while more than a half of the identifications were contradictory. Evidently, one could arrive at final conclusions only after analysis of line intensities, and this may only be accomplished if we have a certain understanding of physical conditions in the solar corona and in the transition layer [1].

The table presents a list of possible emission lines according to the prognosis of [1], and disposed in the order of wavelenth increase for waves λ with the indication of the intensity I of the emitting ion near the Earth, and the number of the line in the catalogue [1]. In a series of most interesting cases, computed were wavelengths of multiplet components, for which only boundary values of wavelengths were brought out in [1].

The proposed line list, found in the Table below, is at present the most complete theoretical list of wavelengths and brightest lines' intensities in the Sun's shortwave spectrum.

The results of comparison of theoretical data of the forecast with experimental data are also brought out in the Table. The sign "+" in the identification column of the Table indicates the reliable identifications of the observed lines, the sign "—" — the absence of identification, and the sign "+?" — the doubtful cases, for which the wavelengths are available, but the theoretical estimates of intensity are more than by one order less.

To compare with the experiments in the spectrum region $\lambda < 500$ Å, one may presently utilize only quite a limited amount of data presented by Hinteregger [2, 3], and Violett & Rense [4], which are compiled in columns 6 — 9 of the Table. The estimate of experimental values of lines' intensity was carried out according to the curves plotted in [2, 3]. At the same time, the lines' wavelengths, taken without the corresponding correction, are estimated only approximately. Presented are in [4] only estimates by sight of lines' intensity i.

For the facility in comparing the observed and forecast lines, we shall divide the whole spectral region into separate portions.

Spectral Region 20— 60 and 60 — 80 Å. In the 20 — 60 Å region of the spectrum, where the line list forcast by us begins, spectral observations are absent. In the 60 — 80 Å spectral region only Hinteregger observations are available [2], which are base on a rather rough analysis of photoelectrons [5].

For maxima 66, 69, 74 and 83 Å, noted on the registrogram [2, 5], coincide with the corresponding most intense theoretical lines. It is important to remark, that the theoretical intensities of the lines $I_{(1)}$ differ from the observed values $I_{(2)}$ only by 1.5 — 3 times, i. e. they are mutually in good agreement.

Spectral region 80 — 250 Å. Experimental data for that region are available in [2, 5] and [4], and they diverge in a series of cases. However, to all the observed bright lines, whose

wavelengths coincide in [2, 5] within the 1 — 2 Å limits, correspond in the Table reliable identifications.

Exceptions are constituted by λ 169 Å, which possibly is by the second order brightest line 84 Å, and the line 243 Å, identified in [2] and [4] with the line HeII, for which too low an estimate was obtained in [1], just as this was done for the basic line HeII 304 Å. An analogus picture is observed in respect to the two other lines HeII 237.1 and 234.3 Å, which however were observed only by Violett and Rense [4] and were not observed in [2, 5].

Aside from the line 180 Å, and the unreliable identified line 166 Å, all other lines are well identified with the bright lines forecast in [1].

Certain lines, only observed by Violett and Rense [4], also coincide with the relatively bright lines of our list (103.7; 115.8; 171.1; 229.1 Å). However, the bulk of these lines and that region of spectrum are impossible to identify (109.8; 113.6; 171.9; 172.7; 234.6; 237.1 Å) , although in certain cases they are ascribed intensities i, equal even to 10 and 20 (the minimum estimate in [4] is equal to 5). One may assume, that when studying spectrograms, these lines were apparently confused with scratches, suggestion which the authors [4] make themselves.

Let us note a series of lines with wavelengths : 89.3 (FeXI), 143 (CaXII), 144(CaXV), 162(CaXIII), 185(CaXV), 187.7 (AXI), 193 and 197 (CaXIV), 246.0 (Si VI) Å. According to estimate [1], these lines must be comparatively bright, but they were neither observed in [2] nor in [4]. However, the absence of the greater part of these lines belonging to Ca and A ions that are in very high stages of ionization, is naturally explained by the fact, that their ionization temperature is too high, while the line intensity must be significantly lesser than that indicated in [1] as the upper limit. An exception is constituted by the line 89.3 (FeXI), whose wavelength was insifficiently well determined, apparently on account of extrpolation,

and also the weaker line 246 Å.

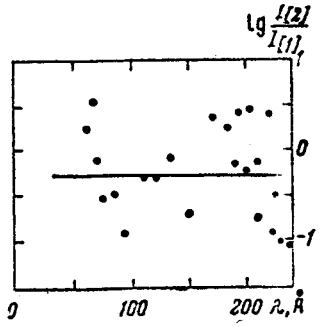

Fig. 1

Presented is in Fig. 1 the variation of the ratio of experimental to theoretical intensities $I_{(2)}/I_{(1)}$ as a function of λ in the 60 – 250 Å wavelength region. Excluding the region of the spectrum λ > 200 Å, one may say that the absolute intensities of most of the lines, computed in [1], differ from the Hinteregger data [2] no more than 2 to 3 times. Taking into account that in calculating $I_{(1)}$ a series of admissions were made, the agreement of the theoretical and experimental data of intensity for λ < 200 Å must be recognized as very good. These values of intensity coincide as an average with other data of rocket measurements of X-ray radiation of the Sun, whose review is available in [3].

A certain systematic displacement of points with wavelength is observed in Fig. 1. However, the points lay within the bounds of computed errors, and that course may be at random with the exception of the region λ > 200 Å, to be considered below.

Thus, in the 60 – 250 Å spectral region all the reliably observed lines (aside from λ 169 Å) are identified with the help of the list [1], and vice-versa, all the forecast bright lines are being observed. At the same time, the theoretical and experimental relative and absolute estimates of lines' intensities basically coincide.

Spectral Region 250 – 500 Å. Comparison may be drawn in that region with the new, more detailed spectrum registrations obtained by Hinteregger [3] with the aid of a diffraction spectrograph of higher resolution, than than applied earlier [2, 5]

It results that all is being registered; even the smallest "bursts" in the examined spectral region of [3] are well identified with the comparatively bright lines in [1]. The exception consists in six unreliably identified weak maxima: 379,420, 441, 456, 463, 494 Å (from the total number of 55 lines in that region of the spectrum). However, it must be noted, that although we ascribed the values of certain real lines to numerous fine "bursts" in Hinteregger's registrogram [3], they may in a series of cases have been linked with non-regular background variations or with some other effects of the apparatus.

A great number of bright lines, forecast in that region of the spectrum, was also obtained by Violett and Rense [4]. However, some of the bright lines failed to register: 249, 278, 313, 316, 321, 349 and 404 Å. Particularly strange was the absence of quite bright lines 285, 359 and 368 Å. Together with that there are in [4] lines 261.2; 280.0; 372.2; 477.4 Å, which are not revealed in the Hinteregger registrogram [3], although to lines 280.0 and 372.2, and possibly 261.2 correspond relatively bright lines in the list of [1], as this may be seen from the Table below. We again reach the conclusion that the data of [4] are not always reliable, although in the region 250 – 500 Å only certain lines in the list [4] are false, for all the lines except 477.4 Å are identified. Finally, let us note still, that the rather bright line 330 Å (FeXIII), forecast by us, was observed neither in [3], nor in [4]. This is possibly linked with poor interpolation of the wavelength*), or with an incorrect estimate of the magnitude of the ascillator's strength. From the total number of 59 lines, 49 are identified with sufficiently bright forecast lines, and only 3 are unidentified.

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*) An extrapolation conducted by another method gave in this unreliable case $\lambda \approx 350$ Å, which is near the bright line 352 Å.

In short, one may state, that as a whole, the agreement of the observed and predicted lines for the 250 – 500 Å region of the spectrum is quite good, with the only exception of separate cases.

Spectral Region 500 – 1100 Å. The examination of the data of the Table that follows shows, that the discrepancy of experimental data by Hinteregger [3] and Rense & Violett [4] is greater, and the identification in that region of the spectrum is poorer than in the spectral region 250 – 500 Å. Thus, out of 84 lines observed in [4], only 53 corresponding lines could be found for 63 in the registogram. At the same time, 13 fairly bright lines failed to register in [3]: 525.8; 580.6; 614.9; 644.9; 707.9; 855.4; 940.9; 964.5; 970.1; 1022.0; 1030.3; 1051.4; 1058.7 Å, although 44 lines could be noticed in the Hinteregger registogram [3], and among them many very bright ones (521, 529, 540, 569, 622, 729, 771, 786, 877, 880, 949, 999, 1006, 1080 Å and others) that were not observed by Violett and Rense. Purcell & al [6] and Friedman [7] pointed to separate examples of non-correpondence between the spectrum in [4] and spectra for $\lambda > 500$ Å, obtained by means of a spectrograph with a normal incidence and higher resolution. Spectrograms with good density and high resolution were recently obtained by Detwiler. Purcell and Tousey [8]. However, these spectrograms have not been processed yet. In a series of cases they may prove useful in mediating controversial questions between the Violett & Rense [4] and the Hinteregger data [3]. In particular, nearly all the indicated bright lines registered in [3], but not noticed in [4], may be found in the reproductions of spectrograms from [8], with the exceptions of the lines 540 and 569 Å. At the same time, among the above-mentioned 13 bright lines of [4], not observed in [3], only weak lines 1022.0 and 1030.3 may be observed in the spectrogram of Detwiler & al [8], which are situated in the wings of the bright lines L_β and 1037 Å, which makes their photoelectric registration difficult. Besides, the indicated lines are either

not identified at all, or have, with the exception of 525.8 Å, a questionable identification.

Let us pass now to the examination of the results of identifications in the λλ 500 – 1100 Å region. First of all we shall consider the lines observed in common by Violett & Rense [4] and Hinteregger [3]. Most of them (43) are identified, and at the same time four lines (606, 617, 695, 737) are of order II, while three (503, 852 – 855 and 912 A) are lines of the III order of the spectrum. Still two strong (914 and 1018 Å) and seven other lines (578, 652, 752, 811, 818, 829 and 961 Å) remain, for which no proper identification has been found as yet.

All bright lines of the Hinteregger registrogram have an identification, provided they are not lines in the second (569, 670 720 Å) or third (745, 999, 1006, 1080 Å) order of the spectrum. 12 weak lines, of which five constitute a compact group 868- -887 Å, could not be identified. Generally, in the narrow region of the spectrum 846 – 925 Å, where the Layman continuum and the strong absorption band of the molecular nitrogen reach [8], out of 15 lines registered in [3], only two – three are reliably identified, the remaining lines appearing to be apparently false.

Out of 21 lines, observed only by Violett and Rense, only 10 are reliably identified. However, for a series of lines this identification may even be accidental, for the coincidence by wavelengths took place with lines, whose theoretical intensity is much lower than that, which may be observed, except for the three cases 525.8, 572.9 and 834 Å.

In the aggregate, out of 128 lines of the 500 – 1100 Å region of the spectrum, 91 are identified. Among them 12–14 are lines in the II and III orders of the spectrum. However, 33 identifications are linked with lines of [1] that are too weak – of the order of 0.001 – 0.005 erg/cm^2 sec (annotated by the sign +?). At the same

90 lines were identified in the region of the spectrum $\lambda \leq 500$ Å, out of which only 12 were doubtful.

Let us make several remarks concerning the identification carried out by us, and let us compare it with the results of other authors.

There are in the Violett and Rense work [4], 55 identifications, among which, according to our calculations of intensities [1], only 29 of the region $\lambda < 1100$ Å may be considered as satisfactory, with four of them doubtful (and marked by the sign ?):

150,1 (OVI); 172,9 (OVI); 184,1 (OVI); 279,6 (OIV); 303,8 (HeII); 374,1 (OIII)?; 419,5 (CIV); 525,8 (OIII)?; 537,0 (HeI); 539,1 (OII); 554,1 (OIV); 584,3 (HeI); 608,4 (OIV); 609,8 (OIV); 625,1 (OIV, Mg X)?; 629,7 (OV); 703,3 (OIII); 790,2 (OIV); 833,7 (OII, OIII); 835,2 (OIII)?; 903,6 (CII); 972,5 (HI); 977,0 (CIII); 989,8 (N III); 1025,7 (HI); 1031,9 (OVI); 1037,6 (OVI); 1040,9 (OI); 1085,1 (N II).

Earlier, we identified in [9] the lines SVI (945 and 934 Å); SiXII (499 Å) and Ne VII (464 Å).

Hineregger brings out in his registrogram [3] the identification of 63 lines in the 250 – 1100 Å region of the spectrum, out of which only 27 must be recognized as correct by way of comparison with the theoretically expected intensities [1]. Aside from the Layman series β, γ, δ and ε, and 17 lines, Hinteregger points among the number of identified lines by authors [4] and [9], to the following confirmed identifications: 312.4 (C IV); 521.1. (Si XII); 761 (OV); 765.1 (N IV); 780.3 (Ne VIII) (for the line 944.5 A S IV was erroneously indicated instead of S VI).

On the Detwiler & al.'s spectrogram [8], a series of identifications in the 500 –1100 Å spectrum region, correctly made in [3, 4, 9], are indicated and besides, the following are added: 770 (Ne VIII); 786.5 (S V) ?; 787.7 (O IV); L_ξ, L_η, 1012.6, (S III); 1062.7 (S IV)?; 1073.3 (S IV).

Identification of nearly 100 lines in the 500 – 2000 Å region

was conducted by Purcell & al [6]: for $\lambda \leq 1100$ Å, 35 separate lines and close multiplets are indicated. The following correct identifications exist among them, which differ from the above : 1036.3 (C II); 832–834 (O II). At the same time, there are 13 lines with unconfirmed identification.

It must be noted, that only the criterion of wavelength coincidence was used in the identification. As we became convinced, it does not provide correct identifications. The final approval and the selection of correct identifications must be carried out on the basis of comparison of the observed and expected values of lines' intensity. Only with the help of the latter criterion may one expect to obtain reliable identifications.

As we completed the manuscipt, we received all the materials of the Liége Astrophysical Symposium of 1960, in which there are several papers devoted to the identification of shortwave lines. In the work bt Allen [10], presented are not only the identifications but also the results of computations for 96 lines and multiplets, among which 67 belong in the spectral region 44 – 1100 Å. At the same time comparison is made in [10] with the estimates of intensity, conducted visually by the spectrograms. The theoretical computations of intensities are based upon the utilization of a specific model of the chromosphere constructed by Oster . The departures between the computed and observed intensities (sometimes reaching one order of magnitude and more) are ascribed to the unreliability of visual estimates, the inaccuracy of the knowledge of constants, and the imperfection of theory.

Among the 27 identifications in the region of the spectrum $\lambda < 1100$ Å carried out by Allen [10], we confirmed 20, among which only three were made earlier by Violett & Rense [4], by Ninteregger [3] or Detwiler & al [8]; they are : 570 (N V); 687 (C II); and the duplet 1068 Å (S IV).

The nitrogen line and 687 Å (C II) were dropped in our list, as being too weak, Excluding these two lines and the lines 374 (N III), 570 (Ne V) and 940 Å (S VI), the intensity estimates in [10] coincide within the limits of one order with our own estimates [1] for 35 general lines.

Computations of four coronal lines were given in the work by Pecker and Rohrlich [11]: 1058.7 (Al XIII); 1048.9 (Si VII); 952.4 (Si IX) and 658.7 (A XIII). Of these identifications three correspond to lines observed by Violett and Rense [4] and Hinteregger [3], and not observed by us. They are included in the Table with appropriate references.

Drawing a balance sheet, one may state, that on the basis of line prediction made bu us in [1], identification of about 180 of the observed lines (most of them strong lines) in the region of the spectrum 60 – 1100 Å, could be completed. However, the identification of some 45 lines of weak intensity is subject to some doubt. Besides, apparently about 20 weak lines which are not lines of the II or III order of the spectrum, or false lines, remained undentified. (Such lines are in the spectrogram of Violett and Rense ~20, may be the false "peaks" in the Hinteregger registrogram too). It is possible that part of these lines may be ascribed to intercombinational transitions, practically not considered in [1], and part of the lines could have been missed on account of an incorrect or of insufficiently correct estimate of the intensity of lines (absence of knowledge of terms in ions, imprecise values f, imperfection of the ionization and excitation theory).

Therefore, basically all the lines were identified. Besides, a large list of weaker lines is given. Their observation must be the affair of a not remote future.

Fig. 2 shows a great of ratio $I_{(3)}/I_{(1)}$ variation as a function of the wavelength for reliably identified lines in the λ 250 – 1100 Å region of the spectrum. Although there are separate points which are deflected from the mean curve (in Fig. 2 a straight line is drawn for simplicity) almost by one order of magnitude, in the whole the points' scattering remains with the bounds of ± 0.5 order.

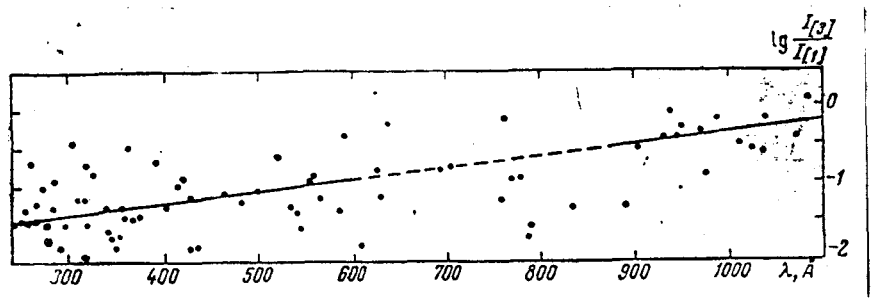

Fig. 2

Let us note that in the region of the line L_α, as earlier in the region $\lambda \approx 100 - 200$ Å (Fig. 1), the intensities predicted in [1], agree well with the experimental data [3]. At the same time, a systematic decrease of the ratio $I_{(3)}/I_{(1)}$ with λ is observed.

The peculiarity of the calibration method, which was proposed by us in [1], consists in that the line intensities of the whole shortwave region of the spectrum were estimated along the limited portion of the spectrum in the region of the L_α line. At the same time, the comparison with the experimental data on the intensity of Sun's X-ray radiation (see Fig. 1) confirms the agreement of the available energetic estimates of the intensity in two quite different regions of the spectrum: X-ray and ultraviolet in the region of $L\alpha$ and provides evidence of sufficient accuracy of the estimates of I in [1]. During the construction of the transition layer model, it was shown in [12] that these energetic estimates of the intensity of Sun's radiation also agree well with the estimates of the intensity of Sun's radio emission in centimeter and decimeter bands.

Therefore, the possibility of conducting by way of theory a correct comparison of the intensity of Sun's radiation in quite different spectral regions is practically demonstrated, just as is the reliable estimate of Sun's radiation flux in the entire short-wave region of the spectrum, which is important for the understanding of ionization processes in the Sun (chromosphere, protuberances) as well as in the ionosphere and in the interplanetary medium.

The variation with the wavelength of the ratio $I_{(3)}/I_{(1)}$ noted in Fig. 2, points to the dependence on λ of intensity calibration either in [1], or in [3]. Inasmuch as the systematic variation of lines' intensity with the wavelength for theoretical estimates (which do not depend on λ but on ionization potentials) are difficult to expect, it is apparently linked with the variation of spectral sensitivity of the apparatus, not accounted for in [3]. According to Fig. 2, the sensitivity of the apparatus in the 250 – 500 Å is by 1 – 1.5 orders less than was admitted in [3]. The same value is obtained if one compares Fig. 2 with Fig. 1 for contiguous wavelength regions $\sim$ 200 and $\sim$ 300 Å. It is possible that the above referred-to sensitivity decrease in the 250 – 500 Å region, where the maximum of water vapors' absorption is situated, is provoked by radiation absorption in the atmosphere layer situated under the rocket at time of spectrum registration, or is related to the effect of construction elements' degassing near luminous beams. A similar decrease in line intensity in the region $\sim$ 300 Å by comparison with theoretical intensities is observed in the Hinteregger data [3], for it is quite possible that they require the accounting of a substantial correction for Sun's radiation absorption in the apparatus.

Let us now examine the visual estimates of lines' intensity brought out by Violett and Rense [4].

Fig. 3 presents a diagram of ratio $i_{(4)}/I_{(1)}$ variation as a function of λ in the 83 – 1100 Å region for reliably indentified lines. The scattering of the points around the median curve is also basically within the limits of one order, as in Fig. 2. The graph of Fig. 3 gives in essence the calibration curve for the transformation of visual estimates of i, brought out in [4] into energetic ones. Plotted also in the graph is the calibration curve, earlier constructed by us [9], only by two points for the lines L_α and He II 304 Å. The nearly total coincidence of this curve with the mean curve for the 300 – 1100 Å spectrum region is evidence of the closeness of calibrations in [9] and in [1]. In the region 100 – 200 Å both curves diverge sharply, while the values of the ratio $i_{(4)}/I_{(1)}$ rise in the examined region, which points to the increase in sensitivity, nearing its value for $\lambda \approx 1000$ Å*. A significant diminution of visual estimates of i by comparison with the theoretical [1] is observed in the 200 – 500 Å region of the spectrum, just as this happens for the photoelectric data on intensities [3]. This corroborates the earlier expressed opinion that the results of investigations of Sun's spectrum by means of rockets, conducted even at greater heights than 200 km, are burdened by absorption effects in the atmosphere or in the apparatus.

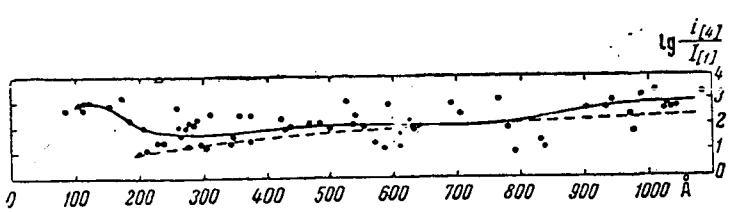

Fig. 3

Let us bring forth certain consequences of the conducted identification. We shall estimate the flux of ultraviolet radiation in the region of the spectrum $\lambda \leqslant 1100$ Å. Presented is in

Fig. 4 the mean curve of the spectral distribution of the energy of Sun's line emission in the region 30 — 1100 Å. The points of the step-like curve of Fig. 4 are obtained by way of averaging by wavelength intervals $\Delta\lambda = 50$ Å the emission energy of identified lines only, and the circles — by averaging all the theoretical lines compiled in the Table. Insamuch as for $\lambda > 400$ Å both curves coincide, all strong lines of that region of the spectrum are basically identified.

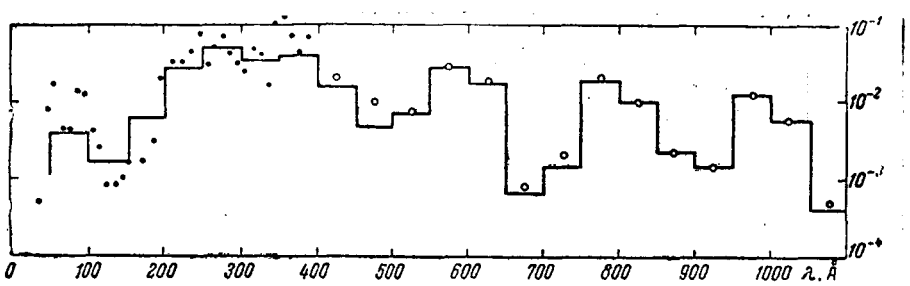

Fig. 4.

The energy distribution in the Sun's shortwave region of the spectrum reveals a maximum in the region 200 — 450 Å with energy density ~ 0.05 erg/cm^2 sec • Å, which is conditioned mostly by the upper part of the transition layer. In the spectrum region $\lambda = 200 \div 450$ Å the basic fraction of energy of Sun's shortwave radiation is concentrated, being equal to ~ 8 erg/cm^2 sec at the Earth.

Besides the principal maximum in the 200—450 Å region, several maxima may still be observed in the wavelength regions 60—100, 550—650, 750—850 and 950—1050 Å. It is interesting to note that accumulations of strong lines are indeed visible in Hiteregger registograms [2, 3] for the indicated wavelength regions. To make the spectrum structure in the region $\lambda < 400$ Å more precise, averaging was effected of lines' strength by spectral intervals $\Delta\lambda = 10$ Å (indicated by dots). Particular interest is

aroused by the maximum in the most extreme shortwave region 60 – 100 Å, for it corresponds only to the emission of coronal highly ionized ions. It must be assumed that the variations of coronal emission during the 11-year cycle of solar activity will be reflected most effectively on the strength and the position precisely of that maximum in the shortwave spectrum of the Sun, while emission variations in the transition region are basically linked with the maximum in the 200 – 450 Å spectral region.

The energy emission in the spectral region $\lambda < 1100$ Å, thus of the whole extreme ultraviolet, during the period of solar activity maximum is 14.7 erg/cm^2 sec, provided it is estimated only by identified lines. In fact, the line emission energy may be even somewhat greater. Preliminary estimates of the total energy made in [9], gave a value from 10 to 100 erg/cm^2 sec. It is interesting to note that Allen reaches the same conclusion [10], that the intensity of solar extreme ultraviolet radiation is much higher than that earlier admitted according to ionospheric data ($\sim$1 – 0.1 erg cm^2 sec). According to Allen [10], the aggregate intensities of the computed lines only constitutes a value greater than $\sim$5 erg/cm^2 sec. The estimates brought out in the paper show that the main part of Sun's shortwave (extreme ultraviolet) radiation energy is concentrated the line spectrum, and that it exceeds many times the energy of continuous emission of the transition layer and of the corona [9].

There is available at present a scant material, by means of which the important conclusions as regards the energy of Sun's ionizing radiation could be compared. According to the first estimate by Hinteregger [2], the emission energy in the region $\lambda < 1040$ Å constitutes $\sim$ 8 erg/cm^2 sec. However, later he obtained in [3], on the basis of more refined data, for $\lambda = 1100 \div 260$ Å, a value of $\sim$ 1.3 erg/cm^2 sec. It has been shown above, that the estimates of intensity in the maximum region of the extreme ultraviolet were

considerably underrated by Hinteregger, and fully accounted for in his work [3]. Therefore a further experimental verification of the conclusions arrived at above must be made.

The new estimates of the intensity of solar radiation in the shortwave region of the spectrum (extreme ultraviolet) set up anew the problem of ionization of the chromosphere and of of protuberances in the Sun [17], of the interplanetary medium [18, 2] and of the Earth's ionosphere. In the light of the new data on the solar extreme ultraviolet radiation, the question of ionosphere ionization was treated in [13], to which the reader is invited to refer.

Conclusion was arrived at in reference [9], that the abundance of nitrogen in the Sun is significantly less (about 30 times) than what was admitted heretofore. Recently the question of various elements' content in the Sun was revized anew in the fundamental work by Goldberg, Müller and Aller [14], according to which $[N]/[H] = 10^{-4}$, which is 2.5 times less than the usually accepted value. Upon completion of the work on identification, we are in a position to make this quantity more precise.

The following nitrogen lines are indicated in the Table: 765.1 (N IV); 764.4 (N III); 1084 – 1086 (N II); 990 – 991.6 (N III); 1238.8 (N V); 922 – 923.5 (N IV); 916.0 (N II); 687 (N IV); 1134.1 - 1135.0 (N I). Among these lines, the first three – four multiplets – are reliably identified. It is easy to see, that the thewretical and the observed values of intensity coincide, if we admit $[N]/[H] = 3 \cdot 10^{-5}$, i.e. 3 times smaller than the value given in [14]. Thus, the nitrogen content in the Sun is 10 times lower than the usually accepted value. The above indicated value $[N]/[H] = 3 \cdot 10^{-5}$ was utilized in the work [1], but by authors' own fault was erroneously indicated as being 10^{-5}.

In a preceding work by the present writers [9], the concentration of nitrogen was belittled by three times yet, because an underrated value of the intensity of the line λ 1238.8 Å was utilized, as brought out in reference [15], and an overrated value was taken for the oscillator's strength for the line λ 765 Å.

****** THE END ******

Institute of Applied Geophysics
of the
USSR Academy of Sciences

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I Z M I R A N.

Translated by ANDRE L. BRICHANT
for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Frelighsburg, Que., Canada

Tables and References follow in
A P P E N D I X.

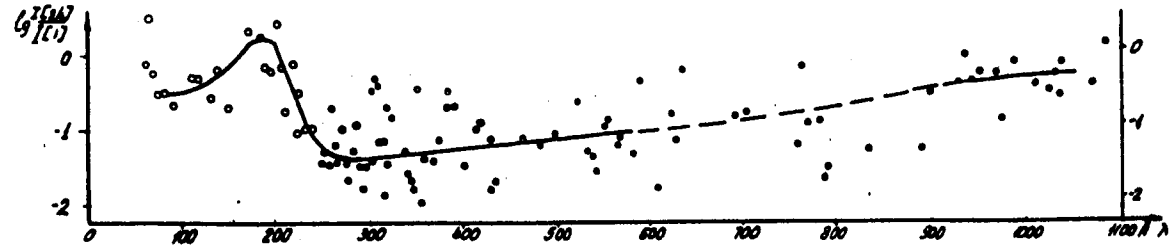

Fig. 2.

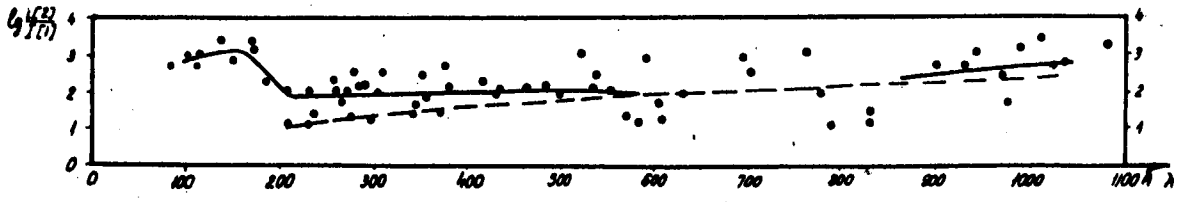

Fig. 3

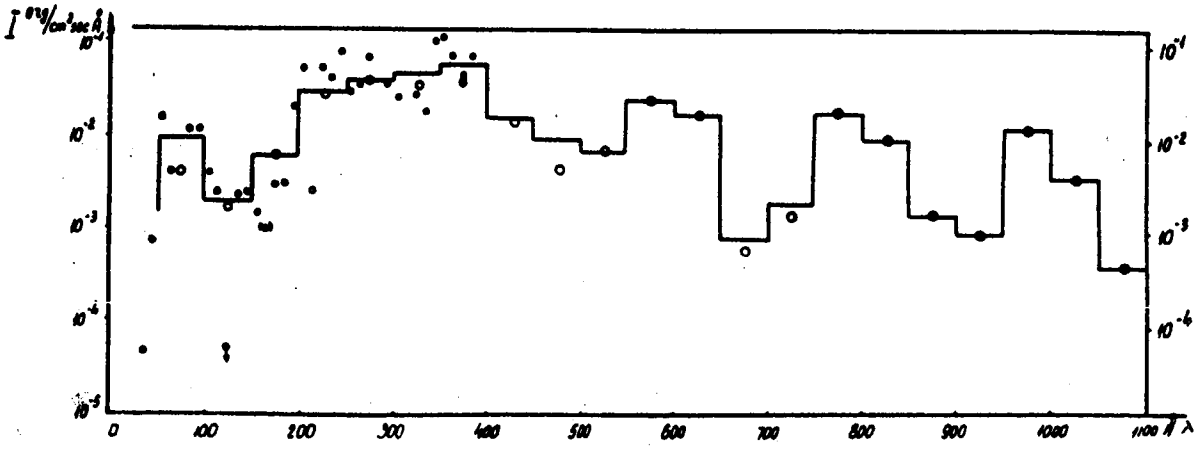

Fig. 4.

N. B. These plates were borrowed from the author's preprint of the paper delivered at Cospar meeting of May 1962, in Washington.

T A B L E

№№ п. п.	№ в [1]	λ	IONS Ион	I, эрг/см²сек erg/cm².sec	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	Identification
1	201	18,6	OVII	<0,015					
2	13	19,0	OVIII	<0,2					
3	200	21,6	OVII	<0,15					
4	390	(22)	CaXIV	<0,002					
5	12	24,8	NVII	<0,004					
6	199	28,8	NVI	<0,003					
7	437	(29,6)	CaXIII	<0,005					
8	475	32,3	CaXII	<0,001					
9	388	(33)	AXII	<0,005					
10	10	33,8	CVI	<0,08					
11	477	~35	CaXII	<0,005					
12	454	35,2	CaXI	0,005					
13	158	(38)	SXII	<0,01					
14	435	(39,7)	AXI	<0,004					
15	198	40,3	CV	0,03					
16	41	(41)	SiXII	0,006					
17	477	~41	CaXII	<0,005					
18	472	(43,8)	AX	<0,001					
19	471	45—50	SVIII	0,02					
20	474	45—50	AX	<0,02					
21	386	~47,7	SX	0,01					
22	453	48,7	AIX	0,006					
23	474	(45—50)	AX	<0,02					
24	79	50,5	FeXVI	<0,15					
25	143	50,6	SiX	0,01					
26	250	52,9	FeXV	<0,1					
27	471	~53	SVIII	0,01					
28	470	53,0	SVIII	0,001					
29	469	54,2	SVIII	0,003					
30	468	54,3	SVIII	0,001					
31	150	54,5	SiX	0,002					
32	431	56,1	SIX	0,015					
33	36	58,0	MgX	0,006					
34	343	(58)	NiXV	<0,002					
35	183	59,0	FeXIV	0,05					
36	467	59,2	SVIII	0,005					
37	184	59,6	FeXIV	0,05			} 62	0,01	+
38	466	61,6	SVIII	0,006					
39	406	(63)	NiXIV	0,006					
40	465	63,3	SVIII	0,002					
41	462	65—69	SiVI	0,003			66	0,01	+
42	450	(69)	NiXIII	0,006			} 69	0,015	+
43	380	~69,8	SiVIII	0,02					
44	452	72,0	SVII	0,003					
45	482	72—77	SiVI	0,007			74	0,015	+
46	338	(75)	FeXIII	0,05					
47	456	(78,1)	NiXI	0,003					
48	400	(80)	FeXII	0,06	83,9	30	83	0,02	+
49	482	80—83	SiVI	0.01					
50	126	82,6	MgVIII	0,002					
51	127	83,2	MgVIII	0,001					
52	482	(84,8)	NiXII	0,002					
53	375	~87,0	AlVII	0,002					
54	31	(87)	NeVIII	0,01					
55	448	(89,3)	FeXI	0,05					?
56	480	94—96	FeX	0,03					
57	479	96,1	FeX:	0,02			} 93	0,015	+
58	480	96—97	FeX	0,02					
59	300	98,0	MgVII	0,001					
60	461	100,0	SiVI	0,003					
61	301	102,3	MgVII	0,001					
62	14	102,6	OVIII	0,005					
63	455	103,6	FeIX	0,03	103,7	25			+
64	—				109,8	20			—
65	365	~111,9	MgVI	0,01	111,5	5	111	0,005	+

contin' 1

№№ п. п.	№ в [1]	λ	ION Ион	I эрг/см²сек erg/cm²sec	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
66	—				113,6	20			—
67	25	115,8	OVI	0,005	115,8	5			+
68	451	117,9	SiV	0,01	118,9	10	120	0,005	+
69	86	130,9	FeVIII	0,01			} 132	0,004	+
70	28	132,3	OVI	0,005					
71	113	138,6	NeVI	0,006	138,5	15	138	0,004	+
72	202	(138,3)	OVII	<0,002					
73	476	(143)	CaXII	<0,02					
74	316	(144)	CaXV	<0,05					
75	476	(149)	CaXII	<0,01					
76	24	150,1	OVI	0,015	150,0	10	149	0,003	+
77	436	(162)	CaXIII	<0,02					
78	473	(166)	AX	<0,015			166	0,01	+ ?
79	473	(171)	AX	<0,007	169,9	15	169	0,03	II order. ?
80	120	171,1	NeVI	0,002	171,1	5			+ ?
81	119	171,2	NeVI	0,001	171,9	5			—
82	219	172,2	OV	0,002	172,7	5			—
83	27	172,9	OVI	0,02	174,8	30	174	0,045	+
84	458	180,6	MgIV	$6 \cdot 10^{-4}$			180	0,055	—
85	11	182,5	CVI	<0,002					
86	341	(182)	NiXV	<0,01					
87	26	184,1	OVI	0,03	184,7	5	187	0,055	+
88	315	(185)	CaXV	<0,02					
89	434	(188,7)	AXI	<0,01					
90	192	(190)	NiXVI	<0,005					
91	313	(191)	SXI	0,15			} 192	0,10	+
92	389	(191)	CaXIV	<0,01					
93	389	(193)	CaXIV	<0,02					
94	87	~195,7	FeVIII	0,03			194	0,05	—
95	389	(197)	CaXIV	<0,03					
96	463	198,6	SVIII	0,05			198	0,03	+
97	191	(199)	NiXVI	<0,015					
98	464	202,6	SVIII	0,03			201	0,08	+
99	182	(208)	FeXIV	0,1	205,9	10	204	0,07	+
100	402	(209)	FeXII	0,2	} 206,7	5	209	0,07	+
101	336	(210)	FeXIII	0,2					
102	383	~215,8	SiVIII	0,008					
103	429	217,8	SiVII	0,003					
104	342	(220)	NiXV	<0,05			} 218	0,055	+
105	387	(220—222)	AXII	<0,02					
106	181	(223)	FeXIV	0,3			} 222	0,035	+
107	308	223,7	SiIX	0,1					
108	430	(224)	SIX	0,03					
109	308	225,0	SiIX	0,07					
110	314	(225)	CaXV	<0,1					
111	387	(226)	AXII	<0,02			226	} 0,045	+
112	308	227,0	SiIX	0,02					
113	308	227,3	SiIX	0,01					
114	382	~230,0	SiVIII	0,008	229,1	10			+ ?
115	157	231,5	SXII	0,1	} 231,0	20	232	0,02	+
116	252	(231)	FeXV	0,1					
117	253	~231,9	FeVII	0,006					
118	154	232	PXI	0,0005					
119	190	(233)	NiXVI	<0,003					
120	154	234,8	PXI	0,001	234,6	5			—
121	189	(236)	NiXVI	<0,006					
122	154	237,0	PXI	0,002	237,1	10			—
123	109	238,6	OIV	0,004					
124	401	(238)	FeXII	0,2	} 238,5	5	238±1	0,025	+
125	159	(239)	SiXII	<0,01					
126	254	239,9	FeVII	0,06					
127	154	240	PXI	0,0005					
128	188	(242)	NiXVI	<0,01					

continuation 2

№ по порядку	№ в [1]	λ	ion Ион	I, эрг/см²сек erg/cm²sec	Experimental Data λ [4]	I [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
129	8	243,0	HeII	$5\cdot10^{-4}$					
130	257	243,4	FeVII	0,002	243,3	10	243	0,025	+ ?
131	255	245,2	FeVII	0,002					
132	460	246,0	SiVI	0,05					?
133	428	246,1	SiVII	0,003					
134	153	247,9	PXI	0,003					
135	460	249,1	SiVI	0,025					
136	337	(250)	FeXIII	0,7			249	0,025	+
137	187	250	NiXVI	0,02					
138	81	(250)	FeXVI	0,01					
139	384	251	SiVIII	0,008					
140	304	251,3	AlVIII	0,001					
141	312	(253)	SXI	0,06			252	0,003	+
142	153	254,0	PXI	0,002					
143	7	256,3	HeII	0,004					
144	236	(257,5)	SXIII	<0,05					
145	385	(258)	SX	0,03	257,1	20	257:	0,003	+
146	141	258,4	SiX	0,06					
147	310	259,7	SiIX	0,01					
148	385	(260)	SX	0,05	260,0	5	259	0,01	+
149	111	260,4	OIV	0,001					
150	408	~260,5	NiVI	0,002					
151	82	(262)	FeXVI	<0,05	261,2	15			+ ?
152	83	(264)	FeXVI	<0,04					
153	178	(264)	FeXIV	0,05			264	0,003	+
154	385	(265)	SX	0,08					
155	177	(266)	FeXIV	0,15	266,4	10	266	0,008	+
156	138	272,1	SiX	0,05	272,3	5	273	0,005	+
157	427	272,7	SiVII	0,02					
158	426	274,1	SiVII	0,015					
159	422	275,4	SiVII	0,06					
160	424	276,2	SiVII	0,015	276,8	5	276	0,009	+
161	180	(276)	FeXIV	0,2					
162	425	276,8	SiVII	0,015					
163	381	~276,9	SiVIII	0,01					
164	137	277,3	SiX	0,1					
165	297	278,4	MgVII	0,2			278,5	0,006	+
166	423	278,4	SiVII	0,02					
167	234	278,7	PXII	<0,002					
168	459	278,7	AlV	0,003					
169	103	~279,8	OIV	0,01					
170	146	280,0	SiX	0,006	280	5			+
171	299	280,7	MgVII	0,005					
172	459	281,4	AlV	0,002					
173	403	(283)	FeXII	0,04	281,4	5	282	0,002	+
174	179	(285)	FeXIV	0,3			285	0,035	+
175	305	287,0	AlVIII	0,001					
176	149	287,2	SiX	0,02					
177	156	(290)	SXII	<0,05					
178	340	(290)	NiXV	<0,02	289,1	10	289	0,002	+
179	306	290,6	SiIX	0,007					
180	306	292,8	SiIX	0,015					
181	311	(293)	SXI	0,2			292	0,003	+
182	84	293,3	NiXVIII	<0,03					
183	194	~294	FeVI	0,01					
184	193	~296	FeVI	0,025					
185	306	296,2	SiIX	0,04			296	0,002	+
186	249	(298)	FeXV	<0,5	298,2	10	299	0,002	+
187	481	(299)	NiXII	0,02					
188	186	(300)	NiXVI	<0,01					
189	156	(302)	SXII	<0,1					
190	231	303,6	SiXI	0,06	303,8	30	303	0,13	+
191	6	303,8	HeII	0,18					
192	449	(304)	NiXIII	0,003					

continuation (3)

№№ п.п.	№ в [1]	λ	ion Ион	I, эрг/см²сек erg/cm²sec	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
129	8	243,0	HeII	$5\cdot10^{-4}$	243,3	10	243	0,025	+ ?
130	257	243,4	FeVII	0,002					
131	255	245,2	FeVII	0,002					
132	460	246,0	SiVI	0,05					?
133	428	246,1	SiVII	0,003					
134	153	247,9	PXI	0,003					
135	460	249,1	SiVI	0,025					
136	337	(250)	FeXIII	0,7			249	0,025	+
137	187	250	NiXVI	0,02					
138	81	(250)	FeXVI	0,01					
139	384	251	SiVIII	0,008					
140	304	251,3	AlVIII	0,001					
141	312	(253)	SXI	0,06			252	0,003	+
142	153	254,0	PXI	0,002					
143	7	256,3	HeII	0,004					
144	236	(257,5)	SXIII	<0,05	257,1	20	257:	0,003	+
145	385	(258)	SX	0,03					
146	141	258,4	SiX	0,06					
147	310	259,7	SiIX	0,01					
148	385	(260)	SX	0,05	260,0	5	259	0,01	+
149	111	260,4	OIV	0,001					
150	408	~260,5	NiVI	0,002	261,2	15			+ ?
151	82	(262)	FeXVI	<0,05					
152	83	(264)	FeXVI	<0,04					
153	178	(264)	FeXIV	0,05			264	0,003	+
154	385	(265)	SX	0,08	266,4	10	266	0,008	+
155	177	(266)	FeXIV	0,15					
156	138	272,1	SiX	0,05	272,3	5	273	0,005	+
157	427	272,7	SiVII	0,02					
158	426	274,1	SiVII	0,015					
159	422	275,4	SiVII	0,06	276,8	5	276	0,009	+
160	424	276,2	SiVII	0,015					
161	180	(276)	FeXIV	0,2					
162	425	276,8	SiVII	0,015					
163	381	~276,9	SiVIII	0,01					
164	137	277,3	SiX	0,1			278,5	0,006	+
165	297	278,4	MgVII	0,2					
166	423	278,4	SiVII	0,02					
167	234	278,7	PXII	<0,002					
168	459	278,7	AlV	0,003					
169	103	~279,8	OIV	0,01	280	5			+
170	146	280,0	SiX	0,006					
171	299	280,7	MgVII	0,005					
172	459	281,4	AlV	0,002					
173	403	(283)	FeXII	0,04	281,4	5	282	0,002	+
174	179	(285)	FeXIV	0,3			285	0,035	+
175	305	287,0	AlVIII	0,001					
176	149	287,2	SiX	0,02					
177	156	(290)	SXII	<0,05	289,1	10	289	0,002	+
178	340	(290)	NiXV	<0,02					
179	306	290,6	SiIX	0,007					
180	306	292,8	SiIX	0,015					
181	311	(293)	SXI	0,2			292	0,003	+
182	84	293,3	NiXVIII	<0,03					
183	194	~294	FeVI	0,01					
184	193	~296	FeVI	0,025			296	0,002	+
185	306	296,2	SiIX	0,04					
186	249	(298)	FeXV	<0,5	298,2	10	299	0,002	+
187	481	(299)	NiXII	0,02					
188	186	(300)	NiXVI	<0,01					
189	156	(302)	SXII	<0,1	303,8	30	303	0,13	+
190	231	303,6	SiXI	0,06					
191	6	303,8	HeII	0,18					
192	449	(304)	NiXIII	0,003					

continuation (4)

№№ п. п.	№ в [1]	λ	ION Ион	I, эрг/см²сек erg/cm²sec	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
193	135	305,1	AlIX	0,02			305:	0,01	+
194	419	~308	AlVI	0,003			308	0,001	+
195	405	(311)	NiXIV	0,01	310,1	10	311	0,002	+
196	237	(311)	SXIII	<0,02					
197	128	311,8	MgVIII	0,005					
198	292	311,9—313,7	NaVI	0,01					
199	449	(312)	NiXIII	0,01					
200	185	(312)	NiXVI	<0,02			313	0,005	+
201	17	312,4	CIV	0,03					
202	414	313,0	NeIII	0,005					
203	128	313,7	MgVIII	0,01					
204	379	314,3	SiVIII	0,05					
205	370	314,5	MgVI	0,01					
206	128	315,0	MgVIII	0,03					
207	405	(315)	NiXIV	0,02					
208	152	315,3	PXI	0,002			316±1	0,002	+
209	339	(316)	NiXV	<0,01					
210	378	316,2	SiVIII	0,1					
211	128	317,0	MgVIII	0,005					
212	449	(317)	NiXIII	0,002					
213	298	319,0	MgXII	0,01			319	0,002	+
214	377	319,8	SiVIII	0,15			321	0,005	+
215	457	321,0	MgIV	0,015					
216	481	(322)	NiXII	0,01					
217	85	322,0	NiXVIII	<0,02					
218	457	323,3	MgIV	0,007					
219	405	(323)	NiXIV	0,03					
220	449	(323)	NiXIII	0,004					
221	302	323,5	AlVIII	0,001					
222	151	325,2	PXI	0,003					
223	302	325,3	AlVIII	0,002					
224	404	(326)	FeXII	0,02			326	0,003	+
225	302	328,2	AlVIII	0,004					
226	335	(330)	FeXIII	0,3					?
227	449	(332)	NiXIII	0,003					
228	229	332,9	AlX	0,008					
229	339	(333)	NiXV	<0,025					
230	124	335,3	MgVIII	0,04					
231	235	335,6	PXII	<0,002					
232	77	336,2	FeXVI	<0,5	338,0	10	335	0,027	+
233	123	339,0	MgVIII	0,08			339	0,004	+
234	307	342,0	SiIX	0,04					
235	134	342,2	MgVIII	0,003					
236	176	(342)	FeXIV	0,2	342,6	5	343	0,005	+
237	307	345,0	SiIX	0,15					
238	280	345,3	CIII	$6 \cdot 10^{-1}$	344,7	20	347	0,01	
239	339	(346)	NiXV	<0,04					
240	478	(347,0)	FeX	0,35					
241	140	347,5	SiX	0,07					
242	371	349,1	MgVI	0,001					
243	147	349,0	SiX	0,006					
244	307	~349,8	SiIX	0,2			349	0,003	+
245	447	(350)	FeXI	0,02					
246	374	352,2	AlVII	0,003					
247	129	352,4	MgVIII	0,015	352,9	5	352	0,006	+
248	418	~352,7	MgV	0,002					
249	373	353,8	AlVII	0,005					
250	399	(356)	FeXII	0,1					
251	175	(356)	FeXIV	0,4	354,9	30	354	0,005	+
252	139	356,1	SiX	0,15					
253	372	356,9	AlVII	0,01					

continuation (5)

№ п. п.	№ в [1]	λ	Ион	I, эрг/см²сек	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
254	447	(358)	FeXI	0,06					
255	283	358,0	NeV	0,1					
256	399	(360)	FeXII	0,2			359	0,017	+
257	334	(360)	FeXIII	0,15					
258	447	(360)	FeXI	0,015					
259	148	360,8	SiX	0,006					
260	293	361,2	NaVI	0,001					
261	75	361,5	MnXV	0,003					
262	78	361,7	FeXVI	<0,3			363	0,005	+
263	295	364—368	MgVII	0,06					
264	233	365,4	SiXI	[0,06]					
265	285	365,4	NeV	0,01					
266	89	365,9	FeVIII	0,002					
267	[19]	(367)	FeX	0,15					
268	447	(367)	FeXI	0,01					
269	295	367,8	MgVII	0,03			368±1	0,02	+
270	227	368,2	MgIX	0,08					
271	399	(369)	FeXII	0,3					
272	447	(369)	FeXI	0,015					
273	88	370,5	FeVIII	0,004					
274	334	(373)	FeXIII	0,4	372,2	10			+
275	274	374,1	OIII	0,03	373,6	15	375	0,002	+
276	447	(376)	FeXI	0,02					
277	416	379,3	NeIII	0,001	379,0	25	378	0,004	+
278	303	381,1	AlVIII	0,002					
279	121	381,3	NaVII	0,008					
280	303	383,7	AlVIII	0,007			383	0,002	+
281	19	384,2	CIV	0,006					
282	136	385,0	AlIX	0,01					
283	76	385,4	MnXV	0,001					
284	334	(386)	FeXIII	0,65			387,5	0,004	+
285	303	~387,8	AlVIII	0,01					
286	369	388,0	MgVI	0,005					
287	73	390,1	CrXIV	0,003					
288	251	391,2	FeXV	[<0,08]					
289	145	~392,4	SiX	0,002					
290	136	392,4	AlIX	0,015			391±1	0,003	+
291	145	~398,9	SiX	0,004					
292	368	399,3	MgVI	0,04					
293	118	399,8	NeVI	0,01					
294	367	400,7	MgVI	0,08					
295	118	401,1	NeVI	0,02					
296	230	401,2	AlX	0,005					
297	118	401,9	NeVI	0,04					
298	366	403,3	MgVI	0,13			404±1	0,004	+
299	118	403,3	NeVI	0,01					
300	417	~409	NaIV	0,001					
301	225	411,2	NaVIII	0,004					
302	74	412,5	CrXIV	0,001					
303	251	414,1	FeXV	[<0,05]					
304	289	414,3	NaVI	0,001					
305	333	414,7	CaVII	0,05					
306	284	416,2	NeV	0,02			416	0,003	+
307	288	416,8	NeV	0,01					
308	18	419,5	CIV	0,05	419,4	10	418	0,006	+
309	42	(421)	SXIV	<0,02			420	0,002	+ ?
310	251	424,1	FeXV	[<0,02]					
311	415	427,8	NeIII	0,001					
312	296	429,2	MgVII	0,03			429	0,002	+
313	115	430,0	NeVI	0,008					
314	354	430,2	OII	$4 \cdot 10^{-4}$					
315	125	430,5	MgVIII	0,05	430,7	10	432	0,002	+
316	296	431,3	MgVII	0,08					
317	114	432,4	NeVI	0,015					

continuation (6)

№№ п. п.	№ в [1]	λ	Ион	I, эрг/см²сек erg/cm²sec	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
318	296	434,9	MgVII	0,14					
319	279	434,9	OIII	0,02	435,1	25	437	0,005	+
320	125	436,7	MgVIIII	0,1					
321	133	442,2	MgVIII	0,003			441	0,003	+ ?
322	—						445	0,004	—
323	43	(446)	SXIV	<0,01	448,0	15	449	0,003	+ ?
324	55	457,8	SiIV	0,001			456	0,003	+ ?
325	56	458,1	SiIV	$3\cdot10^{-4}$					
326	362	459,9	NaV	0,001					
327	71	460,9	TiXII	0,002					
328	362	461,0	NaV	0,003					
329	174	461,7	CaXIII	0,001					
330	362	463,3	NaV	0,004			463	0,003	+ ?
331	223	(464)	NeVII	0,08	463,8	10	467	0,006	+
332	247	466,2	CaIX	0,006					
333	360	470,0	NeIV	0,005					
334	173	471,1	CaVIII	0,002					
335	—						473±1	0,002	—
336	—				477,4	15			—
337	72	480,1	TiXII	0,001					
338	281	480,4	NeV	0,015					
339	281	481,4	NeV	0,025					
340	281	483,0	NeV	0,08	483,7	10	484±1	0,005	+
341	122	486,7	NaVII	0,003					
342	433	(488)	SIX	0,01					
343	413	488,1	NeIII	0,001					
344	413	489,5	NeIII	0,005					
345	131	490,8	MgVIII	0,003					
346	413	491,0	NeIII	0,001					
347	291	491,4	NaVI	0,003					
348	122	491,9	NaVII	0,006					
349	290	494,3	NaVI	0,005	495,0	5	494	0,005	+?
350	39	(499,3)	SiXII	0,06	498,3	5	500±1	0,005	+
351	—				503,9	15	503	0,004	III order
352	—						507	0,003	—
353	—						514±1	0,004	—
354	40	(521,1)	SiXII	0,03					
355	361	521,3	NeIV	0,005			521	0,01	+
356	197	522,2	HeI	0,01					
357	276	525,8	OIII	0,005					
358	407	525,7—526,6	FeIV	0,01	525,8	15			+
359	330	527,7	AV	0,002			529±1	0,004	+ ?
360	—				535,3	5			—
361	196	537,0	HeI	0,04	536,5	5	537	0,002	+
362	206	538,3	CIII	0,001	538,8	5			+ ?
363	355	538,3	OII	$3\cdot10^{-4}$					
364	353	539,1	OII	0,02	539,2	5			+
365	359	541,1	NeIV	0,04			540±1	0,006	+
366	358	542,0	NeIV	0,08					
367	357	543,9	NeIV	0,12			545	0,003	+
368	210	547,9	CIII	0,001					
369	37	(550)	AlXI	0,004			551	0,005	+ ?
370	332	551,5	CaVII	0,002					
371	108	554,1	OIV	0,1	553,7	10	555	0,011	+
372	432	(555)	SIX	0,01					
373	144	555,0	SiX	0,006					
374	69	557,7	CaX	0,004					
375	117	558,6	NeVI	0,015			560	0,002	+
376	116	562,8	NeVI	0,02			565	0,003	+
377	232	565,1	SiXI	[0,03]					
378	282	568,4	NeV	0,06					
379	38	(569)	AlXI	0,002			569	0,02	+. II order
380	282	569,9	NeV	0,17					
381	282	572,1	NeV	0,04					

continuation (7)

№№ п. п.	№ в [1]	λ	Ion Ион	I эрг/см²сек erg/cm²sec	Experimental Data λ [4]	I [4]	λ [2, 3]	I [2, 3]	Identification.
382	282	572,3	NeV	0,23	572,9	5			+
383	70	574,0	CaX	0,002					
384					576,6	10	578±1	0,004	—
385	—				578,5	10			—
386	—				580,6	10			—
387	172	582,8	CaVIII	0,002	581,5	10	581	0,004	+ ?
388	232	582,9	SiIX	[0,02]					
389	195	584,4	HeI	0,7	584,7	10	585	0,03	+
390	244	585,8	AVII	0,004					
391	168	589,0	AVI	0,001	589,9	5			+ ?
392	232	591,2	SiXI	[0,007]	593,6	5	592	0,003	+
393	167	596,7	AVI	0,002					
394	171	596,9	CaVIII	0,004					
395	132	~597,5	MgVIII	0,003					
396	278	597,8	OIII	0,005	597,9	5	599	0,003	+ ?
397	275	599,6	OIII	0,01	599,2	5			+
398	—				602,9	5			—
					607,6	50	606	0,05	II order
399	107	608,4	OIV	0,1	608,5	5	608:	0,006	+
400	106	609,8	OIV	0,3	609,8	5			+
401	34	(609,9)	MgX	0,05					
402	277	610,0	OIII	0,003					
403	277	610,8	OIII	0,005					
404	—				611,4	5			—
405					614,9	20			—
406	—				617,2	25	617	0,002	II order
407	67	621,4	KIX	0,001			622	0,01	+ ?
408	331	624,4	CaVII	0,001					
409	35	(624,9)	MgX	0,025	625,1	5	625	0,008	+
410	112	625,1	OIV	0,03					
411	216	629,7	OV	0,3	630,3	20	629	0,02	+
412	395	629,6	CaVI	0,004					
413	331	630,6	CaVII	0,003					
414	395	633,8	CaVI	0,003	635,5	10	634	0,002	+ ?
415	68	636,3	KIX	$3\cdot10^{-4}$					
416	80	637,2	FeXVI	<0,1			638	0,003	+
417	331	639,2	CaVII	0,005					
418	331	640,5	CaVII	0,001					
419	395	641,9	CaVI	0,001					
420	268	644,8	NII	10^{-4}					
421	446	646,6	CaV	0,001	644,9	20			+ ?
422	97	651,3	CII	10^{-6}	651,5	10	653	0,001	—
423	[11]	658,7	AXIII				661	0,003	+
424	—						670±1	0,01	II order
425	248	678,6	CaIX	[0,001]			676	0,003	+
426	130	680,3	MgVIII	0,003					
427	32	(682)	NaIX	0,005			682±1	0,004	+ ?
428	100	687	NIII	0,001	687,3	15	689	0,004	+ ?
429	228	692,4	MgIX	[0,03]	694,5	25	695±1	0,005	+, II порядок (order)
430	248	693,8	CaIX	[0,001]					
431	33	(695)	NaIX	0,002					
432	65	700,4	AVIII	0,004			700	0,004	+ ?
433	272	702,3—703,9	OIII	0,06	703,3	20	704	0,01	+
434	228	704,5	MgIX	[0,02]					
435	62	706,5	SVI	0,002	707,9	20			+ ?
436	228	710,3	MgIX	[0,01]			710±1	0,005	+ ?
437	62	712,7	SVI	0,001					
438	66	714,0	AVIII	0,002					
439	329	716,4	AV	0,001					
440	—						720	0,01	II order
441	324	728,7	SIII	0,002			729	0,007	+
442	—				737,1	15	738	0,01	II order
443	—						745	0,004	III order
444	—				754,8	10	752±1	0,004	—

Continuation (8)

№№ п. п.	№ в [1]	λ	Ион Ion	I, эрг/см²сек	Experimental Data λ [4]	i [4]	λ [2, 3]	I [2, 3]	IDENTIFICATION
445	220	758,7—759,5	OV	0,02					
446	220	760,2—760,4	OV	0,045			762±1	0,005	+
447	220	761,2—761,9	OV	0,02					
448	99	764,4	NIII	0,004					
449	212	765,1	NIV	0,01	764,5	10	767	0,007	+
450	29	770,5	NeVIII	0,09			771	0,01	+
451	222	774,5	OV	0,05					
452	269	776,0	NII	$3\cdot10^{-4}$					
453	226	778,9	NaVIII	[0,003]					
454	110	779,8	OIV	0,002					
455	30	780,3	NeVIII	0,06	779,4	5	781	0,007	+
456	242	786,5	SV	0,02					
457	105	787,7	OIV	0,2			786:	0,004	+
458	226	788,6	NaVIII	[0,002]					
459	104	790,2	OIV	0,5	791,2	5	790	0,014	+
460	226	793,3	NaVIII	[0,001]			793	0,005	+ ?
461	356	796,8	OII	0,005					
462	63	800,7	ClVII	0,001			802	0,002	+ ?
463	165	809,7	SIV	0,002	809,4	5	808	0,002	+ ?
464	—				810,9	5	812	0,002	—
465	58	815,1	SiIV	0,001					
466	164	816,0	SIV	0,003					
467	—				819,3	5	818	0,005	—
468	328	822,2	AV	0,001	822,5	5	821	0,003	+ ?
469	—				823,0	5			—
470	—				825,6	5	824	0,004	—
471	328	827,2	AV	0,002					
472	—				829,9	10	829	0,004	—
473	352	832,8	OII	0,05					
474	273	832,9	OIII	0,03					
475	351	833,3	OII	0,1	834,0	5			+
476	273	833,7	OIII	0,1					
477	350	834,5	OII	0,15					
478	327	834,9	AV	0,003	835,2	5	835±1	0,015	+
479	273	~835,2	OIII	0,15					
480	327	836,0	AV	0,001	836,7	5			+ ?
481	393	840,0	AIV	0,001					
482	393	843,8	AIV	0,002			846	0,003	+ ?
483	393	850,6	AIV	0,002	852,6	10	852	0,01	+, III order
484	—				855,4	30			
485	91	858,1	CII	0,002	858,2	10	858±1	0,003	+ ?
486	90	858,6	CII	0,004	859,4	20			+ ?
487	—						868	0,003	—
488	—						871	0,005	—
489	—						877	0,01	—
490	—						880	0,01	—
491	—						887	0,003	—
492	224	(892)	NeVII	[0,1]			893±1	0,005	+
493	95	903,6	CII	0,01	902,9	5	901	0,003	+
494	392	906,9	SII	0,001	905,5	5			+ ?
495	392	911,0	SII	0,001	911,4	100	912	0,04	III order
496	—				913,0	10			+ ?
497	—				914,2	50	914	0,013	—
498	267	916,0	NII	0,001	916,0	10	917	0,005	+ ?
499	214	~922,2	NIV	0,002			921	0,008	+ ?
500	214	~923,3	NIV	0,001			923	0,006	+ ?
501	60	933,4	SIV	0,02	932,2	10	932±1	0,008	+
502	5	937,8	HI	0,008			937	0,007	+
503	—				940,9	10			—
504	61	944,5	SVI	0,01	943,7	10	942±1	0,004	+
505	4	949,7	HI	0,015			949±1	0,008	+
506	—				960,5	10	961±1	0,003	—
507	—				961,4	10			—

END.

№№ п. п.	№ в [1]	λ	Ио н.	I, эрг/см²сек	λ [4]	I [4]	λ [2, 3]	I [1,3]	IDENTIFICATION
508	340	~964,5	NI	$2,10^{-6}$	964,5	10			+ ?
509	—				970,1	10			—
510	7	972,5	HI	0,04	972,9	10	972	0,02	+
511	204	977,0	CIII	0,6	977,0	30	976	0,08	+
512	—						986	0,005	—
513	98	989,8—991,6	NIII	0,01	990,0	15	992--1	0,007	+
514	—						999	0,013	III order
515	—						1006	0,014	III order
516	97	1010,7	CII	$6 \cdot 10^{-4}$	1009,8	10	1009	0,004	+ ?
517	317	1012,6	SIII	0,006	1013,3	15	1013	0,002	+
518	—				1018,1	10	} 1018--1	0,004	—
519	—				1019,7	10			—
520	—				1022,0	10			—
521	2	1025,7	HI	0,14	1025,7	60	1024	0,04	+
522	412	1025,7	OI	0,01					
523	48	1026,0	MgII	0,003					
524	49	1026,1	MgII	0,002					
525	—				1028,7	10			—
526	—				1030,3	15			—
527	22	1031,9	OVI	0,06	1032,2	30	1029--1	0,03	+
528	94	1036,3	CII	0,05	} 1038,2	40	1035	0,02	+
529	23	1037,6	OVI	0,03					
530	411	1039,2—1040,9	OI	0,01	1040,9	5	1040	0,007	+
531	[11]	1048,9	SiVII		1048,9	5	1049	0,004	+
532	—				1051,4	10			—
533	[11]	1058,7	AlVIII		1058,7	10	1055--2	0,007	+
534	166	1062,7	SIV	0,005	1065,3	15	1063	0,007	+ ?
535	166	1073,3	SIV	0,01			1073	0,004	+
536	—						1080	0,013	III order.
537	266	1084,0—1084,6	NII	0,005	} 1085,1	10	1083	0,013	+
538	266	1085,5—1085,7	NII	0,005					
539	—						1091--1	0,01	—
540	—						1100	0,01	—

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