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Perioden gehörender Wahrscheinlichkeitswerte, die wahrscheinliche wirkliche Anzahl von Vertretern der einzelnen Gruppen zu berechnen. Es ergibt sich alsdann folgende Übersicht:

Mittlere Periode	N	N/W_3	N/W_6	N/W_9
0ᵈ365	77	—	—	154
1.825	9	9	19	56
3.650	16	27	55	166
7.30	62	**168**	**337**	**984**
12.16	11	39	78	229

Auffallenderweise häuft sich die Anzahl wahrscheinlich wirklich vorhandener Vertreter auch hier um die Periode 7ᵈ30.

Um weitergehende Schlüsse zu ziehen, dürfte das Beobachtungsmaterial zurzeit noch nicht ausreichen, insbesondere ist eine bessere Kenntnis der Dichteverhältnisse erforderlich. Immerhin können wir aber im Hinblick auf die geringe Empfindlichkeit der Formel gegenüber den Masse- und Dichteverhältnissen aus der beobachteten Anzahl von Bedeckungsveränderlichen unter Zugrundelegung maximaler Wahrscheinlichkeiten sagen, daß den etwa 176 beobachteten Bedeckungsveränderlichen eine wirkliche Anzahl entspricht, die nicht viel über 1585 liegt und wohl kaum das Doppelte erreicht. Jedenfalls darf man annehmen, daß die größte Anzahl von Vertretern nicht in jener Gruppe zu suchen ist, in der die meisten beobachteten Fälle vorhanden sind.

Berlin-Friedenau, 1928 Febr. 6.

H. I. Gramatzki.

On the Temperature within the Sun-spots. By *V. A. Ambarzumian* and *N. A. Kosirev.*

1. The method adopted by us for the investigation of the dependence of the temperature T on the optical mass τ for the stars[1]) can also be applied to different details on the sun, in particular to the sun-spots.

Let P be a certain point of the spot and θ the angular distance of this point from the centre of the sun's disk, $E(\lambda, T)$ is the radiation of an absolutely black body, when the length of the wave is λ and the temperature T and $I(\lambda, \theta)$ the visible brightness of the point P in the length of the wave λ. Then

$$I(\lambda,\theta)=\int_0^\infty E(\lambda,T)\,e^{-\tau\sec\theta}\sec\theta\,d\tau\,. \qquad (1)$$

We designate $\tau\sec\theta=t\,.$

Then the equation (1) according to *Planck*'s formula will be transcribed thus:

$$I(\lambda,\theta)\lambda^5/c_1=\int_0^\infty[e^{c_2/\lambda T}-1]^{-1}\,e^{-t}\,dt \qquad (2)$$

where c_1 and c_2 are the constants in *Planck*'s formula. Further supposing: $e^{-t}=u$ we have:

$$I(\lambda,\theta)\lambda^5/c_1=\int_0^1[e^{c_2/\lambda T}-1]^{-1}du\,. \qquad (3)$$

Designating: $c_2/T=s$ we get:

$$I(\lambda,\theta)\lambda^5/c_1=\int_0^{s_0}[e^{s/\lambda}-1]^{-1}\,du/ds\cdot ds \qquad (4)$$

where $s_0=c_2/T_0$, when T_0 is the temperature of the upper boundary of the spot.

Extending the integration likewise on the atmosphere, whose influence is insignificant, we obtain the following equation which is more convenient for the solution:

$$\psi(\lambda)=\int_0^\infty[e^{s/\lambda}-1]^{-1}\,k(s)\,ds\,. \qquad (5)$$

In this integral equation of the first type the function $\psi(\lambda)=I(\lambda,\theta)\,\lambda^5/c_1$ can be obtained from observations. The function to be sought in this equation is $k(s)=du/ds$. The detailed theory of the numerical solution of equation (5) together with the subsidiary tables have been given by us in another work[1]). Having done the investigation thus planned for different points P of the spot we shall get the whole picture of the distribution of the temperature not only in the optical depth (mass) but likewise in other directions.

2. As far as we know there exists no special work concerning the question of the distribution of energy in the spectrum of the sun-spots, except the work of *A. A. Belopolsky*: »On the Temperature of the sun-spots«[2]). In this work *Belopolsky* gives the results of the approximated definition of the brightness of two places in the spectrum of the sun-spot (λ=390$\mu\mu$ and 490$\mu\mu$) obtained by comparing the spectrograms of the spots with those of the sun's disk. The spectrograms were obtained by means of the great refractor of 30 inch of the Pulkovo Observatory. In order to investigate the changes of temperature with respect to the depth of the sun-spots, it is necessary to know the value of the intensity for as many as possible points of their continuous spectrum.

For this purpose, during the summer of the present year 1927, *Belopolsky* has kindly put at our disposal the 30 inch refractor of the Pulkovo Observatory and the experimental side of this investigation has been worked out by us under his direction. We avail ourselves of this opportunity to express him our profound gratitude for many informations and advices.

The spectra of the sun-spots have been obtained by means of a three-prism spectrograph and were taken with a large photographic camera attached to it, so, that the region of the length of wave from 390$\mu\mu$ to 510$\mu\mu$ were obtained on a plate 12 cm long. These photoes were made on »Ilford gaslight Lantern« plates and likewise on »Ilford Special Lantern« plates. When taking the photograph with Ilford gaslight Lantern plates a diaphragm with a free aperture of 130 mm was put on the object glass, but when we employed Ilford Special Lantern plates a diaphragm with a free aperture of 55 mm in diameter was used. (Such a strong diaphragmation was urged by the desire of increasing the exposition in order to diminish its relative error.) For comparison we have obtained a scale consisting of photoes of different points of the sun's disk, disposed at different distances from the centre of the disk. With Ilford gaslight Lantern plates the photoes of the scale were obtained with an exposition of 50 sec and 30 sec. The photograph of the spectrum of the sun-spot was taken at an exposition of 50 sec. But with Ilford Special Lantern plates the scale was taken with an exposition of 6 sec and 4 sec and in this case the spectrum of the spot was obtained with an exposition of 6 sec.

In the first as well as in the second case the spectrograms of the spot, and the scale intended for comparison with them were obtained on the same plate.

[1]) AN **232**.321. [2]) *A. Bélopolsky.* Bull. de l'Acad. Ser. VI t. IX, Nr. 2, 1915 (Russian).

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In the present work we give the results of the working up of four spectrograms of the large spot, which was observed not far from the central meridian, on the 28th of July 1927. Its approximate coordinates are $b = -8°0$, $l = 344°5$.

3. The above mentioned spectrograms of the spot as well as of different points of the sun's disk have been measured with a microphotometer of *Hartmann*'s design (Bamberg No. 70019). 25 points with different length of waves have been measured. The curves for the transition from the readings of the photometrical wedge to the brightnesses were obtained for different parts of the spectrum (length 25–30 $\mu\mu$) in the following way.

First of all, with the help of *Milne*'s theory[1]) the brightnesses in star-magnitudes at different points of the spectrums composing the scale were calculated (In these calculations we considered the temperature of the sun's upper boundary as being = 4970°[2])). It was impossible for us to avail ourselves of *Abbot*'s experimental data, as *Abbot* has only measured the brightnesses of five lengths of waves in the region under investigation of the spectrum (390 $\mu\mu$ – 510 $\mu\mu$). When drawing out the curves (for two different expositions) of the dependence between the readings of the wedge and the intensities obtained in the above stated way, we assumed that within each part the sensitiveness of the plate for different rays, though liable to great changes, however be the readings of the wedge, changes by the same quantity when the intensity is increased the same number of times for the two lengths of waves within the designated part 20–25 $\mu\mu$ of length.

Those curves have given the means to determine the differences of the brightnesses (in star-magnitudes) of different points of the spectrum of the spot and those of the spectrum of the scale, whence we could already obtain the very intensities making use of the above quoted considerations.

Further we give the brightnesses of the continuous spectrum of the centre of the spot, obtained in this manner, in a rather arbitrary unit and for comparison in the same units for the same wave length the brightness of the sun's disk and border (0.99 radius from the centre of the disk).

λ	spot	Sun's border	Sun's centre	λ	spot	Sun's border	Sun's centre
392.40 $\mu\mu$	6.1	18.3	52.4	453.25 $\mu\mu$	9.1	23.0	55.8
395.98	7.4	18.7	52.8	457.38	9.0	23.3	55.8
399.38	7.4	19.0	53.1	460.98	9.4	23.5	55.8
404.29	7.1	19.4	53.5	465.98	9.1	23.6	55.8
409.39	6.5	19.9	54.0	471.32	8.4	23.9	55.7
413.62	6.4	20.3	54.2	478.52	8.9	24.2	55.6
418.85	6.7	20.7	54.6	483.05	9.9	24.4	55.5
420.62	8.0	20.8	54.7	489.50	10.4	24.6	55.4
423.45	8.3	21.0	54.8	494.13	10.6	24.8	55.3
425.20	8.4	21.2	54.9	498.75	11.3	24.9	55.1
440.24	8.4	22.2	55.7	503.37	12.8	24.9	55.0
444.99	9.1	22.5	55.7	506.27	13.4	25.1	54.8
448.70	8.9	22.8	55.7				

With regard to the points near the periphery of the kernel and of the penumbra we dared not attempt measurements in this region as, in consequence of the trembling of the image, the spectrum of the photosphere superposes the spectrum of the border of the spot.

As guarantee that we have indeed taken the photograph of the kernel of the spot we have the aspect of the lines *H* and *K*.

It appears strange at first sight that the above quoted table gives comparatively small figures for the relation of the brightnesses of the photosphere to the brightness of the spot, figures which contradict the subjective impression that arises from visual observation. However it is to be taken into consideration that in the case of ocular estimation an important part is played by the circumstance that our eye is above all sensible to the radiation of the sun's photosphere and has a smaller coefficient of sensitiveness for radiation that has a different spectral composition (corresponding to lower or higher temperatures). The brightnesses here mentioned also agree with the results obtained by *Belopolsky*.

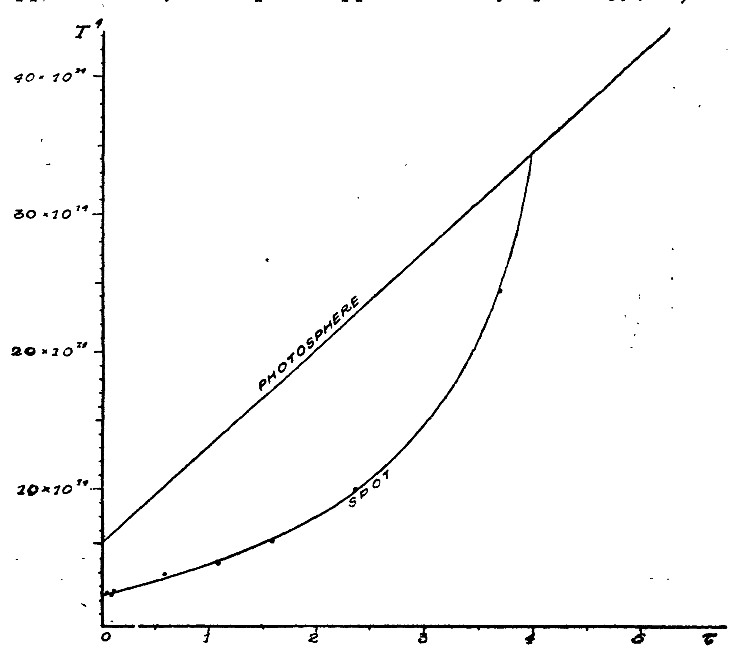
4. Proceeding in the same manner as we did for stars, we find the solution of the integral equation in the following form:

$$Ce^{-t} = \beta_1(c_2/T)^2 + \beta_2(c_2/T)^4 + \beta_3(c_2/T)^6 + \beta_4(c_2/T)^8 \quad (6)$$

where C is a certain constant depending on the choice of the unit of brightnesses and on the distance from the sun, and $\beta_1, \beta_2, \beta_3, \beta_4$ are obtained in a certain way that is pointed out in the above mentioned work from the *Fourier* coefficients of the development of the function $\psi(\lambda)$. As result of all these calculations a table which connects τ with T can be worked out. We give here such a table for the spot under investigation.

τ	T	τ	T
0.02	3950°	1.07	4700°
0.05	3970	1.62	5130
0.12	4030	2.36	5640
0.59	4450	3.65	7050

From this table we perceive that the temperature of the upper boundary of the spots is approximatively equal to 3940°[3]).



Dependence of T^4 on τ for the spot and the photosphere.

[1]) *E. A. Milne*. Phil. Trans. A. Vol. 223, p. 208. [2]) *Kosirev* und *Ambarzumian*. AN 229.89.

[3]) It does not exclude the possibility that lower temperatures may predominate in the reversing layer over the spot. Our method does not take this into account as the influence of the reversing layer on the distribution of energy in the continuous spectrum appears to be insignificant.

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The figure gives: in the first place the dependence for the photosphere, of T^4 on the optical mass τ (a right line according to *Schwarzschild*'s and *Milne*'s theory), in the second place the curve connecting the same values for the spot.

The figure shows that the optical mass, when the temperature of the spot coincides with that of the photosphere, will be equal to 4.0. One can take for granted that at this place the spot loses its particularities and passes into the photosphere. In this way the optical thickness of the spot is approximately equal to 4.0. Being careful to avoid any kind of presumptions concerning the thickness of the spot in kilometers, on account of our ignorance as to the molecular weight of the gases composing the spot (also on account of the doubtfulness of the fulfillment of the conditions of mechanical equilibrium in the spot) we suppose nevertheless from approximative calculations, that the depth of the spot does not surpass 100 km. So again the opinion is satisfied that the depth of the spots is exceedingly small in comparison with the sizes of their surface.

To conclude we shall point out the deficiencies of the present work: we have investigated the spectrum of only one point of the spot, namely of the middle of the kernel. The region of the spectrum that has been investigated is very small, which of course has an influence on the exactitude of the results.

In connection with this it is most desirable to continue the investigations of other parts of the spectrum and, by making use of large spots, to investigate also different parts of the spot (the kernel as well as the penumbra).

Leningrad, 1927 Nov. 21.

V. A. Ambarzumian and *N. A. Kosirev.*

Photographic Observations of Minor Planets.

Plate	1928 G.T.	Mean Position 1925.0		Obs	Δ Ephem.	
		696 Leonora — $13^m.9$.				
3857	Mar. 19.76244	$10^h59^m47^s.50$	$-8°38'14''.7$	*W*	$0^m.0$	$-18'$
3858	Mar. 19.80469	10 59 45.50	− 8 38 5.1			
		516 Amherstia — $9^m.4$.				
3889	Mar. 24.99603	11 48 30.21	−14 7 35.4	*W*	−5.3	+48
3913	Mar. 30.00523	11 42 59.84	−14 16 18.0			
		389 Industria — $10^m.8$.				
3889	Mar. 24.99603	12 10 38.97	−16 1 16.0	*W*	+3.4	−27
3913	Mar. 30.00523	12 6 11.26	−15 36 14.8			
		297 Caecilia — $13^m.6$.				
3970	April 18.80314	12 53 13.80	−14 19 14.6	*W*	−3.6	+29
3971	April 18.83916	12 53 12.10	−14 19 5.1			
		510 Mabella — $12^m.6$, $12^m.7$.				
3970	April 18.80314	13 3 20.41	− 7 15 39.2	*W*	−2.0	+ 5
3971	April 18.83916	13 3 18.59	− 7 15 18.9			
4026	May 8.74091	12 50 31.70	− 4 28 38.3	*Ja*		
4027	May 9.76172	12 50 4.60	− 4 21 34.8			
		1928 HG (new) — 12^m.				
3970	April 18.80314	13 8 57.68	− 9 45 45.5	*W*		
3971	April 18.83916	13 8 56.59	− 9 44 51.5			
		764 [1913 SU] — $13^m.7$.				
4074	May 17.79875	14 40 21.23	−23 24 34.8	*J*	0.0	0
4075	May 17.83338	14 40 20.60	−23 24 22.9			
4116	May 23.82947	14 36 15.41	−22 50 49.3			
4117	May 23.86340	14 36 13.94	−22 50 37.0			
		568 Cheruskia — $13^m.0$.				
4074	May 17.79875	14 44 36.71	−25 49 14.5	*J*	+4.3	− 3
4075	May 17.83338	14 44 34.97	−25 48 56.6			
4116	May 23.82947	14 40 5.30	−25 1 15.8			
4117	May 23.86340	14 40 3.78	−25 1 0.9			

Union Observatory, Johannesburg, 1928 June.

Plate	1928 G.T.	Mean Position 1925.0		Obs.	Δ Ephem.	
		385 Ilmatar — $9^m.7$.				
4107	May 21.75251	$13^h35^m45^s.51$	$-29°30'49''.3$	*J*	$+0^m.4$	$-5'$
4114	May 22.73316	13 35 12.01	−29 26 43.3			
		896 Sphinx — $12^m.5$.				
4116	May 23.82947	14 35 29.53	−21 31 36.5	*J*	+4.5	−14
4117	May 23.86340	14 35 28.53	−21 31 18.3			
		73 Klytia — $12^m.3$.				
4236	June 20.81186	16 27 2.45	−25 12 47.5	*W*	+2.5	− 6
4237	June 20.84579	16 27 0.71	−25 12 43.6			
		104 Klymene — $12^m.9$.				
4236	June 20.81186	16 32 48.10	−24 3 17.0	*W*	+0.1	− 1
4237	June 20.84579	16 32 46.55	−24 3 13.5			
		971 Alsatia — $13^m.6$.				
4236	June 20.81186	16 34 2.00	−19 13 23.1	*W*	−0.3	+ 1
4237	June 20.84579	16 34 0.40	−19 13 24.6			
		258 Tyche — $12^m.1$.				
3970	April 18.80314	12 47 14.25	− 8 41 22.8	*Ja*	−0.3	− 4
3971	April 18.83916	12 47 12.59	− 8 41 13.7			
		63 Ausonia — $9^m.6$.				
3970	April 18.80314	12 50 22.13	−13 10 23.5	*Ja*	+1.6	−14
3971	April 18.83916	12 50 19.97	−13 10 15.6			
		711 Marmulla — $12^m.9$.				
3970	April 18.80314	12 57 36.35	−11 24 21.2	*Ja*	+1.7	−15
3971	April 18.83916	12 57 33.88	−11 24 1.0			
		205 Martha — $12^m.9$.				
3970	April 18.80314	13 2 28.83	− 9 53 52.5	*Ja*	+3.2	− 2
3971	April 18.83916	13 2 27.12	− 9 53 34.9			
		705 Erminia — $12^m.2$.				
4107	May 21.75251	13 28 35.29	−35 24 1.5	*J*	+3.4	−46
4114	May 22.73316	13 27 49.26	−35 20 57.0			

C. Jackson, E. L. Johnson, H. E. Wood.

Berichtigung zu AN Nr. 5553 Bd. 232 p. 173. Statt Helligkeit lies überall Intensität, statt heller lies stärker und statt leuchtet lies hervortritt.

Specola Vaticana, 1928 Juni 23. *J. G. Hagen*, S.J.

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