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Physics. — *"A new method for determining the rate of decrease of the radiating power from the center toward the limb of the solar disk".* By Prof. W. H. JULIUS.

(Communicated in the Meeting of January 27, 1906)

The brightness of the solar disk is known to diminish considerably from the center toward the limb. Although this prominent feature of the solar phenomenon should be among the first accounted for in every theory of the Sun, it leads to problems presenting so many difficulties, that a satisfactory explanation is, until now, altogether wanting. And even the empirical study of the law according to which the radiating power varies across the disk, is not very advanced.

What we know about the question is founded on researches in which either a photometer, or a thermopile, a bolometer or a radio-micrometer was used for exploring an *image* of the Sun. The results obtained by different observers are rather discordant [1]). This may be partly due to instrumental or accidental errors, but there is also a systematical error which must have influenced similarly all of the results thus obtained, and which proceeds from the scattering of the rays by the terrestrial atmosphere. In any point of an image of the Sun is not only to be found the radiation coming from the corresponding point of the disk, but, besides, some diffused radiation proceeding from other parts of the disk. This disturbing effect will, of course, vary in magnitude with the condition of our atmosphere, but it will always act in a levelling way, parts of the image lying near the edge receiving more diffused radiation from the middle parts of the disk, than receive the central parts of the image from the marginal parts of the disk.

We may completely avoid this source of error by using a method in which the radiating power of the different parts of the disk is calculated from observations made on the occasion of a total eclipse of the Sun.

Let us suppose the curve, representing the intensity of the solar radiation from the first until the fourth contact as a function of time, to be exactly known [2]). The curve will show us by how much the total radiation has increased or decreased between any two epochs. Every (positive or negative) increment is exclusively due to rays coming from that strip of the solar disk through which the Moon's limb has appeared to move between those very epochs.

Suppose the time after third contact to be divided into equal intervals of, say, 2 minutes, and the position of the Moon's limb at the end of each interval delineated on the solar disk, then the latter will be divided into 39 narrow strips, successively contributing the *known* quantities $a, b, c, d, \ldots$ to the total radiation.

Now, let us distinguish n concentric zones on the solar disk and denote by $x_\alpha, x_\beta, \ldots x_\nu$ the radiation coming from these zones per

1) Cf. J. SCHREINER, Strahlung und Temperatur der Sonne, p. 43—49 (1899).

2) It is well known that, at Burgos, the observation of the eclipse of August 30, 1905, has not been favoured with a clear sky (Cf. the Preliminary Report in the Proceedings of the Meeting of November 25, 1905). Nevertheless, the measurements of total radiation have yielded some results of sufficient accuracy to justify that, in our present investigation, we make use of the radiation curve then secured. Further particulars regarding the observations will soon be published in the complete report on our expedition.

unit surface. (According to results obtained by LANGLEY and by FROST we shall suppose the radiating power to vary only with the distance from the center, not with the position angle). One of the strips will contribute to the radiation:

$$d = \delta_1\, x_\alpha + \delta_2\, x_\beta + \ldots .\; \delta_n\, x_\nu,$$

if it cuts out of the first zone an area δ_1, out of the second zone an area δ_2 etc. The next strip contributes:

$$e = \varepsilon_1\, x_\alpha + \varepsilon_2\, x_\beta + \ldots .\; \varepsilon_n\, x_\nu,$$

and so on. We get 39 equations from which x_α, x_β, ... x_ν may be resolved.

Determination of the coefficients of the n unknown quantities.

I have found the coefficients δ_1, δ_2 . . . ε_1, ε_2 . . . by weighing. On a piece of excellent homogeneous paper the solar disk was drawn and divided into a suitable number of concentric zones, which were intersected by arcs representing the Moon's limb in its successive positions. The following astronomical data, necessary for making the drawing, have been kindly procured to me by prof. A. A. NIJLAND.

contact	I	II	III	IV
position angle	293°,4	104°,5	304°,9	114°,9
local time	$23^h\,33^m\,10^s$	$0^h\,51^m\,58^s$	$0^h\,55^m\,39^s$	$2^h\,12^m\,14^s$

Moon's radius : Sun's radius = 132,8 : 126,8.

Now the strips were carefully separated from each other and weighed (for subsequent control). Then each strip was cut along the zone circles, and the pieces were weighed separately. In order to make the pieces recognizable, the zones had all been differently painted, each with a narrow line of water-colour. The weighings, which were accurate to half a milligram, gave the coefficients of the unknown quantities x_α, x_β . . . . x_ν. So the unit of area, adopted for measuring the surface of the solar disk, corresponds to a piece of our drawing paper weighing 1 milligram.

The breadth of each of the outer five concentric zones was $^1/_{20}$ of the Sun's radius; then came seven zones with breadth $^1/_{10}$ of the radius each, leaving round the center a circle with radius $^1/_{20}$. The average distances of the zones from the center, expressed in thousandth parts of the radius, will now be used as indices α, β . . . . of our 13 unknown quantities; so these will be written:

$$x_{975},\ x_{925},\ x_{875},\ x_{825},\ x_{775},\ x_{700},\ x_{600},\ x_{500},\ x_{400},\ x_{300},\ x_{200},\ x_{100},\ x_0.$$

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$$
\begin{aligned}
a &= 126\ x_{975} \\
b &= 66\ x_{975} + 101\ x_{925} \\
c &= 28\ x_{975} + 59\ x_{925} + 84\ x_{875} + 1\ x_{825} \\
d &= 18\ x_{975} + 29\ x_{925} + 50{,}5 x_{875} + 77\ x_{825} + 1{,}5 x_{775} \\
e &= 13\ x_{975} + 19\ x_{925} + 27{,}5 x_{875} + 46\ x_{825} + 69{,}5 x_{775} + 2\ x_{700} \\
f &= 10\ x_{975} + 14\ x_{925} + 19\ x_{875} + 28\ x_{825} + 40\ x_{775} + 66\ x_{700} \\
g &= \\
h &= 8\ x_{975} + 10\ x_{925} + 12\ x_{875} + 15\ x_{825} + 18\ x_{775} + 57\ x_{700} + 58\ x_{600} \\
i &= \\
j &= 7\ x_{975} + 8\ x_{925} + 9\ x_{875} + 10{,}5 x_{825} + 12{,}5 x_{775} + 30\ x_{700} + 48\ x_{600} + 51\ x_{500} \\
k &= \\
l &= 6\ x_{975} + 6{,}5 x_{925} + 7\ x_{875} + 8\ x_{825} + 9\ x_{775} + 23\ x_{700} + 28{,}5 x_{600} + 40\ x_{500} + 45\ x_{400} \\
m &= \\
n &= 5{,}5 x_{975} + 6\ x_{925} + 7\ x_{875} + 8\ x_{825} + 8\ x_{775} + 19\ x_{700} + 21\ x_{600} + 25\ x_{500} + 33\ x_{400} + 36\ x_{300} \\
o &= \\
p &= 5{,}5 x_{975} + 6\ x_{925} + 6{,}5 x_{875} + 7\ x_{825} + 7\ x_{775} + 16\ x_{700} + 17{,}5 x_{600} + 19{,}5 x_{500} + 22{,}5 x_{400} + 26{,}5 x_{300} + 31\ x_{200} \\
q &= \\
r &= 5{,}5 x_{975} + 6\ x_{925} + 6{,}5 x_{875} + 7\ x_{825} + 7\ x_{775} + 15{,}5 x_{700} + 16{,}5 x_{600} + 17{,}5 x_{500} + 18{,}5 x_{400} + 18{,}5 x_{300} + 21{,}5 x_{200} + 20{,}5 x_{100} \\
s &= \\
t &= 5{,}5 x_{975} + 6\ x_{925} + 6{,}5 x_{875} + 7\ x_{825} + 7\ x_{775} + 15\ x_{700} + 15{,}5 x_{600} + 16{,}5 x_{500} + 17\ x_{400} + 17{,}5 x_{300} + 18\ x_{200} + 19\ x_{100} + 8 x_{0}
\end{aligned}
$$

On p. 670 the equations are written out. We have confined ourselves to 13 equations; increasing this number would not have led to greater accuracy, as the values of $a, b, c\ldots$ had to be found from the radiation curve, that is by graphical interpolation, in which process it is understood that *all* of the observations have already been taken into consideration.

Determination of the constant terms of the equations.

Table I contains the results of the observations made at Burgos with our actinometer. The second column gives the galvanometer deflections, from which the numbers of the third column, representing the intensity of the radiation, are calculated [1]).

Owing to the clouds there are large gaps in the series of observations; but nevertheless, after the results had been plotted down, we saw that there was only little room left for fancy when drawing the radiation curve in such a way, that closest agreement with the observational data was obtained. As a matter of course the curve has not been drawn *between the series of points*, but *so as to join the highest points*, for the observed values could only be too small. Only one exception is made to this rule, the value found at $0^h\,17^m\,3^s$ being very probably too high by some error or instrumental disturbance.

The middle part of the radiation curve has been reproduced on the annexed plate. For determining $a, b, c, \ldots$ we have used the part included between $0^h\,55^m$ and $1^h\,37^m$, which was very carefully constructed on a larger scale. It deserves notice that the relative accuracy of the small ordinates (corresponding to few minutes after totality) is nearly as great as that of the larger ones, because the galvanometer deflections from which they were calculated are all lying between 118 and 347 scale divisions. Table II refers to this part of the radiation curve. In the second column are given the ordinates of the curve at the epochs $0^h\,55^m\,40^s$ and every two minutes later; the unit corresponds to an intensity $= 1000$.

1) Particulars concerning the connection between the numbers of these two columns will be found in the forthcoming report on the Dutch expedition. The method and the instruments used at Burgos were the same that are described in: "Total Eclipse of the Sun, May 18, 1901. Reports on the Dutch Expedition to Karang Sago, Sumatra, N°. 4: Heat Radiation of the Sun during the Eclipse", by W. H. Julius. The numbers of the third column are proportional to the total radiation coming from a circular patch of the sky, 3° in diameter, with the Sun in its center.

TABLE I.

Time.	Galvano-meter-deflections.	Intensity of radiation.	Time.	Galvano-meter-deflections.	Intensity of radiation.
h m s 22 28 48	280	1750000	h m s 0 20 48	128.5	819000
36 0	231	1444000	2nd contact 51 58		
38 33	287	1794000	53 53	3	9
			54 28	13	13
46 58	287	1794000	55 18	33	33
51 38	270	1688000	3rd contact 55 40		
53 49	260.5	1631000	55 58	600?	600?
56 8	278.5	1745000	57 58	118.5	23000
			58 33	98.5	19100
23 4 58	256	1610000	59 13	219.5	42700
8 3	283.5	1786000	59 53	286	55700
9 56	284.5	1792000	1 1 18	232.5	74800
11 44	275	1736000	2 28	170	108800
1st contact 33 8			3 3	152.5	97700
35 48	226	1430000			
38 3	256.5	1625000	7 38	323.5	207000
40 38	269.5	1709000			
41 38	270	1712000	21 15	331.5	635000
42 48	270.5	1715000	22 3	347.5	665000
44 0	260	1649000	23 3	151.5	676000
45 33	259.5	1646000	23 58	162	722000
46 38	256.5	1627000	24 53	167	745000
47 52	248.5	1566000	25 53	174	776000
48 53	250.5	1589000	26 53	180.5	805000
50 8	249	1580000	27 53	186.5	832000
51 33	241	1529000	28 58	194	865000
53 8	233.5	1483000	30 8	201	897000
55 3	227	1442000	31 8	207.5	926000
56 33	226	1435000	32 11	213	950000
58 23	216.5	1376000	33 13	220	981000
			34 20	225.5	1007000
0 7 23	192	1222000	35 25	232.5	1037000
8 53	184	1170000	36 34	237.5	1060000
10 28	177	1127000			
11 43	171.5	1091000	2 1 58	338	1506000
13 13	165.5	1054000	3 8	248	1581000
14 58	159	1013000	4th contact 12 24		
17 3	150	956000	13 18	258.5	1648000
19 28	136	867000	14 20	260	1657000

But this observational curve has to be corrected, owing to the circumstance that in the lapse of time considered the Sun's altitude has diminished. We may proceed as follows. Apart from a possible influence of sun-spots or faculae there is no reason why the eclipse curve would not be symmetrical if the Sun's altitude (and the condition of our atmosphere) remained constant. Between 23^h and 1^h the variation of altitude is very small. Now taking $0^h\ 53^m\ 50^s$ as

TABLE II.

Time	Ordinates of radiation curve.	Ordinates of corrected radiation curve.	Increments
h m s 0 55 40	0	0	
57 40	20.1	20.1	20.1 = a
59 40	52.5	52.5	32.4 = b
1 1 40	91.0	91.0	38.5 = c
3 40	136.5	136.5	45.5 = d
5 40	187	187	50.5 = e
7 40	240	241	54 = f
9 40	296	297	56 = g
11 40	354	355	58 = h
13 40	412	414	59 = i
15 40	472	474	60 = j
17 40	532	535	61 = k
19 40	594	597	62 = l
21 40	655	659	62 = m
23 40	717	721	62 = n
25 40	776	783	62 = o
27 40	834.5	844.5	61.5 = p
29 40	891.5	905.5	61 = q
31 40	947	966	60.5 = r
33 40	1001	1026	60 = s
35 40	1053.5	1085.5	59.5 = t

TABLE III.

Radiation per unit surface of the concentric zones of the solar disk.
$x_{975} = 0.1595$
$x_{925} = 0.2166$
$x_{875} = 0.2501$
$x_{825} = 0.3023$
$x_{775} = 0.3290$
$x_{700} = 0.3488$
$x_{600} = 0.3662$
$x_{500} = 0.3843$
$x_{400} = 0.4153$
$x_{300} = 0.4278$
$x_{200} = 0.4240$
$x_{100} = 0.4380$
$x_{0} = 0.4388$

the epoch of mid-eclipse, we draw a horizontal line through a point m corresponding to that epoch. The line cuts the descending branch of the curve in l; we make $mn = ml$ and thus find a point n of the hypothetical radiation curve for constant altitude of the Sun. Acting in a similar way for a few more points, we get an idea of the magnitude of the smoothly increasing correction which is to be applied to the ordinates of the ascending branch. K. ÅNGSTROM's measures of the intensity of the radiation for different altitudes of the Sun [1]) have also been considered in determining the correction.

The third column of Table II contains the ordinates of the corrected curve; in the fourth column are given their successive increments which, of course, are the values to be assigned to the absolute terms of our equations.

Results.

The solution of the equations leads to the numbers of Table III; the results are plotted down in fig. 2 on the plate. Through these points we have drawn a curve satisfying the condition that its curvature should gradually diminish; it shows us the law of variation of the radiating power from the edge toward the center of the solar disk. Putting the ordinate at the center equal to 100 and expressing the other ordinates in the same unit, we get numbers comparable with the results obtained by other investigators.

The comparison with the spectro-photometric observations by H. C. VOGEL [2]) and with the measurements of total radiation made with a radio-micrometer by WILSON [3]) and with a thermopile by FROST [4]), is given in Table IV. We add in Table V the results of a spectro-bolometric investigation by VERY [5]), as these numbers have been used by VERY and by SCHUSTER [6]) in testing their explanations of the phenomenon.

According to FROST's measurements the total radiation appears to diminish from the center toward the limb in about the same proportion as the radiation of wave-length $650\mu\mu$, whereas my numbers show a decrease very similar to that exhibited by rays of wave-

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1) K. ÅNGSTRÖM, Intensité de la radiation solaire à différentes altitudes. Recherches faites à Ténériffe 1895 et 1896.

2) H. C. VOGEL, Ber. d. Berl. Akad. 1877, p. 104.

3) W. E. WILSON, Proc. Roy. Irish Acad. [3], Vol. 2, p. 299, (1892).

4) E. B. FROST, Astron. Nachr. 130 (1892), p. 129.

5) F. W. VERY, Astroph. Journ. 16 (1902), p. 73.

6) A. SCHUSTER, Astroph. Journ. 16 (1902), p. 320; 21 (1905), p. 258.

TABLE IV.

Distance from center of disk	H. C. VOGEL's spectro-photometric measurements. 405—412 μμ	440—446 μμ	467—473 μμ	510—515 μμ	573—585 μμ	658—666 μμ	Total radiation. Receiver in solar image. WILSON	FROST	Eclipse curve. JULIUS
0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0.1	99.6	99.7	99.7	99.7	99.8	99.9	99.9	99.9	99.8
0.2	98.5	98.7	98.8	98.7	99.2	99.5	99.6	99.4	98.6
0.3	96.3	96.8	97.2	96.9	98.2	98.9	98.8	98.4	96.6
0.4	93.4	94.1	94.7	94.3	96.7	98.0	97.3	96.3	94.0
0.5	88.7	90.2	91.3	90.7	94.5	96.7	95.3	93.6	90.3
0.6	82.4	84.9	87.0	86.2	90.9	94.8	92.5	89.8	85.5
0.7	74.4	77.8	80.8	80.0	84.5	91.0	88.7	84.6	79.5
0.75	69.4	73.0	76.7	75.9	80.1	88.1			75.3
0.8	63.7	67.0	71.7	70.9	74.6	84.3	83.9	77.9	70.1
0.85	56.7	59.6	65.5	64.7	67.7	79.0			63.5
0.9	47.7	50.2	57.6	56.6	59.0	71.0	74.9	68.0	55.0
0.95	34.7	35.0	45.6	44.0	46.0	58.0		(60.5)	44.0
1.0	13.0	14.0	16.0	16.0	25.0	30.0	45.1		(24.0)

TABLE V.

Distance from center.	F. W. VERY's spectro-bolometric measurements. 416 μμ	468 μμ	550 μμ	615 μμ	781 μμ	1010 μμ	1500 μμ
0.5	85.8	90.2	93.3	94.8	94.1	94.3	95.9
0.75	74.4	76.4	83.1	84.5	88.5	89.4	95.0
0.95	47.1	46.2	58.7	68.1	74.9	76.5	85.6

length 510μμ. At first sight the evidence is in favour of the results obtained by FROST, because the maximum of the curve representing the energy in the solar spectrum (or perhaps rather the "center of gravity" of the enclosed surface) lies closer to 650μμ than to 510μμ. But this argument fails; for the measurements of VOGEL and those of FROST are all disturbed alike by atmospheric diffusion. Had the spectro-photometric observations been free from this influence, then the rate of decrease of the radiation from the center toward the limb would doubtless have been found quicker for all wave-lengths, and, very probably, the distribution for the region $650\mu\mu$ would have proved to agree better with my results than with the uncorrected values of FROST.

WILSON'S measurements seem to have been influenced by other causes of error still, besides atmospheric scattering, as his numbers are greater than those obtained by FROST, and harmonize not as well as the latter with the spectro-photometric series.

The observations of VERY have given considerably greater ratios in the marginal regions than those of VOGEL. Mr. VERY himself points out the difference, and remarks that the bolometer has an advantage over the eye in the red where the heat is great; but I may suggest, on the other hand, that instrumental errors (reflection or scattering of light by prisms, lenses, tubes, etc.) are easier discovered and corrected in spectro-photometric than in spectro-bolometric work.

It seems to me that observing an eclipse-curve by means of a very simple but sensitive actinometer, without lenses or mirrors, must yield results concerning the radiation of different parts of the solar disk which deserve more confidence than the values hitherto obtained in other ways. I wish to lay stress upon the advantages of our *method*, rather than on the reliability of the numbers secured at Burgos under not very favourable circumstances. In a clear sky the shape of the eclipse curve will easily be found with very great accuracy.

The same method will also be applicable with radiations covering limited parts of the spectrum, if we only put suitable ray-filters before the opening of one of the diaphragms in the actinometer. It may even be possible, in a future eclipse, to use an arrangement which brings several ray-filters by turns before the opening; thus, when disposing of a quick galvanometer, one would be able to simultaneously determine, with one actinometer, the eclipse curves for rays belonging to five or more regions of the spectrum, and the results would be independent of selective atmospheric scattering.

Remarks on the hypotheses used for explaining the distribution of the radiating power on the solar disk.

The diminution of the intensity of radiation toward the limb is almost generally ascribed to absorption of the rays by the solar atmosphere [1]), and it is supposed that, in absence of that atmosphere,

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[1]) J. SCHEINER goes as far as to say: "Eine andere Deutung des Lichtabfalls ist nicht zulässig." (Strahlung und Temperatur der Sonne. p. 40).

the photosphere would show itself as an equally luminous disk. But then it appears to be impossible to find such values for the thickness of that atmosphere and for its coefficient of absorption, as to give a law for the rate of diminution of brightness, consistent with observation. VERY [1]) e.g. when attributing the effect to absorption only, arrives at the absurd result that we should have to assume that the absorptive power toward the limb is smaller than that nearer the center. He, therefore, suggests the existence of other influences which, combining with the absorbent process, would reconcile theory to observed facts. Diffraction by fine particles, columnar structure of the solar atmosphere, irregularity of the photospheric surface, are thus introduced.

SCHUSTER [2]), on the other hand, is of opinion that the difficulty which has been felt in explaining the law of variation of intensity across the solar disk is easily removed by placing the absorbing layer sufficiently near the photosphere and taking account of the radiation which this layer, owing to its high temperature, must itself emit. He then really finds values for the absorption and the emission of that layer, harmonizing with the results of VERY's and WILSON's [3]) measurements, and also with the properties of the energy curve of the spectrum of a black body at different temperatures. But, for all that, serious doubts as to the correctness of the premise and the conclusions must subsist.

Indeed, the calculations of SCHUSTER as well as those of VERY, WILSON, LANGLEY, PICKERING and others, concerning the same subject, are based on the assumption that the light travels along straight lines through the solar gases, whereas everybody who has duly noticed A. SCHMIDT's "Strahlenbrechung auf der Sonne" will at the least have to give in that rays coming from the outer zones of the disk must have followed curved paths through the solar atmosphere. By this circumstance the said calculations lose their convincing power.

And besides, the fundamental idea that a considerable portion of the photospheric radiation should be absorbed by a thin atmosphere, encounters a difficulty of greater importance still This point, I think, has also first been moved by A. SCHMIDT. What becomes of the absorbed energy accumulating in the atmosphere? According to SCHUSTER e.g. (l.c. p. 322) the atmosphere transmits largely $^1/_3$ of

1) F. W. VERY. The absorptive power of the solar atmosphere. Astroph. Journ. 16, p. 73—91, (1902).

2) A. SCHUSTER. Astroph. Journ. 16, p.320—327, (1902); 21, p 258—261, (1905).

3) W. E. WILSON and A. A. RAMBAUT. Proc. Roy. Irish Acad. [3], 2, p. 299—334, (1892).

the radiation emitted by the photosphere; so it stops almost $^2/_3$, and only a small fraction of this absorbed energy leaves the Sun in the form of radiation, emitted by the atmosphere itself. After all, more than half of the radiation coming from the photosphere is retained by the absorbing layer, and we cannot suppose it to go back to the interior without violating the second law of thermodynamics. As long as it has not been shown how the solar atmosphere may get rid of that immense quantity of energy continually supplied and never radiated, similar considerations will remain very unsatisfactory.

Our problem appears to be much less intricate when viewed from the stand-point taken by SCHMIDT [1]), though the mathematical treatment will not be easy. A uniformly luminous sphere surrounded by a concentric, perfectly transparent refracting envelope, will offer the aspect of a disk the brightness of which diminishes towards the limb. This has been established approximately by SCHMIDT for the case of a homogeneous, sharply limited envelope. It is easily understood that a similar result must be obtained when assuming a transparent atmosphere of gradually decreasing density and refractive power; but then, of course, the rate at which the luminosity varies on the disk will depend on the law of density variation. We may proceed a little farther, and accept SCHMIDT's hypothesis that the incandescent core of the Sun is *not* a sphere with a sharp boundary, but a gaseous body the density and radiating power of which are smoothly diminishing along the radius. In this way, I think, we dispose of premises from which it seems possible to derive an explanation of the general aspect of the solar disk without involving into such serious difficulties as were hitherto encountered.

Chemistry. — *"On the nitration of ortho- and metadibromobenzene."*
By Prof. A. F. HOLLEMAN.

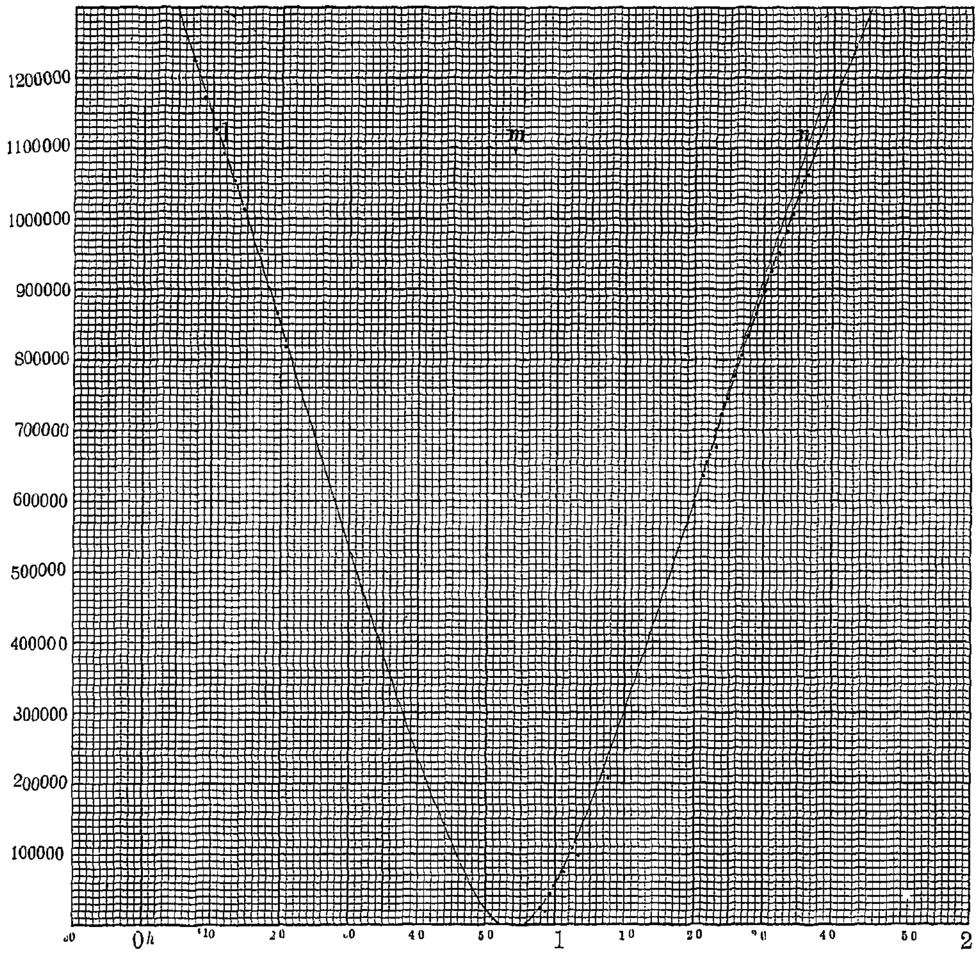
(Communicated in the meeting of January 27, 1906).

After the disturbing influence which the halogen atoms exercise on each other's directing influence in regard to the nitro-group, had been noticed in the nitration of the dichlorobenzenes, it was necessary to extend this research to the nitration of the dibromobenzenes so as to be able to find the connection between the results with the dichloro- and dibromocompounds and to compare the same with the result of the nitration of the corresponding monohalogen benzenes.

1) A SCHMIDT, Physik. Zeitschr. **4**, 282, 341, 453, 476; **5**, 67, 528. (1903 and 1904).

W. H. JULIUS *A new method for determining the rate of decrease of the radiating power from the center toward the limb of the solar disk.*

Middle part of the radiation curve obtained during the solar eclipse of August 30 1905.



Radiating power across the solar disk