DETERMINATION AND DISCUSSION OF THE SPECTRAL CLASSES OF 700 STARS MOSTLY NEAR THE NORTH POLE

PROEFSCHRIFT TER VERKRIJGING VAN DEN GRAAD VAN DOCTOR IN DE WIS- EN STERRENKUNDE AAN DE RIJKS-UNIVERSITEIT TE GRONINGEN, OP GEZAG VAN DEN RECTOR-MAGNIFICUS A. KLEIN, HOOGLEERAAR IN DE FACULTEIT DER GENEESKUNDE, TEGEN DE BEDENKINGEN VAN DE FACULTEIT DER WIS- EN NATUURKUNDE TE VERDEDIGEN OP DONDERDAG 24 JUNI DES NAM. TE 3 UUR

DOOR

GERRIT HENDRIK TEN BRUGGEN CATE,

GEBOREN TE LEEUWARDEN.

GEBROEDERS HOITSEMA — 1920 — GRONINGEN.

AAN MIJNE OUDERS

EN MIJNE VROUW.

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INTRODUCTION.

In the present paper I have collected the results of my attempts to classify the spectra of a 700 stars, photographed by Dr. F. ZERNIKE (formerly assistant of the Laboratory at Groningen) with the 6-inch refractor at Potsdam in the year 1914. He has chosen five regions, the centres of which are given further on in table 2.

Each side of a plate is 20 cM., and the focallength of the instrument being 1494 mM., 1 mM. corresponds with 2'.30, so that the plate contains an area of 460' × 460' = 59.29 square degrees.

All the plates together cover a region of 192 square degrees with 700 stars, so that there are on the average 3.6 stars per square degree. Consequently our list contains, according to the *Publications of the Astronomical Laboratory at Groningen* No. 27, the stars to about 9,5 photographic magnitude of the Harvard scale (*Harvard Annals* 71). The reason why Dr. ZERNIKE has taken the regions in the neighbourhood of the pole is, that all the stars of his plates are to be found in the *Astrographic catalogue* 1900 *Greenwich section*, *Volume III.*

Further he has taken the plate at Declination + 35°, because, as appears from the General eatalogue in the *G. P* 19 (*Area IX*)[1]) this are a contains many stars with great proper motion. Unfortunately the two plates with spectra of large dispersion contain but four stars out of the above-said catalogue, because the spectra on the plate do not go beyond the $8^{m}.5$ (*Bonner Durchmusterung*). The classification of the spectra of the third plate (small dispersion) is impossible. It has been much overexposed It may suffice to give a list of these spectra without discussing the material. It is contained in the list at the end of the paper which gives the whole of our results. In every zone the stars are arranged in the order of increasing Right-Ascension. The second and third columns give the places of the stars from the above mentioned *Astrographic catalogue.* The fifth column (phot. magn.) is also taken from this catalogue applying a correction of $+ 0^{m}.1$, because the magnitudes of this catalogue are based on the scale of *Pickerings North Polar*

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1) *G. P.* means Publications of the Astronomical Laboratory at Groningen.

sequence (*Harvard circular* 170) and they must be reduced to the scale of *H. A.* 71, *part* 3. In *G. P.* 27, table 11, I find

$$\text{H. A. } 71 - \text{H. C. } 170 = +0^{m}.1$$

for stars between $5^{m}.5$ and $10^{m}.5$.

The sixth column contains the visual magnitudes. They have been determined by Messrs. MüLLER and KRON at Potsdam on the Potsdam-scale. They are still unpublished, but have been courteously communicated by the authors.

I have compared these magnitudes with those of *H. A.* 70 and 54. The result, derived from a great number of stars, is:

Table 1.

magn.	< 8.0	8.0—8 9	9.0—9.9	> 9.9
Harvard—Potsdam	— 0.1	— 0.2	— 0.3	— 0.4

The seventh column gives the colour-Index, i. e. phot. magn. H. A. 71 — vis. magn. Potsdam.

The three following columns contain the spectra of the stars; next to those, determined by the author of this paper, the spectra taken from *H. C.* 180 and *Yerkes Actinometry* are shown. The spectrum of many stars has been determined on different plates. If that was the the case I have taken the mean of all the determinations, the results of which are found in the eighth column.

In the last column the reader will find the total proper motion. I have found $\mu_{\alpha} \cos \delta$ and μ_{δ} in a manuscript, kindly communicated by the Astronomer Royal at Greenwich.

In Chapter II and III I have given due attention to the two phenomena mentioned by Professor KAPTEYN [1]):

1) On the average the apparently fainter stars are redder than the brighter ones.

2) Apparent magnitude and spectral lines being the same, the stars are on the average redder the farther away they are.

For the phenomenon (1) Professor KAPTEYN gives the three following possible explanations:

3) Predominance of the later spectral types among the fainter stars.

4) An influence of the absolute brightness on the color index.

5) Selective absorption of light in space.

For the phenomenon (2) there are only the two explanations (4) and (5)

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1) On the change of spectrum and color index with distance and absolute brightness, Present state of the question.

(Contributions from the Mount Wilson Solar Observatory No. 83).

Therefore the complete equation for the colour index for stars of determined spectrum is:

$$C.\,I. = a + bm + cM + dR,$$

where a, b, c and d are constants, m the apparent magnitude, M the absolute magnitude and R the distance.

I think we can take d to be practically zero, mainly because SHAPLEY has found white stars in the globular clusters.

We thus drop the explanation (5).

The data we need are:

1) The photographic and visual magnitude i. e. the colour;

2) The spectral type;

3) The parallax of certain groups of stars.

The parallax is required for the determination of M and is found in *G. P.* No. 8 [1]).

To solve b in the equation

$$C.\,I. = a + bm + cM$$

we must take groups of stars with the same M, but with different m, and to solve c, we take groups of stars with the same m, but with different M.

[1]) Mean parallax of stars of determined proper motion and magnitude.

CHAPTER I.

CLASSIFICATION OF THE SPECTRA OF STARS.

1. Description of the method.

In this chapter I will describe the method and give the results of a spectral classification, depending on the relative intensities of some spectral lines. As was said in the introduction the determined spectra were photographed by Dr. ZERNIKE. He has used two kinds of objective prisms: one with small dispersion (the spectra got in this manner I will call P_1 and the other with large dispersion P_2).

In both cases the spectrum extends from H_γ ($\lambda = 4341$) to $H_\varkappa$ (3750) in the early types and from the G-band to K (3934) in the later types.

The distance from H_γ to K is for $P_1 = 0.8$ mM, and for $P_2 = 3.7$ mM.

According to the „*Publications of the Astronomical Laboratory at Groningen No.* 27" we can compute the photographic magnitude to which the determined spectra extend.

In the following table are given the results for all the plates.

Table 2.

Centre of the Plate.	Galactic latitude [1]).	Dispersion.	Exposure.	Number of Plates.	Number of stars.	Number per square degree.	Intern. phot. lim. magn.
Pole	27°	P1	1^h	1	135	2.3	9.2
Pole	27°	P2	2^h	1	89	1.5	8.8
85° $6^h 30^m$	27°	P1	1^h	3	220	3.7	9.6
85° $6^h 30^m$	27°	P2	2^h	3	80	1.3	8.6
84° $12^h 30^m$	33°	P1	1^h	2	120	2.0	9.2
84° $12^h 30^m$	33°	P2	2^h	2	46	0.8	8.2
84° $21^h 30^m$	33°	P1	1^h	2	200	3.4	9.6
84° $21^h 30^m$	33°	P2	2^h	3	90	1.5	8.9
35° $14^h 35^m$	70°	P2	2^h	2	46	0.8	8.7

[1]) Publications of the Astronomical laboratory at Groningen No. 18.

As was already mentioned, there is one plate P1 (exposure 2 hours) for which the determination of the spectra is impossible.

As for the last column of table 2, attention must be paid to the fact, that the plates contain many stars between $9^m.6$ and $10^m.5$. Of course, the lim magn. is not quite the same for the several spectral classes.

Method of classification. In the spectrum of a star pairs of lines were selected not far from one another and their relative intensities were estimated. For P1 two pairs of lines were selected, for P2 three. I have constructed a normal curve for each pair, the abscissa of each point representing the spectrum, the ordinate the relative intensities.

I have adopted the Harvard-scale of classification [1]). Each of the classes A, F, G and K is subdivided into 10 subdivisions A0, A1, A2 . . . . A9, F0 etc.

The subdivisions M*a* and M*b* were dropped. I have written down M at the appearance of flutings (due to titanium-oxyde) and a great intensity of the line $\lambda = 4227$.

As for the B stars I could only estimate B8 and B9 by the aid of the chosen lines; only a few stars contained helium-lines ($\lambda = 4010$ and $\lambda = 4026$).

With the available spectra this is about all that proved to be feasible.

The estimates were made on an arbitrary scale, extending from 0 to 10, in the same way as is done in the *Stufenmethode* of ARGELANDER for the estimates of variable stars. Hence, my numbers are approximately proportional to the logarithms of the intensity differences of two lines. I have noted 0, when there was no difference between the lines, 1 at the smallest difference in intensities that could be discovered, 10 when one of the lines was only just visible.

I have used the following pairs of lines (H is the compound line H and H_ε):

$$\mathbf{P2}: \frac{H_\delta}{K}, \frac{H}{K} \text{ and } \frac{H}{H_\delta}.$$

In the first two cases a line decreasing in intensity with advancing type (H_δ and H) has been combined with a line increasing in intensity with advancing type. $\frac{H_\delta}{K}$ en $\frac{H}{K}$ give a descending curve, $\frac{H}{H_\delta}$ an ascending curve (see the figures at the end of the paper).

P1: $\frac{H}{K}$ and $\frac{H}{H_\zeta}$. The first gives a descending, the second an ascending curve.

I have constructed the curves in the following way:

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1) Annals of the Harvard College Vol. 28, Part II.

On one of the best plates (P2) I have chosen the finest spectra and then determined the intensity-differences of each pair of lines. These I have compared with the spectral classes given in *H. C.* 180. In this manner I obtained many points, which determined the curve. In the same way I did with P1.

From F2 to K5 there is in reality no important change in the ratio $\frac{H}{K}$, as may be seen in the same curve for P2 and in *H. A.* 28, *part II.* Notwithstanding this the ordinate in my curve for P1 shows a regular decrease for the same interval.

A possible explanation is, that owing to the smaller dispersion, several lines, variable with the spectrum, well separated in the P2 plates, have coalesced.

I regret that as yet I have found no occasion to investigate the phenomenon more closely.

The K-line has the appearance of a large „band". I think there will be no objection against calling this band K.

That there is no doubt, that the curve is useful, is obvious in the average difference (paying no attention to the sign) between my estimates and those of *Harvard* or *Yerkes Actinometry* (of course made on the spectra from F2 to K5). This average difference is 0.4 spectral class. I find an average difference of 0.3 class between *all* my estimated spectra and Harvard or Yerkes.

I have therefore no reason to suppose that the curve $\frac{H}{K}$ (P1) below F2 is not real. It is however a very curious phenomenon.

In order to show that my scale of classification is identical with the *Harvard-scale*, I give here a list, taken from *H. A.* 28, *Part I*, containing the intensities of the lines used in the present paper

Table 3.

INTENSITIES (CANNON).

Spectral class.	B8	A0	F5	G0	K0	Ma
$H\zeta$	65	62.5	16	8		
K	5	10	135	160	200	170
$H + H\varepsilon$	70	70	100	120	170	140
$H\delta$	65	62.5	16	10	6	4

If I suppose the light-ratio between two lines, for an intensity difference of one *grade* to be x and if we call m_1 and m_2 the intensities of these lines expressed in magnitudes, then we have according to my curves and the preceding table:

Table 4.

P2 for $\frac{H_\delta}{K}$: $x^6 = 6.25$ (Ao) therefore $\log x = 0.13$

$x^8 = 8.44$ (F5) „ $\log x = 0.11$

$x^9 = 16.00$ (Go) „ $\log x = 0.13$

$x^{10} = 13.00$ (B8) „ $\log x = 0.11$

$\frac{H}{K}$: $x^7 = 7.00$ (Ao) „ $\log x = 0.12$

$\frac{H}{H_\delta}$: $x^7 = 6.25$ (F5) „ $\log x = 0.11$

$x^9 = 12.00$ (Go) „ $\log x = 0.12$

mean $\log x = 0.12$

Therefore
$$0.12 = 0.4\,(m_2 - m_1)$$
$$m_2 - m_1 = 0.3.$$

P1 for $\frac{H}{K}$: $x^{10} = 7.00$ (Ao) therefore $\log x = 0.08$

$x^2 = 1.35$ (F5) „ $\log x = 0.07$

$\frac{H}{H_\zeta}$: $x^{10} = 6.25$ (F5) „ $\log x = 0.08$

mean $\log x = 0.08$

Therefore
$$0.08 = 0.4\,(m_2 - m_1)$$
$$m_2 - m_1 = 0.2.$$

By comparison with *H. C.* 180 I find the following systematic difference:

H. C. 180 — ten Bruggencate = + 0.14 class.

2. Probable error of spectral classification.

From one of the plates (P1) I have taken the differences Δ between two estimates $\left(\frac{H}{K} \text{ and } \frac{H}{H_\zeta}\right)$ made on the same star, expressed in one subdivision as unit. I find:

Table 5.

Δ	observed number		computed number	
0	20	26	10	27
1	6		17	
2	10	20	14	22
3	10		8	
4	10	11	5	7
5	1		2	
6	0		1	
	57		57	

Accepting the error curve we get:
p. e. of a difference = 1.50.
p. e. of one estimate = 1.06.
p, e. of mean of 2 estimates = 0.75.
For the modulus h of the error curve we find the value 0.30
As far as can be judged from so small of number of observations the distribution agrees tolerably with the distribution of accidental errors.

The last column shows the distribution in the supposition that the number of differences $\Delta = 0$ is equal to the number between -0.5 and $+0.5$, that the number of differences $\Delta = 1$ is equal to the sum of the number between -1.5 and -0.5 and between $+0.5$ and $+1.5$ and so on.

I have treated exactly in the same manner a second plate (P1) Here I find for the p. e. of the mean of 2 estimates the value ± 0.53 and for the number of differences:

Table 6.

Δ	observed number		computed number	
0	31	40	14	38
1	9		24	
2	18	22	17	25
3	4		8	
4	1	6	4	5
5	5		1	
	68		68	

The irregularities in the numbers of the tables 5 and 6 must be the consequence of my preference for estimating the spectrum rather in one division than in another one. Therefore some divisions will extend over a larger interval than one tenth of a spectral class, whereas others will cover less than a tenth.

Taking two consecutive intervals the theoretical and observed numbers agree tolerably well.

For the greater dispersion plates (P2) the results are still better. I find for one of the plates for the p. e. of the mean of 2 estimates the value ± 0.38 and for the number of differences Δ:

Table 7.

Δ	observed number		computed number	
0	31	43	16	40
1	12		24	
2	8	15	13	17
3	4		4	
4	3		1	
	58		58	

Furtheron an average value of the probable error will be required. As even a very rough estimate will be sufficient for our purpose I assumed as the p. e. of a spectrum on a simple plate the value

p. e. = ± 0.55 subdivision.

This result represents the mean accuracy of our measures. The accuracy however differs pretty considerably for the several spectral classes. In general, the determination of an A star was easier than of a F — M star.

3. The distribution of the spectra.

As was to be expected from the irregularities in the numbers (Tables 5, 6 and 7), we find irregularities in the observed numbers as is shown by the following table:

Table 8.

Spectrum	Number of stars	Spectrum	Number of stars	Spectrum	Number of stars	Spectrum	Number of stars
		B8 and B9	20	F3	15	G7	2
		A0	69	F4	8	G8	5
		A1	20	F5	25	G9	0
A	19	A2	42	F6	7	K0	39
F	24	A3	30	F7	4	K1	0
G	27	A4	17	F8	19	K2	0
K	39	A5	25	F9	3	K3	1
M	14	A6	17	G0	26	K4	0
		A7	8	G1	2	K5	6
		A8	9	G2	3	K6	0
		A9	4	G3	23	K7	0
		F0	26	G4	3	K8	0
		F1	52	G5	17	K9	0
		F2	12	G6	5		

In the first column I have brought together the stars, for which the subdivision of the spectrum was not to be determined. When I take together all stars of each class, I find:

Table 9

Number	of	A-stars:		260
,,	,,	F-	,,	195
,,	,,	G-	,,	113
,,	,,	K-	,,	89
,,	,,	M-	,,	14.

A somewhat similar behaviour is shown by the stars in the *Yerkes Actinometry*.

In other catalogues, where the magnitudes are visual, the K-stars are found in much greater number than the F- and G stars.

Probably the apparent contradiction must be explained by the fact, that, as we have admitted all measurable spectra, the limit in visual magnitude for the K-stars is not nearly so faint as that for the F- and G-stars.

4. Correction for observation error.

Supposing the deviations of the true spectrum X are distributed according to the law of errors, we can compute which fraction of the observed number of X really belongs to this subdivision, and which fraction belongs to $X \pm 1$, $X \pm 2$ etc. We are not far from the truth in assuming for the p. e. r of an estimated spectrum the value ± 0.55 (see page 9).

Table 10.

MIXTURE OF SPECTRAL CLASSES IN WHAT HAS BEEN OBSERVED AS SPECTRUM X ($r = \pm 0.55$).

Spectrum	Fraction
X	0.457
$X \pm 1$	0.238
$X \pm 2$	0.032
$X \pm 3$	0.001

The meaning of this table is, that of the stars observed as belonging, say, to A5, the fraction 0.457 belongs really to this class, the fraction 0.238 belongs to A4 and another equal fraction to A6. Similarly the fraction 0.032 belongs to A3 and another equal fraction to A7.

CHAPTER II.

THE DISTRIBUTION OF THE SPECTRA AMONG STARS OF DIFFERENT MAGNITUDES.

It is of course important to examine whether the proportion of the stars of the first and the second type varies with apparent magnitude. Especially the question arises whether the later type stars predominate among the fainter ones.

It appears that, comparing bright and faint stars of the same spectrum and absolute magnitude, the average colour index of the faint stars is different from that of the brighter ones, a phenomenon, which must be due to an error in the photographic or the visual scale. Consequently, an investigation of the relative frequency of the several spectral classes among the stars of the fainter magnitudes is necessary.

As a small contribution to such an investigation I have examined the stars of the end of the paper and some other sources. The difficulty is, to determine to which magnitude the stars of the different regions are complete. I have used two methods in order to investigate this point.

In the first place I have determined the proportions of the number of stars between fixed limits of photographic magnitudes, both from *G. P.* 27 and from my list.

For the stars from my list I find, denoting $N_{7.8}^{8.2}$ the number of stars from magnitude 7.8 to magnitude 8.2 and so on:

Table 11.

$\frac{N_{8.3}^{8.7}}{N_{7.8}^{8.2}} = 1.55$	$\frac{N_{8.5}^{8.9}}{N_{8.0}^{8.4}} = 1.73$	$\frac{N_{8.7}^{9.1}}{N_{8.2}^{8.6}} = 1.98$	$\frac{N_{8.9}^{9.3}}{N_{8.4}^{8.8}} = 1.80$
$\frac{N_{8.4}^{8.8}}{N_{7.9}^{8.3}} = 1.55$	$\frac{N_{8.6}^{9.0}}{N_{8.1}^{8.5}} = 1.75$	$\frac{N_{8.8}^{9.2}}{N_{8.3}^{8.7}} = 1.90$	$\frac{N_{9.0}^{9.4}}{N_{8.5}^{8.9}} = 1.53$

For all the quotients I find in *G. P.* 27 the value 1.74.

From $\frac{N^{9.1}_{8.7}}{N^{8.6}_{8.2}}$ to $\frac{N^{9.2}_{8.8}}{N^{8.7}_{8.3}}$ there is a decrease. Therefore I assume that my list is complete up to and including magnitude 9.1.

In the second place I have determined the number of stars included in *the Astrographic catalogue* 1900, *Greenwich section, volume III,* and missing in my list. For the zones 80 to 88, the result is as follows:

Table 12.

Magnitudes (phot.)	Total number of stars (in the Greenwich catalogue)	Number of stars, missing in my list
6.0—6.9	28	3
7.0—7.4	24	1
7.5—7.9	35	3
8.0	8	0
8.1	13	1
8.2	13	0
8.3	15	0
8.4	12	1
8.5	20	3
8.6	17	2
8.7	24	1
8.8	22	2
8.9	26	3
9.0	34	3
9.1	32	2
9.2	35	8
9.3	55	21
9.4	45	23

That there is a certain number of brighter stars missing need no surprise. There are stars for which I found it impossible to assign the spectral class.

The *Greenwich catalogue* is complete up to

photographic magnitude 9.0 for the B stars
,, ,, 9.2 ,, ,, A stars
,, ,, 10.2 ,, ,, K stars.

I conclude that we may consider my list to be complete up to and including magnitude 9.1.

I have included in my examination not only the spectra from my list but also from *Harvard Circular* 180 in which the spectra are complete to $8^m.2$ (photogr.).

In *H. C.* 180 and in my list there are but few stars brighter than the seventh magnitude. Therefore I have completed my results with those from *Harvard Annals Volume L* (*Revised Harvard photometry*) and with the results, kindly sent to me by Dr. VAN RHIJN of the *Boss-stars*, the spectra of which are taken from *H. A.* 28, 56 and — in some cases — 50.

Harvard Annals 50 contains all the stars of visual magnitude $6^m.5$ and brighter, therefore photographically up to different magnitudes, depending on the spectrum in accordance with the values of the colourindices in the following table:

	Bo	B5	Ao	A5	Fo	F5	Go	G5	Ko	K5	M
Colour Index	— 0.24	— 0.12	0.00	+ 0.14	+ 0.28	+ 0.42	+ 0.56	+ 0.78	+ 1.00	+ 1.18	+ 1.35

Thus: The B-stars from H. A. 50 extend to photogr. magn. 6.5
„ A- „ „ „ „ „ „ „ 6.7
„ F- „ „ „ „ „ „ „ 7.0
„ G- „ „ „ „ „ „ „ 7.4
„ K- „ „ „ „ „ „ „ 7.8
„ M- „ „ „ „ „ „ „ 8.0.

We must therefore diminish the number of A-stars with the number lying between $6^m.7$ and $6^m.4$. According to *G. P.* 27, page 60, the proportion

$$\frac{\text{Number of stars from B to } 6^m.50}{\text{Number of stars from B to } 6^m.70} \text{ is equal to } \frac{126}{159}.$$

Now in *H. A*, 50 there are 2973 A-stars down to $6^m.7$ (phothogr.). Therefore

$$\text{the number of A-stars down to } 6^m.5 \text{ (photogr.)} = \frac{126}{159} \times 2973 = 2360.$$

In the same manner I have computed the number of F, G, K and M-stars, down to $6^m.5$ (photogr.). The number of B-stars remains the same.

Table 13.

Spectrum	Number in H. A. 50	Number to $6^m.5$ (photogr.)
B	865	865
A	2973	2360
F	1171	674
G	973	353
K	2327	546
M	396	74

The final results are:

Table 14

RELATIVE FREQUENCY OF THE SEVERAL STECTRAL CLASSES AMONG THE STARS OF DIFFERENT PHOTOGRAPHIC MAGNITUDES.

Region	Galactic latitude — 20° to — 40° and + 20° to + 40°		Whole sky	Circumpolar stars within 10° from the North Pole (Galactic latitude + 25° to + 35°)		
Catalogue	Boss		H. A. 50	H. C. 180 and Author		Author
Photogr. magn.	< 3.50	3.50—5.49	< 6.5	5.1—7.0	7.1—8.0	8.1—9.1
	Fraction	Fraction	Fraction	Fraction	Fraction	Fraction
Spectrum B	0.39	0.30	0.18	0.06	0.06	0.01
A	0.32	0.37	0.49	0.54	0.32	0.32
F	0.11	0.12	0.14	0.17	0.25	0.30
G	0.00	0.07	0.07	0.06	0.21	0.21
K	0.18	0.11	0.11	0.17	0.15	0.15
M	0.00	0.02	0.02	0.01	0.01	0.01
Total Number of stars	28	380	4872	71	143	221

From this table we draw the following conclusions:

The number of B-stars decreases with decreasing brightness.

The number of A-stars increases down to $7^m.0$ but for fainter stars there is a strong decrease.

The number of F stars increases with decreasing brightness.

The number of G-stars is constant down to $7^m.0$, but then there is a large increase.

The number of K- and M-stars seems to remain rather constant down to $9^m.1$.

The following table gives the relative numbers of the first (B and A) and second type (F, G and K) stars.

Table 15.

Photogr. magn.	< 3.50	3.50—5.49	< 6.5	5.1—7.0	7.1—8.0	8.1—9.1
$\frac{\text{Type I}}{\text{Type II}}$	2.50	2.27	2.05	1.50	0.62	0.49

Conclusion: The quotient $\frac{\text{Type I}}{\text{Type II}}$ decreases with decreasing brightness.

CHAPTER III.

ON THE CHANGE OF COLOUR INDEX WITH ABSOLUTE AND APPARENT MAGNITUDE.

1. General outline of the method.

As is stated in the introduction, we must solve the equation

$$\text{C. I.} = a + bm + c\text{M},$$

in order to investigate the change of C. I with absolute magnitude, spectral type being the same. Owing to the scale error, treated above, the C. I. will also depend on the apparent magnitude; without this error b would be zero. The all important question however is the determination of c, i. e. the increase of the C. I per unit of absolute magnitude.

The unknowns b and c have been solved in two steps:

In the first place I divided the stars of every spectral division into two or three groups according to their apparent magnitude. Every group gives an equation of the form:

$$\overline{\text{C. I.}} = a + b\overline{m} + c\overline{\text{M}}$$

where a dash over a letter denotes the mean of the quantities, defined by those letters for the stars of a group.

From these equations we find

$$b = p + qc.$$

The coefficients p and q may be computed from our data; q will be small, if the mean absolute magnitudes of the different groups are approximately equal.

In the second place I divided the stars of every spectral division into groups according to their absolute magnitude. I thus found c as a function of b:

$$c = r + sb,$$

where s will be probably a small quantity. For every spectral division the unknowns b and c are solved from the two equations

$$b = p + qc$$
$$c = r + sb.$$

For the solution of the above-mentioned equations I have used the stars from my lists at the end of this paper and the stars from *Harvard Circular* 180. As was said in the Introduction, the visual magnitudes are determined by Messrs. KRON and MÜLLER at Potsdam.

The absolute magnitude M, i. e. the apparent magnitude at the distance of one parsec ($\pi = 1''$), is a function of the apparent magnitude and distance; they are connected by the relation

$$M = m + 5 \log \pi$$

I have calculated for every star the absolute magnitude by means of the formula

$$M = m + 5 \log \bar{\pi} - \frac{5\varrho^2}{0.92 \text{ mod.}} \quad ^{1)}$$

where $\bar{\pi}$ = mean parallax of stars of determined proper motion and magnitude and ϱ = probable error of the error curve

$$z = \log \frac{\pi}{\pi_0}.$$

π being the true parallax of a star and π_0 the most probable parallax of stars of the same magnitude and proper motion [2]).

We can find $\bar{\pi}$ in Table G in the *G. P.* 8. The photometric magnitudes in this Table are based on the Potsdam scale. Adopting the scale of MÜLLER and KRON, we have to diminish the visual magnitudes in my lists by an amount of $0^m.1$ [3]), in order to compute $\bar{\pi}$.

According to *G. P.* 8 the value of ϱ is equal to 0.19; therefore

$$\frac{5\varrho^2}{0.92 \text{ mod.}} = 0.46.$$

2. Solution of *b*.

As some of the spectral divisions do not contain a sufficient number of stars to give a reliable result for the unknowns, the stars of these divisions were

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1) P. J. VAN RHIJN's dissertation p. 72.

2) $\bar{M} = \bar{m} + 5 \overline{\log \pi}$.

As for stars of the same proper motion and apparent magnitude, $\log \pi - \log \pi_0$ is distributed in accordance with the law of errors, we have:

$$\overline{\log \pi} = \log \pi_0 = \log \bar{\pi} + \log e^{-\frac{1}{4 \text{mod}^2 h^2}} = \log \bar{\pi} - \frac{5\varrho^2}{0.92 \text{ mod}}.$$

3) Harvard-Potsdam 17 = $-0^m.16$.

Harvard-Potsdam (MÜLLER and KRON) = -0.25 (see Introduction).

combined with those of other divisions into a single group. This was done, for instance, for the A9 and A8 stars. The colour-indices of the A 9 stars were diminished by $0^m.04$, i. e. the average difference between the mean colour-indices of two successive spectral divisions. Moreover the absolute magnitudes of the A9-stars were diminished by $0^m.10$, a value derived from a smooth curve, which was drawn through the plotted points, representing the mean absolute magnitude as a function of the spectral type. It must be noted, that this curve has a maximum at F5.

In the same way the quantities of the A7-stars, changing systematically with the spectral type have been reduced to what they would have been, had the stars been of the A8 type.

The following table gives the spectral divisions which were combined into a single group:

Table 16.

Spectral divisions combined into a single group	C. I. en M. reduced to:	Number of stars.
B8 and B9	B9	16
A0	A0	76
A1	A1	19
A2	A2	57
A3	A3	36
A4	A4	16
A5	A5	36
A6	A6	14
A7, A8 and A9	A8	20
F0	F0	39
F1	F1	46
F2	F2	20
F3 and F4	F3	20
F5 and 6	F5	49
F7. F8 and F9	F8	51
G0, G1 and G2	G0	45
G3 and G4	G3	24
G5. G6, G7 en G8	G5	60
K0	K0	78
K2, K3 and K5	K5	23
M	M	13

There are no stars belonging to G9, K1, K4, K6 to K9. We first divide the stars of a certain group into two or three subgroups, according to their apparent magnitude The stars with a very large or a very small absolute magnitude were omitted, in order to make the mean absolute magnitudes of the subgroups of stars of different apparent magnitude as equal as possible.

Every sub-group gives an equation of condition, which was written in the form

$$a + b\,(m - 9.00) = \text{C. I.} - c\,(\text{M} + 3.00).$$

The resulting equations of condition of this form are given in:

Table 17.

Spectrum	Limits of magnitude	Equations of condition for the unknown b	Number of stars
B	$\leqq 8.9$	$a - 1.89b = -0.39 + 1.26c$	7
	$\geqq 9.0$	$a + 0.79b = -0.33 + 0.21c$	9
A0	$\leqq 8.9$	$a - 1.41b = -0.32 + 0.75c$	26
	9.0 to 9.9	$a + 0.44b = -0.25 + 0.36c$	26
	$\geqq 10.0$	$a + 1.96b = -0.35 + 0.08c$	16
A1	$\leqq 8.9$	$a - 1.73b = -0.14 + 0.85c$	8
	$\geqq 9.0$	$a + 0.58b = -0.34 + 0.36c$	11
A2	$\leqq 8.9$	$a - 1.11b = -0.19 + 0.72c$	27
	$\geqq 9.0$	$a + 0.74b = -0.38 + 0.24c$	24
A3	$\leqq 8.9$	$a - 0.92b = -0.20 + 0.44c$	12
	9.0 to 9.9	$a + 0.36b = -0.15 + 0.17c$	10
	$\geqq 10.0$	$a + 1.29b = -0.17 - 0.29c$	7
A4	$\leqq 8.9$	$a - 1.28b = -0.12 + 0.53c$	5
	$\geqq 9.0$	$a + 0.64b = -0.38 + 0.10c$	9
A5	$\leqq 8.9$	$a - 0.61b = -0.17 - 0.32c$	13
	$\geqq 9.0$	$a + 0.52b = -0.21 - 0.39c$	18
A6	$\leqq 9.5$	$a - 0.27b = -0.08 - 0.66c$	6
	$\geqq 9.6$	$a + 1.05b = -0.18 - 0.72c$	8
A8	$\leqq 9.5$	$a - 0.49b = -0.09 - 0.23c$	8
	$\geqq 9.6$	$a + 0.87b = -0.20 - 0.77c$	6

Table 17 (continued).

Spectrum	Limits of maguitude	Equations of condition for the unknown b	Number of stars
F0	$\leqq 8.9$	$a - 0.84b = -0.09 + 0.00c$	17
	$\geqq 9.0$	$a + 0.39b = -0.05 - 0.48c$	14
F1	$\leqq 9.2$	$a - 0.39b = +0.05 - 0.57c$	16
	9.3 to 9.7	$a + 0.50b = -0.04 - 1.41c$	10
	$\geqq 9.8$	$a + 1.01b = -0.08 - 1.22c$	16
F2	$\leqq 8.9$	$a - 0.82b = 0.00 + 0.64c$	9
	$\geqq 9.0$	$a + 0.30b = -0.08 - 0.39c$	9
F3	$\leqq 8.9$	$a - 0.86b = +0.03 - 0.41c$	9
	$\geqq 9.0$	$a + 0.43b = -0.05 - 0.28c$	8
F5	$\leqq 8.9$	$a - 0.74b = +0.07 - 0.55c$	25
	$\leqq 9.0$	$a + 0.35b = +0.02 - 0.61c$	18
F8	$\leqq 7.9$	$a - 1.70b = +0.11 + 0.02c$	10
	8.0 to 8.9	$a - 0.52b = +0.12 - 0.36c$	24
	$\geqq 9.0$	$a + 0.46b = -0.10 - 0.66c$	13
G0	$\leqq 7.9$	$a - 1.59b = +0.44 - 0.28c$	9
	8.0 to 8.9	$a - 0.58b = +0.25 - 0.40c$	25
	$\geqq 9.0$	$a + 0.28b = +0.12 - 0.74c$	9
G3	$\leqq 8.9$	$a - 0.98b = +0.53 - 0.05c$	9
	$\geqq 9.0$	$a + 0.51b = +0.09 - 0.69c$	7
G5	$\leqq 7.9$	$a - 1.97b = +0.65 + 0.73c$	23
	8.0 to 8.6	$a - 0.63b = +0.55 + 0.65c$	20
	$\geqq 8.7$	$a + 0.10b = +0.22 + 0.27c$	14
K0	$\leqq 7.9$	$a - 2.04b = +0.93 + 0.88c$	19
	8.0 to 8.7	$a - 0.60b = +0.75 + 0.26c$	24
	$\geqq 8.8$	$a + 0.12b = +0.34 - 0.31c$	17
K5	$\leqq 8.5$	$a - 1.27b = +1.22 + 0.70c$	12
	$\geqq 8.6$	$a - 0.12b = +0.97 + 0.25c$	9
M	$\leqq 7.9$	$a - 2.24b = +1.32 + 1.17c$	5
	$\geqq 8.0$	$a - 0.40b = +0.99 + 1.24c$	8

If there are more than two equations, I have solved by the method of least squares, the weights being equal to the number of stars, given in the last column. The results are:

Table 18.

Group	$b =$	Weight
B	$+\overset{m}{0.020} - 0.391c$	28
Ao	$-0.005 - 0.201c$	118
A1	$-0.086 - 0.212c$	25
A2	$-0.100 - 0.260c$	43
A3	$+0.016 - 0.290c$	25
A4	$-0.134 - 0.224c$	12
A5	$-0.033 - 0.062c$	10
A6	$-0.070 - 0.045c$	6
A8	$-0.085 - 0.400c$	20
Fo	$+0.033 - 0.390c$	12
F1	$-0.094 - 0.839c$	16
F2	$-0.070 - 0.920c$	20
F3	$-0.061 - 0.100c$	7
F5	$-0.040 - 0.055c$	12
F8	$-0.053 - 0.166c$	50
Go	$-0.138 - 0.503c$	15
G3	$-0.300 - 0.430c$	9
G5	$-0.176 - 0.179c$	41
Ko	$-0.214 - 0.442c$	54
K5	$-0.218 - 0.400c$	7
M	$-0.180 + 0.038c$	7

3. Solution of *c*.

As in the solution of b the stars of some divisions were combined into a single group. The groups are the same as those on page 17.

For the solution of c, the stars of a certain group were divided into two or three sub-groups according to their absolute magnitude. The stars with a very large or a very small apparent magnitude were omitted, in order to make the mean apperent magnitudes of the sub-groups of stars of different absolute magnitude as equal as possible.

Every sub-group gives an equation of condition, which was written in the form

$$a + c\,(M + 3.00) = C.\,I. - b\,(m - 9.00).$$

If we compute the value of c in this manner, a systematic error will creep in, due to the accidental uncertaintes in the determination of the class of spectrum [1]).

This error will tend to diminish the value of c for the early type stars and to increase its value for the later types. Therefore we have to apply corrections to the colour indices; I have computed these corrections, but they are so small, that they may be neglected.

Now wo can derive c as a function of b:

The stars of every group were divided into two or three subgroups according to the amount of their absolute magnitude.

Table 19.

Spectrum	Limits of Abs. magn.	Equations of condition for the unknown c	Number of stars
B	$\leqq -4.01$	$a - 2.05c = -0.33 + 1.01b$	9
	$\geqq -4.00$	$a - 0.01c = -0.31 - 0.13b$	8
A0	$\leqq -4.01$	$a - 2.42c = -0.28 + 0.52b$	25
	-4.00 to -3.01	$a - 0.41c = -0.35 + 0.46b$	23
	$\geqq -3.00$	$a + 0.75c = -0.25 - 0.34b$	20
A1	$\leqq -3.61$	$a - 1.18c = -0.23 + 0.69b$	8
	$\geqq -3.60$	$a - 0.15c = -0.25 - 0.03b$	8
A2	$\leqq -4.01$	$a - 1.73c = -0.24 + 0.81b$	18
	-4.00 to -3.01	$a - 0.56c = -0.27 + 0.35b$	17
	$\geqq -3.00$	$a + 0.52c = -0.33 + 0.16b$	16
A3	$\leqq -3.01$	$a - 0.73c = -0.13 + 0.21b$	15
	$\geqq -3.00$	$a + 0.67c = -0.17 - 0.44b$	18
A4	$\leqq -3.01$	$a - 0.56c = -0.30 - 0.10b$	7
	$\geqq -3.00$	$a + 0.70c = -0.33 - 0.41b$	7
A5	$\leqq -3.01$	$a - 1.12c = -0.19 + 0.09b$	15
	$\geqq -3.00$	$a + 0.70c = -0.19 - 0.01b$	21

1) J. C. KAPTEYN, Contributions Mt. Wilson Observatory No. 42, p, 10, 1909.

Table 19 (continued).

Spectrum	Limits of Abs. magn.	Equations of condition for the unknown c	Number of stars
A6	$\leqq -2.01$	$a + 0.15c = -0.17 - 0.70b$	6
	$\geqq -2.00$	$a + 1.33c = -0.13 - 0.70b$	7
A8	$\leqq -2.51$	$a - 0.69c = +0.06 - 0.33b$	9
	$\geqq -2.50$	$a + 1.63c = -0.25 - 0.64b$	9
F0	$\leqq -3.01$	$a - 1.04c = -0.11 + 0.47b$	19
	$\geqq -3.00$	$a + 0.86c = -0.12 - 0.10b$	17
F1	$\leqq -3.01$	$a - 1.07c = +0.03 - 0.39b$	9
	-3.00 to -2.01	$a + 0.36c = +0.04 - 0.42b$	15
	$\geqq -2.00$	$a + 1.85c = -0.06 - 0.50b$	21
F2	$\leqq -3.01$	$a - 2.26c = -0.03 + 0.33b$	6
	$\geqq -3.00$	$a + 1.00c = -0.05 + 0.34b$	8
F3	$\leqq -3.01$	$a - 0.63c = +0.04 + 0.25b$	6
	$\geqq -3.00$	$a + 0.64c = -0.09 + 0.06b$	9
F5	$\leqq -3.01$	$a - 0.60c = +0.07 + 0.47b$	10
	-3.00 to -2.01	$a + 0.42c = +0.03 + 0.20b$	19
	$\geqq -2.00$	$a + 1.54c = +0.07 + 0.02b$	17
F8	$\leqq -3.01$	$a - 0.78c = +0.13 + 0.72b$	16
	-3.00 to -2.01	$a + 0.46c = +0.05 + 0.30b$	12
	$\geqq -2.00$	$a + 1.67c = -0.01 + 0.42b$	18
G0	$\leqq -3.01$	$a - 1.46c = +0.43 + 0.90b$	16
	$\geqq -3.00$	$a + 1.27c = +0.15 + 0.57b$	26
G3	$\leqq -2.41$	$a - 0.34c = +0.38 + 0.37b$	12
	$\geqq -2.40$	$a + 1.56c = +0.22 - 0.01b$	10
G5	$\leqq -4.01$	$a - 2.09c = +0.56 + 1.09b$	20
	-4.00 to -3.01	$a - 0.58c = +0.71 + 1.26b$	17
	$\geqq -3.00$	$a + 0.73c = +0.38 + 0.77b$	15
K0	$\leqq -4.01$	$a - 1.86c = +0.88 + 1.28b$	23
	-4.00 to -2.70	$a - 0.26c = +0.73 + 0.85b$	24
	$\geqq -2.69$	$a + 1.13c = +0.56 + 0.31b$	17
K5	$\leqq -3.50$	$a - 1.21c = +1.27 + 1.00b$	10
	$\geqq -3.49$	$a - 0.15c = +1.00 + 0.52b$	12
M	$\leqq -4.01$	$a - 2.31c = +1.13 + 0.87b$	6
	$\geqq -4.00$	$a - 0.43c = +1.06 + 1.11b$	7

If there are more than two equations, we solve by least squares, the weight of every equation being equal to the number of stars.

The values of *c* are found in the following table:

Table 20.

Group	$c =$	Weight
B	$+\overset{m}{0.007} - 0.559b$	18
A0	$-0.001 - 0.232b$	116
A1	$-0.030 - 0.700b$	4
A2	$-0.034 - 0.294b$	43
A3	$-0.031 - 0.464b$	16
A4	$-0.026 - 0.246b$	6
A5	$+0.002 - 0.055b$	29
A6	$+0.030 + 0.000b$	4
A8	$-0.134 - 0.134b$	24
F0	$-0.008 - 0.300b$	32
F1	$-0.037 - 0.041b$	58
F2	$-0.004 + 0.003b$	42
F3	$-0.098 - 0.150b$	6
F5	$+0.001 - 0.210b$	30
F8	$-0.050 - 0.116b$	52
G0	$-0.100 - 0.121b$	74
G3	$-0.084 - 0.200b$	20
G5	$-0.056 - 0.107b$	70
K0	$-0.100 - 0.315b$	89
K5	$-0.230 - 0.435b$	6
M	$-0.035 + 0.128b$	11

4. Values of *b* and *c*.

Combining the tables 18 and 20, we find for *b* and *c* the following values:

Table 21.

Group	b	Weight	c	Weight
	m		m	
B	+ 0.022	13	— 0.005	8
A0	— 0.005	104	0.000	102
A1	— 0.094	15	+ 0.038	2
A2	— 0.099	35	— 0.004	35
A3	+ 0.029	14	— 0.045	9
A4	— 0.135	10	+ 0.005	5
A5	— 0.033	10	0.000	29
A6	— 0.071	6	+ 0.030	4
A8	— 0.033	6	— 0.130	22
F0	+ 0.041	9	— 0.021	19
F1	— 0.065	13	— 0.035	47
F2	— 0.066	18	— 0.004	29
F3	— 0.052	7	— 0.090	6
F5	— 0.041	12	+ 0.018	30
F8	— 0.047	46	— 0.036	48
G0	— 0.093	13	— 0.090	64
G3	— 0.272	10	— 0.026	22
G5	— 0.169	33	— 0.039	56
K0	— 0.177	37	— 0.084	61
K5	— 0.154	4	— 0.160	3
M	— 0.182	7	— 0.053	11

5. Discussion of the results.

When we combine the values of b according to the spectral types B, A, F, G, K and M, we find:

Table 22.

Spectrum	Average b	Weight	p. e. of b
	m		m
B and A	— 0.033	213	± 0.010
F	— 0.044	105	± 0.008
G	— 0.170	56	± 0.027
K and M	— 0.176	48	± 0.003

On the average the probable error of the unit of weight is ± $0^m.125$.

The unit of weight in these computations is the weight of a single colour-index determination i. e. the difference between the photogr. magnitude of a star of *the Greenwich catalogue* and the vis. magn. of *Potsdam* (MÜLLER *and* KRON). For the weight of the second member of every equation of condition was taken equal to the number of stars from which the latter was derived.

As to the fact that *b* is different for different spectral classes, Prof. KAPTEYN found the same result in his paper *On the Absorption of light in space* (*Contributions Mount Wilson* No. 42). The author attributes the phenomenon to an error in the photogr. scale of the Draper Catalogue (see pages 5 and 6 of the above-mentioned paper).

In the same manner I have treated the values of *c*:

Table 23.

Spectrum	Average *c*	Weight	p. e. of *c*
	m		m
B and A	— 0.015	216	± 0.010
F	— 0.022	179	± 0.007
G	— 0.060	142	± 0.013
K and M	— 0.083	75	± 0.008

Here we find on the average the same value for the probable error of the unit of weight i. e. the probable error of a single colour-index determination, viz. ± $0^m.126$.

6. Summary of results.

1) The later spectral types predominate among the fainter stars (Table 15)

2) The apparent faint stars are, ceteris paribus, bluer thant he bright stars (Table 22).

In my opinion this effect is probably due to an error in the photographic scale of the *Greenwich catalogue* or an error in the visual scale of *Potsdam.*

The surprising result of table 22 is, that the value of *b* changes with the spectrum.

3) The stars with small proper motion are, ceteris paribus, redder than those with large proper motion (Table 23).

This effect is probably due to an influence of the absolute magnitude on the colour. This influence seems to increase with advancing type, but the effect seems not to exist for the B and A stars, because for these spectra the value of *c* ($\pm 0^m.015$) is but 1.5 times larger than its probable error ($\pm 0^m.010$).

The same phenomenon is found by Dr. P. J. van Rhijn in his dissertation *Derivation of the change of colour with distance and apparent magnitude* and by Adams and Kohlschütter. In the discussion of the results on page 71, of the above-mentioned dissertation we can see that *c* i. e. the increase of the colour index per unit of distance for the B-stars and early A-stars is equal to 0.00000, whereas *c* shows a systematic change with the spectral type.

Adams and Kohlschütter came to the following conclusion on page 1 of their paper *Some spectral criteria for the determination of absolute stellar magnitudes* [1]).

„The continuous spectrum of the small proper motion stars is relatively fainter in the violet as compared with the red than is the spectrum of the large proper motion stars. The magnitude of this effect appears to depend on the spectral type, and increases with advancing type between F0 and K0."

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[1]) Contributions from the Mount Wilson Solar Observatory No. 89.

TABLES AND PLATES.

EXPLANATION OF THE TABLES AND THE PLATES.

Columns 2 and 3 give α and δ of the stars from *Astrographic catalogue* 1900 *Greenwich section*, Volume III.

Column 4 gives the numbers from the *Bonner Durchmusterung*.

Column 5 is taken from the above mentioned *Astrographic catalogue*, applying a correction of $+ 0^m.1$ (see pages 5 and 6)

Column 6 contains the visual magnitudes, determined by MÜLLER and KRON.

Column 7 gives the differences between the magnitudes in the columns 5 and 6.

Columns 8, 9 and 10 give the spectra.

Column 11 contains the total proper motion (see page 6).

Plates: The ordinate represents the relative intensities between several spectral lines.

The abscissa gives the spectrum.

There are three curves $\left(\frac{H_\delta}{K}, \frac{H}{K} \text{ and } \frac{H}{H_\delta}\right)$ for large dispersion (P2) and two curves $\left(\frac{H}{K} \text{ and } \frac{H}{H_\zeta}\right)$ for small dispersion (P1).

ZONE 79.

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h	m	°	′								″
1	20	30.6	79	53	675	7.2			Ao		Ao	
2	21	21.5	79	55	701	7.6			Fo			
3	21	55.9	79	50	721	7.8			Ko		M	
						ZONE 80.						
4	5	12.9	80	58	168	8.8	7.9	+ 0.9	M	Ko		
5	5	33 7	80	34	181	8.0	8.2	− 0.2	A2	A2		
6	6	8.9	80	56	206	8.7	8 2	+ 0 5	G8	G5		
7	6	53.2	80	42	227	8.1	8.6	− 0.5	A6	Ao		
8	7	5.8	80	48	230	8.1	7 3	+ 0.8	G3	Ko	G5	
9	7	25.2	80	47	233	8.8	8.9	− 0.1	F6	F8		
10	7	39.8	80	31	238	7.1	6.7	+ 0 4	G5	G5	G1	
11	11	33.8	80	53	381†	9.3	9.6	− 0.3	A2	A2		0.029
12	12	31.1	80	48	400†	7.4	7.3	+ 0.1	A5	F2	A6	0.120
13	12	46.6	80	57	407†	8.3	7.7	+ 0.6	F5	G5		0.018
14	12	55.5	80	27	398	8.2	8.3	− 0.1	F1	F5		
15	13	25.6	80	58	427†	9.5	9.7	− 0.2	A2	A2		0.013
16	13	37.8	80	59	440†	8.8	9.1	− 0.3	F2	F5		0.081
17	20	18.0	80	9	648	7.7	7.9	− 0.2	Fo	Fo		
18	20	20.2	80	13	650	6.6	7.1	− 0.5	B9	Ao	B9	
19	20	20.4	80	16	651	8.0	8.0	0.0	F1	A5		
20	20	23.0	80	50	652	8.6	8.1	+ 0.5	G	Ko		
21	20	35.3	80	45	660	6.6	6.3	+ 0.3	K	Ko	K2	
22	20	36.2	80	47	662	8.9	9.0	− 0.1	F1			
23	20	40.2	80	33	664	9.1	9.3	− 0.2	A6			
24	20	45.3	80	27	667	9.2	9.5	− 0.3	Ao			
25	20	52.1	80	11	672	6.3	5.4	+ 0.9	Ko	Ko	G8	
26	21	8.1	80	45	679	7.1	7.2	− 0.1	Fo	Fo	A6	
27	21	11.1	80	37	682	8.4	7.1	+ 1.3	K	K2	G—K	
28	21	11.2	80	59	683	9.2	9.1	+ 0.1	G3			
29	21	16.9	80	59	689		9.0		Ko			
30	21	16.8	80	23	688	7.1	7.5	− 0.4	A1	Ao	A1	
31	21	17.5	80	49	690	6.2	6.4	− 0.2	Ao	A2	A2	
32	21	26.0	80	29	695	8.6	9.0	− 0.4	A1			
33	21	27.8	80	·5	707*	6.7			F		G1	
34	21	37.4	80	43	700	8.8	8.8	0.0	F5	F5		
35	21	48.3	80	15	706	8.3	8.5	− 0.2	F	F2		
36	21	50.1	80	12	717*	8.5			A6			
37	22	25.8	80	54	722	9.1	9.4	− 0.3	Ko			
38	22	26.2	80	11	739*	7.7			Ko		G6	
39	22	29.5	80	20	724	9.3	9.5	− 0.2	Ao			
40	22	39.2	80	52	731	7.4	7.0	+ 0.4	A5	[F8 / A5	F5	
41	22	53.9	80	45	739	8.1	8.3	− 0.2	A2	A3		
						ZONE 81.						
42	4	54 8	81	50	174	9 3	9.5	− 0.2	Ao	A		0.024
43	4	59.2	81	49	177	8.9	9.0	− 0.1	F1	F		0.031
44	5	0.4	81	6	178	8.9	8.2	+ 0.7	G3	G5		0.027
45	5	8.9	81	16	180	9.2	9.5	− 0.3	A2	Ao		0.009

† Zone 81 in B. D.
* Zone 79 in B. D.

ZONE 81. — *Continued.*

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum			Proper Motion Greenwich.
									author.	Harvard circular 180.	Yerkes Actinometry.	
	h	m	°	′								″
46	5	14.4	81	37	183	9.2	8.6	+ 0.6	Go	Go		0.174
47	5	15.5	81	34	184	9.8	9.7	+ 0.1	A5			0.025
48	5	20.4	81	19	187	8.7	8.7	0.0	A6	F2		0.021
49	5	23.8	81	15	189	9.7	9.6	+ 0.1	F1			0.022
50	5	35.0	81	45	192	8.7	8.8	— 0.1	A1	Ao		0.031
51	5	38.4	81	20	194	8.5	8.0	+ 0.5	Go	G5		0.010
52	5	40.4	81	20	195	10.0	10.1	— 0.1	A2			0.011
53	5	50.2	81	31	201	9.5	9.0	+ 0.5	F	Go		0.375
54	5	51.1	81	38	202	10.2	10.4	— 0.2	Ao			0.016
55	5	52.7	81	6	204	9.8	9.8	0.0	B9			0.017
56	5	53.6	81	52	205	10.2	10.2	0.0	A			0.017
57	5	53.8	81	4	207	10.1	10.0	+ 0.1	Ao			0.006
58	5	58.7	81	58	210	9.6	8.9	+ 0.7	Ko	Ko		0.030
59	6	3.6	81	47	214	9.9	9.3	+ 0.6	Ko	G5		0.025
60	6	3.8	81	8	215	10.0	9.2	+ 0.8	K			0.065
61	6	24.2	81	42	221	9.7	9.5	+ 0.2	F3			0.022
62	6	26.1	81	54	222	9.3	9.3	0.0	A5	F2		0.022
63	6	29.4	81	14	225	9.6	8.4	+ 1.2	M	K5		0.012
64	6	37.2	81	49	226	10.1	9.9	+ 0.2	F1			0.018
65	6	39.5	81	3	227	9.1	9.0	+ 0.1	G3	Go		0.034
66	6	47.6	81	53	229	9.5	9.6	— 0.1	A9			0.007
67	6	49.0	81	21	231	9.6	9.1	+ 0.5	K	G5		0.030
68	6	51.3	81	44	233	9.6	8.8	+ 0.8	K	K2		0.033
69	6	56.1	81	10	236	9.7	9.4	+ 0.3	K			0.023
70	7	2.3	81	2	239	9.1	8.1	+ 1.0	K	Ko		0.071
71	7	2.4	81	27	238	9.9	10.3	— 0.4	A1			0.019
72	7	2.6	81	20	240	10.1	10.4	— 0.3	B9			0.009
73	7	6.4	81	26	242	6.2	6.6	— 0.4	B9	B9	B8	0.026
74	7	8.2	81	10	243	8.9	8.9	0.0	A8	F2		0.034
75	7	8.7	81	14	244	10.1	10.2	— 0.1	A4			0.029
76	7	14.0	81	13	250	9.9	10.5	— 0.6	A2			0.018
77	7	16.5	81	6	252	7.3	6.7	+ 0.6	K	Ko		0.020
78	7	27.7	81	55	213†	7.8	7.8	0.0	B9	B9	Ao	0.006
79	7	38.9	81	36	257	8.3	7.2	+ 1.1	Ko	K2	K2	0.043
80	7	50.4	81	59	224†	9.2	8.3	+ 0.9	Ko			0.035
81	7	50.8	81	58	226†	9.4	9.7	— 0.3	Ao			0.014
82	7	54.5	81	20	263	9.2	8.7	+ 0.5	G8	G5		0.018
83	11	19.6	81	6	369	9.2	9.7	— 0.5	A2	Ao		0.016
84	11	22.9	81	35	370	10.0			F3	F8		0.062
85	11	24.8	81	41	373	6.2	6.4	— 0.2	Ao	Ao	A2	0.169
86	11	28.0	81	22	375	9.4	9.7	— 0.3	A2	Ao		0.009
87	11	29.4	81	51	338†	9.5	9.8	— 0.3	A7			0.150
88	11	35.9	81	8	384	8.6	9.0	— 0.4	A2	A5		0.041
89	11	52.8	81	11	388	8.4	8.4	0.0	F1	F8		0.080
90	11	55.1	81	25	389	7.7	6.5	+ 1.2	M	Ma	K8	0.072
91	12	7.0	81	59	358†	10.3	10.5	— 0.2	A6			0.008
92	12	30.2	81	30	399	9.0	8.4	+ 0.6	G6	G5		0.039
93	12	41.9	81	10	402	6.4	6.6	— 0.2	A2	Ao	A3	0.035
94	12	45.4	81	49	375†	11.4			A2	Ao		0.014
95	12	53.7	81	55	379†	9.6	10.0	— 0.4	A9			0.036

† Zone 82 in B. D.

ZONE 81. — *Continued.*

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum			Proper Motion Greenwich.
									author.	Harvard circular 180.	Yerkes Actinometry.	
	h	m	°	′								″
96	12	58.6	81	25	412	7.8	7.5	+ 0.3	G7	Go	Go	0.066
97	13	11.5	81	0	416	7.0	6.4	+ 0.6	F4	G5	G3	0.008
98	13	28.4	81	47	395†	8.7	8.9	− 0.2	A3	A5		0.031
99	13	41.9	81	41	444	9.3	9.7	− 0.4	F1			0.054
100	13	42.5	81	34	445	10.6	10.7	− 0.1	Ko			0.033
101	13	52.5	81	16	452	7.7	6.8	+ 0.9	G5	Ko	K2	0.051
102	14	19.0	81	38	464	9.2	9.3	− 0.1	F1	G5		0.023
103	19	56.0	81	19	687	8.0	8.2	− 0.2	A7	Fo		0.066
104	20	4·2	81	52	691	9.3	9.3	0.0	K			0.041
105	20	14.4	81	55	697	10.2	10.2	0.0	Fo			0.098
106	20	14.7	81	12	696	9.9	9.8	+ 0.1	F1			0.027
107	20	15.5	81	9	698	9.0	9.1	− 0.1	A3			0.025
108	20	15.6	81	55	699	7.6	7.7	− 0.1	F9	F5	F	0.054
109	20	33.2	81	6	657*	7.4	6.7	+ 0.7	G3	Ko	G4	0.052
110	20	34.5	81	5	659*	6.3	5.4	+ 0.9	Ko	Ko	G4	0.037
111	20	38.6	81	35	710	8.9	8.3	+ 0.6	G	Ko		0.020
112	20	41.6	81	39	712	8.2	7.1	+ 1.1	K	Ko	K	0.075
113	21	0.7	81	25	725	8.3	8.4	− 0.1	K	F2		0.016
114	21	11.1	81	49	728	8.9	8.8	+ 0.1	Fo			0.052
115	21	11.2	81	49	729	8.6	8.6	0.0	F2	F8		0.005
116	21	21.7	81	20	735	8.7	7.6	+ 1.1	K	Ko		0.034
117	21	22.8	81	36	736	8.3	7.5	+ 0.8	Ko	Ko		0.017
118	21	25.6	81	37	739	9.1	9.3	− 0.2	G			0.040
119	21	30.8	81	18	742	8.6	8.1	+ 0.5	G3 } A5 }	G5 Ao		0.241
120	21	33.6	81	45	744	9.0	9.2	− 0.2	Ao			0.004
121	21	42.5	81	39	750	9.6	9.6	0.0	F5			0.021
122	21	42.8	81	33	752	9.1	9.5	− 0.4	Ao			0.018
123	22	1.0	81	9	713*	10.2	10.6	− 0.4	Ao			0.048
124	22	16.0	81	4	720*	9.7	10.0	− 0.3	Ao			
125	22	21.9	81	39	773	9.7	9.9	− 0.2	Ao			0.015
126	22	23.7	81	26	775	7.1	7.3	− 0.2	F5	F2	F3	0.098
127	22	29.1	81	39	781	8.6	8.8	− 0.2	Ao	Ao		0.017
128	22	42.9	81	22	788	8.6	7.6	+ 1.0	K	Ko		0.005
129	22	43.2	81	58	789	8.7	8.0	+ 0.7	Ko	K		0.016
130	22	48.5	81	25	795	8.5	8.8	− 0.3	A5	A3		0.010
131	22	50.4	81	27	797	9.7	9.1	+ 0.6	Ao			0.032
132	22	53.5	81	24	801	8.3	7.7	+ 0.6	K	Ko		0.023
133	23	10.4	81	51	814	7.9	7.7	+ 0.2	G	Go		0.124

ZONE 82.

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	author.	Harvard circular 180.	Yerkes Actinometry.	Proper Motion Greenwich.
134	4	40.1	82	41	127	9.6	9.7	− 0.1	A7			0.036
135	4	47.8	82	22	132	8.8	8.3	+ 0.5	G5	Ko		0.017
136	4	49.7	82	25	133	8.9	9.0	− 0.1	Fo	F2		0.022
137	4	51.5	82	40	135	9.8	10.0	− 0.2	A1			0.011
138	4	52.7	82	21	136	9.3	9·7	− 0.4	Ao			0.008
139	5	8.6	82	31	141	9.6	9.8	− 0.2	B9			0.024
140	5	12.2	82	19	143	9.3	8.5	+ 0.8	G5			0.017

† Zone 82 in B. D.
* Zone 80 in B. D.

Zone 82. — *Continued.*

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h	m	°	'								"
141	5	13.7	82	36	144	9.8	9.5	+ 0.3	F1			0.043
142	5	22.9	82	22	146	10.2	10.3	− 0.1	A0			0.004
143	5	28.2	82	38	147	10.2	9.1	+ 1.1	K5			0.021
144	5	33.8	82	42	148	10.1	10.2	− 0.1	A3			0.033
145	5 5 5	37.5 37.5 37.5	82 82 82	37 37 37	151	10.3 9.5 11.0	10.1		A3			0.027
146	5	40.3	82	44	152	7.8	7.8	0.0	F6	F8		0.061
147	5	44.5	82	49	154	10.1	10.4	− 0.3	A3			0.024
148	5	46.9	82	27	155	9.5	8.3	+ 1.2	K3	K0		0.019
149	5	53.4	82	43	156	10.3	10.3	0.0	A			0.030
150	6	13.6	82	36	168	9.0	8.7	+ 0.3	F8	G0		0.009
151	6	17.0	82	3	173	9.8	9.9	− 0.1	A5			0.023
152	6	19.8	82	21	174	9.3	9.1	+ 0.2	K0	G		0.156
153	6	23.4	82	12	177	6.8	6.8	0.0	A2	A2	A3	0.054
154	6	23.5	82	30	176	9.3	8.7	+ 0.6	K	K0		0.017
155	6	28.1	82	39	179	10.2	10.6	− 0.4	A2			0.013
156	6	34.5	82	41	183	10.2	10.1	+ 0.1	G3			0.021
157	6	36.8	82	42	184	9.8	9.6	+ 0.2	F1			0.111
158	6	37.1	82	36	185	9.6	8.7	+ 0.9	K	K2		0.041
159	6	39.7	82	47	187	9.9	10.2	− 0.3	A3			0.017
160	6	39.8	82	23	188	9.3	8.6	+ 0.7	K0	K2		0.016
161	6	42.1	82	44	189	9.0	9.3	− 0.3	A5	A2		0.017
162	6	45.9	82	0	191	9.7	8.9	+ 0.7	K	K2		0.015
163	6	54.6	82	36	194	8.7	7.4	+ 1.3	K5	K5		0.013
164	7	10.1	82	36	201	6.7	5.1	+ 1.6	M	Ma	M	0.053
165	7	12.4	82	52	203	10.4	10.6	− 0.2	F1			0.027
166	7	14.9	82	12	204	8.6	8.7	− 0.1	F5	F5		0.014
167	7	17.5	82	44	205	9.6	9.7	− 0.1	A5			0.012
168	7	20.1	82	53	207	8.7	8.8	− 0.1	F5	F5		0.042
169	7	20.3	82	57	188†	10.1	9.7	+ 0.4	F5			0.026
170	7	30.1	82	57	195†	9.7	9.2	+ 0.5	A3	F		0.011
171	7	40.9	82	26	217	9.8	10.1	− 0.3	G5			0.022
172	7	49.0	82	41	222	9.0	9.4	− 0.4	A1	A		0.007
173	7	52.6	82	45	228	9.0	9.2	− 0.2	F4	F5		0.017
174	7	55.1	82	3	231	8.4	8.2	+ 0.2	G0	F5		0.067
175	8	5.2	82	44	235	6.3	6.5	− 0.2	A0	A0	B9	0.034
176	8	18.2	82	29	245	9.2	8.8	+ 0.4	G5	G5		0.006
177	8	22.9	82	57	220†	9.7	8.6	+ 1.1	K	K0		0.010
178	8	27.3	82	41	251	8.8	8.7	+ 0.1	G0	F5		0.025
179	8	28.3	82	36	253	6.7	7.1	− 0.4	B9	A0	A0	0.015
180	10	52.1	82	43	321	9.3	9.6	− 0.3	A5			0.028
181	11	2.2	82	17	325	7.7	7.4	+ 0.3	F8	G0	F8	0.214
182	11	23.0	82	39	332	9.0	9.0	0.0	F2	G0		0.079
183	11	33.3	82	38	342	8.9	8.3	+ 0.6	K0	G5		0.035
184	11	36.8	82	3	343	8.9	9.2	− 0.3	A3	A3		0.059
185	11	38.1	82	53	336†	8.6	7.9	+ 0.7	G3	G5		0.024
186	11	48.4	82	30	348	9.1	9.1	0.0	A6	F8		0.051
187	11	52.8	82	44	351	9.5	9.6	− 0.1	F1			0.016
188	11	58.3	82	15	355	8.2	7.6	+ 0.6	K0	G5		0.018
189	12	6.5	82	16	356	7.4	6.2	+ 1.2	G6	K2	K2	0.015
190	12	7.0	82	16	357	8.4	8.5	− 0.1	A7	F5		0.041

† Zone 83 in B. D.

ZONE 82. — *Continued.*

No.	α 1900.0 h	α 1900.0 m	δ 1900.0 °	δ 1900.0 ′	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum: author.	Spectrum: Harvard circular 180.	Spectrum: Yerkes Actinometry.	Proper Motion Greenwich. ″
191	12	23.3	82	2	363	9.3	9.4	− 0.1	A5			0.021
192	12	25.2	82	33	365	8.2	8.3	− 0.1	F5	F5		0.060
193	12	31.2	82	29	368	9.7	9.6	+ 0.1	F0			0.058
194	12	45.1	82	15	374	9.2	9.1	+ 0.1	F2			0.005
195	12	46.7	82	6	377	10.1			F1			0.085
196	12	47.8	82	58	365†	9.0	9.1	− 0.1	A4	A3		0.017
197	12	53.4	82	42	378	8.9	9.0	− 0.1	A6	A3		0.068
198	13	16.5	82	2	390	8.4	8.5	− 0.1	F1	F5		0.072
199	13	41.9	82	12	402	9.5	9.9	− 0.4	A1			0.019
200	13	56.7	82	31	406	10.1	10.1	0.0	A3			0.018
201	13	59.1	82	6	407	8.3	8.7	− 0.4	A2	A0		0.017
202	14	31.0	82	24	423	8.9	9.1	− 0.2	A3	A2		0.034
203	14	43.0	82	54	423†	8.9	8.7	+ 0.2	K0			0.021
204	14	57.1	82	55	431†	6.2	5.9	+ 0.3	G6	G0	F8	0.271
205	19	58.9	82	11	598	8.5	var. 7.5–8.0		G	K0		0.029
206	20	13.1	82	32	609	8.5	8.4	+ 0.1	G0	F8		0.096
207	20	24.9	82	44	611	9.0	9.2	− 0.2	A0	A0		0.004
208	20	28.7	82	2	706*	7.2	7.2	0.0	F8	F5	F2	0.043
209	20	29.4	82	31	613	8.1	8.3	− 0.4	A1	A0		0.014
210	20	34.4	82	51	617	7.5	6.9	+ 0.6	G4	G5	G2	0.004
211	20	48.1	82	41	627	8.3	8.4	− 0.1	A2	A5		0.045
212	20	49.9	82	10	718*	5.7	6.2	− 0.5	A0	A0	B8	0.059
213	21	5.5	82	35	636	8.1	8.3	− 0.2	A3	A5		0.017
214	21	14.0	82	25	640	9.7	9.9	− 0.2	B9			0.017
215	21	17.5	82	37	644	9.8	9.9	− 0.1	A0			0.039
216	21	23.0	82	5	737*	8.1	8.1	0.0	G1	F8	F	0.100
217	21	27.9	82	33	648	8.1	8.3	− 0.2	A2	A2		0.006
218	21	30.1	82	51	650	8.8	8.4	+ 0.4	G2	G0		0.016
219	21	32.1	82	3	743*	9.4	9.5	− 0.1	A3			0.021
220	21	41.9	82	28	657	8.7	8.3	+ 0.4	G	G5		0.042
221	21	43.8	82	59	660	10.5	10.7	− 0.2	A			0.039
222	21	45.9	82	11	753*	9.8	9.8	0.0	F			0.004
223	21	48.9	82	37	663	9.5	8.3	+ 1.2	G			0.021
224	21	54.6	82	59	667	9.2	8.7	+ 0.5	K			0.011
225	22	1.8	82	23	673	7.6	7.2	+ 0.4 }	F1	F5	F5	0.136
226	22	1.9	82	23	674	8.2	7.8	+ 0.4 }				0.142
227	22	7.2	82	14	677	9.9	10.0	− 0.1	A6			0.019
228	22	9.0	82	10	767*	7.8	7.9	− 0.1	A1	A0		0.046
229	22	21.1	82	14	687	9.7	9.8	− 0.1	K0			0.018
230	22	22.4	82	28	688	9.4	9.4	0.0	G5			0.176
231	22	43.9	82	45	700	7.3	7.5	− 0.2	A1	B8		0.034
232	22	47.9	82	37	703	6.0	4.8	+ 1.2	K0	K0	K2	0.059
233	22	56.7	82	31	707	9.0	8.4	+ 0.6	K0	K0		0.024
234	23	7.5	82	2	810*	8.3	7.6	+ 0.7	K	K2		0.046
235	23	13.5	82	54	712	9.1	10.0	− 0.9	A0			0.052
							ZONE 83.					
236	4	11.6	83	57	111	8.7	8.6	+ 0.1	F4			0.039
237	4	21.5	83	50	114	8.0	7.4	+ 0.6	K0	K0	G2	0.050
238	4	28.1	83	33	118	8.8	8.6	+ 0.2	G5			0.039
239	4	34.1	83	7	121	8.2	8.3	− 0.1	F	F5		0.043
240	4	37.0	83	1	125§	7.4	7.8	− 0.4	B9	B9		0.033

† Zone 83 in B. D.
* Zone 81 in B. D.
§ Zone 82 in B. D.

ZONE 83. — *Continued.*

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h m	° ′								″
241	4 38.4	83 33	123	9.4	8.9	+ 0.5	F5			0.022
242	4 42.4	83 19	126	8.8	8.0	+ 0.8	K	K2		0.028
243	4 49.8	83 24	129	9.2	8.8	+ 0.4	K5			0.033
244	5 4.9	83 43	137	8.5	8.8	− 0.3	A5	F5		0.053
245	5 5.5	83 52	138	9.4	9.2	+ 0.2	F1			0.016
246	5 8.9	83 19	139	9.3	9.3	0.0	G	Go		0.065
247	5 11.8	83 47	141	7.0	7.2	− 0.2	Ao	Ao	Ao	0.021
248	5 14.9	83 17	142	9.7	8.7	+ 1.0	M	K5		0.009
249	5 16.3	83 4	144	9.7	9.1	+ 0.6	Ko	Ko		0.026
250	5 19.5	83 21	145	9.4	9.7	− 0.3	A3	A		0.010
251	5 30.0	83 5	151	10.0	9.9	+ 0.1	G3			0.031
252	5 30.1	83 22	150	10.0	10.5	− 0.5	A3			0.017
253	5 30.3	83 34	149	8.9	8.2	+ 0.7	G5	Ko		0.029
254	5 34.6	83 40	153	9.5	9.7	− 0.2	Ko			0.026
255	5 41.7	83 36	155	9.9	10.0	− 0.1	G3			0.023
256	6 9.7	83 49	164	9.1	9.3	− 0.2	F2	Fo		0.033
257	6 24.6	83 33	167	9.9	10.0	− 0.1	F1			0.021
258	6 40.2	83 31	170	9.4	9.5	− 0.1	F5			0.026
259	6 41.1	83 45	172	9.2	8.8	+ 0.4	G3	G5		0.235
260	6 44.5	83 19	174	10.4	10.5	− 0.1	A			0.031
261	6 47.7	83 9	177	9.6	9.1	+ 0.5	Go	Ko		0.032
262	6 50.4	83 9	178	8.9	8.2	+ 0.7	G	Ko		0.025
263	6 53.2	83 1	181	9.7	9.1	+ 0.6	Ko			0.032
264	6 59.2	83 39	182	8.4	8.6	− 0.2	Ao	B9		0.031
265	7 9.3	83 32	185	10.3	10.5	− 0.2	F1			0.017
266	7 25.9	83 18	191	9.0	8.0	+ 1.0	G	Ko		0.019
267	7 27.9	83 12	193	10.4	10.2	+ 0.2	A3			0.012
268	7 29.1	83 48	194	9.4	9.4	0.0	F1			0.064
269	7 42.1	83 7	201	10.3	10.0	+ 0.3	A3			0.039
270	7 57.0	83 13	206	10.6	10.7	− 0.1	A2			0.047
271	8 3.6	83 24	207	7.9	7.7	+ 0.2	F6	F8		0.080
272	8 5.6	83 4	210	9.5	9.6	− 0.1	A8			0.020
273	8 8.9	83 18	212	9.5	9.2	+ 0.3	F5			0.075
274	8 9.5	83 40	213	10.7	10.7	0.0	A			0.008
275	8 9.6	83 29	214	9.8	9.7	+ 0.1	Go			0.048
276	8 27.1	83 35	223	9.6	10.1	− 0.5	A2			0.042
277	8 27.7	83 46	224	9.5	9.9	− 0.4	A2			0.009
278	8 35.5	83 55	187†	9.0	9.4	− 0.4	A4	A3		0.029
279	8 41.8	83 6	232	8.0	7.3	+ 0.7	G5	Ko	G3	0.007
280	8 44.5	83 8	233	7.3	7.1	+ 0.2	Go	Fo	F1	0.014
281	8 49.1	83 34	236	9.1	8.5	+ 0.6	G1	Go		0.002
282	8 57.0	83 45	239	8.9	9.1	− 0.2	Ao			0.008
283	10 35.8	83 59	241†	10.1	10.0	+ 0.1	A9			0.020
284	10 52.0	83 46	312	8.7	Double 9.3 + 10.1		F2	F8		0.028
285	10 58.8	83 17	318	8.6	8.5	+ 0.1	F1	F8		0.103
286	11 9.7	83 10	324	9.6	10.1	− 0.5	A6			0.036
287	11 38.0	83 59	260†	8.8	9.2	− 0.4	A1			0.022
288	11 45.2	83 13	339	8.5	8.7	− 0.2	A2	A2		0.023
289	11 52.3	83 23	343	9.4	9.5	− 0.1	F3			0.061
290	11 54.5	83 18	345	9.9	9.8	+ 0.1	A6			0.039

† Zone 84 in B. D.

ZONE 83. — *Continued.*

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum: author.	Spectrum: Harvard circular 180.	Spectrum: Yerkes Actinometry.	Proper Motion Greenwich.
	h m	° ′								″
291	12 14.8	83 46	273*	10.2	10.3	− 0.1	F2			0.030
292	12 16.0	83 32	350	9.3	9.6	− 0.3	Ko			0.021
293	12 16.5	83 56	274*	8.6	7.9	+ 0.7	Ko	Ko	G	0.009
294	12 18.9	83 13	352	8.9	9.1	− 0.2	F1	G		0.049
295	12 20.7	83 59	276*	8.5	8.2	+ 0.3	F3	F8		0.017
296	12 21.2	83 13	354	9.0	9.4	− 0.4	A2	A3		0.010
297	12 48.9	83 4	366	9.6	9.3	+ 0.3	F1	G5		0.012
298	12 53.2	83 4	369	8.1	7.2	+ 0.9	G6	Ko	G–K	0.050
299	12 53.3	83 46	291*	9.5	9.5	0.0	F1			0.005
300	12 58.9	83 28	373	8.2	8.3	− 0.1	A3	Ao		0.018
301	13 11.2	83 55	302*	9.1	8.9	+ 0.2	F1	F5		0.029
302	13 26.7	83 49	311*	7.8	7.4	+ 0.4	G6 F5	G5	F9	0.114
303	13 45.2	83 15	397	6.8	6.1	+ 0.7	G5	G5	G3	0.058
304	13 56.3	83 26	402	10.0	9.9	+ 0.1	F1			0.050
305	14 36.4	83 54	327*	9.3	9.2	+ 0.1	F5			0.108
306	14 44.5	83 1	424	10.5	10.9	− 0.4	F7			0.008
307	19 4.0	83 46	547	6.8	7.1	− 0.3	A2	A2	A2	0.026
308	19 15.7	83 41	549	10.1	10.2	− 0.1	A2			0.045
309	19 28.0	83 16	552	6.8	6.8	0.0	A1	A2	A2	0.044
310	19 29.8	83 36	554	9.4	9.7	− 0.3	A1			0.025
311	19 40.8	83 10	557	10.0	10.1	− 0.1	K			0.004
312	19 45.4	83 33	559	9.7	9.7	0.0	A5			0.026
313	19 45.7	83 6	592†	9.1	8.2	+ 0.9	K	Ko		0.012
314	20 6.4	83 59	569	9.3	9.3	0.0	Fo			0.065
315	20 10.0	83 8	608†	8.4	8.6	− 0.2	A2	A5		0.028
316	20 18.5	83 53	572	9.1	8.9	+ 0.2	F5			0.037
317	20 19.2	83 17	573	9.9	9.9	0.0	F1			0.033
318	20 28.7	83 58	581	9.6	9.3	+ 0.3	G5			0.066
319	20 33.0	83 14	586	9.2	9.4	− 0.2	Ao			0.009
320	20 34.4	83 18	587	10.4	10.5	− 0.1	Ao			0.029
321	20 39.1	83 17	588	6.4	6.6	− 0.2	A1	A2	A2	0.029
322	20 52.8	83 19	593	9.5	9.9	− 0.4	Ao			0.016
323	20 53.9	83 22	594	9.1	8.5	+ 0.6	G	Ko		0.002
324	20 59.0	83 33	596	7.5	7.4	+ 0.1	F8	F2		0.114
325	21 21.6	83 50	603	7.9	7.0	+ 0.9	G	G5	K	0.043
326	21 31.0	83 8	651†	8.6	8.6	0.0	F6	F8		0.064
327	21 35.4	83 24	613	8.5	8.5	0.0	Go	Fo		0.036
328	21 39.5	83 30	614	8.2	8.0	+ 0.2	F8	F5		0.035
329	21 42.7	83 53	615	9.5	9.0	+ 0.5	K			0.028
330	21 43.0	83 12	658†	10.2	10.3	− 0.1	Ao			0.016
331	21 44.0	83 10	661†	10.9	10.8	+ 0.1	A			0.030
332	21 45.7	83 51	616	8.1	8.3	− 0.2	A4	A3		0.014
333	21 47.3	83 52	617	8.8	8.5	+ 0.3	K	Ko		0.348
334	21 50.4	83 34	618	7.4	7.3	+ 0.1	A4	A5	A4	0.096
335	21 55.4	83 34	620	8.9	8.1	+ 0.8	G5	Ko		0.050
336	22 1.5	83 1	672†	7.8	8.1	− 0.3	A8	Fo		0.005
337	22 3.8	83 52	622	8.7	9.1	− 0.4	A4	A5		0.031
338	22 12.2	83 35	626	9.3			Ao			0.026
339	22 12.8	83 5	682†	8.8	8.4	+ 0.4	G3	Ko		0.056
340	22 14.1	83 18	627	9.0			Ao			0.022

* Zone 84 in B. D.
† Zone 82 in B. D.

ZONE 83. — *Continued.*

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h	m	°	′								″
341	22	22.3	83	2	689†	8.8	8.6	+ 0.2	G	G5		0.305
342	22	40.5	83	47	635	9.4			A5			0.029
343	22	48.5	83	10	704†	8.2	7.3	+ 0.9	K	K2		0.204
344	22	55.2	83	49	640	6.1	4.8	+ 1.3	Ko	Ko		0.112
345	23	13.2	83	42	647	7.5	8.0	— 0.5	Ao	B9		0.028
						ZONE 84.						
346	0	1.5	84	51	546	8.1	8.5	— 0.4	A4	A3		0.016
347	4	7.9	84	21	77	10.2	10.7	— 0.5	Ao			0.042
348	4	9.0	84	14	78	8.5	7.4	+ 1.1	K	K2	Ko	0.034
349	4	19.5	84	48	83	8.9	9.4	— 0.5	A2] F6]			0.025
350	4	24.3	84	26	85	9.0	9.0	0.0	F3			0.031
351	4	33.4	84	42	88	7.6	7.9	— 0.3	B9	A2		0.010
352	4	43.8	84	46	90	9.3	9.9	— 0.6	A4	A2		0.008
353	4	50.8	84	5	130*	9.6	8.7	+ 0.9	M			0.030
354	4	58.2	84	45	97	8.7	8.7	0.0	F5	F5		0.168
355	5	16.7	84	14	106	9.1	8.5	+ 0.6	Ko	K2		0.032
356	5	43.6	84	59	112	9.0	8.9	+ 0.1	F8	G		0.176
357	5	46.3	84	6	114	8.7	8.7	0.0	Go] A5]	F5		0.038
398	5	49.2	84	7	117	8.8	8.8	0.0	F8	F5		0.083
359	5	53.8	84	12	118	8.9	8.8	+ 0.1	Go	F8		0.087
360	6	0.8	84	49	120	10.0	10.0	0.0	A			0.065
361	6	28.6	84	46	132	9.5	10.1	— 0.6	A1			0.026
362	6	34.1	84	47	135	8.1	7.6	+ 0.5	G4	G5		0.099
363	6	35.3	84	52	136	9.2	10.2	— 1.0	A4			0.021
364	6	37.9	84	6	139	10.1	10.8	— 0.7	Ao			0.034
365	7	13.7	84	24	152	8.9	8.1	+ 0.8	K5	Ko		0.054
366	7	16.3	84	28	149	9.6	9.7	— 0.1	A3			0.037
367	7	23.5	84	2	154	10.0	10.2	— 0.2	F			0.073
368	7	27.7	84	43	156	9.5	9.7	— 0.2	G			0.041
369	7	28.9	84	1	158	10.2	10.1	+ 0.1	F1			0.144
370	7	32.1	84	4	160	10.2	10.6	— 0.4	A2			0.023
371	7	37.2	84	11	161	9.3	9.4	— 0.1	F3			0.033
372	7	40.1	84	11	163	9.0	8.7	+ 0.3	F9	G5		0.023
373	7	41.5	84	56	117§	9.3	8.5	+ 0.8	F1			0.054
374	7	45.8	84	41	168	7.4	7.8	— 0.4	Ao	Ao		0.019
375	7	53.0	84	21	169	6.4	6.7	— 0.3	Ao	Ao	Ao	0.054
376	7	53.9	84	36	170	9.4	9.3	+ 0.1	F1			0.124
374	7	54.2	84	18	171	9.6	9.5	+ 0.1	F1			0.008
378	8	1.9	84	19	173	8.4	8.4	0.0	Go	Fo		0.033
379	8	5.6	84	27	175	9.7	9.7	0.0	A6			0.021
380	8	8.9	84	33	177	10.1	9.8	+ 0.3	G3			0.079
381	8	14.3	84	33	178	9.4	8.8	+ 0.6	F7			0.027
382	8	23.6	84	28	183	9.4	9.5	— 0.1	A6			0.053
383	8	35.4	84	16	186	7.9	7.7	+ 0.2	F5	F8		0.161
384	8	53.3	84	53	135§	9.0	9.0	0.0	F1			0.016
385	8	54.5	84	35	196	6.7	6.5	+ 0.2	A7	Fo	A6	0.015

† Zone 82 in B. D.
* Zone 83 in B. D.
§ Zone 85 in B. D.

ZONE 84. — *Continued.*

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h	m	°	′								″
386	8	56.6	84	2	199	8.5	8.8	− 0.3	A0	B9		0.030
387	9	11.6	84	22	204	10.1	10.1	0.0	A4			0.046
388	9	31.8	84	48	215	9.5	8.8	+ 0.7	G	G		0.024
389	9	34.7	84	57	150 §	8.6	8.0	+ 0.6	G	G5		0.022
390	10	15.2	84	46	234	5.9	5.7	+ 0.2	A4	A3	A4	0.115
391	10	16.7	84	4	237	9.0	8.9	+ 0.1	F0			0.073
392	10	20.8	84	55	161 §	8.0	7.4	+ 0.6	G2	K0	G0	0.058
393	10	46.7	84	53	170 §	9.3	8.7	+ 0.6	G3	G5		0.012
394	11	26.2	84	14	256	9.2	9.6	− 0.4	G3			0.110
395	12	8.8	84	4	269	8.5	8.4	+ 0.1	F8	G0	F	0.021
396	12	36.1	84	11	284	10.0	9.8	+ 0.2	F1			0.201
397	12	37.5	84	8	285	10.0	10.3	− 0.3	F1			0.018
398	12	37.8	84	12	286	7.8	7.5	+ 0.3	G0	G0	F5	0.232
399	13	1.3	84	48	214 §	9.3	9.4	− 0.1	F1	G5		0.144
400	13	4.6	84	10	296	9.2	8.4	+ 0.8	G3	K0		0.037
401	13	17.4	84	26	305	9.3	8.6	+ 0.7	F3	G5		0.030
402	13	20.5	84	25	307	7.8	7.8	0.0	F4	F2		0.098
403	13	52.6	84	37	317	9.4	9.7	− 0.3	A3			0.031
404	14	41.7	84	44	329	9.5	10.1	− 0.6	A0			0.029
405	15	1.7	84	20	335	8.2	7.0	+ 1.2	K0	K0	K2	0.011
406	15	29.4	84	13	345	7.8	7.9	− 0.1	A3	F0		0.031
407	18	47.4	84	32	423	8.7	8.8	− 0.1	A5	F0		0.039
408	18	54.3	84	47	425	9.2	9.9	− 0.7	A			0.022
409	19	1.1	84	25	426	8.9	9.1	− 0.2	F1	F8		0.046
410	19	21.4	84	26	436	9.1	9.2	− 0.1	F4	F5		0.042
411	19	34.1	84	5	556*	9.0	9.1	− 0.1	A9	F0		0.033
412	19	42.7	84	22	440	10.5	10.7	− 0.2	A			0.018
413	19	53.8	84	31	445	8.0	8.2	− 0.2	A0	A0		0.031
414	19	56.9	84	28	446	8.8	8.5	+ 0.3	F5	G0		0.109
415	20	5.5	84	26	448	8.8	8.9	− 0.1	A2	A0		0.038
416	20	14.0	84	23	451	6.8	7.1	− 0.3	A0	A2	A2	0.053
417	20	15.0	84	43	452	9.6	10.2	− 0.6	B9			0.032
418	20	22.8	84	47	461	8.7	7.9	+ 0.8	G	K0		0.023
419	20	24.5	84	14	462	7.4	7.3	+ 0.1	F	F0	A8	0.076
420	20	24.5	84	49	463	7.5	7.3	+ 0.2	G	F8	F5	0.082
421	20	53.4	84	15	474	8.3	8.7	− 0.4	A2	A2		0.040
422	21	8.6	84	53	479	9.7	10.0	− 0.3	F1			0.009
423	21	27.0	84	12	608*	8.9	9.0	− 0.1	F1	F5		0.053
424	21	46.8	84	36	495	10.0	10.6	− 0.6	A			0.021
425	21	59.5	84	21	500	9.3	9.3	0.0	G3			0.033
426	22	2.4	84	43	501	9.4	9.8	− 0.4	A2			0.040
427	22	13.7	84	55	505	8.5	8.2	+ 0.3	G	G0		0.108
428	22	20.9	84	0	630*	7.3	7.8	− 0.5	A0	A0		0.019
429	22	27.5	84	33	509	7.9	7.3	+ 0.6	K	K0		0.031
430	22	50.1	84	15	513	7.8	7.2	+ 0.6	K	K0	G5	0.104
431	22	53.5	84	50	517	7.1	6.0	+ 1.1	K	K5	K4	0.098
432	22	53.5	84	31	516	8.5	7.2	+ 1.3	M	Mb		0.053
433	23	9.1	84	45	525	10.4	10.4	0.0	A8			0.955
434	23	18.0	84	9	649*	9.9			A0			0.011
435	23	34.0	84	37	533	8.3	8.7	− 0.4	A3	A2		0.039

§ Zone 85 in B. D.
* Zone 83 in B. D.

ZONE 84. — *Continued.*

No.	α 1900.0		δ 1900.0		B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum			Proper Motion Greenwich.
									author.	Harvard circular 180.	Yerkes Actinometry.	
	h	m	°	′								″
436	23	39.4	84	55	536	8.4	7.7	+ 0.7	K	Ko		0.030
437	22	44.0	84	31	539	8.3	8.0	+ 0.3	G	G5		

ZONE 85.

No.	α h	α m	δ °	δ ′	B. D. No.	Int. phot. magn.	Vis. magn.	Colour Index	author	Harvard	Yerkes	Proper Motion
438	0	56.1	85	55	21	10.5	10.0	+ 0.5	M			0.008
439	3	21.7	85	57	56	9.9	10.2	— 0.3	Ao			0.003
440	3	38.4	85	20	57	9.0	8.9	+ 0.1	F1			0.029
441	4	4.7	85	38	62	9.1	9.3	— 0.2	A1			0.015
442	4	5.1	85	17	63	6.9	6.7	+ 0.2	F9	F8	F6	0.034
443	4	17.5	85	14	64	9.1	8.8	+ 0.3	F5			0.034
444	4	32.1	85	29	67	10.2	10.5	— 0.3	A6			0.034
445	4	34.4	85	59	68	10.3	10.3	0.0	A3			0.026
446	4	47.9	85	3	93†	9.1	8.3	+ 0.8	K	Ko		0.036
447	4	56.3	85	50	74	6.7	6.7	0.0	A6	A5	A5	0.062
448	4	59.8	85	37	75	8.7	8.3	+ 0.4	Go	G5		0.115
449	5	6.0	85	10	77	9.1	9.4	— 0.3	B9			0.009
450	5	9.9	85	35	78	6.5	6.8	— 0.3	Ao	Ao		0.029
451	5	29.9	85	9	80	7.5	6.2	+ 1.3	Go	Ko	K5	0.018
452	5	34.6	85	16	81	8.4	7.4	+ 1.0	Ko	G5		0.010
453	5	46.9	85	17	85	9.3	9.7	— 0.4	A8			0.164
454	5	47.6	85	7	87	9.6	9.2	+ 0.4	F1			0.011
455	6	4.8	85	24	91	9.4	9.8	— 0.4	A7			0.024
456	6	12.3	85	5	93	9.6	10.3	— 0.7	Ao			0.040
457	6	36.1	85	42	98	9.4	8.1	+ 1.3	M	Ma		0.008
458	6	36.3	85	1	99	9.1	9.1	0.0	F5			0.022
459	6	40.1	85	20	101	9.0	9.2	— 0.2	A3	Fo		0.022
460	7	7.5	85	5	107	9.5	9.9	— 0.4	A6			0.030
461	7	14.0	85	13	108	9.7	10.4	— 0.7	A4			0.017
462	7	44.2	85	2	118	9.3	9.8	— 0.5	F1			0.075
463	7	52.4	85	59	113 §	8.1	7.5	+ 0.6	G3	G5	Go	0.044
464	8	8.7	85	34	124	9.4	8.7	+ 0.7	G			0.056
465	8	8.8	85	7	125	9.7	9.4	+ 0.3	A7			0.012
466	8	11.1	85	7	126	10.3	10.6	— 0.3	A2			0.035
467	8	21.1	85	3	127	10.0	9.2	+ 0.8	K			0.222
468	8	25.3	85	24	128	7.7	7.6	+ 0.1	Go	F2	F3	0.141
469	8	38.4	85	9	131	9.7	9.6	+ 0.1	A3			0.056
470	8	47.0	85	57	126 §	9.0	7.8	+ 1.2	Ko	Ko		0.040
471	8	48.3	85	6	132	8.5	8.4	+ 0.1	Fo	Fo		0.038
472	8	55.3	85	59	130 §	10.1	9.7	+ 0.4	F6			0.029
473	9	19.5	85	32	147	9.3	8.5	+ 0.8	M	K5		0.022
474	9	42.2	85	22	152	10.5	11.0	— 0.5	A			0.056
475	10	2.3	85	56	146 §	9.1	9.4	— 0.3	Ao	Ao		0.014
476	10	4.0	85	47	155	9.3	8.7	+ 0.6	G2	G5		0.023
477	10	19.9	85	45	160	8.7	8.5	+ 0.2	F1	Go		0.037
478	10	31.1	85	16	166	9.1	8.1	+ 1.0	Ko	Ko		0.031
479	10	40.7	85	54	154 §	8.5	8.2	+ 0.3	F7	Go		0.102
480	11	24.4	85	15	183	8.1	7.3	+ 0.8	G5	Ko	G1	0.038

† Zone 84 in B. D.
§ Zone 86 in B. D.

ZONE 85. — *Continued.*

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h m	° ′								″
481	11 27.3	85 11	184	9.5	9.8	− 0.3	F1			0.052
482	11 38.4	85 54	171§	9.1	9.2	− 0.1	F4			0.019
483	11 45.0	85 33	191	8.7	8.9	− 0.2	F2	F5		0.010
484	12 6.5	85 38	196	8.6	8.9	− 0.3	A3	A3		0.031
485	12 20.4	85 52	180§	8.8	9.1	− 0.3	A0	A0		0.016
486	12 44.8	85 59	184§	9.2	9.1	+ 0.1	G3			0.122
487	12 53.1	85 15	209	9.4	9.3	+ 0.1	F5			0.050
488	13 0.5	85 7	213	9.2	9.6	− 0.4	F1			0.058
489	13 32.4	85 47	193§	8.0	8.1	− 0.1	F3	F2	F5	0.037
490	13 41.0	85 16	231	10.8	10.2	+ 0.6	F3			0.010
491	13 42.6	85 46	233	9.1	8.9	+ 0.2	F7	G		0.037
492	13 51.5	85 1	234	8.8	7.9	+ 0.9	G6	K0	G4	0.036
• 493	14 22.0	85 1	239	9.1	9.3	− 0.2	A5			0.068
494	14 55.9	85 42	248	8.9	9.1	− 0.2	F0			0.016
495	15 6.3	85 54	221§	8.0	7.9	+ 0.1	F3	F8		0.055
496	15 9.2	85 31	249	8.2	7.7	+ 0.5	K5 F5	K0		0.097
497	15 49.8	85 33	266	8.8	8.8	0.0	A5	G		0.062
498	18 27.7	85 26	304	9.2			F0			0.025
499	19 0.6	85 29	320	8.9	9.3	− 0.4	A0			0.019
500	19 10.8	85 28	324	9.5	9.5	0.0	A1			0.012
501	19 13.7	85 4	431†	9.5	9.4	+ 0.1	F			0.008
502	19 35.7	85 53	330	9.2	8.8	+ 0.4	G	G5		0.073
503	20 3.1	85 36	337	8.7	9.0	− 0.3	A5	A5		0.040
504	20 7.3	85 46	339	9.6	9.1	+ 0.5	F5			0.069
505	20 10.8	85 0	449†	9.6	10.4	− 0.8	A0			0.035
506	20 13.6	85 28	340	9.1	7.8	+ 1.3	K	K2	K	0.012
507	20 15.6	85 3	455†	9.0	9.4	− 0.4	F0			0.032
508	20 27.2	85 57	347	9.0	8.6	+ 0.4	G3	G5		0.057
509	20 48.0	85 40	352	9.5	10.0	− 0.5	G			0.021
510	20 50.1	85 18	354	9.0	7.9	+ 1.1	K	K0		0.061
511	20 52.1	85 28	355	9.2	9.6	− 0.4	A5	G5		0.057
512	20 59.0	85 11	357	9.2	9.3	− 0.1	F2	F8		0.266
513	21 6.5	85 29	359	8.3	8.7	− 0.4	F0	F0		0.035
514	21 23.4	85 15	361	9.2	9.6	− 0.4	A0			0.012
515	21 38.2	85 52	364	9.4	9.8	− 0.4	F1			0.061
516	21 50.9	85 59	367	8.7	9.1	− 0.4	A0	A		0.036
517	21 55.3	85 31	370	9.3	9.6	− 0.3	G			0.039
518	21 55.8	85 26	371	9.1	9.4	− 0.3	F0			0.034
519	22 2.1	85 23	376	8.8	8.9	− 0.1	F4	F0		0.011
520	22 21.3	85 36	383	5.3	5.4	− 0.1	A1	A0	B8	0.065
521	22 21.7	85 43	384	7.6	6.7	+ 0.9	K	K0	K0	0.045
522	23 7.3	85 11	523†	8.3	8.8	− 0.5	F0	F		0.054
523	23 19.2	85 31	398	9.4	8.7	+ 0.7	K0	K2		0.042
524	23 24.4	85 52	399	6.7	6.8	− 0.1	A8 G0	F0	A6	0.033
525	23 26.3	85 27	400	8.2	7.7	+ 0.5	G4	G5		0.017
526	23 30.4	85 38	403	7.0	7.3	− 0.3	A2	A5		0.021
527	23 50.9	85 21	406	8.5	9.0	− 0.5	A0	A0		0.020

† Zone 84 in B. D.
§ Zone 86 in B. D.

Zone 86.

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h m	° ′								″
528	0 37.1	86 24	9	8.5	8.8	− 0.3	A4	A3		0.025
529	0 49.2	86 47	14	9.2	8.8	+ 0.4	G	G5		0.315
530	0 59.1	86 37	17	7.1	6.3	+ 0.8	G8	K0	G5	0.063
531	1 2.1	86 27	18	9.9	9.7	+ 0.2	K			0.019
532	1 40.3	86 26	25	8.1	8.4	− 0.3	F4	F5		0.039
533	1 41.8	86 29	27	10.3	9.5	+ 0.8	A7			0.008
534	2 3.6	86 58	31	9.4	10.0	− 0.6	B9			0.029
535	2 25.3	86 33	38	9.0	9.3	− 0.3	A5	A5		0.006
536	2 32.2	86 37	39	7.9	7.9	0.0	F0	F0		0.044
537	2 46.6	86 42	42	10.0	10.3	− 0.3	A3			0.011
538	2 53.9	86 49	45	9.1	9.6	− 0.5	A4			0.021
539	3 4.6	86 3	53*	8.9	9.1	− 0.2	F0			0.043
540	3 26.4	86 59	49	9.2	9.7	− 0.5	A0			0.002
541	3 36.5	86 25	52	9.4	9.9	− 0.5	A1			0.012
542	3 52.6	86 40	54	8.8	9.1	− 0.3	F8 A2	F0		0.021
543	4 31.4	86 9	62	10.0	10.0	0.0	F1			0.018
544	4 34.8	86 18	64	9.0	9.6	− 0.6	A2			0.027
545	4 35.5	86 0	69*	9.2	9.8	− 0.6	A0			0.016
546	4 38.0	86 43	65	8.8	8.6	+ 0.2	G3	G5		0.034
547	4 46.3	86 19	66	7.7	8.3	− 0.6	B9	B9		0.018
548	4 50.8	86 44	67	9.1	9.2	− 0.1	F1	G		0.026
549	5 47.3	86 26	77	9.5	8.9	+ 0.6	K0			0.026
550	5 48.6	86 20	78	10.3	10.6	− 0.3	M			0.090
551	6 8.1	86 46	79	7.6	6.8	+ 0.8	G7	G5	K1	0.116
552	6 9.9	86 48	80	10.3	10.5	− 0.2	A0			0.020
553	6 23.0	86 3	86	9.1	9.2	− 0.1	F3	F8		0.025
554	6 35.0	86 28	91	9.2	9.7	− 0.5	A0	A		0.023
555	7 11.5	86 35	103	8.2	8.1	+ 0.1	G0	G0		0.174
556	7 40.2	86 37	107	9.4	9.5	− 0.1	F5			0.047
557	7 46.1	86 44	109	10.3	10.0	+ 0.3	F1			0.038
558	7 46.9	86 40	110	9.9	8.5	+ 1.4	K	Ma		0.030
559	8 8.6	86 56	63§	10.1	9.9	+ 0.2	F			0.017
560	8 19.8	86 8	120	9.2	8.6	+ 0.6	G5			0.021
561	8 20.0	86 12	119	9.6	9.8	− 0.2	F5			0.035
562	8 41.9	86 49	124	10.5	10.3	+ 0.2	A0			0.046
563	9 58.2	86 19	143	8.3	8.7	− 0.4	A2	A3		0.023
564	10 18.8	86 52	89§	9.9	9.9	0.0	A6			0.035
565	10 42.7	86 16	155	10.6	11.0	− 0.4	A2			0.011
566	10 53.9	86 13	157	10.4	9.5	+ 0.9	G0			0.036
567	10 57.0	86 5	159	8.4	8.7	− 0.3	A3	A3		0.011
568	11 2.5	86 11	161	7.4	7.4	0.0	A3	A2	A5	0.040
569	11 13.0	86 36	163	9.3	9.3	0.0	F			0.072
570	11 17.3	86 11	165	9.3	10.0	− 0.7	A2			0.012
571	11 25.1	86 4	169	9.3	9.6	− 0.3	F			0.033
572	11 28.3	86 10	170	7.5	7.5	0.0	A7	F0	A8	0.059
573	11 40.1	86 5	172	8.7	8.2	+ 0.5	G3	K0		0.022
574	11 47.4	86 47	99§	8.7	8.3	+ 0.4	G0	G5		0.344
575	11 59.7	86 8	176	6.7	6.7	0.0	F3	F5	F5	0.104

* Zone 85 in B. D.
§ Zone 87 in B. D.

ZONE 86. — *Continued.*

No.	α 1900.0 h	α 1900.0 m	δ 1900.0 °	δ 1900.0 ′	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich. ″
576	12	6.9	86	16	177	8.8	8.9	− 0.1	A5			0.011
577	12	13.9	86	59	107§	6.6	6.5	+ 0.1	F1	F2	Fo	0.221
578	12	34.6	86	17	182	7.3	7.4	− 0.1	A2	Fo	A3	0.021
579	13	5.8	86	46	117§	9.3	9.6	− 0.3	Fo			0.055
580	13	9.7	86	15	188	10.0	10.2	− 0.2	A			0.033
581	14	30.0	86	3	211	9.0	9.1	− 0.1	F1			0.045
582	14	49.6	86	22	217	7.8	7.3	+ 0.5	Ko	Ko	G3	0.009
583	15	9.1	86	17	222	9.3	9.3	0.0	Go			0.097
584	16	20.2	86	3	242	9.2			K			0.046
585	16	34.8	86	26	244	8.6	var. 8.7—9.8		B9	Ao		0.034
586	17	12.1	86	13	256	9.0	8.4	+ 0.6	Ko	G5		0.059
587	18	4.5	86	37	269	4.5	4.7	− 0.2	B9	Ao	B9	0.058
588	18	13.2	86	48	274	11.0	11.1	− 0.1	Ao			0.031
589	18	40.7	86	9	277	9.1	9.3	− 0.2	Ao			0.029
590	18	47.7	86	35	282	8.0	6.6	+ 1.4	Ko	Ma	M	0.021
591	19	20.5	86	35	290	9.2	9.3	− 0.1	Go			0.045
592	19	40.9	86	44	297	9.2	9.4	− 0.2	A4			0.017
593	21	19.6	86	37	319	7.3	7.7	− 0.4	Ao	A3	A2	0.019
594	21	46.4	86	33	324	8.3	8.5	− 0.2	A2	A2		0.033
595	21	58.0	86	11	374*	9.9	10.4	− 0.5	B9			0.010
596	22	24.4	86	4	386*	10.2	9.4	+ 0.8	A			0.010
597	22	37.8	86	1	389*	9.5	9.4	+ 0.1	G8			0.024
598	22	42.3	86	46	335	7.9	8.3	− 0.4	Ao	Ao		0.008
599	22	43.3	86	8	390*	9.1	8.6	+ 0.5	G5	G5		0.034
600	23	12.6	86	15	396*	9.9			A			0.021
601	23	27.5	86	0	401*	7.4	7.4	0.0	F8	F5		0.043
602	23	27.8	86	45	344	5.8	5.8	0.0	Fo	Fo	A4	0.080
603	23	54.8	86	9	409*	6.7	7.0	− 0.3	Ao	Ao		0.046
604	23	57.3	86	29	347	7.8	7.9	− 0.1	F8	Fo		0.019

ZONE 87.

No.	α 1900.0 h	α 1900.0 m	δ 1900.0 °	δ 1900.0 ′	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich. ″
605	0	0.3	87	20	220	9.4	9.0	+ 0.4	F	G5		0.025
606	0	7.5	87	51	1	8.9	9.3	− 0.4	A2	A		0.013
607	0	27.1	87	15	7†	9.0	9.0	0.0	F2			0.047
608	0	38.9	87	17	5	9.4	9.4	0.0	F			0.031
609	0	42.8	87	21	7	9.8	10.1	− 0.3	A5			0.011
610	0	59.6	87	44	9	8.9	9.0	− 0.1	F8	F5		0.017
611	1	21.4	87	23	13	9.9	9.8	+ 0.1	F			0.068
612	2	49.9	87	1	44†	9.2	9.3	− 0.1	F8			0.029
613	2	50.3	87	8	43†	9.1	9.4	− 0.3	A3			0.055
614	2	58.5	87	33	26	8.9	9.0	− 0.1	F			0.050
615	3	33.3	87	23	29	10.2	10.4	− 0.2	B9			0.055
616	3	53.7	87	16	31	9.8	9.8	0.0	Fo			0.013
617	4	35.6	87	42	35	9.2	9.5	− 0.3	Fo			0.026
918	5	9.1	87	25	38	9.9	10.1	− 0.2	Fo			0.011
619	5	30.9	87	0	75†	9.3	9.8	− 0.5	A5			0.041
620	5	45.6	87	20	41	9.3	8.2	+ 0.1	M	Ko		0.023

§ Zone 87 in B. D.
* Zone 85 in B. D.
† Zone 86 in B. D.

ZONE 87. — *Continued.*

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h m	° ′								″
621	6 24.3	87 23	45	9.2	9.4	− 0.2	A			0.016
621	6 35.5	87 32	46	9.0	8.5	+ 0.5	G	G5		0.048
623	6 53.7	87 12	51	6.6	5.2	+ 1.4	K5	Ma	K5	0.063
624	7 16.6	87 57	39§	9.1	9.4	− 0.3	Ao	Fo		0.074
625	8 26.2	87 15	68	8.8	8.8	0.0	F	Go		0.040
626	8 27.0	87 1	69	9.5	9.2	+ 0.3	F			0.020
627	8 27.2	87 46	67	9.3	9.7	− 0.4	A5			0.032
628	9 28.0	87 34	79	9.2	8.4	+ 0.8	F8	Ko		0.037
629	9 38.3	87 45	81	9.5			K5			0.135
630	9 40.4	87 37	82	9.2	9.4	− 0.2	F8			0.052
631	9 44.0	87 3	83	8.6	7.7	+ 0.9	Go	G5		0.054
632	10 4.0	87 46	85	9.0	8.3	+ 0.7	Go	Ko		0.034
633	11 54.3	87 33	100	9.4	9.8	− 0.4	A1	A2		0.027
	11 54.6	87 33	101	8.1	8.3	− 0.2				0.032
634	12 8.1	87 29	104	8.9	8.2	+ 0.7	F8			0.023
635	12 16.4	87 6	108	9.4	9.9	− 0.5	Fo			0.030
636	12 42.1	87 2	113	9.3	9.7	− 0.4	F3			0.017
637	12 58.1	87 12	115	8.8	8.8	0.0	F3	F8		0.077
638	13 25.1	87 5	122	8.5	8.7	− 0.2	A8 Go	F2		0.022
639	13 34.8	87 1	124	9.5	9.6	− 0.1	A2			0.010
640	13 46.9	87 40	127	10.0	10.2	− 0.2	A2			0.019
641	13 53.6	87 48	80§	8.9	9.3	− 0.4	A2	Ao		0.012
642	14 18.1	87 52	86§	8.7	9.3	− 0.6	B9	B9		0.026
643	15 9.3	87 37	143	8.1	7.1	+ 1.0	Ko	Ko	K5	0.029
644	15 27.2	87 23	147	8.3	8.4	− 0.1	F3	F8		0.050
645	16 5.5	87 45	151	9.2	9.3	− 0.1	F5	F8		0.029
646	18 4.4	87 25	169	8.3	8.5	− 0.2	A5 Go	Fo		0.022
647	19 14.5	87 10	180	8.3	8.8	− 0.5	Ao	A5		0.029
648	19 15.7	87 41	181	8.4	8.7	− 0.3	Ao	A3		0.006
649	19 53.8	87 53	185	9.3	9.7	− 0.4	A4			0.015
650	20 25.1	87 38	187	9.0	8.2	+ 0.8	K	K2		0.024
651	21 16.4	87 8	318†	8.6	8.5	+ 0.1	F	F2		0.046
652	21 49.3	87 58	199	9.5	10.0	− 0.5	Ao F8			0.031
653	21 59.3	87 19	201	8.5	8.5	0.0	F6	F8		0.036
654	22 22.0	87 5	332†	9.1	9.4	− 0.3	A6	F2		0.041
655	22 24.2	87 34	205	7.3	7.4	− 0.1	A	A2	A2	0.042
656	23 42.9	87 47	217	8.8	9.1	− 0.3	A3	Ao		0.023

ZONE 88.

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
657	0 16.1	88 53	2	8.8	8.2	+ 0.6	Go	Ko		0.008
658	0 59.5	88 27	5	9.4	9.1	+ 0.3	G3			0.048
659	1 17.4	88 34	6	10.0	10.0	0.0	A			0.034
660	1 18.1	88 3	12*	8.9	7.9	+ 1.0	M	Ko		0.039
661	1 49.7	88 0	15*	8.1	8.3	− 0.2	Fo	A3		0.050
662	1 56.1	88 12	16*	9.0	9.1	− 0.1	F8	Go		0.063
663	2 14.2	88 42	9	8.2	8.2	0.0	Go	Fo		0.060
664	2 17.4	88 15	11	8.8	8.8	0.0	F8	Go		0.176
665	2 42.3	88 34	13	8.8	9.1	− 0.3	A8	A		0.038

† Zone 86 in B. D.
§ Zone 88 in B. D.
* Zone 87 in B. D.

Zone 88. — *Continued.*

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
	h m	° ′								″
666	2 52.0	88 9	23*	9.2	8.6	+ 0.6	G8	Ko		0.046
667	3 9.3	88 27	16	9.8	9.8	0.0	F5			0.107
668	4 4.9	88 2	33*	8.6	8.7	− 0.1	Go	F2		0.031
669	5 47.1	88 44	29	9.6	9.3	+ 0.3	G5			0.032
670	6 9.0	88 36	33	10.0	10.1	− 0.1	F			0.007
671	6 17.7	88 20	35	9.3	9.5	− 0.2	F			0.031
672	7 58.1	88 56	13†	7.1	7.3	− 0.2	A	Ao	A3	0.022
673	8 7.7	88 41	43	9.7	9.8	− 0.1	F2			0.047
674	9 27.0	88 13	55	9.9	10.1	− 0.2	A8			0.031
675	10 19.4	88 23	60	8.9	9.0	− 0.1	F8	F8		0.038
676	11 4.2	88 11	64	7.3	7.7	− 0.4	B9	B8	B9	0.012
677	12 15.3	88 20	72	9.4	9.8	− 0.4	A8			0.033
678	12 46.0	88 31	75	9.3	9.2	+ 0.1	G3			0.043
679	13 4.5	88 11	76	8.8	7.6	+ 1.2	K5	K2		0.022
680	13 26.8	88 4	77	8.7	8.7	0.0	F8	F2		0.035
681	16 21.8	88 27	96	9.8	10.0	− 0.2	A5			0.012
682	17 6.1	88 10	100	9.2	9.1	+ 0.1	F			0.038
683	17 31.7	88 41	101	9.2	9.7	− 0.5	Fo			0.003
684	17 51.6	88 44	105	8.9	8.5	+ 0.4	F5	Ko		0.032
685	17 53.9	88 15	104	8.3	8.3	0.0	A	F5		0.021
686	18 48.6	88 38	110	9.1	9.4	− 0.3	A8	F5		0.022
687	19 22.5	88 59	112	7.8	6.5	+ 1.3	M	Mb	M	0.013
688	19 43.3	88 41	114	9.0	8.2	+ 0.8	K	Ko		0.007
689	19 54.1	88 34	115	9.0	9.4	− 0.4	A2	A2		0.023
690	19 59.0	88 50	117	8.8	var. R. Cephei		F8	G5		0.146
691	21 57.0	88 23	130	9.3	9.4	− 0.1	F	F		0.021
692	22 12.1	88 58	131	8.8	9.1	− 0.3	A1	A5		0.015
693	22 30.9	88 44	133	9.4			A4			0.016
694	23 44.2	88 17	139	9.4			F1			0.014

Zone 89.

No.	α 1900.0	δ 1900.0	B. D. No.	Int. phot. magn. Greenwich.	Vis. magn. Müller and Kron.	Colour Index.	Spectrum author.	Spectrum Harvard circular 180.	Spectrum Yerkes Actinometry.	Proper Motion Greenwich.
695	2 31.6	89 6	10§	9.7	9.4	+ 0.3	Go			0.024
696	3 0.0	89 12	6	10.1						0.037
697	3 18.9	89 41	3	9.0	9.1	− 0.1	A5	A5		0.031
698	11 0.4	89 18	17	9.5	9.6	− 0.1	F2			0.086
699	11 35.0	89 29	18	9.4	9.8	− 0.4	A2			0.016
700	12 42.2	89 14	21	9.4	9.5	− 0.1	F	F		0.017
701	13 51.5	89 29	25	9.6	10.0	− 0.4	Ao			0.024
702	23 11.0	89 16	38	9.6	10.0	− 0.4	Ao			0.001

* Zone 87 in B. D.
† Zone 89 in B. D.
§ Zone 88 in B. D.

CENTRE OF THE PLATE + 35° 14^h 30^m.

No.	α 1900.0			δ 1900.0		Bonner Durchmusterung			Spectrum author.
						No.	Zone.	magn.	
	h	m	s	°	′				
1	14	12	46	35	58.1	2468	36	4.8	G
2	14	13	30	33	43.1	2436	33	7.3	Fo
3	14	13	51	38	7.3	2541	38	7.5	A5
4	14	14	9	34	40.1	2515	34	8.7	K
5	14	16	41	33	45.1	2447	33	8.2	Fo
6	14	16	42	36	51.0	2519	37	7.0	A1
7	14	18	2	36	5.4	2478	36	8.0	Go
8	14	18	23	32	53.7	2453	33	9.2	G
9	14	19	10	34	0.9	2525	34	8.6	Go
10	14	19	16	37	18.3	2527	37	8.1	Fo
11	14	19	20	37	39.6	2528	37	7.2	F6
12	14	20	15	38	53.0	2762	39	8.6	Ko
13	14	23	31	33	25.3	2466	33	8.2	A2
14	14	23	44	35	11.1	2561	35	8.0	F3
15	14	23	48	36	1.3	2493	36	7.5	G3
16	14	24	10	36	38.8	2495	36	6.5	G5
17	14	25	33	32	14.0	2482	32	6.5	B9
18	14	26	4	37	36.5	2540	37	7.5	F6
19	14	28	3	38	45.4	2565	38	2.8	Fo
20	14	28	10	33	38.9	2471	33	8.5	Ao
21	14	29	0	38	48.9	2776	39	9.0	Fo
22	14	29	17	37	23.8	2545	37	6.8	Go
23	14	29	31	36	1.4	2505	36	7.3	Go
24	14	29	55	32	58.6	2474	33	6.8	Go
25	14	30	30	38	26.4	2570	38	7.5	A3
26	14	30	35	37	3.8	2551	37	6.2	Ko
27	14	32	55	34	9.5	2543	34	9.0	G
28	14	33	4	36	22.1	2509	36	6.5	B9
29	14	35	4	32	57.8	2482	33	8.3	G5
30	14	35	22	36	56.2	2559	37	8.1	Go
31	14	36	35	34	42.5	2551	34	8.5	A5
32	14	37	0	38	34.3	2579	38	7.2	F8
33	14	37	38	35	40.1	2597	35	8.2	Go
34	14	37	56	32	20.7	2505	32	8.4	F5
35	14	38	37	37	10.4	2568	37	6.8	A4
36	14	40	35	32	33.3	2511	32	7.9	G
37	14	41	3	33	13.1	2489	33	6.6	M
38	14	42	18	32	56.5	2491	33	8.2	F7
39	14	43	20	35	59.3	2530	36	7.5	B9
40	14	43	48	36	4.6	2531	36	7.5	F7
41	14	44	47	36	27.7	2533	36	8.4	Go
42	14	45	2	36	1.1	2535	36	8.4	G
43	14	45	13	38	12.9	2593	38	6.2	Fo
44	14	45	23	35	37.1	2614	35	8.3	F5
45	14	45	53	37	0.7	2578	37	8.4	A1
46	14	46	35	37	40.6	2580	37	5.7	Go

PLATE 1.

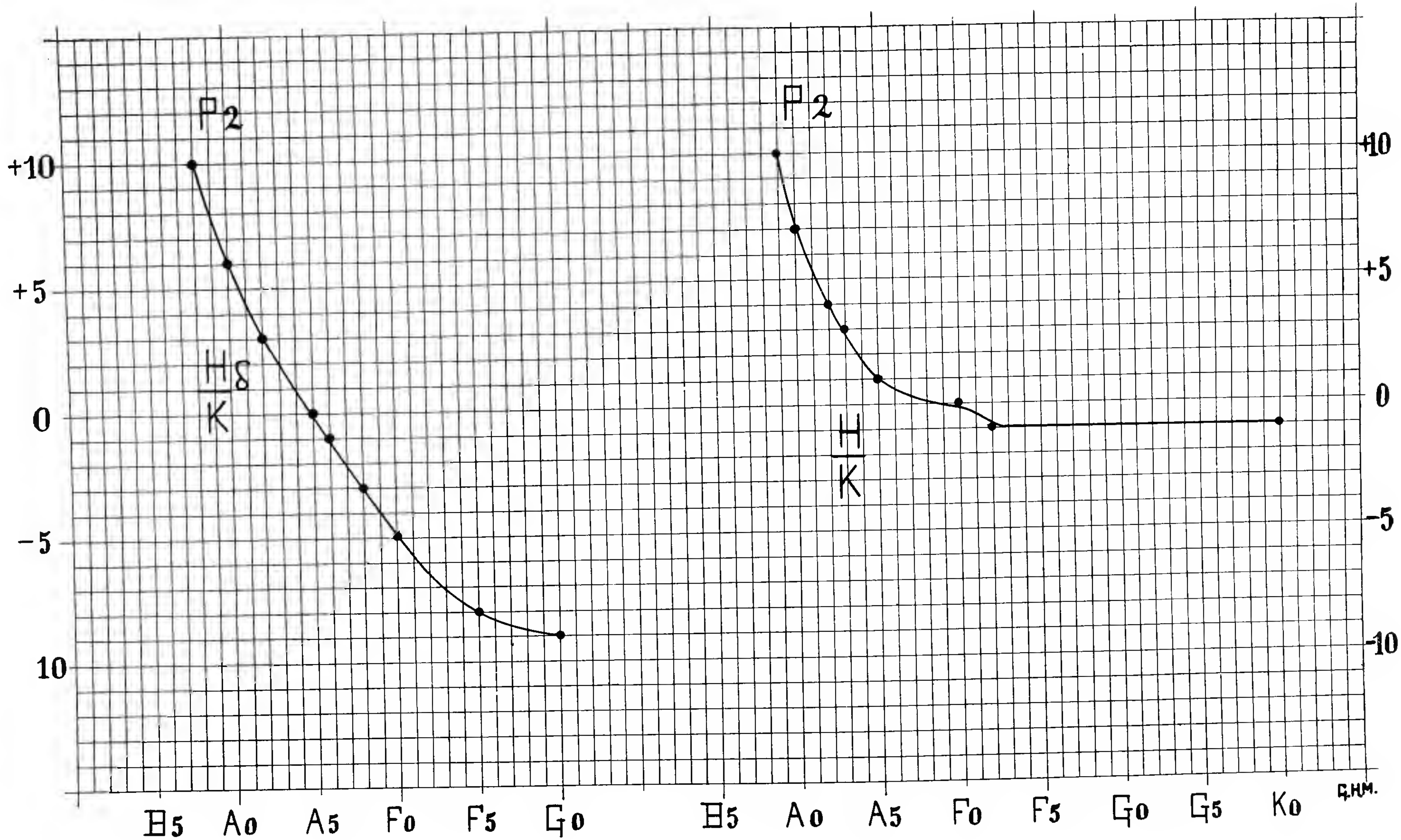
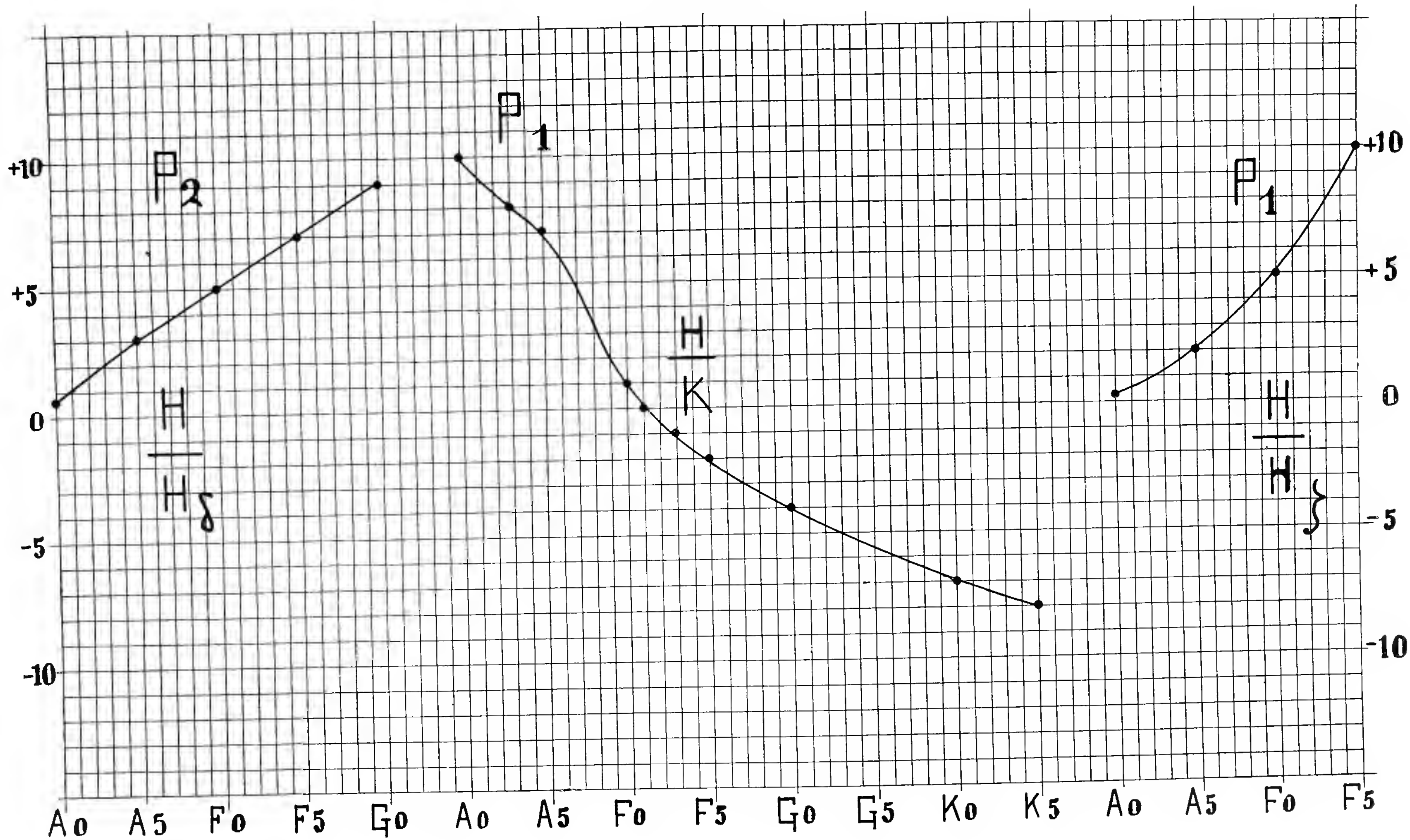

P2
Hδ/K
+10
+5
0
-5
10
B5 A0 A5 F0 F5 G0
P2
H/K
+10
+5
0
-5
-10
B5 A0 A5 F0 F5 G0 G5 K0
c.HM.

PLATE 2.



P2
H / Hδ
P1
H / K
P1
H / Hζ
+10
+5
0
-5
-10
A0 A5 F0 F5 G0 A0 A5 F0 F5 G0 G5 K0 K5 A0 A5 F0 F5

STELLINGEN.

I.

De sterren met kleine E. B. (althans die van het II^e^ type) zijn, ceteris paribus, rooder dan die met groote E. B.

Dit effect moet waarschijnlijk meer worden toegeschreven aan een invloed van de absolute magnitude, dan aan selectieve verstrooiing van 't licht in de ruimte.

II.

Het bedrag van dit effect neemt toe voor de spectraalklasse in de volgorde A, F, G, K, M.

III.

Dr. MOGENDORFF's bewering dat de sterren voor meer dan de helft tot type I behooren, geldt alleen voor de heldere. Van de 7^e^ tot de 9^e^ grootte neemt percentsgewijze 't aantal sterren van type II sterk toe.

Zie: „Kosmografie" door Dr. E. E. Mogendorff.

IV.

De voorstelling, die men zich vormt van de verdeeling der sterren in de wereldruimte en de daaruit voortvloeiende z.g.n. structuur van het sterrenstelsel is moeilijk vereenigbaar met de opvatting als zouden de sterstroomen zijn te verklaren uit twee van elkaar onafhankelijke sterrenwolken, die thans bezig zijn elkaar te doordringen.

Zie: Rede Prof. J. C. Kapteyn op 't Genees- en Natuurkundig Congres 1911.

V.

Het verschijnsel van de twee sterstroomen kan niet verklaard worden uit de excentriciteit van de zon t. o. v. 't zwaartepunt van het sterrenstelsel.

S. Oppenheim, Ueber die Eigenbewegung der Fixsterne (IV Mitteilung).

VI

De methode, volgens welke G. J. BURNS de helderheid van den hemel bepaalt, is verwerpelijk.

Astrophysical Journal, Volume XVI blz. 166.

VII.

In het „Handboek der Kosmografie" van Dr. P. H. SCHOUTE wordt 't verschil in middelbare tijd tusschen 2 plaatsen omgezet in sterrentijd, teneinde het lengteverschil tusschen beide plaatsen te vinden.

Dit is onjuist.

VIII.

De wijze waarop Dr. P. MOLENBROEK de inhoud van een kegelvormige bolsector bepaalt, is uit streng wetenschappelijk oogpunt af te keuren.

Zie: Dr. P. Molenbroek, Leerboek der Meetkunde, 2e deel.

IX.

De constructie van een drievlakshoek uit drie zijner elementen behoort meer thuis in een leerboek over stereometrie dan in een over beschrijvende meetkunde.

X

„Het aantal der eenheden van een hoeveelheid is onafhankelijk van de plaats der eenheden"

Het is niet mogelijk voor deze grondeigenschap der Rekenkunde een bewijs te leveren.

XI.

Met 't oog op de groote vorderingen die de Wis- en Natuurkundige wetenschappen den laatsten tijd gemaakt hebben, is een algeheele reorganisatie van 't Wiskundeonderwijs aan de Gymnasia en de Hoogere Burgerscholen hoog noodig.

XII.

De zoogenaamde „afstand van duidelijk zien" heeft noch physische noch physiologische beteekenis; bij de behandeling van loupe en microscoop is dit begrip overbodig.

XIII

Vaihinger's bewering dat de methoden der theoretische natuurkunde slechts fictieve methoden zijn, is niet in overeenstemming met de wijze, waarop hij zelf 't verschil tusschen Hypothese en Fictie definieert.

Hans Vaihinger: Die Philosophie des Alsob.

XIV.

Het Dierkundeboek van Dr. A. Schierbeek en D. Valkema en de daarbij behoorende atlas zijn voor de lagere klassen der scholen, waarvoor het boek bestemd is, uit paedagogisch oogpunt niet aan te bevelen.

XV.

Evenals op de middelbare scholen in Frankrijk, behoort ook ten onzent de zedenleer in de hoogste klassen onderwezen te worden.