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Classification of the Spectral Lines of Cl, Br and I

By

Kwan-ichi Asagoe

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Abstract

The spectral lines of chlorine, bromine and iodine were first classified into arc and spark types by observing, (1) the effect of constriction of a part of a Geissler tube upon the intensities of the lines, (2) the change of relative intensities called forth by putting a capacity in the circuit, and (3) the effect of insertion of a self-induction in the condensed heavy discharge circuit.

Then the spark lines were further sorted out into spark, supper-spark lines etc. by investigating the exciting stages. The various excitation conditions were obtained by (1) varying the intensity of a magnetic field applied to the Geissler tube and (2) capacity and (3) self-induction placed in the circuit.

Thus all the spectral lines of these elements lying in the region covering visible and ultra-violet (up to 2000 A) were classified. Arc lines are found only in the visible region, while spark lines are distributed all over the entire region investigated. Super- and super-super-spark lines lie generally in the more refrangible side.

In order to find certain series relations which may exist among lines of the spectra of halogen elements, chlorine, bromine and iodine, classification of the lines into arc and spark types, and further of spark lines into spark, super-spark, etc. is the first problem to be studied. The present investigation was undertaken for this purpose.

I Classification of the Spectral Lines of the Halogen Elements into Arc and Spark Types

The following three methods were employed to determine the types of lines.

(1) *The first method* was the same as that used by Kimura. He studied the lines of iodine[1] and bromine[2] with a small glass prism

1 These Memoirs, **4**, 167 (1920)

2 These Memoirs, **4**, 127 (1920)

spectroscope. In the present experiment, these were re-examined minutely with a spectrograph having a higher dispersion, and the examination of the chlorine spectrum was extended to the region lying from the red to the ultra-violet.

A piece of an ordinary glass tube of about 5 mm. diameter, (in the ultra-violet region, a quartz tube of 3 mm. diameter was used), was drawn into a conical capillary, the narrowest part being about 0.2 mm. in diameter and 5 mm. in length. The constricted capillary thus obtained was used in place of an ordinary one as a part of a discharge tube (say, Tube I). The tube was simply excited by a 20 cm. induction coil. A well defined vertical image of the glow in this conical part was formed on the spectrograph slit, and the light coming from various parts of the cone were simultaneously photographed on a plate.

It was observed that certain lines strongly emitted from the wide part disappeared from, or weakened in intensity in the capillary, while a number of faint lines presented in the former were remarkably enhanced in the latter. Thus lines in the spectrum may be divided into the two types according to the mode of their appearance.

Now, the current density and the potential gradient in the wide part of the tube would both have smaller values than those in the constricted portion. Hence it is evident that much energy will be required to excite lines of the latter type. It is then natural to regard the lines of the first type as arc lines, and those of the second as spark ones.

In order to test the correctness of this consideration, lines of the spectra of tin and antimony were first examined by this method. A small quantity of $SnCl_4$ (or $SbCl_5$) was poured into a small glass cup, and this was connected to the discharge tube by a very fine capillary drawn from a piece of glass, the length of which was about 50 cm. The spectrum of the light emitted from the conical part of the tube was then photographed, the pump being operated during the exposure to the spectrograph. In this case, however, a condensed discharge was sent through the tube. Since the vapour of $SnCl_4$ (or $SbCl_5$) was flowing through this constricted portion, the lines of tin (or antimony) were excited in company with chlorine lines. The spectrum of $SnCl_4$ thus taken is reproduced in Pl. I, Fig. 1. Fig. 2 represents the spectrum of a spark produced between electrodes of tin. Comparing these two, we see that in Fig. 1, the spark lines and super-spark lines of tin[1] were easily sorted out, lines marked with one dot denoting the spark lines, and those with two dots the super-spark ones of tin. Thus the results obtained by the two different methods are in harmony with each other, and this shows that the method mentioned above is suitable for classifying the lines of gaseous elements into the arc and spark types.

(2) *The second method* is to investigate the change called forth in the relative intensities of lines when a capacity is inserted in a circuit parallel to a discharge tube. An ordinary Geissler tube having a main tube of about 3 mm. diameter and about 25 cm. length (say, Tube II) was simply excited by the 20 cm. induction coil, and the light thus emitted was examined. We see that the spectral lines already classified as arc lines in the first method were stronger, while spark lines were fainter or entirely unexcited. On the other hand, by the insertion of a condenser of a capacity of about 0.003 μF in the circuit, the arc lines were suppressed, while the spark lines were enhanced. The two spectra were taken one above the other on a photographic plate as seen in Fig. 4, the same exposure being given to each spectrum. The relative intensities of the lines in these two spectra being examined, the lines were easily classified into arc and spark ones. The result thus obtained coincided with that of the first method.

(3) *The third method.* Changes called forth in the spark spectra of the halogen elements by putting a self-induction in the discharge circuit were next investigated. Carbon electrodes were placed in a tube of fused silica filled with the vapour or the gas of the elements and sparks were passed through the electrodes by the discharge from a condenser charged up by a Thordarson transformer of 3/4 kVA, giving 10,000 volts in the secondary, and the spectrum was taken. Next, an appropriate self-induction was put in the discharge circuit, and then the second spectrogram was taken. Comparing these two (see, Fig. 5, in Pl. I), we see that, in the latter spectrum, lines classified as spark type in the above two experiments were weakened, while those of the arc type were rather enhanced.

The three methods mentioned above gave results concordant with each other, and thus we can determine decidedly the types of lines, arc or spark, except in the case of a few very faint lines. The result of the experiments will be given below.

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1 Japanese Journ. Phys., **3**, 197 (1924)

The visible region of the spectrum to be studied is divided into three parts, namely λλ 6600-4500, 4600-4100 and 4200-3500. In the first two regions, a three glass prism spectrograph, having an achromatic camera lens of 50 cm. focus, was used, the linear dispersion on the photographic plate being about 0 02 mm. per 1 A at H_α and 0.076 mm. at 4600 A in the first setting, and 0 082 mm. at 4520 A and 0.137 mm. at 4170 A in the second. In the remaining region, two prisms were employed, which gave a dispersion of 0.060 mm. at 4100 A and 0.144 mm. at 3540 A. The ultra-violet region was photographed with a small Hilger quartz spectrograph (E31). Rapid process panchromatic plates were employed for all the regions.

Results

(I) Iodine

Goldstein[1] and Nutting[2] have observed a change called forth in the iodine spectrum by putting a capacity in the discharge circuit. But their results were only fragmental. The spectrum was then studied minutely by Wood and Kimura[3], and the many lines lying in the region between 6585 A and 4632 A were sorted out into arc and spark types. Kimura[4] has also investigated the spectrum by the first method described above. The arc lines lying in the Schumann region were investigated by Turner[5]. Quite recently, L. and E. Bloch[6] have studied the spark lines of iodine, and also selected out several arc lines in the visible region. In the present experiment, the region extending from the visible to the ultra-violet (up to about 2000 A) was examined minutely, and the result obtained was compared with those of the previous investigators.

A small quantity of well-dried potassium iodide was put in a glass cup having a platinum wire sealed in at one end and this was again sealed in an outer tube. Two tubes of such construction were connected to a discharge tube and these were used as the electrodes. During the evacuation, the glass walls of the tube were strongly heated by a Bunsen flame and a heavy discharge was sent through. The

1 Astrophys. J., **27**, 25 (1908)
2 Astrophys. J., **19**, 239 (1904)
3 Astrophys. J., **46**, 181 (1917)
4 Loc. cit.
5 Phys. Rev., **27**, 397 (1926)
6 Ann. de Physique, **11**, 141 (1929)

tube was then sealed off from the pump, when the discharge gave a bright green glow.

When a tube having a constricted capillary of about 0.2 mm. diameter was excited simply by an induction coil, a glow of yellowish orange colour appeared in the wide part, and a bluish green one in its capillary. The spectrum of the latter consisted of iodine lines, while that of the former consisted of lines, fluted bands and continuous bands. A similar change in the spectrum of the glow in Tube II was also noticed, a weak excitation giving the yellowish orange spectrum, while the condensed discharge gave the bluish green one.

Strong lines in the spectrum of the yellowish orange glow, were $\lambda\lambda$ 5119, 4917, 4897, 4862 and 2062, and these were reduced in intensity or entirely disappeared in the green spectrum, and consequently these may be considered as arc lines. Most of these arc lines lie in the region beyond 4100 A, none being found in the more refrangible region between 4100 A and 2062 A. In the Schumann region, a number of arc lines were observed by Turner, and we could also photograph the lines at $\lambda\lambda$ 1876, 1845 and 1830 in addition to the line at 2062 A, when a photographic plate was bathed in paraffin oil and over-exposed. On the other hand, spark lines which were strongly enhanced in the green spectrum, were found in the whole region of the spectrum investigated, the strongest lines being

$\lambda\lambda$ 5613, 5497, 5465, 5407, 5405, 5161, 4676, 4667, 4453, 4445, 4424, 4410, 4236, 3940, 3931, 3498, 3482, 3303, 3288, 3275, 3194, 3055, 2994, 2879, 2809, 2730, 2675, 2566, 2465, etc.

Now, a pair of carbon electrodes was placed in a silica tube of about 2 cm. diameter having a side tube containing a certain quantity of iodine crystals. The side tube being heated by a Bunsen burner, the tube was filled up with a dense vapour of iodine, and after this condition was reached a spark was started between the electrodes.

In the spectrum of the heavy condensed discharge, the spark lines of iodine were strongly developed, some of them being broadened on both sides, and the others unsymmetrically on the red side; and no arc lines were found. However, when a considerably large self-induction was put in its circuit, the strongest lines of the arc type, i. e, $\lambda\lambda$ 5119, 4917 and 4862, were developed as faint lines showing diffuse wings on the red side.

The lines of iodine were thus classified into arc and spark types, and the results obtained are shown in Table I with the relative intensities of the lines. The wave-lengths of the lines from the red to 4632 A were taken from the measurements made by Wood and Kimura[1], and those of the lines lying between 4632 A and 3030 A from the table given by Konen[2]. The lines shorter than 3030 A, and some arc lines lying in the blue and violet region (these lines are marked with asterisks) were newly determined by the present writer from the spectrogram of a Geissler tube with an iron comparison photographed with a Hilger quartz spectrograph (size El), international wave-length unit being used. In the sixth column, the results of the previous investigators are shown. The coincidence of these results is perfect except in the case of a few faint lines.

(II) Bromine

Goldstein[3] and Nutting[4] have already noticed the multiplicity of the bromine spectrum. Kimura[5] examined the spectrum of this element minutely and classified the strong lines of the spectrum into arc and spark types, using a method similar to the first one described above. The arc lines lying in the Schumann region were observed by Turner[6]. Recently L. and E. Bloch[7] have also sorted out some arc lines in their study of the spark lines of bromine.

The tubes employed in the present investigation were prepared similarly to the iodine ones, potassium bromide being used as electrodes. When the discharge was sent through the tube, the wide part of Tube I was filled up with a glow of chamois yellow, while a blue light was emitted from the capillary portion; in Tube II, the colour of the light also varied in a similar manner when a capacity was placed in the circuit.

The light emitted from the capillary portion consisted of the line spectrum of bromine and that from the wide part, of lines, fluted bands and continuous bands. We see that the strong lines in the red region,

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1 Loc. cit.
2 Kayser's Handbuch der Spektroskopie, **5**, p. 574
3 Loc. cit.
4 Loc. cit.
5 Loc. cit.
6 Loc. cit.
7 Ann. de Physique, **7**, 207 (1925)

i. e., λλ 6632, 6560, 6351, 6150 and the bright lines in the blue, i. e., λλ 4781, 4752, 4615, 4576, 4526, 4478, 4473 and 4442 are characteristic lines of the chamois yellow spectrum, but their intensities are much reduced in the blue spectrum. Besides these, there are, however, many lines enhanced in the blue spectrum. Among these, the lines at

λλ 5332, 5238, 5194, 5184, 4931, 4929, 4817, 4786, 4743, 4720, 4705, 4679, 4366, 4224, 4180, 3987, 3981, 3562, 3418, 3350, 3333, 3074, 2972, 2969, 2927, 2594, 2557, 2541, 2522, 2395, 2392, 2390, 2389, 2387, etc.

are the strongest. Thus we consider the former group of lines as arc lines, and the latter as spark ones. We see that the spark lines are distributed all over the entire region investigated, while the lines of the arc type are found only in the visible region beyond about 3700 A, and can not be detected in the ultra-violet. But in the Schumann region, as reported by Turner, many arc lines seem to be emitted.

In the spectrum of a spark discharge between carbon electrodes placed in a dense vapour of bromine, the spark lines were strongly developed, some of them being broadened out on both sides, others unsymmetrically on the red side, while the arc lines were seen faintly showing diffuse wings on the red side. By the insertion of a self-induction in the discharge circuit, the spark lines mentioned above were suppressed strongly, while the lines of the arc type were enhanced.

Table II records the result thus obtained, the wave-lengths of the lines from the red to 3699 A being taken from the tables[1] given by Eder and Valenta and Galitzin and Willip; while those shorter than this, and also a number of arc lines in the visible region (they are marked with asterisks in Table II) were newly measured by the present writer. Kimura's result is given in the sixth column; these two results are in harmony.

(III) Chlorine

Lines of chlorine at λλ 4661, 4601, 4526 and 4390 were noticed by Goldstein[2] to show an arc character. Nutting[3] has also observed the multiplicity of the chlorine spectrum. Nelthorpe[4] has found about twenty lines of chlorine which disappeared from the " Grundspektrum",

1 Kayser's Handbuch der Spektroskopie, **5**, p. 182

2 Loc. cit.

3 Loc. cit.

4 Astrophys. J., **41**, 16 (1915)

and he regarded these lines as of arc type. Turner[1] has investigated the spectrum in the Schumann region, and found several arc lines. Most recently, several lines lying in the visible region were selected out as of an arc type by L. and E. Bloch[2].

Electrodes provided with pure, well-dried sodium chloride were used in the present work. When the tube was sealed off from the pump, the carbon monoxide bands soon appeared and also the gas pressure increased gradually, so that to get rid of these troubles the tube was connected to the pump during the exposure to the spectrograph.

The tubes first used in this experiment had nearly the same dimensions as those employed in the case of iodine and bromine. The results, however, were found to be unsatisfactory. Then a fine capillary of about 0.1 mm. diameter was drawn from a piece of a narrow capillary tube having a diameter of 1 mm, and by using this as a part of Tube I, a fairly good result was obtained when a small spark gap was put in the discharge circuit. In the second method, a condenser of a slightly larger capacity was necessary in order to weaken the arc lines.

The wide part of Tube I was filled up with a glow of bluish gray, while a green light was emitted from the capillary portion. A similar change in the glow was noticed in Tube II when a capacity was placed parallel to the tube.

The green spectrum chiefly consisted of lines of chlorine, while the bluish gray one consisted of lines, fluted bands and continuous bands. Enlarged reproductions of the spectra obtained from Tubes I and II are given in Figs. 3 and 4 respectively.

Lines whose intensities were suppressed in the capillary part or under the heavy excitation chiefly lie in the region from 4700 A to 4200 A, stronger lines of which are

$\lambda\lambda$ 4661, 4601, 4526, 4491, 4439, 4404, 4390, 4380, 4370, 4324, etc.

These are regarded as arc lines. Lines of spark type behaving just opposite to the former, however, are distributed all over the whole region of the spectrum examined, the following being the strong lines :—

$\lambda\lambda$ 5457, 5444, 5423, 4820, 4810, 4795, 4373, 4344, 4309, 4254, 4241, 4?34, 4133, 3861, 3851, 3846, etc.

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1 Loc. cit.

2 Ann. de Physique, **8**, 397 (1927)

Nearly all the lines of chlorine could be excited in a spark produced between carbon electrodes placed in a silica tube through which chlorine gas was flowing. Of the spark lines, some show broad wings on the red side and others symmetrical ones, while the arc lines have diffuse wings on the red side. Again, as will easily be seen in Fig. 5, the insertion of a self-induction in the circuit markedly reduced the intensities of the spark lines mentioned above, while the arc lines classified above developed rather strongly.

The result thus obtained is recorded in Table III, the wave-lengths of the chlorine lines longer than 3353 A being taken from the table given by Eder and Valenta[1], and those for shorter ones from the Jevons[2] measurement. Lines selected out by Nelthorpe as of an arc type are shown in the sixth column ; coincidence of the two results is satisfactory except in the case of three lines at $\lambda\lambda$ 3982, 3872 and 3854. De Bruin[3] has remarked some regularities in the arc spectrum of chlorine. It seems to the present writer, however, that most of the lines studied by him are not of the arc type.

Recently, Dr. Laporte[4], during his stay in Kyoto, found that the arc lines in the visible region sorted out by the present writer form the combination $4s^{4,2}P\text{-}4p^{4,2}(S,P,D)$, the frequency differences between the five lower levels being 530.4, 338.7, 1399.1 and 640.8 cm^{-1}.

II Further Classification of the Lines of Spark Type into Spark, Super-Spark Lines, etc.

It is known that if a magnetic field is applied to a discharge tube the discharge path is affected and the glow is strengthened on one side of the tube, resulting in the increase of the current density. Thus, by adjusting the intensity of the magnetic field, we can regulate the current density in the path of the discharge or the intensity of excitation. If spectra of the Geissler tube are taken under increasing magnetic fields, arc, spark, super-spark, etc. lines will probably appear in succession, and by this means also the lines may be sorted out into arc, spark, super-spark etc.

In order to ascertain the correctness of this consideration, the spectrum of $SbCl_5$ was first examined. The short capillary part (diam.

1 Kayser's Handbuch der Spektroskopie, **5**, p. 307
2 Proc. Roy. Soc., **103**, 193 (1923)
3 ZS. f. Phys., **39**, 869 (1926)
4 Nature, June 30, p. 1021 (1928)

=1.9 mm.) of a Geissler tube was horizontally mounted between truncated pole pieces of an electro-magnet of the Du-Bois type. As already mentioned above, a small glass cup filled with $SbCl_5$ was connected to the tube by a very fine capillary of glass. The pump being operated during the exposure, the tube was excited by a 20 cm. induction coil, and the image of an end-on emission from the capillary part was projected on the slit of a spectrograph. In this experiment, a Hilger wave-length spectrograph and a Fuess quartz spectrograph (model B) were used.

The intensity of the magnetic field was varied gradually, from zero to 350, 1270, 2300, 3750 and 5570 gausses successively. The spectra of $SbCl_5$ emitted under these magnetic fields were taken one above the other on a photographic plate, an exposure of 75 minutes being given to each spectrum. Enlargements of the spectrograms thus obtained are reproduced in Pl. II, Fig. 7. Fig. 6 represents the spark spectrum of antimony, spark, super-spark and super-super-spark lines being marked with one, two and three dots respectively according to the result of Kimura and Nakamura[1].

Now, as is easily seen from Fig. 7, spark lines of antimony, for example, $\lambda\lambda$ 3241, 3041, 2981 and 2966, are developed in all the spectra with nearly equal intensities. Super-spark lines at $\lambda\lambda$ 2913, 2791, 2671 and 2617 are very faint or not developed in the spectrum taken under the lowest field, but strongly increased in intensity as the field intensity was strengthened. Super-super-spark lines, $\lambda\lambda$ 2857, 2741 and 2632, however, are seen only in the spectrum taken under the highest magnetic field. Thus we can easily sort out the lines into spark, super-spark and super-super-spark by this method, and the result thus obtained coincides perfectly with that of Kimura and Nakamura. This shows that by this method also the lines of gaseous elements can be classified into arc, spark, super-spark ones etc.

Using the same tube mentioned above, we then proceeded to see the influence of the variation of the capacity and self-induction in a discharge circuit upon the spectrum. The capacity or the self-induction were varied step by step, and the corresponding spectra were taken. Figs. 8 and 9 in Pl. II represent the spectra thus obtained by changing the capacity and self-induction respectively, exposure times, as shown in Figs., being so regulated that certain lines behaving similarly

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1 Loc. cit.

would be impressed with nearly equal blackness in all the spectra. By examining the behaviours of the lines in these spectra, the lines were easily classified into three classes and they corresponded exactly to the spark, super-spark and super-super-spark lines of antimony determined already by the first method.

Thus the three methods mentioned above were ascertained to give the same result, and we then proceeded to investigate the spectra of iodine, bromine and chlorine employing these methods. The results so far obtained will be described below.

Results

(I) Iodine

The tube used was of the form similar to the $SbCl_5$ tube (diameter of the capillary was 1.1 mm.), but with electrodes of potassium iodide. During the evacuation of the tube, heavy discharges were sent through and the walls of the tube were highly heated. After such treatment, the tube was sealed off from the pump when the iodine vapour got a suitable pressure. When the intensity of the magnetic field was increased gradually, the colour of the glow changed from yellowish orange to bluish green. The same phenomenon was also observed in the experiments in which the capacity and the self-induction were varied. The photograms obtained are reproduced in Pl. III. Figs. 10, 11 and 12 represent the spectra taken varying the imtensity of the magnetic field, the capacity and the self-induction respectively, exposure times being also given in the figures.

Iodine lines were sorted out into four classes. The intensities of lines of the first class were suppressed when the field intensity or capacity was increased, and also when the self-induction was reduced. These lines correspond to the arc lines (I I) classified already. Lines belonging to the second class, as will be seen in the reproduction, at $\lambda\lambda$ 2730, 2689, 2675, 2611, 2583, 2566, 2461 and 2408, have nearly equal intensities in all the spectra. Lines of the third class, for example, $\lambda\lambda$ 2949, 2873, 2837, 2759, 2705 and 2344, are very faint or missing in the lowest spectrum, but their intensities increase gradually in the upper spectra as can easily be seen in the photograph. Typical lines of the fourth class are $\lambda\lambda$ 3005, 2918, 2547, 2520 and 2426. They are not developed in the lower spectra, but they appear in the third or the fourth one, their intensities increasing so rapidly that lines of this class can be easily differentiated from those of the third class.

The lines belonging to these classes are regarded as the spark (I II), super-spark (I III) and super-super-spark (I IV) spectrum of iodine respectively. The results thus obtained are recorded in the fifth column of Table I.

While the present experiment was going on, L. and E. Bloch[1], employing a method of an electrodeless discharge, sorted out the spark lines into I II, I III and I IV. Coincidence of my result with Bloch's is perfect with respect to the spark lines. But their selection of arc lines seems to be unsatisfactory.

(II) Bromine

Tubes similar to that used in the study of iodine were employed, potassium bromide being used as the electrodes. The experiment being conducted quite similarly to the case of iodine, BrI, BrII, BrIII and BrIV (unfortunately the wave-lengths of lines of this class were not measured) were easily selected out. The result is recorded in the fifth column of Table II, and compared with that obtained by L. and E. Bloch[2]. These two results are in harmony with respect to the spark lines.

(III) Chlorine

Similar tubes to the above (capillary diameter about 0.7 mm.) were employed, sodium chloride being used as the electrodes. The pump was operated while the spectrograms were being taken.

Intensity of Magnetic Field	Exposure Time
8,000 gausses	55 minutes
3,950 "	62 "
2,300 "	75 "
680 "	92 "
0 "	105 "

In a preliminary experiment, the same exposure was given to each spectrum taken under different magnetic fields, but the results were unsatisfactory until the exposure times were so regulated that similarly behaving lines would be impressed on a photographic plate with nearly equal intensities in every spectrum. The exposure times thus adjusted are shown in the foregoing table, with the corresponding field intensities.

1 Ann. de Physique, **11**, 141 (1929)
2 Ann. de Physique, **7**, 207 (1925), and **9**, 554 (1928)

Chlorine lines were sorted out as arc, spark and super-spark lines, no super-super-spark line of chlorine being found; such lines would perhaps not be emitted under the excitation used in the present experiment. It may be worthy of mention that a greater amount of energy seems to be required to excite spark lines of chlorine, especially of Cl III and Cl IV, than those of iodine and bromine.

The result obtained is shown in the fifth column of Table III. Comparing this with the results of Paschen[1] and L. and E. Bloch[2], coincidence of these three is perfect in regard to the spark lines.

Summary of the Results

Besides the lines listed above as arc type, there may be combination lines whose emission is forbidden by the selection principle. Such lines may, in general, be emitted in a strong electric or magnetic field, and hence they may also behave in a manner similar to spark lines. It seems, however, to be difficult to distinguish these lines from the spark ones by our methods. Therefore, such lines, if excited, may have been included in spark lines in Tables I, II and III.

Examining the results obtained minutely, the following facts seem to be established.

(1) These halogen elements, chlorine, bromine and iodine, have a number of arc lines in the visible region; no arc line could be found in the ultra-violet region examined except intense lines of iodine at $\lambda\lambda$ 2062, 1876, 1845 and 1830.

(2) On the contrary, spark lines emitted by singly ionized atoms of these elements are distributed all over the entire region investigated.

(3) Super-spark lines due to doubly ionized atoms are found chiefly in the ultra-violet region, super-super-spark lines lying generally in the more refrangible side.

(4) The modes of broadening of the lines of these elements observed already by the present author[3] are shown in the seventh column of Tables I, II and III, in which 1), 2) and 3) denote the first, second and third type of the broadening respectively. As can easily be seen in the tables, lines of the first type all belong to the arc spectrum, while those of the second and third types belong to the spark one. Nearly all lines of the third type, which suffered large shifts when

1 Ann. d. Phys., **71**, 559 (1923)
2 Ann. de Physique, **8**, 397 (1927), and **11**, 554 (1928)
3 These Memoirs, **10**, 15 (1925), and Japanese Journ. Phys., **4**, 85 (1927)

the pressure of the gas and the current density were increased, belong to the spark spectrum of the first order. The remaining few of this type are the super-spark or super-super-spark lines, but the displacements of such lines are, in general, comparatively small.

In conclusion, the writer wishes to express his hearty thanks to Prof. M. Kimura, under whose direction this work was done.

Table I, Iodine

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
6585.0	3 : 5	2 : 5	—	S II	. 9)
83.2	2 : 0	2 : 0	—	A I	5) 8)
38.3	0 : 2	0 : f	—	S III	5) 10)
16.1	1 : 3	0 : 3	—	S II	2) 9)
6488.1	2 : 1	1 : 0	—	A I	5) 9)
76.0	0 : 1	—	—	S III	. 10)
40.2	0 : 1	0 : f	—	S III	. 10)
6359.1	2 : 1	1 : 0	—	A I	5) 8?)
39.5	4 : 2	4 : 2	—	A I	2) 5) 8?)
20.9	0 : 1	0 : 1	—	S III	. 10)
13.1	1 : 0	f : 0	—	A I	5)
6296.4	2 : 0	1 : 0	—	A I	5)
93.9	3 : 0	2 : 0	—	A I	5) 8)
91.3	0 : 4	0 : 4	—	S II	3) 9)
80.3	0 : 2	0 : 2	—	S II	3) 5) 8?)
76.8	0 : 1	f : 1	—	S II	3) 5) 8?)
68.5	0 : 3	0 : 1	—	S III	3) 10?)
57.4	2 : 6	1 : 7	—	S II	2) 9)
55.5	2 : 4	1 : 5	—	S II	2) 9)
50.6	0 : 3	0 : 2	—	S II	2) 9)
44.3	3 : 0	2 : 0	—	A I	5) 8)
36.3	0 : 3	0 : 1	—	S III	. 10)
33.2	1 : 0	f : 0	—	A I	5)
32.9	0 : 2	0 : 1	—	S II	. 10)
29.2	0 : 1	—	—	S III	. 10)
13.0	2 : 0	1 : 0	—	A I	5)
04.7	3 : 6	2 : 6	—	S II	2) 9)
00.4	0 : 2	0 : 1	—	S III	2) 10)

1……Tube I, w……Wide, c……Capillary.
2……Tube II, W……Weak, H……Heavy.
3……Spark, C……Capacity, L……Self-Induction.
A……Arc Type, S……Spark Type.
I: Arc Line, II: Spark Line, III: Super-Spark Line, IV: Super-Super-Spark Line.

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
6195.5	0 : 3	0 : 2	—	S III	2)10)
91.6	2 : 0	1 : 0	—	A I	5) 8)
61.9	1 : 3	0 : 3	—	S II	2) 9)
49.0	1 : 3	f : 3	—	S III(?)	2)10)
32.9	0 : 1	0 : 1	—	S III	. 10)
27.4	3 : 8	3 : 8	—	S II	2) 9)
6086.8	0 : 2	0 : 1	—	S —	2)10)
84.7	0 : 3	0 : 3	—	S III	2) 9)
82.3	6 : 3	4 : 1	—	A I	5) 8?)
78.2	0 : 2	0 : 2	—	S II	. 9)
74.9	3 : 6	3 : 6	—	S II	2) 9)
68.8	1 : 4	1 : 5	—	S II	2) 9)
53.0	1 : 0	1 : 0	—	A I	5)
48.4	0 : 1	f : 1	—	S(?) —	5) 8?)
43.9	1 : 3	0 : 3	—	S II	. 10)
36.5	0 : 1	0 : 1	—	S —	5)10)
23.9	2 : 0	2 : 0	—	A I	5) 8)
15.8	0 : 3	0 : 2	—	S III	. 10)
07.6	0 : 2	0 : 1	—	S III	. 10)
5980.5	1 : 0	1 : 0	—	A I	5)
67.7	1 : 0	f : 0	—	A I	5)
50.1	6 : 10	5 : 10	—	S II	2) 9)
20.7	1 : 5	1 : 5	—	S II	2?) 9)
5893.8	5 : 4	4 : 3	—	A I	1) 5)8?)
75.1	0 : 2	0 : 1	—	S III	. 10)
32.7	1 : 0	1 : 0	—	A I	5)10)
30.0	0 : 3	0 : 2	—	S III	. 10)
19.6	1 : 4	0 : 4	—	S II	. 9)
5793.0	0 : 1	0 : f	—	S(?) —	5) 9)
87.1	1 : 6	0 : 6	—	S II	. 9)
80.4	1 : 0	1 : 0	—	A I	5)
74.7	6 : 10	5 : 10	f : 1	S II	2) 9)
64.3	3 : 1	3 : 0	—	A I	5) 9)
60.8	3 : 7	3 : 7	—	S II	2) 9)
39.5 } 38.5 }	5 : 10	6 : 12	f : 1.5	S II	2) 9) 2) 9)
10.43	4 : 10	5 : 10	f : 3	S II	2) 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 w : c	2 W : H	3 C+L : C	Types	Remarks
5702.07	1 : 4	1 : 5	—	S II	2?) 9)
5690.96 90.89	4 : 10	4 : 10	f : 1	S II	2) 9)
79.9	0 : 1	0 : 2	—	S —	. 9)
78.15 78.06	4 : 10	4 : 10	—	S II	2) 9)
73.7	0 : 3	0 : 1	—	S III	. 10)
43.4	1 : 5	1 : 5	0 : f	S II	. 9)
25.66	6 : 13	6 : 12	1 : 2	S II	2) 9)
12.82	3 : 5	3 : 5	—	S II	2) 9)
03.2	1 : 3	1 : 3	—	S II	. 9)
00.21	3 : 6	3 : 6	0 : f	S II	. 9)
5598.68 98.55	2 : 6	3 : 6	0 : f	S II	2) 9)
93.09	2 : 4	2 : 4	—	S II	2) 9)
90.3	0 : 2	1 : 3	—	S II	. 9)
86.3	3 : 1	3 : f	—	A I	5) 8?)
68.7	0 : 3	0 : 3	—	S II	. 9)
51.7	2 : 5	2 : 6	0 : 1	S II	2) 9)
46.4	1 : 2	1 : 2	—	S III	. 9)
22.1	2 : 4	3 : 6	—	S II	2) 9)
04.77	4 : 8	4 : 8	f : 1	S II	2) 9)
01.00	1 : 0	1 : 0	—	A I	5)
5497.08 96.96 .85 .79 .73	6 : 15	6 : 15	1 : 4	S II	2) 9)
93.45 .05	1 : 8	1 : 8	0 : f	S II	3) 9)
91.52	3 : 8	2 : 8	0 : f	S II	3) 9)
79.55	1 : 5	0 : 5	—	S II	. 9)
68.1	0 : 2	0 : 3	—	S —	. 9)
64.77	8 : 20	8 : 20	2 : 4	S II	2) 9)
57.1	1 : 4	1 : 4	—	S II	.
49.0	0 : 1	0 : 1	—	S III	. 10)
37.97	4 : 8	3 : 8	—	S II	2) 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
5435.80	6 : 10	6 : 10	—	S II	2) 9)
27.4	3 : 2	3 : 2	—	A I	1) 5) 10)
22.71	2 : 5	1 : 5	—	S II	3) 9)
21.97	0 : 3	0 : 3	—	S II	. 9)
15.0	0 : 3	f : 3	—	S II	. 9)
11.7	0 : 1	0 : 1	—	S III	. 10)
07.35	6 : 12	6 : 12	0 : 2	S II	2) 9)
05.59 .38 .23 .11	6 : 16	6 : 14	1 : 3	S II	2) 9)
5380.1	1 : 4	f : 4	—	S II	2?) 9)
74.5	0 : 1	0 : 1	—	S(?) —	5) 8)
72.5	0 : 3	0 · 3	—	S II(?)	2?) 9)
69.75	4 : 10	4 : 10	0 : f	S II	2) 9)
67.5	0 : 3	1 : 4	—	S II	. 9)
56.0	0 : 1	1 : 2	—	S III	. 10)
51.9	0 : 2	1 : 3	—	S II	2?) 9)
49.7	0 : 3	0 : 3	—	S II	2?) 9)
45.17	6 : 18	6 : 18	f : 2	S II	2) 9)
38.20	6 : 18	6 : 18	f : 2	S II	2) 9)
26.4	1 : 4	1 : 4	—	S II	2?) 9)
22.71	3 : 5	3 : 5	—	S II	2) 9)
14.6	0 : 1	0 : 1	—	S III	. 10)
09.0	1 : 3	1 : 3	—	S III(?)	2) 10)
04.3	0 : 1	f : 2	—	S(?) —	5) 8?)
5299.68	2 : 5	2 : 5	—	S II	2) 9)
96.7	0 : 2	1 : 3	—	S II	2?) 9)
88.7	1 : 3	1 : 4	—	S II	. 9)
69.36	4 : 8	4 : 8	0 : f	S II	2) 9)
66.8	0 : 2	0 : 2	—	S II	. 9)
65.27 .15	3 : 6	3 : 6	—	S II	2) 9)
45.65	6 : 10	6 : 10	0 : f	S II	2) 9)
34.58	4 : 2	4 : 1	—	A I	1) 4) 5) 8)
28.93	2 : 5	2 : 5	—	S II	2?) 9)
16.22	4 : 9	4 : 9	—	S II	2) 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities						Types	Remarks
	1		2		3			
	w	c	W	H	C+L	C		
5214.04	1 : 5		1 : 5		—		S II	2) 9)
05.5	0 : 3		0 : 4		—		S II	. 9)
04.08	3 : 1		4 : 0		—		A I	4) 5) 8)
5198.9	0 : 3		0 : 3		—		S III	2) 10)
89.4	0 : 3		0 : 3		—		S II	. 9?) 10)
86.3	1 : 0		—		—		A(?) —	5)
85.14	3 : 7		1 : 6		—		S II	3) 9)
78.1	2 : 4		1 : 4		—		S III	2) 10)
61.20	8 : 30		10 : 30		1 : 3		S II	2) 9)
56.4	2 : 5		1 : 5		—		S II	3?) 9)
54.9	0 : 2		0 : 3		—		S II(?)	3?) 9)
49.7	2 : 5		2 : 5		—		S II	2?) 9)
47.4	1 : 4		1 : 4		—		S II	2) 9)
36.1	0 : 1		0 : 1		—		S II	5)
31.3	1 : 3		1 : 4		—		S II	2) 9)
24.6	0 : 1		0 : 3		—		S II	2) 9)
19.32	5 : 3		5 : 1		f : 0		A I	1) 4) 5) 8)
14.44	0 : 3		0 : 3		—		S III	2) 10)
5098.8	0 : 1		0 : 1		—		S III(?)	.
68.2	0 : 1		0 : 1		—		S —	5) 8?)
65.5	3 : 6		3 : 6		—		S II	2) 9)
61.9	1 : 4		1 : 4		—		S II	2) 9)
57.4	0 : 1		0 : 1		—		S III	. 10)
48.1	0 : 1		0 : 1		—		S —	5)
46.4	2 : 4		2 : 4		—		S II	2) 9)
36.1	0 : 3		0 : 3		—		S III	. 10)
32.3	0 : 1		f : 1		—		S(?) —	5)
28.8	1 : 4		1 : 4		—		S II	. 9)
08.4	1 : 4		1 : 4		—		S II	. 9)
4992.2	1 : 3		0 : 3		—		S II	2)
86.95	4 : 10		4 : 8		0 : 2		S II	2) 9)
84.4	0 : 2		f : 3		—		S II	2)
74.5	0 : f		—		—		— —	5)
68.33	2 : 5		2 : 5		—		S II	2) 9)
65.7	0 : 2		0 : 3		—		S II	.
57.6	1 : 5		1 : 4		—		S II	3) 9)
43.1	2 : 5		1 : 4		—		S II	3) 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	2 (W : H)	3 (C+L : C)	Types	Remarks
4938.6	0 : 2	0 : 2	—	S III	·
29.9	0 : 3	0 : 2	—	S II	·
24.4	0 : 2	1 : 2	—	S II	·
16.94	6 : 4	6 : 2	f : 0	A I	1) 4) 5) 8)
10.3	0 : 3	0 : 3	—	S II	· 9)
08.5	0 : 3	0 : 3	—	S II	2) 9)
02.2	1 : 0	1 : 0	—	A I	5)
4896.72	4 : 3	4 : 1	—	A I	1) 5) 8)
91.3	0 : 3	0 : 2	—	S III	· 10)
87.7	1 : f	1 : f	—	A(?) —	5)
83.7	2 : 7	2 : 7	—	S II	2) 9)
81.6	1 : 5	1 : 4	—	S II	2) 9)
64.5	1 : 5	1 : 5	—	S II	· 9)
62.33	20 : 10	20 : 10	1 : 0	A I	1) 5) 8?)
53.1	1 : 4	f : 4	—	S II	3?) 9)
50.4	4 : 10	4 : 10	—	S II	2) 9)
35.1	2 : 5	2 : 5	—	S II	3?) 9)
28.3	3 : 6	3 : 6	—	S II	2) 9)
08.0	0 : 4	f : 4	—	S II	2?) 9)
06.4	3 : 6	4 : 6	—	S II	2) 9)
4799.8	0 : 1	0 : 1	—	S III	2?) 10)
90.9	1 : 3	1 : 3	—	S II	3?) 9)
88.2	1 : 4	2 : 4	—	S III	2) 9)
87.2	1 : 4	1 : 5	—	S II	2?) 9)
82.5	—	f : 0	—	A(?) —	5)
75.8	0 : 1	0 : 1	—	S II	5) 9)
73.1	0 : f	0 : f	—	S III	5) 10)
68.2	1 : 6	1 : 7	—	S III&II	3?) 9)
65.7	0 : 5	0 : 5	—	S II	· 9)
63.4	5 : 6	5 : 6	—	A&S I&II	2) 9)
52.7	1 : 4	1 ; 4	—	S II	2) 9)
42.9	1 : 3	1 : 3	—	S II	· 9)
37.1	0 : 1	0 : 1	—	S II	·
30.5	2 : 6	2 : 6	—	S III&II	3) 9)
26.3	1 : 2	2 : 3	—	S II	5) 8?)
22.1	1 : 2	1 : 2	—	S II	5)
11.7	1 : 4	1 : 4	—	S II	· 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 w	1 c	2 W	2 H	3 C+L	3 C	Types		Remarks
4707.9	1	4	1	4	—		S	II	. 9)
02.5	0	2	1	3	—		S	II	. 9)
00.8	1	0	1	0	—		A	—	.
4691.1	0	2	0	1	—		S	—	5)
* 90.62	1	f	2	1	—		A	I	. 8?)
87.3	0	3	1	3	—		S	—	5) 8?)
76.5	3	8	2	8	—		S	II	3)
75.5	6	10	6	12	0	f	S	II	2) 9)
66.5	5	12	6	12			S	II	3) 9)
63.8	1	3	0	3	—		S	III	3) 10)
57.4	1	5	2	5	—		S	II	3) 9)
40.7	4	10	4	8	f	2	S	II	3) 9)
34.8	0	4	0	4	—		S	III	3) 10)
32.4	6	10	5	10	f	2	S	II	2) 9)
22.11	4	6	4	6			S	II	3) 9)
11.46	2	5	1	5	—		S	II	2) 9)
00.04	3	6	3	6	—		S	II	3)
4597.05	0	3	0	3	—		S	III	3) 9)
91.19	2	4	2	4	—		S	II	3) 9)
86.85	2	4	1	4	—		S	II	3) 9)
80.13	0	3	1	3	—		S	III	2) 10)
76.82	2	6	2	5	—		S	II	3) 9)
74.44	2	8	1	6	—		S	II	3) 9)
71.68	0	3	f	3	—		S	II	2) 9)
60.99	1	3	f	3	—		S	II	2) 9)
58.16	0	3	0	3	—		S	III	2) 10)
44.26	2	5	2	5	—		S	II	3) 9)
40.94	1	3	1	3	—		S	II	2) 9)
28.29	0	4	0	3	—		S	III	2) 10)
12.80	0	5	0	4	—		S	III	2) 10)
4499.86	f	5	1	4	—		S	II	3?) 9)
96.21	f	5	1	4	—		S	II	. 10)
95.94					—				. 9)
88.82	1	8	2	6	0	f	S	II	2) 9)
87.69	0	3	f	3	—		S	II	. 9)
81.11	0	2	f	3	—		S	—	2?) 10)
* 78.60	3	2	4	2	—		A	I	. 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 w	1 c	2 W	2 H	3 C+L	3 C	Types		Remarks
4476.22	f	10	3	8	—		S	II	3) 9)
73.69	2	12	5	10	0	1	S	II	2) 9)
64.58	3	12	4	9	0	1	S	II	2) 9)
63.05	2	5	1	4	—		S	II	2) 9)
58.66	f	5	1	4	—		S	II	3?) 9)
56.87	2	8	2	7	0	f	S	II	2?) 9)
53.17	3	18	6	18	0	1	S	II	3) 9)
51.39	f	3	f	2	—		S	II	2?) 9)
46.96	1	8	4	8	0	f	S	II	3?) 9)
45.04	2	12	6	12	0	1	S	II	3) 10)
42.84	2	8	4	7	0	f	S	II	2) 9)
34.43	0	1	0	3	—		S	III	3) 10)
31.89	0	1	f	3	—		S	III	3) 10)
28.41	1	8	5	8	—		S	II	3) 9)
23.98	2	12	8	12	0	f	S	II	3) 9)
22.27	1	5	3	6	—		S	II	3) 9)
17.47	f	3	f	4	—		S	II	. 9)
16.95	f	8	3	8	—		S	II	3?) 9)
12.62	2	5	4	8	—		S	II	3) 9)
10.26	3	15	8	15	0	f	S	II	3)
* 07.83	2	1	3	2	—		A	I	.
04.60	0	3	1	3	—		S	II	. 9)
03.72	3	6	4	6	0	f	S	II	2) 9)
4399.15	2	6	5	8	—		S	II	3) 9)
94.83	0	3	1	3	—		S	III	. 9)
88.77	f	5	2	4	—		S	II	2) 9)
76.34	3	8	6	10	—		S	II	3) 9)
62.62	f	6	3	6	—		S	II	3) 9)
42.25	2	7	6	10	0	f	S	II	3) 9)
22.92	1	5	2	6	0	f	S	II	3?) 9)
* 21.92	8	5	9	5	f	0	A	I	. 9)
17.25	f	4	1	4	—		S	III	2)
4296.51	f	7	2	6	—		S	II	3) 9)
92.14	1	7	3	8	—		S	II	3) 9)
88.32	f	6	0	3	—		S	II	2) 9)
82.12	f	7	2	6	—		S	II	3) 9)
73.75	0	2	0	1	—		S	—	.

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1	Relative Intensities 2	Relative Intensities 3	Types	Remarks
	w : c	W : H	C+L : C		
4271.75	0 : 4	1 : 4	—	S II	2?)10)
63.91	0 : 4	f : 4	—	S III	2?)10)
60.32	0 : 4	f : 3	—	S II	. 9)
59.18	0 : 4	f : 4	—	S III	2?)10)
40.81	0 : 6	f : 3	—	S II(?)	2?) 9)
35.65	6 : 15	6 : 15	0 : f	S II	2) 9)
* 34.59	1 : f	2 : 1	—	A I	. 9)
25.65	2 : 5	3 : 6	—	S II	2) 9)
23.54	0 : 3	f : 4	—	S II	2?)10)
21.24	f : 5	4 : 7	—	S III	2)10)
19.43	f : 7	3 : 6	—	S II	. 9)
* 08.98	1 : 0	1 : f	—	A I	.
4174.02	2 : 6	3 : 8	—	S II	2) 9)
70.57	0 : 3	f : 4	—	S III	2,10)
* 48.37	4 : 3	5 : 3	—	A I	.
45.87	0 : 2	0 : 2	—	S III	2)10)
38.14	0 : 4	0 : 3	—	S III	2) 9)
36.45	0 : 3	0 : 4	—	S III	2)10)
* 34.11	5 : 2	6 : 3	—	A I	.
33.38	0 : 3	0 : 2	—	S III	2)10)
* 29.15	8 : 5	9 : 5	—	A I	.
28.85	0 : 5	2 : 5	—	S III	2)10)
26.30	0 : 2	0 : 2	—	S III	. 9)
20.46	0 : 2 (bracketed with next line)	0 : 1 (bracketed with next line)	—	S III (bracketed with next line)	.
20.15			—		. 9)
16.80	0 : 2	0 : 2	0 : f	S II	. 9)
08.39	0 : 3	0 : 3	f : 1	S III	2)10)
03.22	1 : 3 (bracketed with next line)	0 : 3 (bracketed with next line)	1 : 2 (bracketed with next line)	S II (bracketed with next line)	.
03.09					. 9)
4093.60	0 : 3	0 : 3	—	S III	2)10)
70.87	f : 5	f : 5	2 : 3	S III	2)10)
56.32	0 : 2	0 : 3	0 : 1	S III	2)10)
49.96	0 : 3	0 : 3	f : 1	S III	2)10)
44.01	f : 3	f : 2	f : 1	S II	2) 9)
42	0 : 2	0 : 2	f : 1	S III	. 10)
36.20	1 : 3	1 : 4	1 : 2	S II(?)	2) 9)
32.14	0 : 3	0 : 3	f : 1	S III	2)10)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	2 (W : H)	3 (C+L : C)	Types	Remarks
4025.16	o : 4	o : 3	f : 1	S III	2) 10)
17.44	o : 3	o : 2	o : f	S III	2) 9)
14.15	o : 2	o : 2	—	S II	.
3984.05	f : 5	f : 5	2 : 3	S III	2) 10)
72.99	f : 2	1 : 5	1 : 2	S II	2?) 9)
65.89	1 : 4	1 : 5	1 : 2	S II	2) 9)
63.60	o : 3	o : 2	f : 1	S III	.
63.26					. 11)
54.28	o : 1	o : 1	—	S —	.
50.08	o : 3	o : 3	f : 1	S III	2) 10)
42.52	1 : 3	f : 2	—	S III	. 9)
40.22	1 : 6	1 : 8	4 : 6	S III	2) 10)
38.29	o : 3	o : 3	f : 1	S III(?)	2) 10)
37.37	1 : 2	1 : 3			2?) 9)
31.25	2 : 7	1 : 7	4 : 5	S III	2) 10)
24.34	o : 2	o : 2	o : f	S II(?)	. 9)
15.35	f : 3	f : 3	f : 1	S II	. 9)
12.70	o : 3	o : 4	f : 1	S III	2) 10)
07.50	1 : 3	1 : 2	f : 1	S II	2) 9)
05.95	o : 3	o : 2	f : 1	S III	2) 10)
01.33	f : 1	f : 1	—	S II	2) 9)
3897.51	1 : 5	1 : 6	4 : 5	S III	2) 10)
93.19	1 : 3	1 : 3	f : 1	S II	2) 9)
77.40	f : 2	f : 2	o : f	S III(?)	2) 9)
75.94	o : 3	o : 3	o : f	S III(?)	2) 10)
72.15	o : 1	o : 1	—	S II	2) 9)
51.04	f : 3	o : 4	1 : 2	S II	2) 9)
43.17	f : 3	f : 3	o : f	S II(?)	2) 9)
41.21	o : 1	f : 1	—	S —	. 9?)
38.47	o : 3	o : 3	o : f	S III	2) 10)
33.82	f : 3	1 : 4	f : 1	S II	2) 9)
21.62	f : 5	1 : 5	2 : 3	S III	2) 10)
08.36	1 : 6	1 : 6	3 : 4	S III	2) 10)
03.70	o : 3	f : 3	—	S III	. 10)
01.69	o : 1	f : 2	—	S —	.
00.07	o : 2	o : 3	o : f	S III	.
3793.72	o : 1	f : 2	—	S III	. 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 w	1 c	2 W	2 H	3 C+L	3 C	Types		Remarks
3789.55	o	f	o	1	—		S	—	.
81.81	f	3	1	3	o	f	S	III	2)10)
79.54	f	3	f	4	o	f	S	II(?)	. 10)
79.19									2) 9)
74.04	o	4	o	3	o	f	S	III	2?)10)
71.19	o	1	f	2	—		S	—	. 9)
54.76	o	3	o	3	—		S	IV	2)11)
42.38	1	3	2	3	1	2	S	II(?)	2) 9)
42.03	o	2	o	3			S	III(?)	.
34.54	f	2	f	3	1	2	S	II	. 9)
31.23	o	1	f	2	—		S	II	2)
27.44	o	f	f	2	o	f	S	III(?)	.
25.02	f	4	f	5	1	2	S	III	2)10)
16.52	f	1	1	3	o	f	S	II	2)
11.66	o	3	f	4	f	1	S	III	2?)10)
10.16	f	1	1	2	o	f	S	II	.
09.71									2) 9)
02.29	o	2	o	3	o	f	S	III	2?)10)
3696.56	o	f	f	1	—		S	II	3?)
95.92	o	f	o	f	—		S	—	. 9)
92.49	o	f	f	2	o	f	S	II	2) 9)
88.48	f	4	f	5	2	3	S	III	2)10)
86.79	f	4	f	5	2	3	S	III	2)10)
78.90	o	2	o	2	o	f	S	III	2)10)
61.99	f	3	1	4	f	1	S	II	2) 9)
57.34	f	2	1	3	f	1	S	II	2) 9)
51.05	o	f	o	1	—		S	II	. 9)
38.01	o	2	o	3	o	f	S	III	2)10)
27.72	o	f	o	1	o	f	S	II	. 9)
27.00	o	f	o	1	—		S	—	2) 9)
16.10	o	f	o	1	o	f	S	II(?)	2) 9)
14.02	o	f	o	1	—		S	IV	2)11)
07.76	o	2	o	3	f	1	S	III	2)10)
03.27	o	f	o	1	—		S	II	2)
00.88	o	f	o	1	—		S	III(?)	.
00.71					—				.
00.48	o	f	o	1	o	f			2)10)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities						Types	Remarks
	1		2		3			
	w	c	W	H	C+L	C		
3583.45	0	3	f	4	1	2	S III	2)10)
75.94	0	f	f	2	0	f	S II	2) 9)
73.78	0	1	f	2	0	f	S II	2) 9)
61.47	0	3	f	5	f	1	S III	. 10?)
61.32								2)10)
58.26	0	f	0	1	—		S II	2) 9)
52.51	0	f	f	2	0	f	S II	3) 9)
47.07	0	f	0	1	—		S IV	2)11)
36.29	0	f	0	1	—		S II	. 10)
36.15								2) 9)
33.66	0	f	0	1	—		S II	2) 9)
27.12	0	1	f	3	0	f	S II	2) 9)
26.55	0	f	0	1	—		S II	. 9)
16.17	0	f	0	1	—		S II	2) 9)
12.82	0	1	0	2	0	f	S III(?)	2)10)
11.64	0	f	0	1	—		S —	. 9)
3498.15	2	6	1	10	2	3	S III	2)10)
84.10	0	f	0	2	f	1	S II	2)
81.97	1	5	f	9	2	3	S III	2)10)
74.21	0	1	0	2	0	f	S III	3?)10)
61.16	1	3	0	8	1	2	S III	2)10)
47.81	0	1	0	1	0	f	S II	2) 9)
35.16	0	1	0	1	0	1	S II	2) 9)
26.58	—		0	1	—		S —	2) 9)
25.09	1	3	0	3	f	2	S II(?)	2) 9)
14.03	0	2	0	4	f	1	S III	2)10)
01.61	0	f	0	1	—		S II	2) 9)
3384.08	0	f	0	1	—		S II	2) 9)
82.02	0	2	0	4	f	1	S III	2)10)
77.78	0	f	0	1	—		S III	3)10)
74.82	0	1	0	4	f	1	S II(?(	2)10)
60.16	0	f	0	2	f	1	S II	2) 9)
54.71	0	f	0	1	—		S —	.
50.26	1	4	1	8	1	2	S III	2)10)
42.63	1	3	1	9	1	2	S III	2)10)
26.58	0	1	0	1	—		S II	2)10
23.65	0	1	0	1	—		S III	3?)10)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
3321.74	0 : 1	0 : 2	0 : f	S III	2)10)
18.24	0 : f	0 : 1	—	S II	2) 9)
03.17	2 : 8	2 : 10	4 : 6	S III	2)10)
02.55				S II(?)	2) 9)
00.63	0 : 2	0 : 4	f : 1	S IV	2)11)
3295.88	0 : 1	0 : 2	—	S III	. 10)
89.01	0 : 2	0 : 5	6 : 8	S III(?)	2) { 9)
88.44	2 : 10	1 : 16		S III	10)
75.11	1 : 8	0 : 10	4 : 6	S III	2)10)
73.77	0 : 1	0 : 3	—	S III	3?)
73.4			—		. 10)
66.91	0 : 1	0 : 2	0 : f	S III	2)10)
56.58	1 : 2	0 : 3	f : 1	S II	2) 9)
53.95	0 : 1	0 : 3	f : 1	S III	2)10)
44.41	0 : 1	0 : 1	—	S III	3?)10)
35.78	0 : 2	0 : 3	f : 1	S III	. 10)
30.59	1 : 4	0 : 6	2 : 3	S III	2)10)
30.06				S III	2)10)
25.06	0 : 1	0 : 3	0 : f	S IV	2)11)
13.76	0 : 1	0 : 4	f : 1	S III	2)11)
09.71	0 : 1	0 : 3	f : 1	S II	. 9)
00.56	0 : 1	0 : 2	0 : f	S III	2)10)
3195.23	0 : 1	0 : 2	—	S III(?)	. 10)
94.11	1 : 6	1 : 8	4 : 6	S IV	2)10)
86.28	0 : f	0 : f	—	S II	. 9)
81.81	0 : 3	0 : 6	2 : 3	S IV	2)11)
75.29	1 : 2	1 : 3	f : 1	S II	2) 9)
73.36	0 : f	0 : f	—	S II(?)	3?)10)
69.83	0 : f	0 : 1	0 : f	S IV(?)	. 9)11)
61.07	0 : 1	0 : 1	0 : f	S II	. 9)
57.34	0 : 1	0 : 2	f : 1	S II	2)10)
54.48	0 : 3	0 : 4	1 : 2	S IV	.
54.16					2)11)
49.83	f : 2	0 : 3	1 : 2	S III	2)
39.91	1 : 4	0 : 4	2 : 3	S III	3)10)
36.71	f : 1	0 : 1	1 : 2	S II	2) 9)
17.85	f : 2	f : 3	1 : 2	S II	2) 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities						Types		Remarks
	1		2		3				
	w	c	W	H	C+L	C			
3113.27	f	2	0	3	0	1	S	III	3)10)
06.73	0	1	0	1	0	f	S	II	2) 9)10)
03.84	1	2	0	2	f	1	S	III	3)10)
3091.08	1	4	0	5	1	2	S	III	3?)
90.11	—		f	0	—		A(?)	—	.
88.35	1	3	0	5	1	2	S	III	3?)10)
83.00	0	2	0	4	1	2	S	III	3)10)
81.81	2	4	f	4	2	3	S	III	2) 9?)10)
78.91	3	4	3	3	3	4	S(?)	II(?)	2) 9)
78.00	1	3	0	6	1	2	S	III	3)10)
74.00 }	0	2	0	3	f	1	S	III	3)10)
73.65 }									3)
72.55	0	f	0	1	—		S	II(?)	3) 9)10)
69.47	0	1	0	2	0	f	S	III	2)11)
68.37	0	1	0	2	0	f	S	II	3)
64.11	0	2	f	4	f	1	S	III	3)
55.35	2	7	f	8	5	7	S	III	2)10)
38.56	1	3	0	7	2	3	S	III	2)10)
33.42	0	2	0	4	f	1	S	III	2)10)
30.53	1	4	0	6	1	2	S	III	2)10)
21.2	1	4	1	5	3	5	S	II(?)	2)6)9)10?)
19.9	0	f	0	2	—		S	III(?)	. 10)
18.04	—		0	1	—		S	III	3)10)
15.5	0	2	0	4	1	2	S	III	2)10)
13.2 }	0	1	0	3	—		S	III	3)10)
12.6 }									3) 9)
06.9	—		0	1	0	2(?)	S	III	3?)10)
04.76	0	2	0	2	0	2	S	IV	.
00.6	0	2	0	3	0	3	S	III	2) 9)10)
2993.8	2	6	1	5	3	6	S	II	2) 6) 9)
92.6	0	1	0	2	—		S	III	. 10)
91.39	—		0	2	—		S(?)	III	. 10)
88.4	0	4	0	5	1	2	S	III	2) 6)10)
83.3	0	5	f	5	2	4	S	III	3)10)
79.0	0	1	0	2	1	2	S	II	3)10)
78.1	0	2	0	3	1	2	S	III	2)10)
73.7	0	2	0	2	1	2	S	III	3)10)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
2970.74	0 : 5	f : 7	3 : 6	S II	. 9)
69.92				S III	2)10)
58.3				S III	2) 6)10)
57.5	1 : 9	2 : 12	8 : 12	S II	2) 9)
56.2				S II	2) 9)
54.3	0 : 1	0 : 2	0 : 1	S III	2)10)
51.0	0 : 1	0 : 1	—	S III	. 10)
49.0	0 : 7	f : 6	4 : 6	S III	3) 6)10)
42.4	0 : 1	f : 3	—	S II	. 6) 9)
41.6			—	S III	. 10)
37.1	0 : 2	1 : 4	1 : 2	S III	6)10)
36.9					.
34.1	0 : 1	0 : 1	—	S III	3)10)
31.7	1 : 5	2 : 4	1 : 2	S II(?)	2) 6) 9)
30.2	—	0 : 1	0 : 1	S II	. 10)
28.42	0 : 1	0 : 2	0 : 1	S III	2)10)
25.0	0 : 1	f : 2	1 : 2	S II	2) 6) 9)
22.7	0 : 1	0 : 2	0 : 1	S III	. 10)
17.7	0 : 5	0 : 6	3 : 5	S IV	2) 6)10)
15.8	0 : f	0 : 1	0 : f	S II	. 9)10)
06.54	0 : 3	0 : 3	—	S IV(?)	3) 6)10)
02.9	0 : 1	0 : 1	0 : 1	S II	2) 9)
2883.0	0 : 2	0 : 3	1 : 3	S II	2)10)
82.6				S III	6) 9)
78.6	3 : 12	3 : 8	5 : 8	S II	3) 6) 9)
72.8	0 : 6	0 : 5	2 : 6	S III	3) 6)10)
68.7	0 : 2	0 : 3	1 : 2	S III	2)10)
61.8	0 : 1	0 : 2	—	S II	3) 9)
57.5	—	0 : 1	—	S II	. 9)
47.5	f : 4	1 : 6	1 : 3	S III	3)10)
46.9				S II	6) 9)
36.9	0 : 6	0 : 7	2 : 10	S III	6)10)
32.87	0 : 2	0 : 3	f : 2	S III	2)10)
24.8	0 : 3	0 : 3	0 : 1	S III	3) 6)10)
10.0	0 : 3	0 : 3	1 : 3	S III	2)10)
08.5	2 : 6	1 : 5	3 : 6	S II	2) 9)
04.7	—	0 : 1	—	S II	. 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities						Types		Remarks
	1		2		3				
	w	c	W	H	C+L	C			
2799.65	0	4	f	5	0	1	S	III	3)10)
93.5	0	1	0	1	—		S(?)	—	2)10)
90.44	0	1	0	2	—		S	III	3)10)
89.4	f	3	f	3	2	4	S	III	3) 6)10)
80.3	0	1	0	2	0	1	S	III(?)	3)10)
76.1	0	1	0	2	0	1	S	III	3?)10)
74.8	0	2	0	2	0	1	S	III	2?)10)
71.9	0	3	0	3	1	2	S	III	3?)10)
70.7	0	1	0	1	—		S(?)	III	. 9)
65.6	2	5	1	4	1	2	S	IV	3) 6) 9)
65.1							S	II	. 9)
63.2	0	1	0	3	0	1	S	III	2?)10)
59.2	0	3	0	4	f	2	S	III	3)10)
54.7	—		0	1	—		S	III	2)10)
53.5	0	1	0	2	—		S	II(?)	. 9)
51.5	0	2	0	3	0	1	S	III	. 10)
46.50	0	1	0	2	1	2	S	II	2) 9)
44.45	0	1	0	1	—		S	II	2) 9)
38.39	0	1	0	2	—		S	III	2)10)
37.46	0	2	0	2	0	f	S	III	2)10)
32.2	0	1	0	1	—		S(?)	II(?)	. 10)
31.8					—				.
30.1	3	8	3	8	6	10	S	II	2) 6) 9)
24.1	0	2	0	3	1	2	S	III	2)10)
23.04	0	1	0	1	—		S	II	. 9)
19.70	0	1	0	2	0	1	S	II	. 9)
12.2	3	7	1	6	4	8	S	II	2) 6) 9)
08.1	f	4	f	3	1	2	S	II	2) 9)
05.3	0	3	f	3	—		S	III	3)10)
04.5	0	1	0	1	—		S	II	. 9)
01.4	f	3	1	3	0	1	S	II	2) 6) 9)
2698.3	2	5	f	3	1	3	S	II	2) 6) 9)
90.44	0	1	0	2	0	1	S	III	2)10)
88.9	4	10	3	6	7	15	S	II	2) 9)
88.5							S	—	. 6)
74.8	3	8	3	6	5	10	S	II	2) 6) 9)
71.2	0	1	0	1	—		S	II(?)	2) 9)

Table I, Iodine (continued)

Wave lengths	Relative Intensities 1 (w : c)	2 (W : H)	3 (C+L : C)	Types	Remarks
2665.24	f : 2	f : 2	—	S II	. 9)
61.2	0 : 1	0 : 3	0 : 1	S III	. 10)
60.7				S III	2) 10)
59.2	0 : 1	0 : 1	—	S III	2) 10)
55.77	0 : 1	0 : f	—	S II	. 9)
43.3	0 : 2	0 : 2	—	S III	. 10)
41.3	0 : 1	0 : 1	—	S III	. 9)
36.7	2 : 5	2 : 5	2 : 5	S II	3?) 6) 9)
36.2				S II	3?) 9)
32.0	—	0 : 1	—	S II	. 9)
25.0	0 : 3	0 : 3	—	S III	2) 10)
22.9	0 : 1	0 : 2	—	S III	2) 10)
19.84	0 : f	0 : 1	—	S II	2) 9)
17.5	0 : f	0 : 1	f : 1	S III	2) 10)
14.69	0 : 3	0 : 5	1 : 3	S IV(?)	2) 6) 10)
12.9	0 : 1	0 : 1	—	S II	. 9)
10.69	2 : 5	2 : 5	3 : 5	S II	2) 9)
07.3	f : 3	f : 2	1 : 2	S II	2) 9)
05.6	0 : 2	0 : 3	f : 1	S III	2) 6) 10)
05.5					
03.6	—	0 : 1	—	S II	2) 9)
2596.5	0 : f	0 : 1	—	S III	2) 10)
93.4	5 : 12	4 : 8	6 : 10	S II	2) 6) 10)
91.04	0 : 1	0 : 2	0 : 1	S III	2) 10)
88.6	2 : 6	2 : 6	2 : 4	S II	2) 6) 9)
88.09				S II	2) 9)
86.7	2 : 5	2 : 5	2 : 4	S II	2) 6) 9)
84.8	0 : 1	0 : 2	0 : 1	S II	2) 9)
84.7					
82.7	8 : 18	5 : 8	8 : 15	S II	2) 6) 9)
81.57	f : 2	0 : 2	0 : 1	S III	2) 10)
80.71	f : 2	0 : 2	—	S III	2) 10)
75.5	0 : 2	0 : 5	1 : 2	S III	2) 10)
67.48	0 : 3	0 : 6	0 : 3	S III	2) 6)
66.2	6 : 15	4 : 16	6 : 10	S II	2) 6)
64.34	2 : 5	2 : 5	2 : 4	S II	2) 6) 9)
62.4	2 : 4	2 : 4	0 : 1	S II	3?) 6) 9)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	2 (W : H)	3 (C+L : C)	Types	Remarks
2559.7	f : 2	f : 3	0 : 1	S II	2) 9)
59.2				S II	.
57.64	0 : f	0 : f	—	S II	.
54.9	0 : f	0 : 2	—	S III	. 9)
52.41	0 : 1	0 : 2	—	S III	2)
46.7	—	0 : 1	—	S IV	. 10)
42.1	0 : 1	0 : 1	—	S II	. 9?)
40.1	0 : f	f : 1	—	S II	. 9)
37.56	0 : 2	0 : 3	—	S III	2) 11)
34.5	f : 2	f : 2	0 : 1	S II	6) 9)
34.2					9)
33.57	2 : 6	1 : 4	2 : 4	S II	2) 9)
30.94	1 : 3	f : 2	0 : 1	S II	2) 9)
27.7	—	0 : 1	—	S III	. 10)
27.3			—	—	. 10)
26.9	f : 4	f : 5	1 : 2	S III	2) 10)
26.6					. 10)
15.0	0 : 1	0 : 1	|	S II	. 9)
03.6	2 : 6	1 : 4	1 : 3	S —	. 9?)
02.97				S II	2) 9)
2499.6	1 : 4	1 : 4	1 : 3	S III	2) 10)
99.3				S II	2) 9)
94.71	2 : 6	1 : 4	1 : 3	S II	2) 6) 9)
91.61	1 : 3	f : 3	0 : 2	S II	2) 6) 9)
89.8	—	0 : f	—	S II	. 9)
89.1	0 : 2	f : 3	0 : 1	S IV	6) 11)
89.0				—	9)
84.6	0 : 2	0 : 3	0 : f	S III	2) 10)
82.0	—	0 : 1	—	— III	. 9) 10)
71.3	f : 2	f : 2	—	S II	. 9)
69.2	0 : 1	0 : f	—	S II	. 9) 10)
66.7	0 : 1	0 : 1	—	S III	. 11)
65.0	3 : 8	2 : 6	2 : 6	S —	. 10)
64.7				S III	2) 6) 9)
64.1				S II	. 9)
61.1	1 : 4	f : 4	2 : 3	S II	2) 9)
57.3	0 : 1	0 : 2	—	S III	2) 10)

Table I, Iodine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
2454.5	f : 1	f : 2	o : f	S II	2) 9)
50.4	—	o : 2	o : f	S III	. 10)
48.5	o : 1	o : f	—	S II	. 9)
47.8	f : 2	f : 2	1 : 2	S III	3?)10)
44.19	f : 3	f : 3	1 : 2	S II	3?) 9)10)
38.3	}	}	—	S II	. 9)
37.9	o : 1	f : 2	—	S —	. 9)
37.6	}	}	—	S III	2)10)
36.20	o : 2	o : 2	o : f	S III	2)10)
30.92	o : 2	o : 2	—	S III	. 10)
26.2	—	o : 1	—	S IV	. 11)
23.5	} o : 1	} o : 2	} 1 : 2	} S III	} 3?) 10)
23.3	}	}	}	}	} 10)
22.35	o : 1	o : 2	—	S III	3?)10)
19.5	} 2 : 5	} 2 : 6	} 2 : 4	} S II	2)10)
19.3	}	}	}	}	2) 9)
12.51	o : 2	f : 2	1 : 2	S II	3) 9)
11.9	o : f	o : 1	—	S III	. 10)
08.0	f : 3	f : 3	f : 1	S II	2) 9)
04.08	o : 2	o : f	—	S IV(?)	.
2398.2	o : 1	o : 1	—	S II	. 9)
97.25	f : 1	f : 1	—	S II	. 9)
84.05	o : 4	o : 5	o : 2	S II	. 9)
72.2	o : 5	f : 5	1 : 4	S II(?)	. 9)
61.3	o : 3	o : 3	f : 2	S III	. 10)
48.47	f : 2	f : 1	o : f	S II	2) 9)
46.25	o : 3	o : 3	o : 1	S II	2) 9)
44.5	} 2 : 5	} 2 : 3	—	} S III	. 10)
44.3	}	}	—	}	2?)10)
42.38	o : 1	o : 2	—	S II	2) 9)
35.5	f : 3	f : 2	o : 2	S II	2) 9)
34.13	f : 1	f : 1	—	S II	2) 9)
31.6	f : 2	f : 2	o : 1	S II	2) 9)10)
28.4	o : 1	o : 2	o : 1	S III	2)10)
27.4	—	o : 1	o : f	S III(?)	. 10)
20.3	f : 2	f : 2	—	S II	. 9)
2062.1	20 : 3	20 : 3	f : o	A I	7)
1876.4	12 : 2	12 : 2	—	A I	7)
44.5	16 : 3	16 : 3	—	A I	7)
30.4	15 : 3	15 : 3	—	A I	7)

Notes:— 1) The first type of modes of broadening.
2) The second type of modes of broadening.
3) The third type of modes of broadening.
4) Lines disappeared when a capacity was put in the discharge circuit. (Goldstein).
5) Lines sorted out as arc type. (Wood and Kimura).
6) The wave-lengths of these lines were measured also by Cario and Oldenberg. (ZS. f. Phys., **31**, 919 (1925)).
7) The wave-lengths of these lines were measured by Turner.
8) Lines classified as I I. (L. and E. Bloch).
9) Lines classified as I II. (L. and E. Bloch).
10) Lines classified as I III. (L. and E. Bloch).
11) Lines classified as I IV. (L. and E. Bloch).

Table II, Bromine

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
6632.02	2 : 0	4 : 3	2 : 1	A I	4) 7) 9)
6582.52	f : 0	3 : 1	2 : 1	A I	9)
60.17	1 : 0	3 : 1	2 : 0	A I	1) 4) 7) 9)
45.00	1 : 0	3 : 1	2 : f	A I	4) 9)
6353.07	} 6 : 1	} 8 : 5	} 4 : 3	S III(?)	2) 10)
51.02				A I	1) 4) 7) 9)
6204.36	f : 0	3 : f	—	A I	4)
6178.72	f : 0	4 : f	—	A I	.
70.09	f : 1	0 : 2	—	S II	2)
59.60	f : 0	3 : 1	—	A I	4)
49.95	4 : f	7 : 6	3 : 2	A I	1) 4) 7)
42.02	1 : 2	0 : 3	—	S II	2)
23.49	f : 0	5 : 2	—	A I	.
18.89	f : 2	0 : 4	—	S II	2)
6097.05	f : 0	2 : f	—	A I	.
5950.70	2 : 0	3 : 1	—	A I	.
40.83	f : 0	3 : f	—	A I	7)
5871.97	1 : 3	f : 4	—	S II	2) 10)
68.40	0 : f	0 : 1	—	S II	2) 10)
64.55	0 : f	f : 2	—	S II	2) 10)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 w	1 c	2 W	2 H	3 C+L	3 C	Types		Remarks
5852.40	2	0	5	2	f	0	A	I	4) 7) 9)
33.71	f	0	3	0	—		A	I	·
31.04	4	6	3	5	—		S	II	2)10)
5719.17	1	3	f	4	—		S	II	10)
16.50	f	0	1	f	—		A(?)	—	·
11.25	2	3	1	4	—		S	II	10)
5657.83	0	1	0	2	—		S	II	2)10)
27.5	2	f	2	f	—		A	I	1)
22.38	1	2	1	2	—		S	—	10)
21.95					—			II	10)
00.90	f	1	1	2	—		S	II	2)10)
5590.15	8	10	2	5	f	3	S	II	2)10)
88.40			0	3			S	II	3)
45.91	0	1	0	2	—		S	II	2?)10)
36.52	f	0	3	f	—		A	I	·
29.19	f	0	2	0	—		A	I	·
16.87	0	f	0	2	—		S	II	2)10)
11.04	0	f	0	2	—		S	—	·
08.49	2	5	1	3	0	f	S	II(?)	2)10)
06.97	3	6	2	4	0	f	S	II	2)10)
5495.24	4	7	1	6	f	2	S	II	2)10)
89.00	3	6	1	6	f	1	S	II	2)10)
83.20	0	f	0	f	—		S	II	·
81.41	f	1	f	2	—		S	—	2)
80.20	0	f	0	1	—		S	II	
66.43	3	1	4	1	—		A	I	1) 4) 7)
50.28	f	0	2	0	—		A	I	1)
42.55	2	3	f	4	—		S	II	2)10)
35.30	2	4	f	5	—		S	II	2)10)
33.49	f	1	f	2	—		S	II	10)
25.21	2	4	1	6	f	1	S	II	2)10)
23.01	4	6	1	6	f	2	S	II	2)10)
5395.69	2	0	4	2	—		A	I	4) 7) 9)
70.51	1	0	2	f	—		A	I	·
64.38	f	0	2	f	—		A	I	1)
60.99	f	1	f	2	—		S	II	2)
45.53	3	1	3	1	f	0	A	I	4) 7) 9)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 w	1 c	2 W	2 H	3 C+L	3 C	Types	Remarks
5335.30	0	f	0	2	—		S II	2?)
32.18	8	12	5	8	f	5	S II	2) 8)10)
04.31	5	8	3	7	f	2	S II	2) 8)10)
5272.89	2	3	1	4	0	f	S II	2)10)
63.68	2	4	1	4	0	f	S II(?)	2)10)
39.99	1	4	0	3	—		S II	10)
38.47	8	12	5	10	1	6	S II	2) 8)10)
33.65	1	3	f	3	—		S II	10)
27.91	4	6	1	5	0	f	S II	2)10)
5199.50	f	2	0	2	—		S II	2)
94.08	4	8	1	4	f	1	S II	2) 10)
84.07	5	7	1	5	} 2	8	S II	2)10)
82.57	6	8	2	5			S II	8)10)
80.19	1	3	0	3	—		S II	10)
74.09	0	f	0	1	—		S II	.
64.56	5	7	3	6	f	2	S II	2) 8)10)
5054.85	6	10	2	7	f	2	S II	2)10)
38.96	1	5	f	5	—		S II	3)10)
11.00	2	4	0	4	—		S II	2)10)
02.96	—		2	f	—		A(?) —	.
4987.23	1	5	f	5	—		S II	3)10)
79.95	4	f	8	3	f	0	A I	1) 4) 7) 9)
59.51	3	6	1	6	0	f	S II	2)10)
45.77	3	7	2	5	0	f	S II	2)
42.21	1	3	f	3	—		S II(?)	2)10)
30.82	6	10	3	9	0	4	S II	2) 8)10)
28.97	6	10	3	9	0	4	S II	2) 8)10)
26.76	f	3	0	3	—		S II	3)10)
21.39	} 4	7	} 4	6	} 0	f	} S II	10)
21.20							—	.
4867.94	2	5	f	5	} f	1	S II	2) 8)10)
66.85	3	6	2	5			S II	2) 8)10)
60.19	f	1	1	2	—		S II(?)	.
48.99	5	8	2	6	0	1	S II	3)10)
45.20	2	5	1	5	—		S II	3) 8)10)
38.82	2	4	1	4	—		S II	2)10)
18.56	f	4	f	2	—		S II	3)10)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	2 (W : H)	3 (C+L : C)	Types	Remarks
4816.90	6 : 12	3 : 10	2 : 8	S II	2)10)
07.80	f : 0	2 : f	—	A I	11?)
02.54	3 : 5	1 : 4	—	S II	3?)10)
4798.42	f : 0	1 : f	—	A(?) —	.
95.28	1 : 3	0 : 3	0 : f	S II	2)10)
91.99	1 : 2	0 : 2	—	S II	10)
85.64	8 : 16	8 : 16	3 : 10	S II	2)10)
80.52	4 : 1	8 : 3	1 : 0	A I	1) 4) 6) 7) 9)
77.30	0 : 2	1 : 2	—	S II(?)	2) 8)10)
76.61	2 : 6	2 : 5	0 : f	S II	2)10)
74.01	1 : 4	f : 3	—	S II	2)10)
67.28	4 : 7	3 : 5	f : 3	S II	2) 8)10)
66.27	4 : 7	3 : 5		S II	3?)10)
53.05	f : 2	0 : 1	—	S II	10)
52.47	3 : f	5 : 3	f : 0	A I	1) 4) 5) 7)9?)
44.53	1 : 4	f : 3	—	S II	3)10)
42.87	5 : 10	3 : 6	0 : 3	S II	2) 8)10)
35.67	4 : 7	1 : 5	—	S II	3) 8)10)
28.90	2 : 5	f : 4	—	S II	10)
28.49				S II	3) 8)10)
20.56	6 : 12	4 : 8	f : 4	S —	8)10)
19.95				S II	2)10)
05.00	10 : 20	5 : 13	5 : 15	S II	2)10)
01.93	0 : f	f : 1	—	S II	11)
4696.59	2 : 3	1 : 3	—	S II	10)
93.48	5 : 7	3 : 5	f : 1	S II	2)10)
91.42	f : 2	0 : 2	—	S II	10)
78.89	7 : 13	5 : 12	1 : 6	S II	2) 8)10)
73.56	f : 2	0 : 2	—	S II	10)
72.75	4 : 6	2 : 5	0 : f	S II	2)10)
66.42	f : 1	f : 2	—	S II	10)
52.18	4 : 6	1 : 5	0 : f	S II	3?)8)10)
44.17	f : 0	3 : 1	—	A —	8)10)
43.74			—		.
42.35	2 : 4	0 : 3	—	S II	3)10)
29.66	1 : 2	f : 3	—	S II	3?)10)
22.99	5 : 8	3 : 8	f : 1	S II	2) 8)10)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
4614.86	2 : f	5 : 2	f : 0	A I	1) 4) 7) 9?)
05.90	f : 2	f : 2	—	S II	3) 8)10)
01.63	1 : 4	0 : 4	—	S II	3)10)
4597.14	f : 2	0 : 2	—	S II	3?)10)
75.95	1 : 0	5 : 1	—	A I	1) 4) 7) 9?)
58.21	f : 2	0 : 1	—	S II	2?)10)
43.12	2 : 5	2 : 8	} f : 4	S II	2) }8) 10)
42.67	0 : 2	0 : 4		S II	2?) 10)
38.95	f : 3	1 : 5	0 : 1	S II	2)10)
30.21			—		.
30.00	} f : 1	} 1 : 3	—	} A&S I&II	3)
29.78			—		10)
25.82	3 : 0	4 : 2	2 : 1	A I	1) 4) 7) 9)
13.99	} 2 : 0	} 3 : 1	} f : 0	} A I	} 1) 4) 5) 7) 9?)
13.67					
08.29	0 : 2	f : 2	—	S II	2) 8) 10)
4490.68	1 : 0	2 : 1	f : 0	A I	1) 6) 7) 9?)
77.96	5 : 1	6 : 4	3 : 2	A I	1) 4) 7) 9)
72.83	4 : f	4 : 3	2 : 1	A I	1) 4) 7) 9)
71.99	0 : f	0 : 1	—	S(?) —	10)
66.42	} 0 : f	} 0 : f	—	} S(?) —	11)
65.99			—	—	.
60.92	} 0 : 1	} 0 : 2	—	} S —	.
60.39			—	III(?)	3)10)
53.75	0 : f	0 : 2	—	S —	.
41.94	4 : 1	4 : 3	2 : 1	A I	1) 4) 7) 9)
31.13	0 : 1	0 : 3	—	S II	3)10)
25.32	1 : 0	3 : 2	1 : f	A I	1) 7) 9)
23.22	f : 0	1 : 0	—	A(?) —	.
12.66	1 : 0	1 : f	—	A(?) —	.
07.80	f : 3	1 : 5	—	S II	3)10)
05.18	0 : f	f : 2	—	S II	3)10)
4399.87	f : 0	1 : f	—	A I	7)
96.55	1 : 4	0 : 6	—	S II	3)10)
95.10	1 : 4	2 : 5	—	S II	2)10)
91.76	1 : 0	3 : 1	—	A I	6)
86.83	0 : 1	0 : 4	—	S II	3)10)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
4372.20	0 : 1	0 : 4	—	S II	3)10)
* 69.71	1 : 0	1 : 0	—	A I	.
* 68.24	1 : 0	1 : 0	—	A I	.
65.76	8 : 10	5 : 10	1 : 5	S II	2) 8)10)
65.31	—	3 : f	—	A I	1)
51.38	2 : 5	3 : 5	0 : f	S II	10)
07.96	1 : 4	3 : 5	f : 1	S II	3)10)
4297.27	1 : 4	3 : 5	0 : 1	S II	3?)10)
91.54	5 : 8	4 : 8	1 : 4	S II	2) 8)10)
61.44	0 : 1	0 : f	—	S —	3) 8)10)
60.74	0 : 1	1 : 3	—	S II	.
37.00	3 : 6	3 : 6	f : 3	S II	2) 8)10)
30.10	1 : 4	1 : 5	0 : 1	S II	2)10)
24.00	6 : 10	5 : 12	1 : 5	S II	2) 8)10)
22.48	f : 3	2 : 5	—	S II	10)
10.76	0 : f	0 : f	—	S(?) —	.
08.70	0 : 2	f : 3	0 : f	S II	2)10)
06.23	0 : 2	f : 3	—	S II	10)
02.64	1 : 0	2 : 0	f : 0	A I	.
01.46	0 : 3	0 : 3	—	S II	10)
4193.62	3 : 6	3 : 5	} f : 4	S II	} 2) 8)10)
93.34	f : 3	f : 4	}	S II	} 2) 10)
79.76	4 : 8	4 : 10	1 : 8	S II	2) 8)10)
75.92	1 : 0	3 : 2	—	A I	1) 9?)
60.14	0 : 3	1 : 6	—	S II	3?)10)
57.54	0 : 3	f : 3	—	S II	2)
* 57.30	1 : 0	1 : 0	—	A I	.
57.23	0 : 2	1 : 4	—	S II	2)10)
51.52	0 : 1	0 : 3	—	S II	2)10)
44.12	f : 0	1 : f	—	A I	1) 5)10?)
40.37	2 : 6	3 : 8	0 : 2	S II	2) 8)10)
38.78	0 : 1	f : 4	—	S II	3?)10)
35.79	2 : 6	2 : 6	0 : 1	S II	2) 8)10)
18.81	1 : 4	1 : 4	} 1 : 2	S II	2)10)
17.69	1 : 4	1 : 4	}	S II	3?) 8)10)
10.20	1 : 5	1 : 5	f : 1	S II	2)10)
06.60	f : 1	f : 1	0 : f	S II	2)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
4106.52	f : 1	f : 2	o : f	S II	2)10)
05.66	o : 2 (for 05.66 and 05.06)	f : 1	—	S II	2)10)
05.06		f : 2	—	S II	10)
02.72	1 : 3	f : 3	o : f	S II	2)10)
4098.07	o : 2	o : 2	—	S II	2)10)
96.22	1 : 2	f : 2	—	S II	3?)10)
90.76	o : 1	o : 2	o : f	S II	2)10)
89.36	f : 2	f : 2	—	S II	10)
* 77.68	2 : 1	2 : 1	—	A I	.
75.70	2 : 6	1 : 6	f : 1	S II	3)10)
72.30	1 : 3	f : 3	o : f	S II	2)
63.77	2 : 4	f : 4	1 : 2	S II	2)10)
46.74	o : 2	o : 2	—	S —	.
37.51	o : 1	o : 1	—	S II	3)
* 36.70	2 : 1	2 : 1	—	A I	.
36.61	1 : 3	1 : 4	o : f	S II	3)10)
* 24.48	1 : o	1 : o	—	A I	.
24.19	3 : 6	1 : 6	2 : 3	S II	3)10)
* 21.66	3 : 2	3 : 2	2 : 1	A I	.
* 18.21	2 : 1	2 : 1	—	A I	.
* 12.41	1 : o	1 : o	—	A I	.
08.92	3 : 6	2 : 6	1 : 2	S II	3)10)
07.44	o : 1	f : 3	f : 1	S II	3)10)
05.78	f : 2	1 : 3	f : 1	S II	3)10)
01.58	f : 2	f : 4	o : f	S II	3)10)
3999.74	1 : 4	f : 3	—	S II	3)10)
* 98.93	1 : o	1 : o	—	A I	.
97.22	1 : 2	1 : 3	—	S II	3)10)
94.01	o : 1	o : 3	—	S II	3)10)
* 92.26	5 : 3	6 : 4	2 : 1	A I	10)
* 87.70	2 : 1	2 : 1	—	A I	.
86.70	4 : 8	4 : 10	2 : 3	S II	2)10)
* 82.74	1 : o	1 : o	—	A I	.
80.57	6 : 2 (for 80.57 and 80.18)	6 : 12	5 : 8 (for 80.57 and 80.18)	S II	3)10)
80.18		o : 3		S II	3)10)
70.75	f : 2	1 : 3	—	S II	3)10)
68.81	2 : 6	2 : 4	o : f	S II	3)10)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	2 (W : H)	3 (C+L : C)	Types	Remarks
3955.49	3 : 7	2 : 7	2 : 3	S II	3)10)
50.74	2 : 5	1 : 7	2 : 3	S II	3)10)
47.11	f : 3	0 : 3	f : 1 (47.11 and 46.80)	S II (47.11 and 46.80)	3)10)
46.80	0 : 3	0 : 3			3)10)
44.73	f : 2	0 : 2	—	S —	10)
39.83	2 : 5	1 : 4	1 : 2	S II	3)10)
38.80	f : 4	1 : 3	0 : f	S II	3)10)
29.71	2 : 4	f : 4	1 : 2	S II	3)10)
24.25	6 : 15 (24.25 and 23.50)	2 : 8	2 : 4 (24.25 and 23.50)	S II	3)10)
23.50		2 : 5		S II	3)10)
20.81	2 : 6	2 : 5	1 : 2 (20.81 and 19.68)	S II	3)10)
19.68	1 : 5	2 : 4		S II	3)10)
14.40	3 : 7	1 : 5	2 : 3	S II	3)10)
01.39	1 : 3	1 : 4	0 : f	S II	3)10)
3897.88	0 : 3	0 : 3	0 : f	S III	2?)
91.78	2 : 5	f : 5	1 : 2	S II	3)10)
71.39	2 : 5	1 : 4	0 : 1	S II	3)10)
57.37	1 : 4	0 : 4	f : 1	S II	3)10)
40.73	1 : 3	0 : 3	0 : f	S II	3)10?)
34.85	2 : 5	1 : 4	0 : f	S II	3)10)
* 28.74	2 : 1	2 : 1	—	A I	.
* 15.81	5 : 2	5 : 3	1 : 0	A I	.
11.54	f : 2	1 : 3	—	S II	2?)
* 3794.18	3 : 1	3 : 2	—	A I	.
72.69	f : 3	0 : 3	—	S III	3)10)
70.41	0 : 2	0 : 2	—	S II	3)10?)
53.78	f : 2	f : 3	—	S II	3)10?)
40.65	1 : 4	1 : 4	f : 1	S II	2)10)
37.82	0 : 2	0 : 3	0 : f	S II	2?)10?)
25.54	f : 2	f : 3	—	S II	2)10?)
14.45	f : 3	1 : 4	0 : f	S II	3)10)
3699.60	f : 1	f : 2	—	S II	3)10)
93.46	1 : 6	0 : 3	f : 1	S III	2)11)
84.6	f : 1	f : 2	—	S II	3)10)
81.6	f : 1	0 : 2	—	S III	3)10)
79.3	0 : f	0 : 1	—	S II (79.3 and 78.2)	.
78.2	0 : f	f : 1	—	S	.

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
3659.4	3 : 10	1 : 6	1 : 2	S III	2)10)
48.0	f : 1	0 : 2	—	S II	2?)
33.6	f : 2	0 : 4	0 : 1	S II	3)10)
24.7	0 : f	f : 1	—	S } II	.
23.9	0 : f	0 : 1	—	S } II	.
22.0	f : 1	f : 2	—	S II	10)
20.9	f : 2	f : 3	0 : f	S II	10)
19.4	0 : f	f : 1	—	S II	10)
13.3	0 : f	f : 1	—	S III	10?)
12.2	0 : 2	0 : 1	—	S —	11)
08.9	0 : f	f : 1	—	S II	.
06.6	2 : 3	f : 4	f : 1	S II	3)10)
00.7	1 : 4	f : 3	1 : 2	S II(?)	2)11)
3585.5	f : 1	0 : 2	f : 1	S II	2?)10)
62.4	2 : 8	f : 6	1 : 4	S III	2)11)
51.04	f : 4	0 : 2	f : 1	S III	2)11)
40.2	1 : 5	0 : 3	f : 3	S III	2)11)
28.9	0 : 2	0 : 1	0 : 1	S III	2)11)
27.9	0 : f	0 : f	—	S III	11)
26.1	0 : f	0 : f	—	S(?) —	11)
25.4	—	0 : 1	—	S II	2)10)
17.4	0 : 2	0 : 2	0 : 2	S III	2)11)
06.5	0 : 2	0 : 2	0 : 1	S III	2)11)
3495.1	—	0 : 1	—	S II	3)10)
76.9	—	0 : 2	—	S II	2)10)
66.7	—	0 : 1	—	S II	3?)10?)
47.33	0 : 2	0 : 8	f : 3	S III	2)11)
36.8	—	0 : 1	0 : f	S II	3?)10)
28.9	—	0 : 1	0 : f	S II	2)10)
23.78	0 : f	0 : 2	0 : f	S II	10)
17.55	f : 5	f : 6	2 : 6	S III	2)11)
14.5	0 : 1	0 : 4	f : 2	S III	2)11)
09.8	—	0 : 1	—	S II	3)10)
02.4	0 : 2	f : 4	f : 3	S III	3)11)
3397.8	} f : 3	} f : 5	} f : 3	S III	2)11)
97.1				S III	11)
85.5	—	0 : 2	f : 1	S III	2)11)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
3366.1	—	o : 1	—	S II	2)10)
49.69	o : 4	o : 5	1 : 5	S III	3?)11)
46.98	o : f	o : 2	f : 2	S II	3?)10)
41.9	—	o : 1	—	S II	.
33.08	o : 5	o : 6	1 : 5	S III	2)11)
20.97	o : 2	f : 5	1 : 3	S III	2)11)
01.2	o : f	o : 3	f : 2	S III	11)
3289.2	—	o : 1	—	S II	10)
82.2	o : 1	o : 3	2 : 3	S III	2)11)
70.0	o : 1 (70.0 & 69.0)	o : 3 (70.0 & 69.0)	f : 2 (70.0 & 69.0)	S III(?)	3?)11)
69.0				S II(?)	10)
08.4	—	o : 1	—	S II	3)10)
3199.7	o : 1	o : 6	f : 2	S III	2)11)
67.5	o : 1	o : 4	f : 3	S III	3)11)
3074.3	o : 2	o : 5	f : 5	S III	3?)11)
53.0	—	o : 1	—	S II	3?)10)
28.91	o : 1	o : 3	o : 1	S II	2)10)
20.7	o : 4	o : 8	2 : 4	S III	3)11)
16.4	f : 3 (16.4 & 15.9)	1 : 6 (16.4 & 15.9)	f : 2 (16.4 & 15.9)	S II	2)10)
15.9				S —	10)
11.4	o : f	o : 2	o : f	S II	3?)10)
2999.7	—	o : 1	—	S II	2)10)
94.0	o : 1	o : 3	1 : 3	S III	3)11)
86.5	f : 3 (86.5 & 85.9)	o : 6 (86.5 & 85.9)	2 : 3 (86.5 & 85.9)	S II	2)10)
85.9				S II	2)10)
83.7	—	o : 1	—	S III	10)
81.84	o : f	o : 4	o : 1	S II	3?)10)
73.46	—	o : 1	—	S II	2?)10)
72.2	1 : 7	1 : 5	3 : 5	S II	2)10)
68.94	f : 3	f : 5	2 : 5	S III	3?)11)
67.2	f : 2	1 : 5	f : 2	S II	2)10)
61.1	—	o : 4	o : 2	S III	3?)11)
54.0	—	o : 3	—	S II	.
44.3	—	o : 1	f : 1	S II	10)
36.2	—	o : 4	1 : 2	S III	3?)11)
26.87	f : 5	o : 7	2 : 7	S III	3?)11)
25.64	o : f	o : 2	o : 1	S II	10)

Table II, Bromine (continued)

Weve-lengths	Relative Intensities			Types	Remerks
	1	2	3		
	w : c	W : H	C+L : C		
2921.86	o : f	o : 2	o : 1	S II	3?)10)
17.19	o : 1	o : 4	f : 2	S II	2)10)
13.3	—	o : 1	—	S II	2)10)
10.7	—	o : 2	o : 1	S II	2)10)
05.8	o : f	o : 1	—	S II	2)10)
04.1	—	o : 1	—	S II	10)
00.1	o : f	1 : 3	1 : 3	S II	3?)10)
2893.39	f : 5	f : 6	3 : 4	S II	2)10)
92.9				S II	2)10)
92.0	—	o : 2	o : 1	S II	2)10)
87.1	o : f	o : 1	o : 1	S II	10)
75.37	o : f	o : 2	o : 1	S II	3?)10)
73.2	1 : 5	f : 6	1 : 3	S II	3?)10)
72.5				S II	3?)10)
66.97	o : 2	o : 3	f : 1	S II	3?)10)
46.1	o : f	f : 3	f : 1	S III	2)10)
14.0	—	o : 2	—	S II	3?)10)
07.5	—	o : 1	f : 2	S II(?)	2)10)
00.0	—	o : 2	—	S III	10)
2798.95	f : 5	1 : 5	2 : 3	S II	2)10)
70.5	—	o : 2	o : f	S II	3?)10)
66.65	o : f	o : 5	1 : 3	S III	3?)11)
46.4	f : 4	1 : 6	2 : 4	S II	.
46.0				S III(?)	.
28.4	o : f	o : 1	—	S II	3)10)
26.99	o : f	f : 3	1 : 2	S II	2)10)
25.2	—	o : 1	o : 1	S(?) II(?)	.
24.8					.
20.33	o : 2	f : 3	f : 1	S II	3?)
18.3	—	o : 1	1 : 1	S(?) —	10)
13.67	1 : 5	1 : 6	1 : 3	S II	3)10)
09.8	o : 1	f : 4	o : f	S II	10)
09.6					
2690.1	f : 2	f : 5	f : 2	S II	2)10)
89.9				S —	.
84.0	—	o : 1	f : 1	S II	10)
77.3	—	o : 3	o : 1	S III	11)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
2660.44	1 : 2	1 : 5	1 : 5	S II	2)10)
58.6	—	0 : 4	0 : 2	S III	11)
28.7	—	0 : 3	f : 2	S --	.
26.44	0 : f	f : 5	f : 2	S III	3)11)
13.1	0 : 1	0 : 6	1 : 4	S III	3)11)
06.2	0 : f	0 : 4	0 : 2	S III	3)11)
03.2	—	0 : 3	0 : 2	S III	3)11)
01.8	f : 3	2 : 5	0 : 2	S III	11)
01.17				S II	3?)10)
2595.9	—	0 : 2	0 : 1	S III	3?)11)
93.70	1 : 6	1 : 5	3 : 5	S II	2)10)
89.1	0 : f	0 : 4	0 : 2	S III	11)
86.9	—	0 : 1	—	S II	2)10)
78.1	0 : 1	2 : 3	0 : 1	S II	3)10)
77.8				S II	10)
69.14	0 : f	1 : 2	0 : 1	S II	10)
67.3	—	0 : 1	f : 1	S II	2)10)
63.2	—	0 : 1	—	S II	2)10)
56.9	1 : 5	2 : 7	4 : 10	S II	2)10)
56.6				S —	.
51.1	f : 1	f : 2	0 : 2	S III(?)	11)
50.7				S II(?)	3?)
41.42	1 : 5	2 : 8	3 : 8	S II	2)10)
24.94	0 : 1	0 : 3	1 : 2	S II	2)10)
21.69	1 : 7	2 : 8	4 : 10	S II	2)10)
2499.3	0 : f	0 : 2	0 : 1	S III	2)11)
98.4	—	0 : 1	—	S II	2?)11)
95.18	0 : 1	f : 4	1 : 2	S II	2?)11)
88.9	—	0 : 1	0 : 2	S —	.
88.4				S —	2)10)
2395.40	f : 3	1 : 8	1 : 5	S II	2)10)
93.4	—	0 : 1	—	S II	.
92.5	f : 4	2 : 10	2 : 6	S II	10)
92.3					2)10)
89.74	2 : 10	3 : 9	3 : 8	S II	2)10)

Table II, Bromine (continued)

Wave-lengths	Relative Intensities						Types	Remarks
	1		2		3			
	w	c	W	H	C+L	C		
2388.98	f : 3		1 : 7		2 : 6		S II	2) 10)
88.73								2) 10)
86.77	1 : 7		2 : 12		2 : 8		S II	2) 10)
86.6								2) 10)
55.71	0 : 2		f : 5		f : 3		S II	2) 10)
46.9	0 : 6		0 : 2		—		S II	2) 10)
37.93	f : 3		1 : 4		2 : 5		S II	2) 10)
36.96	0 : f		0 : 2		1 : 2		S II	2) 10)
17.35	f : 2		1 : 4		1 : 4		S II	2) 10)
13.8	—		0 : 1		0 : 1		S II	10)
10.3	—		0 : 1		0 : 1		S II	.
04.1	—		0 : 1		—		S II	2)
2287.6	0 : f		0 : 2		f : 2		S III(?)	2) 10)
85.2	—		0 : 1		f : 1		S II	2) 10)
84.5	—		f : 1		0 : f		S II	10)
81.4	—		f : 1		f : 1		S II	2) 10)
80.6	—		0 : 1		—		S II	2) 10)
70.4	—		0 : 1		f : 1		S II	2)
45.9	—		0 : 1		—		S II	.
43.0	—		0 : 1		—		S II	.
37.0	—		f : 2		—		S II	.

Notes :— 1) The first type of modes of broadening.
2) The second type of modes of broadening.
3) The third type of modes of broadening.
4) Lines disappeared when a capacity was put in the discharge circuit. (Goldstein).
5) Lines weakened by a capacity. (Galitzin and Willip).
6) Lines disappeared by a large capacity. (Galitzin and Willip).
7) Lines classified as arc type. (Kimura).
8) Lines regarded as spark type. (Kimura).
9) Lines classified as BrI. (L. and E. Bloch).
10) Lines classified as BrII. (L. and E. Bloch).
11) Lines classified as BrIII. (L. and E. Bloch).

Table III. Chlorine

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
6093.4	—	0 : 3	f : 4	S II	8)
5785.4	—	0 : f	0 : f	S II	.
5635.1	—	0 : 1	0 : 1	S II	8)
5570.4	—	0 : 1	0 : f	S II	.
5457.70					6) 8)
57.28	f : 3	f : 10	2 : 8	S II	2) 6) 8)
56.39					2) 6) 8)
45.12					6) 8)
44.41	1 : 4	f : 12	2 : 10	S II	2) 6) 8)
43.59					2) 6) 8)
23.70	2 : 6	f : 12	3 : 12	S II	6) 8)
23.44					2) 6) 8)
5392.30	2 : 4	1 : 9	2 : 8	S II	2) 8)
5285.8	0 : f	0 : 4	0 : 3	S II(?)	2) 8)
21.48	f : 4	f : 10	1 : 7	S II	2) 8)
18.07	2 : 7	1 : 12	2 : 10	S II	2) 8)
5193.6	—	0 : 1	0 : 1	S II	8)
89.74	0 : f	0 : 3	0 : 3	S II(?)	8)
76.0	0 : f	0 : 2	0 : 2	S II	8)
73.4	0 : f	0 : 2	0 : 3	S II(?)	8)
65.20	—	0 : 2	0 : 1	S II	8)
58.9	—	0 : 1	0 : f	S II	.
13.3	0 : f	0 : 4	0 : 2	S II	2) 8?)
03.18	f : 3	f : 8	f : 6	S II	2) 8)
5099.36	0 : 1	1 : 6	0 : 4	S II	2) 8)
78.36	2 : 5	1 : 10	1 : 7	S II	2) 8)
4995.7	0 : 1	0 : 5	f : 4	S II	2) 8)
70.3	0 : 1	0 : 5	0 : 3	S II	2) 8?)
43.1	—	0 : 2	0 : f	S II	.
24.90	0 : 1	f : 5	f : 3	S II	2) 8)
17.87	f : 3	1 : 10	f : 5	S II	2) 8)
04.91	1 : 5	1 : 10	1 : 8	S II	2) 8)
4896.91	1 : 6	1 : 10	2 : 10	S II	2) 8)
19.63	1 : 5	2 : 12	3 : 15	S II	2) 6) 8)
10.19	2 : 7	2 : 13	4 : 16	S II	2) 6) 8)
4794.67	3 : 8	2 : 13	5 : 18	S II	2) 6) 8)
85.41	0 : f	0 : 3	0 : 1	S II	2) 8)

Table III, Chlorine (continued)

Wave-lengths	Relative Intensities			Types	Remarks
	1	2	3		
	w : c	W : H	C+L : C		
4781.49	0 : 3	1 : 8	1 : 5	S II	2) 8)
79.06	0 : f	0 : 3	0 : 2	S II	2) 8)
71.22	0 : f	0 : 4	0 : 2	S II	2)
68.80	0 : 1	1 : 5	0 : 4	S II	2) 8)
55.9	0 : f	0 : 2	1 : 0	S II	2) 8)
40.51	f : 2	1 : 5	f : 5	S II	2) 8)
* 4691.9	2 : 1	3 : 1	f : 0	A I	.
61.38	2 : 1	4 : 2	f : 0	A I	1) 4)
54.3	1 : 0	2 : 0	—	A I	.
24.23	1 : 0	2 : 1	—	A I	1) 5) 8)
01.19	4 : 2	6 : 4	2 : f	A I	1) 4) 5) 7?)8?)
4585.05	f : 1	0 : 1	0 : f	S II(?)	2) 8)
72.79	2 : 5	0 : 8	0 : 5	S II(?)	3) 8)
70.16	1 : 3	0 : 5	0 : 4	S II(?)	3) 8)
37.0	f : 1	0 : 2	0 : f	S II	2) 8)
26.44	6 : 3	8 : 5	5 : 4	A I	1) 4) 5) 7?)8?)
19.4	f : 1	0 : 2	0 : f	S II	2) 8)
04.50	f : 1	0 : 2	0 : f	S II	2) 8)
4497.45	0 : 1	0 : 2	0 : f	S II	2) 8)
91.25	1 : 0	3 : 1	f : 0	A I	1)
90.16	1 : 3	f : 5	0 : 3	S II	2) 8)
75.50	2 : f	5 : 4	2 : 1	A(?) I & II	5) 8)
69.57	1 : 0	3 : 1	f : 0	A I	1) 5)
46.35	0 : f	f : 1	—	S II	.
46.10	1 : f	1 : f	f : 0	A I	1)
38.74	2 : f	5 : 4	2 : 1	A I	1) 8)
03.61	2 : f	6 : 5	2 : f	A I	1) 5)
4399.37	f : 1	0 : 1	0 : f	S II	2) 8)
90.57	1 : f	3 : 2	} 5 : 3	A I	1) 4) 5)
89.95	3 : 1	6 : 5		A I	1) 4) 5) 7?)8?)
87.73	f : 0	2 : 1	f : 0	A I	1)
80.08	2 : f	4 : 3	1 : f	A I	1) 7?)8?)
73.12	2 : 5	1 : 8	f : 8	S II	2) 8)
71.72	f : 1	f : 1	f : 1	S(?) II(?)	.
69.68	1 : 0	4 : 2	1 : f	A I	1) 5) 9?)
63.48	2 : f	5 : 3	1 : f	A I	1) 5) 7)
43.82	4 : 8	5 : 10	f : 10	S II	2) 8)

Table III, Chlorine (continued)

Wave-lengths	Relative Intensities 1 (w : c)	Relative Intensities 2 (W : H)	Relative Intensities 3 (C+L : C)	Types	Remarks
4336.37	1 : 3	f : 5	0 : 4	S II	2) 8)
33.13	0 : f	0 : f	—	S II	2) 8)
23.52	2 : f	5 : 4	2 : f	A I	1) 5) 7)
09.19	1 : 3	f : 7	0 : 5	S II	2) 8)
07.59	4 : 7	2 : 9	0 : 6	S II	2) 8)
04.21	1 : 3	f : 6	0 : 4	S II	2) 8)
4291.86	2 : 4	f : 7	0 : 5	S II	2) 8)
80.62	f : 0	f : 0	—	A(?) I(?)	1) 5)
76.63	f : 2	f : 5	0 : 3	S II	3) 8)
70.73	0 : 2	f : 4	0 : 3	S II	3) 8)
64.74	f : 0	1 : f	—	A I	1) 5)
61.35	f : 1	f : 3	0 : 2	S II	3) 8)
59.63	f : 2	f : 5	0 : 2	S II	2) 8)
53.53	2 : 7	1 : 10	0 : 10	S II	3) 6) 8)
41.44	2 : 6	1 : 10	0 : 9	S II	3) 6) 8)
35.61	0 : 2	f : 4	0 : 3	S II	3) 8)
34.14	f : 3	f : 8	0 : 4	S II	3) 6) 8)
26.58	f : 0	3 : 2	—	A I	1) 5)
25.14	0 : 1	f : 1	—	S II	3) 8)
09.87	f : 0	2 : 1	f : 0	A I	1) 5)
08.16	1 : 2	1 : 4	—	S II	2) 8)
4189.38	0 : f	0 : 1	—	S II	8)
58.02	0 : f	0 : 1	0 : f	S II(?)	2) 8)
47.20	0 : 1	f : 2	0 : f	S II	3) 8)
33.83	0 : f	0 : 1	—	S II(?)	8)
32.68	2 : 5	3 : 9	f : 5	S II	2) 8)
30.99	0 : f	0 : 1	—	S II(?)	8)
24.15	0 : 2	0 : 1	0 : f	S II	3) 8)
04.97	0 : 4	0 : 1	f : 1	S III	2)
4054.24	0 : 1	0 : 1	—	S II	8)
* 30.69	1 : 0	1 : f	—	A I	5)
3991.63	0 : 4	0 : 1	f : 2	S III	2) 9)
82.06	f : 3	f : 2	f : 1	S II	2) 5) 8)
61.77	f : 3	f : 2	1 : 2	S II	2) 8)
55.58	f : 4	0 : 3	f : 1	S II	2) 9)
17.72	f : 3	1 : 3	} 1 : 3	S II	3) 8)
16.83	1 : 4	1 : 4		S II	3) 8)

Table III, Chlorine (continued)

Wave-lengths	Relative Intensities 1 w : c	2 W : H	3 C+L : C	Types	Remarks
3914.06	2 : 6	2 : 5	2 : 3	S II	3) 8)
3884.05	o : 3	f : 1	—	S II	3) 8)
71.54	o : f	f : 1	—	S II	5)
68.84	1 : 5	1 : 3	o · 1	S II	3) 8)
61.01	3 : 12	2 : 8	4 : 6 (61.01–58.83)	S II	3) 6) 8)
58.83	o : 1	o : f		S —	.
55.74	o : f	—	—	S(?) —	8?)
54.00	f : 2	f : 2	o : f	S —	3) 5)
51.75				S —	6) 8)
51.53	3 : 8 (51.75–51.17)	2 : 8 (51.75–51.17)	2 : 4 (51.75–51.17)	S II	3) 6) 8)
51.17				S II	3) 6) 8)
49.30	o : f	o : f	—	S(?) —	.
45.83	2 : 6 (45.83–45.55)	1 : 5 (45.83–45.55)	1 : 3 (45.83–45.55)	S II	3) 6) 8)
45.55				S II	3) 6) 8)
43.39	1 : 4	2 : 3	f : 1	S II	3) 8)
38.48	o : 1	o : 1	—	S —	8)
33.50	2 : 4	2 : 3	1 : 3	S II	3) 8)
30.96	o : 1	o : 1	—	S —	3) 8)
29.55	o : 2	o : 2	o : f	S II	3) 8)
27.80	1 : 3	1 : 3	o : 1	S II	3) 8)
20.42	1 : 3	1 : 3	f : 2	S II	3) 8)
18.58	f : 2	o : 2	o : f	S II	8)
10.22	o : 2	o : 2	f : 1 (10.22–09.70)	S II	3) 8)
09.70	f : 2	1 : 2		S II	3) 8)
05.38	1 : 4	1 : 3	f : 2	S II	3) 8)
3798.99	1 : 3	1 : 3	f : 2	S II	8)
81.38	f : 3	2 : 3	o : f	S II	2) 8)
74.32	f : 2	o : 2	o : f (74.32–73.81)	S II	2) 8)
73.81	o : 2	o : 1		S II	2) 8)
69.19	o : 1	o : 1	—	S II (69.19–67.65)	2) 8)
68.23	o : f	f : 1	—	S(?)	2) 8)
67.65	f : 2	f : 2	o : f	S	2) 8)
50.10	1 : 4	f : 3	f : 1	S III (50.10–48.59)	2) 8)
48.59	f : 3	o : 1	f : 1	S	2) 8)
26.69	f : o	f : o	—	A(?) —	.
25.91	f : 3	f : 3	o : f	S II	3) 8)
20.4	o : f	o : 1	—	S III	9)

Table III, Chlorine (continued)

Wave-lengths	Relative Intensities 1 w	1 c	2 W	2 H	3 C+L	3 C	Types	Remarks
3689.1	f	1	0	1	0	f	S II	3) 8)
82.1	—		0	1	—		S III	9)
73.9	f	1	0	2	f	1	S II	2) 8)
68.1	0	1	0	1	0	f	S II(?)	8)
59.91	0	1	0	1	0	f	S II	2) 8)
58.50	0	1	0	2	0	f	S III	2) 8)
50.24	f	2	f	2	0	1	S II	2) 8)
24.3	0	1	0	1	—		S III	3) 9)
13.9	—		0	1	—		S III	9)
02.2	—		0	2	—		S III	9)
3568.03	1	4	0	4	0	1	S —	3) 8)
09.09	0	2	0	2	0	f	S II(?)	8)
3479.82	0	1	0	3	—		S II(?)	8)
3353.30	4	8	3	8	3	4	S II	2) 8)
40.36	0	4	0	4	1	6	S IV(?)	9)
29.06	4	12	1	10	2	5	S III(?)	2) 9?)
20.51	0	2	0	3	1	3	S III	2) 9)
16.78	0	2	0	2	—		S III	2) 8)
15.40	2	6	2	6	1	2	S II	2) 8)
13.18	0	1	0	1	—		S II	8)
07.86	1	3	0	3	0	1	S II	2) 8)
06.38	0	2	0	2	0	f	S II	2) 8)
3289.72	0	2	0	2	f	4	S III	9)
83.32	0	2	0	1	—		S III	2) 9)
76.72	f	2	0	3	0	1	S II	2) 8)
59.24	f	3	1	4	f	4	S II(?)	2) 9)
51.03	0	f	0	f	—		S III(?)	9)
44.36	0	f	0	f	0	1	S III	2) 9)
02.96	f	2	f	4	0	1	S II	8)
3191.40	f	8	0	5	f	6	S III	2) 9)
39.28	0	3	0	2	0	3	S III	2) 9)
23.67	f	2	f	3	0	1	S II	8)
3071.58	f	2	f	3	f	1	S II	2) 8)
71.31								
63.38	0	f	0	1	0	1	S III	9)
63.07								
02.45	0	f	0	1	0	f	S III	9)

Table III, Chlorine (continued)

Wave-lengths	Relative Intensities			Types		Remarks
	1	2	3			
	w : c	W : H	C+L : C			
2965.50	0 : 1	0 : 2	0 : f	S	III	2) 9)
2783.14	0 : f	0 : f	0 : 2	S	III	9)
82.43						9)
51.23	—	0 : f	—	S	II(?)	9)
10.38	0 : f	0 : 1	2 : 4	S	III	9)
2691.49	0 : 1	0 : 1	f : 3	S	III	2) 9)
88.03	2 : 4	2 : 7	4 : 4	S	II	2) 8)
85.40	0 : f	0 : f	0 : 2	S	III	2) 9)
84.75	0 : 1	0 : 1	0 : 2	S	III	9)
82.40	—	0 : 1	0 : 1	S	III	9)
76.92	f : 2	1 : 6	2 : 3	S	II	2) 8)
69.57	0 : f	0 : 1	0 : 1	S	III	9)
65.52	0 : 2	0 : 3	f : 5	S	III	2) 9)
63.20	—	0 : 1	0 : 1	S	III(?)	9)
61.56	0 : 1	0 : 2	f : 4	S	III	2) 9)
58.74	f : 3	1 : 5	2 : 3	S	II	2) 8)
51.16	—	0 : 1	f : 2	S	III	9)
41.85	—	0 : f	0 : 2	S	III	9)
33.16	0 : f	0 : 1	0 : 2	S	III	9)
32.68						9)
24.72	0 : 2	0 : 3	1 : 6	S	III	2) 9)
20.5	0 : f	0 : 2	0 : 3	S	III	9)
20.08						2) 9)
18.76	0 : f	0 : 1	0 : 1	S	III(?)	9)
16.99	0 : 3	f : 5	1 : 7	S	III	2) 9)
11.45	0 : f	0 : 1	0 : f	S	III	9)
09.50	0 : 3	0 : 4	f : 3	S	III	9)
03.50	0 : 3	0 : 4	0 : 3	S	III	2) 9)
01.14	0 : 1	0 : 2	0 : 2	S	III	9)
2595.17	—	0 : f	0 : f	S	III(?)	9)
88.80	—	0 : f	0 : f	S	III	9)
80.69	0 : 2	0 : 2	1 : 7	S	III	2)
80.41						.
78.23	0 : f	0 : 1	f : 4	S	III	9)
77.13	0 : f	0 : 1	f : 4	S	III	2) 9)
65.29	f : 1	0 : 1	f : 1	S	II	8)
64.87		0 : 2				8)

Table III, Chlorine (continued)

Wave-lengths	Relative Intensities						Types	Remarks
	1		2		3			
	w	c	W	H	C+L	C		
2559.50	—		o : f		o : f		S III	9)
47.00	o : f		o : 2		—		S II	8)
32.46	o : f		o : 1		o : 3		S III	9)
31.72	o : f		o : f		o : 1		S III(?)	9)
28.04	o : 1		o : 1		o : 2		S III(?)	9)
19.49	o : f		o : 1		f : 3		S III	9)
05.71	—		o : f		o : f		S III	9)
2484.25	—		o : f		o : f		S III(?)	9)
15.49	o : f		o : f		—		S III	9)
03.29	—		o : 1		—		S III	9)
2370.37	o : f		o : f		o : 1		S III	9)
40.64	—		o : f		—		S III	9)
36.45	o : f		o : f		o : f		S III	9)
23.50	o : f		o : 1		f : 3		S III	9)
2251.50	f : 1		f : 2		2 : 3		S II	8)
50.94	f : 1		f : 2		2 : 3		S II	8)

Notes : — 1) The first type of modes of broadening.
2) The second type of modes of broadening.
3) The third type of modes of broadening.
4) Lines disappeared when a capacity was put in the discharge circuit. (Goldstein).
5) Lines disappeared from the "Grundspektrum". (Nelthorpe).
6) Lines recorded as Cl II. (Paschen).
7) Lines classified as Cl I. (L. and E. Bloch).
8) Lines classified as Cl II. (L. and E. Bloch).
9) Lines classified as Cl III. (L. and E. Bloch).

Plate I

Fig. 1, $SnCl_4$, Tube I

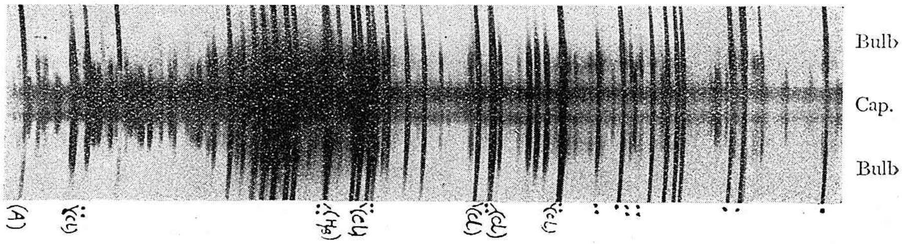

Fig. 2, Sn–Spark

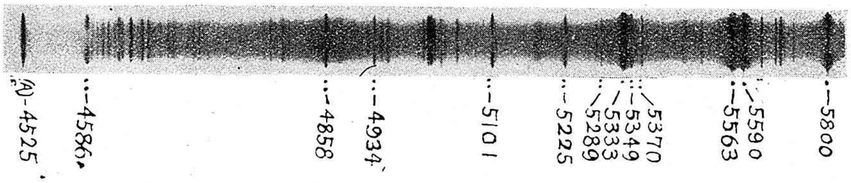

Fig. 3, Chlorine, Tube I

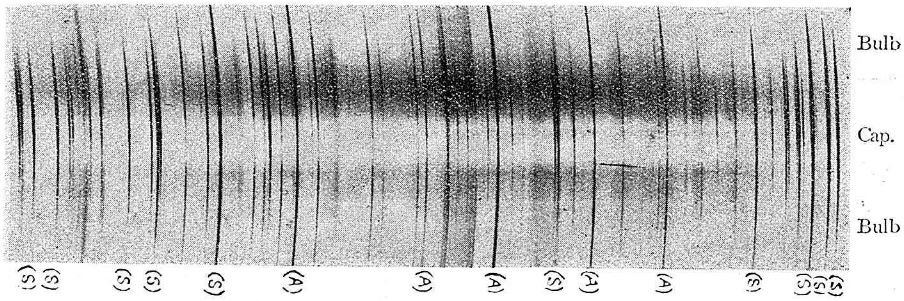

Fig. 4, Chlorine, Tube II

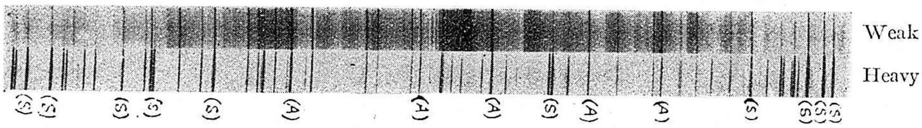

Fig. 5, Chlorine, Spark

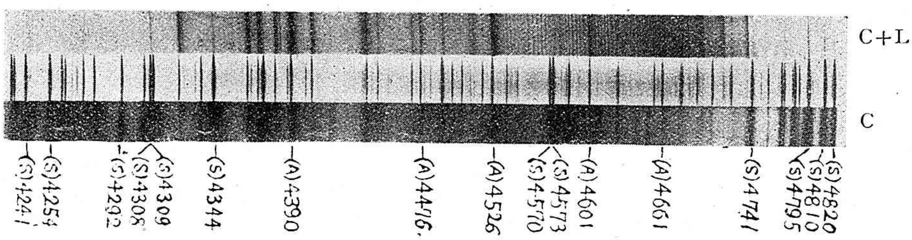

Plate II

Fig. 6, Sb-Spark

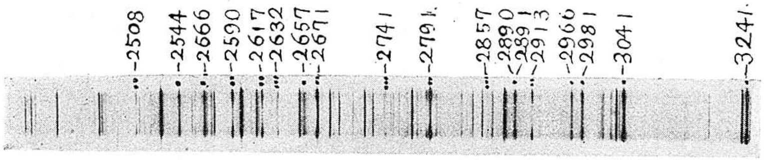

Fig. 7, $SbCl_5$ H-Variation

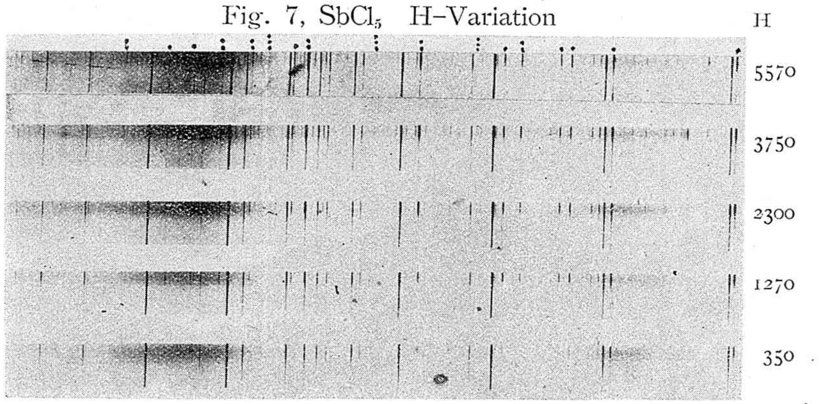

Fig. 8, $SbCl_5$, C-Variation

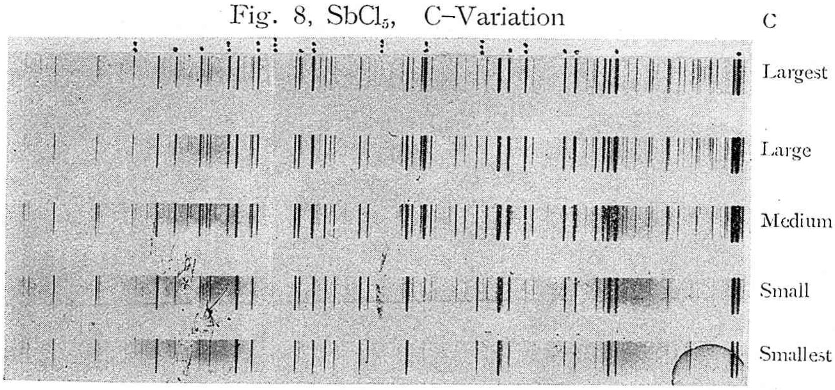

Fig. 9, $SbCl_5$, L-Variation

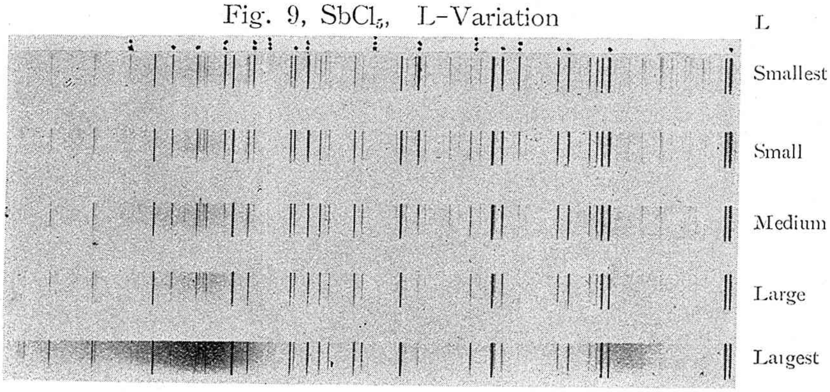

Plate III

Fig. 10, Iodine, H-Variation

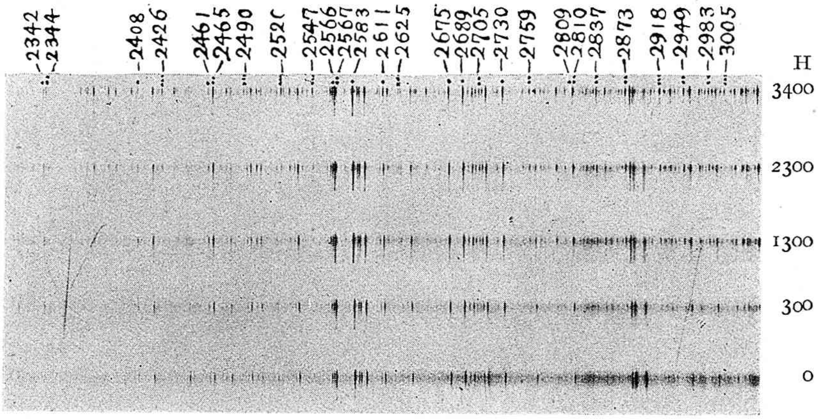

Fig. 11, Iodine, C-Variation

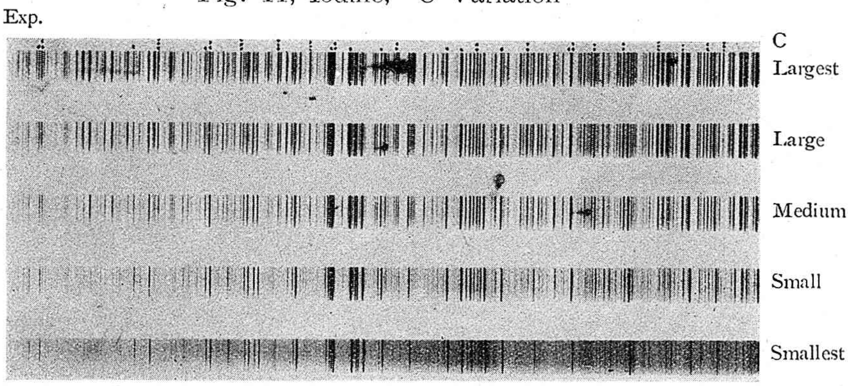

Fig. 12, Iodine, L-Variation