PUBLICATIONS
DE
L'OBSERVATOIRE ASTRONOMIQUE DE L'UNIVERSITÉ DE TARTU
(DORPAT)
TOME XXV № 6

Statistical Studies of Double Stars

Second paper:

On the Distribution of Relative Luminosities and Distances of Double Stars in the Harvard Revised Photometry North of Declination — 31°

By

E. Öpik

Tartu 1924

Abbreviations used:

T. P. = Publications de l'Observatoire Astronomique de l'Université de Tartu (Dorpat)
H. R. = Harvard Revised Photometry
H. D. = Henry Draper Catalogue

K. Mattiesen'i trükk, Tartus

Statistical Studies of Double Stars.

Continued from *T. P.* 25_5 (1923).

---

1. Introduction.

The present paper presents a second step in a planned investigation which has for its final object the derivation of the frequency-function of relative luminosities and of the relative distribution in space (frequency-function of distances) of the components of double stars of different spectral classes. The importance of these two fundamental functions in several problems of stellar evolution cannot be emphasized enough.

Statistical investigations on double stars have been made in the course of time by many authors[1]; the purpose of these former investigations is, however, somewhat different from ours: ordinarily the distribution of double stars by different regions of the celestial sphere, magnitude classes and distance limits has been studied, the relative luminosities (or differences of magnitude) of the components being generally neglected; thus, of the two functions which we seek for, the frequency of relative luminosities must be determined for the first time, whereas the distribution of distances has been studied previously by other authors; but in this respect also our investigation differs from the preceding ones in the important particular that our purpose is to determine the *true* distribution, whereas in all preceding investigations only the *apparent* distribution was studied. In solving our problem *factors of selection* must be taken into account

1) As the most recent ones may be mentioned: *A Statistical Study of the Visual Double Stars in the Northern Sky*, chapter X of *The Binary Stars* by R. G. Aitken; and *Distribution of Double Stars* by R. Jonkheere, *Memoirs of the R. A. S.* vol. **61** pp. 17—22.

to make data for different distances or differences of magnitude comparable; e. g. if for $d = 1''$ the data may be regarded as complete up to $\Delta m = 3.0$, for $d = 0''.3$ they are so only, say, up to $\Delta m = 1.0$; it would be therefore incorrect to compare directly the total numbers of double stars of a distance $1''.0$ and $0''.3$ respectively: in the comparison only those stars with $d = 1''$. should be retained which have $\Delta m \leqslant 1.0$. This simplified example gives an idea of the principle used in the present paper; in fact we did not content ourselves with the portion of the data which might be regarded as complete, but used all data where a plausible estimate of the *coefficient of selection* (or degree of completeness) could be obtained.

Our first paper, "On the Luminosity-Curve of Components of Double Stars", loc. cit., may be regarded as preliminary; there were considered only the relative luminosities without taking into consideration the distances, and the factors of selection were determined by a somewhat imperfect method; in a rigorous solution of the problem the distribution of luminosities cannot be derived without knowing the distribution of distances and vice versa; nevertheless the chief results arrived at in the first paper are confirmed by the present investigation; this may be regarded as a test of the reliability of the method of factors of selection, even if used in such a primitive manner as in *T.P.* **25** 5.

Another improvement introduced in the present paper is the use of a magnitude-scale calibrated with the aid of photometric measures made on the components of several hundred bright double stars at the Harvard College Observatory by E. C. Pickering, O. C. Wendell, and others; all available estimates of magnitudes of every double star made by different double star observers were collected; from comparison with the photometric measures systematic corrections depending on the personality of the observer and on the separation of the components were derived; the magnitudes used ultimately for each pair represent the mean of the estimates of all observers computed by applying to them the systematic corrections and by taking into account the relative weights of the single estimates.

Such a treatment of the entire double-star material, consisting at present of over 20 000 entries, would require several years of hard work; therefore it was decided to publish the results of the first part of the investigation relating to the double stars of the Harvard Revised Photometry[1]), i. e. practically to the naked-eye double stars, north of declination — 31°. The separate publication of a part of the whole investigation is justified also by certain properties of this selected material: a) the bright stars are the most frequently examined for duplicity and the data for them are therefore considerably more complete than for the faint stars; this is especially true for the *wide pairs,* not included in the great survey by R. G. Aitken and W. J. Hussey; b) for the majority of the naked-eye stars well determined proper motions are available; this makes the discrimination between optical and physical companions much easier; c) the majority of the Harvard photometric measures of double stars relate to companions of stars of the Harvard Revised Photometry, whereas for fainter stars there are few measures; therefore the systematic corrections derived from a comparison with the photometric measures are directly applicable to estimates of the double stars of the *H. R.*, whereas for fainter stars the use of the same corrections involves to some extent extrapolation; d) the greatest differences of magnitude and the smallest absolute distances (for a given spectral type) may be observed only among the brightest stars; so that the present material may give information on such parts of the *luminosity-curve* and *distribution of distances* on which little or no information can be gained from the remaining great number of faint doubles.

From all these considerations it appears that a separate statistical treatment of the bright double stars is of quite an independent value.

As a by-product of the investigation magnitudes reduced to a standard scale for the components of over 1 500 double stars resulted; the complete catalogue of these magnitudes together with other data used in the statistical discussion is reproduced here; the reason for doing so was that the catalogue may be of use for others dealing with different problems of double star astronomy.

All the work relating to the compilation of the catalogue, the collection of magnitude-estimates from various sources and the derivation of final magnitudes was done by Miss A. Piiri, as well as many other computations needed in the course of the

---

1) *Harvard Annals* **50.**

investigation; a revision of the catalogue and the illustrations were made by Mr. R. Livländer; to both I owe my sincerest thanks for their devoted assistance.

2. Catalogue.

Table 1 contains the catalogue of double stars included in the present investigation; this list comprises the stars of the *Harvard Revised Photometry* north of declination — 31°, which are recorded as double in one of the following catalogues: 1) Burnham's *General Catalogue of Double Stars*; 2) R. Jonkheere's *Catalogue and Measures of Double Stars*, Memoirs of the R. A. S. vol. 61 (1917); 3) pairs discovered by R. T. A. Innes, lists of which were published in several *Union Observatory Circulars*; 4) pairs discovered by Aitken, Hussey, Espin, Jonkheere, not included in the preceding catalogues, contained in different *Lick Observatory Bulletins*, *Monthly Notices*, and *Astronomische Nachrichten*; 5) occasionally noted wide pairs with common proper motion, such as Furuhjelm's companion to Capella and others: this category of pairs is probably not fully represented in the catalogue.

Several unidentified pairs of Burnham's General Catalogue, chiefly those of the Herschels, were not included; rejected were also a few stars which were only once observed as double but could afterwards not be verified under more favourable circumstances; it is probable that many of these stars will prove to be binaries in orbital motion. *Wide pairs* noted *in star clusters*, such as Praesepe, Plejades etc, were rejected. Generally 128″ was assumed as the limit of distance in the list.

The data of the different columns of table 1 are explained below.

The 1st *column* gives the number from Burnham's General Catalogue;

The 2d *column* — the number in the Harvard Revised Photometry;

in these columns only the two last figures of the corresponding number are printed for each star, whereas the other figures must be taken from the nearest preceding number printed in full; the table is arranged in the order of *β. G. C.* (except the Appendix), or when the star does not appear there — in the order of *H. R.*

A bracketed number in the 1st column relates to *Jonkheere's Catalogue*, loc. cit.; the numbers of Burnham's *Appendix* are in italics.

The 3d *column* gives the name of the *first observer*; this is in the majority of cases also the name of the discoverer; economy of printing necessitated the omission of the full name by which the double star is ordinarily called. As will be shown later on, the data of this column are of especial importance in the estimate of the coefficients of selection. The abbreviations of the names of the observers are generally those used by Burnham, with a few exceptions; stars discovered by both Herschels or in the cooperation of South and J. Herschel are denoted by the same letter *H*; if the star was measured by F. G. W. Struve, although discovered by the preceding observers, the letter Σ is nevertheless assigned to it; for pairs discovered by Burnham the aperture of the objective in inches (fractions rejected) is appended to the letter β.

The 4th *column* gives the distance in seconds of arc; the hundredths of a second were simply rejected, not rounded off, so that e. g. 0″.1 means distances from 0″.10 to 0″.19; 1″.9 means — from 1″.90 to 1″.99 etc. The distance may change on account of orbital or proper motion, errors of observation may also influence its numerical value; for convenience's sake the *first measured value* of *d* was always adopted; in the majority of cases the distance corresponds to the epoch of discovery except for the Herschel pairs for which generally later data were used.

The 5th *column*, under the heading "*Rem.*" gives information on the physical relation between the components and on the use which was made of the corresponding pair in the subsequent statistical discussion; the physical relation is denoted by the following letters:

m = physical pair showing change attributed to orbital motion;
c = common proper motion;
f = relatively fixed;
opt. = optical;

a *?* after the letter indicates that the classification is uncertain;

a *?* alone means, that no classification could be made for lack of measures or for some other reason.

The classification was derived chiefly from the character of the relative motion and the proper motion of the star, if available; in a few cases the method of *hypothetical parallaxes* was also applied. The remarks refer only to the relation between the companion and the *principal* star; if in a triple or multiple star two faint companions constitute a physical pair, but if this pair is only optically related to the principal (bright) star, both companions are classified as optical notwithstanding their mutual physical relation. Particulars as to the method of classification will be given below. It must be remembered that the classification in many cases although categorical indicates only the *probable* character of the pair as it appears from the measures available. New measures may substantially alter the conclusions.

The letters by which the physical relation is denoted are preceded in column 5 by numerical coefficients or the letter *n*; the coefficients represent effective *factors of selection*, called also *extrapolation factors*; the method of deriving these coefficients and their meaning will be explained later on; the coefficients are given only for physical or probably physical pairs, and for pairs without classification (marked by a ?) if the probability of being physical exceeds 0.50; the letter *n* denotes that the corresponding pair (or companion) although possibly or probably physical was for some reason not used in the count.

The 6th *column* contains the centennial proper motion of the principal star; the proper motions were taken from a compilation by R. Schorr[1]) and graphically converted into seconds of the great circle.

The 7th *column* contains the spectral class of the principal star according to the Henry Draper Catalogue[2]); beginning from right ascension 21^h the catalogue was not available, but the spectral class of many stars could be taken from several other publications where the H. D. spectra of double stars were published[3]); for other stars the classification, given in several *Contributions from the Mt Wilson Observatory* and in the *Publications*

1) *Eigenbewegungs-Lexikon,* Sternwarte Bergedorf, 1923; and *Erster Nachtrag zum Eigenbewegungslexikon, Mitteilungen der Hamburger Sternwarte* B. **5** Nr. **18**.

2) *Harvard Annals* vol. **91—98.**

3) e. g. The *Greenwich Astrographic Catalogue*; The *Greenwich 10 year Catalogue for 1910*; several papers on hypothetical parallaxes of double stars by Jackson and Furner and by Jackson, which appeared in the *Monthly Notices*.

of the Victoria Astrophysical Observatory, was used; also a paper by Fr. C. Leonard [1]) was consulted; the remaining spectra were taken from *Harvard Annals* **50**; since for only about 30 physical or probably physical pairs spectra from the latter source given without the subclasses were used, the relative inaccuracy of these spectra is of no real consequence in the statistical treatment which comprises 1216 counted entries.

The letters preceding the spectral class mean:

d — a dwarf, *g* — a giant, *s* — a supergiant; for optical pairs or those marked in the 5th column by the letter *n* no subdivision into classes of absolute magnitude is made; as to the principles of the subdivision, they will be explained below.

The 8th *column* gives the concluded magnitudes of the components reduced to the Harvard Scale; for triple or multiple stars the magnitudes are so arranged that they at once indicate to what combination of components the *distance* given in the 4th column refers; e. g. in a triple star *ABC* the distance given first refers always to *AB*; if the magnitude of *B* is given in the same line with *A*, and the magnitude of *C* stands alone in the second line, the distance in the second line refers to *AC*; if, however, the first line contains only the magnitude of *A*, the second — the magnitudes of *B* and *C*, the distance in the second line refers to *BC*; in more complicated multiple stars the magnitude of the component from which the distance of a companion is reckoned is given sometimes in parentheses preceding the magnitude of the companion. For quadruple stars consisting of two pairs *AB* and *CD* the distance *AB—CD* is given between the lines referring to each pair separately.

The 9th *column* gives the difference of magnitude, the 10th *column* — the weight, and finally are given the *estimates* of the difference of magnitude used in the derivation of the final magnitudes; the method of deriving the data of columns 8,9 and 10 will be fully explained in a following section; here may be noted, that the letters *ph* in the 10th column mean that for the corresponding pair photometric measures made at Harvard were available, and that the Δm in the 9th column was adopted according to these measures, without using the estimates made by

---

1) *An Investigation of the Spectra of Visual Double Stars, Lick Observatory Bulletin 343* (1923).

double star observers. In the remaining cases the Δm were derived from the estimates after applying to them certain systematic corrections.

From a comparison with the photometric measures the following empirical formulae for the probable errors of the concluded Δm were found:

$$\text{p. e.} = \pm\left(\frac{0.50}{\sqrt{W}} + 0.06\right) \text{ for } W \leqslant 15;$$

and

$$\text{p. e.} = \pm\frac{0.50}{\sqrt{W}} \text{ for } W \geqslant 16.$$

The accidental errors for weights below 2 appear to be practically constant; the low weights indicate generally a less accurately known systematic correction.

The abbreviations of the names of observers used for the estimates are explained in a following section; generally the abbreviations are those used in Burnham's General Catalogue.

Table 1.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
—	1	Es	13.″3	2.2 ?	3.″1	d Ao	6.5 ; 12.7	6.2	1	Es 7.0
—	"	"	20. 4	0.6 ?			··· ; 10.2	3.7	1	Es 2.7
19	15	Σ	64. 9	opt	21. 2	Aop	2.2 ; 10.5	8.3	ph	Σ 9.2 ; Δ 9.2 ; OΣ 8.7
21	20	Σ	0. 8	1.0 m	11. 4	d A3	6.8 ; 7.1	0.3	22	Σ 0.3 ; β 0.1 ; A 0.3
24	21	Clark	22. 6	opt	56.	F5	2.4 ; 14.2	11.8	1	β 12.4 [Ol 0.0
30	24	β6	0. 7	1.0 c	7. 0	d F2	6.2 ; 6.2	0.0	42	Cin 0.1 ; Gla 0.0 ; A 0.0 ; See 0.0
38	26	Σ	8. 0	1.0 c	3. 4	d B8	5.5 ; 10.0	4.5	17	Σ4.5; Cmb 6.5; Doo 3.5; Δ 4.5; Com 4.5 ; Gla 4.4
70	40	OΣ	0. 8	1.1 c	3. 6	d F5	6.6 ; 7.9	1.3	10	OΣ 1.4; Δ 1.5; HΣ 1.0; Lv 1.5
"	"	H	17. 8	1.0 c			··· ; 10.2	3.6	7	AC: OΣ 2.7; Δ 3.4; Lv 3.0
81	46	β18	2. 8	2.1 c	6. 1	g Ma	5.4 ; 10.4	5.0	4.5	β 6.0; Cin 4.6; LM 5.5; Bd 5.8; Cg 6.0
87	50	Σ	11. 5	1.0 c	10. 1	d F0	6.1 ; 7.8	1.7	20	Σ1.6; Cmb 1.9; Δ 2.0; Gla 1.2 |A 6.6|
92	55	Σ	0. 4	1.1 m	2. 5	d B9	6.9 ; 7.1	0.2	42	Σ0.5; Δ 0.2; β 0.1; Gla 0.1; A 0.0
99	56	H	9. 0	1.0 c	8. 8	d A0	6.1 ; 10.1	4.0	7	Doo 4.0; OΣ 2.7; HΣ 4.0; β 3.2
106	60	β6	19. 3	2.0 f?	0. 2	g G5	5.8 ; 11.7	5.9	1.5	β 6.2 ; Doo 6.0
31	70	OΣ	6. 1	1.0 c	8. 4	d B9	6.0 ; 10.1	4.1	2.5	OΣ 3.7 ; Δ 4.1
41	74	H	62. 0	opt	3. 7	K0	3.8 ; 12.0	8.2	1	β 8.2
53	81	β36	0. 3	1.3 m	—	d A0	6.9 ; 7.8	0.9	17	Doo 1.1; β 1.0; Bd 0.7; Ol 1.2; A 0.8
65	86	Σ	31.	opt	6. 3	K0	6.4 ; 10.8	4.4	ph	Σ 3.9; Δ 4.4; OΣ 4.5
80	91	Hu	0. 1	32. m	1. 5	d B3	5.5 ; 7.2	1.7	3	Hu 2.5; A 1.6
236	**113**	β36	0. 7	2.1 c	4. 7	d B9	6.0 ; 9.0	3.0	3	β 3.8 ; A 3.8
39	14	β36	2. 4	6.1 c	21.	d F0	5.3 ; 11.8	6.5	1	β 7.6
42	17	H	8. 7	opt	0. 8	K5	6.0 ; 10.9	4.9	5	Doo 4.5; Δ 4.8; β 5.1
58	22	H	55. 0	1.5 f	—	(g)K0	6.1 ; 9.3	3.2	3	Δ 2.8
60	23	OΣ	0. 5	1.1 m	4. 9	d B8	5.4 ; 5.7	0.3	24	OΣ 0.3 ; Δ 0.5 ; HΣ 0.0
74	32	Σ	27. 4	1.0 c	3. 0	d A0	5.7 ; 9.3	3.6	ph	Σ 4.0; Δ 3.8; Gla 3.9
75	31	H	38. 3	opt	13. 9	G5	5.5 ; 11.6	6.1	2	Com 6.1 ; β 6.1
314	42	Ho	0. 3	1.3 m	41.	d G0	5.6 ; 6.3	0.7	15	Ho 0.7 ; A 0.7 ; Lv 1.0
"	"	β18	37. 1	opt			··· ; 13.0	7.4	1.5	AC : A 7.5 ; β 7.6
29	54	H	35. 3	1.1 c?	2. 3	d B3	4.4 ; 8.7	4.3	ph	Δ 3.8 ; Fr 3.7 [See 0.1
35	59	β6	0. 6	1.1 m	139.	d K0	6.3 ; 6.6	0.3	39	LM 0.2; Doo 0.4; β 0.2; A 0.2; Lv 0.4;
49	64	OΣ	14. 7	opt	1. 9	K2	5.7 ; 10.8	5.1	3	OΣ 4.5; Δ 5.0
54	65	β26	27. 8	2.0 c	16. 4	g K2	3.5 ; 12.4	8.9	1	β 9.5
60	67	Σ	6. 3	1.0 c	4. 7	g K0	5.6 ; 8.8	3.2	ph	Σ 3.2 ; Cmb 2.5 ; Δ 3.2 ; Gla 3.2
61	68	β36	17. 5	1.6 ?	6. 1	g K0	2.5 ; 13.9	11.4	1	β 12.0
"	"	β18	40. 1	opt			··· ; 13.4	10.9	1	AC : β 11.0
"	"	H	61. 4	opt			··· ; 9.0	6.5	ph	AD : β 6.5
64	72	β6	91. 1	n ?	5. 5	G5	6.5 ; ···	4.1	4	AB : Δ 3.7
"	"	"	11. 0	n ?			10.6 ; 11.1	4.6	2	AC : Δ 4.2
91	92	H	35. 8	4.0 c	3. 2	d A2	5.6 ; 10.2	4.6	1	β 4.0
95	93	β6	32. 8	n f ?	2. 4	B2	4.7 ; 11.4	6.7	3	Δ 6.5 ; β 6.3
401	96	β26	1. 9	1.3 c	2. 8	d A0	5.5 ; 9.6	4.1	4.5	Doo 5.8; β 5.8; HΣ 4.0
26	* **219**	Σ	9. 3	1.0 m	87.	d F8	3.7 ; 7.4	3.7	ph	Σ3.6; Δ 3.8; OΣ 2.0; Com 4.4; Gla 3.4; A 2.8; Ho 4.0; Ab 4.8; Es 6.0
38	27	β36	1. 1	6.1 c	13. 6	g K2	5.8 ; 10.8	5.0	1.5	β 6.2 ; Doo 5.5 |Gla 0.2|
39	* 30	Σ	4. 4	1.0 c	9. 3	d F0	6.3 ; 6.3	0.0	ph	Σ 0.0 ; Cmb 0.0 ; Δ 0.2 ; OΣ 0.5 ;
58	44	β18	121. 2	opt	18. 9	F8	5.0 ; ···	3.9	6	β 2.9; Com 4.3; Doo 2.5
"	"	"	0.9	opt			8.9 ; 10.4	5.4	1	AC : β 5.4
66	47	β6	10. 7	1.0 c	3. 7	g K0	5.6 ; 9.9	4.3	3.5	β 4.5; Doo 4.0; See 4.0
71	51	Stone	5. 3	1.0 f ?	—	(d)F2	6.6 ; 8.7	2.1	4	Cin 1.6 ; Gla 2.5
75	53	β36	12. 7	opt	5. 3	K0	5.0 ; 12.4	7.4	1.5	β 7.8 ; A 7.8 [Lv 0.8
79	54	OΣ	0. 6	1.1 m	2. 6	d A0	6.1 ; 6.7	0.6	25	OΣ 1.3 ; Δ 0.6 ; Com 1.8 ; β 0.4 ;

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
482	**258**	Σ	0.″9	1.0 m	14.″4	g Ko	6.1 ; 6.6	0.5	65.	Σ0.6; Cmb0.5; Δ0.6; OΣ0.5; Com1.9; Gla0.3; A 0.6; Lv 0.3
88	64	β36	2. 1	2.5 c	3. 1	d Bop	2.3 ; 9.5	7.2	2	β 8.9; A 8.6
„	„	β18	52. 1	opt			… ; 12.8	10.5	1.5	AC: β 10.8; A10.8
89	66	β36	0. 1	2.1 m	3. 9	d B9	6.0 ; 6.6	0.6	12	β 0.4 ; A 0.5
97	69	β18	37. 2	opt	15. 8	A2	3.9 ; 12.4	8.5	1	β 9.2
„	„	H	38. 3	opt			… ; 11.3	7.4	ph	
508	77	β6	0. 7	1.1 m	0.	d A0	6.8 ; 7.8	1.0	21	Δ 1.4; Doo 1.2; OΣ1.0; HΣ0.9; β 1.2
20	* 82/83	Σ	7. 6	1.0 f	—	d B9	6.0 ; 6.8	0.8	ph	Σ 1.0; Δ 1.0; Gla 0.7;
41	89	OΣ	0. 5	1.1 m	7. 0	d F0	6.7 ; 7.7	1.0	4	OΣ 1.3; β 0.5
42	90	H	20. 6	2.0 f	2. 4	d A2	5.9 ; 11.6	5.7	3	β 6.4; Es 4.8
43	92	β6	1. 2	1.3 c	2. 4	d F0	6.0 ; 9.0	3.0	6	Δ 3.1; β 3.2; HΣ3.5
53	**301**	Σ	16. 0	1.0 c	12. 3	d F0	6.1 ; 8.9	2.8	8.5	Σ2.4; Δ2.8; OΣ3.0; Com 3.4; Gla2.7
61	08	H	55. 0	opt	4. 4	F2	5.7 ; 11.9	6.2	2	β 6.6; Doo 6.5; A 5.3
70	* 10/11	Σ	29. 9	1.0 c	5. 6	d A2	5.6 ; 5.8	0.2	ph	Σ0.1; Δ 0.4; OΣ 0.0; Gla 0.4
74	* 13/14	Σ	32. 8	1.0 c	14. 0	d F2	6.7 ; 7.6	0.9	ph	Σ 1.1; Δ 0.7; OΣ 0.5; Gla 0.8
76	18	H	22. 6	2.0 f?	0. 7	g K0	6.5 ; 11.3	4.8	2	Es 4.3
600	35	OΣ	0. 5	1.3 m	1. 0	d B8	4.6 ; 5.9	1.3	9	OΣ 1.6; β 1.0; A 1.1; A* 1.6
05	37	Bar	28.	1.6 ?	19.	g Ma	2.4 ; 13.9	11.5	0.5	Bar. 12.0
„	„	β	85.	opt			… ; 12.8	10.4	0.5	β 10.5
„	„	„	91.	opt			… ; 12.0	9.6	0.5	β 9.7
„	„	„	126.	opt			… ; 11.2	8.8	0.5	β 8.9
37	54	β6	0. 7	1.3 f	—	(d) B9	6.4 ; 8.9	2.5	12	Δ 2.8; Doo 3.0; β3.3; HΣ3.0; A 3.4; [A* 2.2
44	56	OΣ	10. 8	1.0 c	3. 2	g K0	6.4 ; 10.4	4.0	4.5	OΣ 3.3; Δ 3.8
47	60	Σ	7. 9	1.1 c	4. 6	g K0	4.7 ; 9.6	4.9	ph	Σ 5.4 ; Cmb 5.2 ; Δ 4.8
48	* 61	Σ	23. 4	1.0 c	14. 3	d A5	5.6 ; …	0.9	ph	Σ 1.1; Doo 2.0; Gla 1.5; Δ 0.6
„	62	β36	0. 9	32. c			6.5 ; 13.0	7.4	2	AC: β 6.8; Doo 9.0; A 9.0
55	66	Σ	50. 1	1.0 c	30.	d F0	5.2 ; 7.8	2.6	ph	Σ 1.9; Δ 2.8; Gla 1.9
85	79	Σ	5. 9	1.0 f	—	(d) A3	6.4 ; 9.5	3.1	6	Σ 2.8; Δ 3.2
91	82	H	49.	n ?	1. 9	s F5p	5.3 ; 12.6	7.3	1	β 7.1
97	84	•S	53. 4	opt	13. 2	A0	6.3 ; 8.3	2.0	10	β 1.9; Δ 1.9; Fr 1.4
707	385	Σ	1. 1	1.0 m	1. 2	d F5	6.4 ; 7.2	0.8	39	Σ 1.0; Cmb 1.5; Doo 0.8; Δ 1.0;
13	* **424**	Σ	18. 2	1.0 c	3. 4	s F8	2.1 ; 8.8	6.7	ph	Σ7.0; Δ6.4 [OΣ1.0; Gla 0.6; O10.3]
„	„	β	82. 7	n ?			… ; 13.0	10.9	1	AC: β 11.0
18	**391**	Σ	0. 8	1.0 c	15. 8	d F5	7.0 ; 7.2	0.2	44	Σ 0.2; Δ 0.4; OΣ 0.3; Gla 0.2
27	94	H	5. 0	1.0 c	12. 5	d F5	6.6 ; 8.8	2.2	4.5	Cin 2.0; Gla 2.8; See 2.0
32	99	β36	3. 1	32. c	8. 9	g K0	5.0 ; 12.2	7.2	1	β 9.0;
„	„	Σ	32. 2	opt			… ; …	5.1	ph	AC: Σ 4.5 ; Com 5.4; Δ 4.6
„	„	Σ	3. 0	opt			10.1 ; 10.7	5.7	ph	AD: Σ 5.1; Com 5.6; Δ 5.5
40	**401**	H	76. 4	opt	17. 3	A5	6.5 ; 11.5	5.0	0.2	H 6.0
41	02	β18	58. 8	opt	24.	K0	3.8 ; 14.6	10.8	1	β 10.9
43	04	β36	0. 1	2.1 m	—	d F0	6.7 ; 6.7	0.0	17	β 0.2; Doo 0.0; A 0.1; A* 0.0
57	18	Ho	13. 4	opt?	—	A3	6.4 ; 12.1	5.7	1	Ho 7.0; Doo 6.2
58	17	β12	2. 2	6.1 c	38.	d F5	5.0 ; 10.5	5.5	1	β 6.4
60	19	Σ	5. 7	1.0 f	—	(d) B8	6.6 ; 8.9	2.3	7	Σ 2.0; Δ 2.5; Gla 2.1
68	25	β6	1. 5	1.3 c	16. 2	g K0	6.3 ; 9.4	3.1	12.5	Δ 3.7; Doo3.1; β 3.0; W 3.3; LM2.6; [Bd 2.8; A* 3.7
70	* 26	S	69. 7	3.3 c	9. 0	g K0	6.7 ; 8.3	1.6	8	β1.0; Δ1.6
78	33	See	22. 3	1.0 c	5. 6	d A0	5.1 ; 10.8	5.7	0.5	See 6.8
85	36	β12	2. 6	1.3 c?	5. 0	g K0	6.0 ; 10.7	4.7	2	β 5.4; Doo 5.5; Cg 5.5
90	37	β18	1. 0	2.5 c	3. 1	g G5	3.7 ; 9.4	5.7	3.5	β 7.0; Doo 5.7; Lv 7.5
—	41	Inn	1. 3	1.3 ?	6. 9	g K0	5.8 ; 9.3	3.5	0.5	Inn 4.0
819	56	H	53. 3	n ?	0. 8	K0	5.5 ; 11.2	5.7	1	β 5.4

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
836	* **462**	H	2.″8	1.0 m	—	d F0	6.0 ; 7.1	1.1	ph	See 2.4
—	74	Inn	20. 1	1.2 ?	2.″7	d A0	6.4 ; 11.8	5.4	0.5	Inn 6.4
61	77	β18	52. 3	n ?	2. 9	B8	4.9 ; 10.6	5.7	1	β 5.2
68	82	H	19. 5	1.0 c	7. 8	d B9	6.3 ; 9.8	3.5	2.5	β 2.5; Es 3.3
70	84	Σ	11. 2	1.0 c	10. 4	d F5	6.3 ; 10.5	4.2	ph	Σ 4.6; Δ 4.8
72	91	β36	1. 7	6.1 c	2. 8	d B9	5.8 ; 11.5	5.7	1	β 6.6
77	92	Σ	4. 0	1.0 c	39.	d F5	6.1 ; 7.3	1.2	14	Σ 1.6; Δ 1.0; Gla 1.6; Ol 0.9
82	93	H	38. 4	opt	75.	G5	5.3 ; 11.5	6.2	ph	β 6.7; Ho 8.0
”	”	”	65. 2	opt			··· ; 10.7	5.4	4	AC : β 5.0; Com 5.3; OΣ 5.0
87	99	β18	1. 0	1.1 c	3. 6	d A2	6.3 ; 8.0	1.7	6	β 1.8; Doo 1.8; Gla 1.5
928	**514**	H	4. 5	1.0 c	16. 8	d F0	5.4 ; 8.2	2.8	3	Ab 3.3; See 2.8 [Gla 1.2
41	26	Σ	1. 9	1.0 m	0. 1	d A2	6.5 ; 7.1	0.6	30	Σ 0.5 ; Cmb 0.5 ; Δ 0.8 ; OΣ 0.5 ;
”	”	”	20. 3	1.0 f			··· ; 9.3	2.8	10	AC: Σ 2.3; Cmb 2.5; Δ 2.7; OΣ 2.0; Gla 4.0
63	* 30	Σ	2. 5	1.0 c	1. 8	g F5	6.3 ; 7.1	0.8	27	Σ 1.2 ; Cmb 1.0 ; Δ 0.9 ; Gla 1.0
—	31	β.p.m.	184.	n c	18.	d F0	4.8 ; 6.2	1.4	···	
89	43	H	60.	opt	0. 9	K0	5.6 ; 12.9	7.3	1	β 6.7
93	* 45/46	Σ	8. 6	1.0 c	13. 8	d A0p	4.8 ; 4.9	0.1	ph	Σ 0.2; Δ 0.2; OΣ 0.0; Com 0.1; Gla 0.2
1008	56/57	Σ	177. 5	opt	0. 5	K0	5.8 ; 6.0	0.2	ph	Σ 0.0; Δ 0.0
”	”	Es	17. 9	n ?			··· ; 12.3	6.5	1	AC : Es 7.3
15	60	Σ	1. 2	1.0 m	26.	d G0	6.8 ; 7.0	0.2	42	Σ 0.0 ; Cmb 0.0 ; Com 0.8 ; β 0.0 ;
23	67	H	39.	opt ?	4. 9	A0	5.2 ; 10.1	4.9	1	β 4.3 [Lv 0.1
28	69	H	36. 6	1.0 c	9. 6	d A5	5.0 ; 7.5	2.5	ph	Δ 2.3; Fr 2.4; Σ 2.5
36	75	β18	1. 0	1.1 m	6. 1	d A3	4.8 ; 6.9	2.1	3.5	β 2.0; Com 3.1; OΣ 2.0; A 2.6
”	”	”	23. 6	8.0 c?			··· ; 13.0	8.2	1	AC : β 8.6
”	”	”	47. 0	n ?			··· ; 12.8	8.0	1	AD : β 8.0
40	79	Σ	5. 5	1.0 c	3. 5	d A3	6.3 ; 9.2	2.9	8	Σ 2.3; Δ 3.0; Gla 3.3
44	81	H	93. 5	opt	14. 0	F0	5.4 ; 9.5	4.1	5	Com 4.1
51	92	β15	5. 2	2.1 c	1. 8	g G5	5.3 ; 11.9	6.6	3.5	β 7.5; Doo 7.2; HΣ 6.7
53	87	H	61. 6	opt	8. 7	Mb	5.7 ; 9.8	4.1	1	β 3.6 [Gla 1.0
61	* 95/96	Σ	3. 6	1.0 c	4. 3	d A2p	4.3 ; 5.2	0.9	ph	Σ 1.1 ; Cmb 1.2 ; Δ 1.3 ; OΣ 1.0 ;
64	99	Σ	3. 7	1.3 c	2. 2	d A2	5.4 ; 10.2	4.8	7	Σ 6.0 ; Δ 5.2 ; Com 5.7 ; OΣ 4.5
70	* **603**	Σ	10. 3	1.0 c	7. 2	g Ko	2.3 ; ···	3.1	ph	AB: Σ 2.3; Cmb 3.6; Δ 3.7; OΣ 1.3 Gla 2.7 |OΣ 1.1; A 1.2|
”	04	OΣ	0. 3	1.0 m			5.4 ; 6.8	1.4	20	BC : Cmb 1.9 ; Δ 1.9 ; Com 1.2 ;
74	05	Σ	1. 9	1.0 m	11. 3	d F5	5.8 ; 7.8	2.0	10	Σ 2.2 ; Cmb 2.2 ; Δ 2.2; OΣ 2.5 ;
83	* 10	H	42. 7	1.5 c	8. 6	(g) G5	6.0 ; 9.4	3.4	1.5	β 3.1; Doo 2.4 [HΣ 3.5 ; A 2.0
98	15	Ho	1. 0	6.1 c	12. 6	d B8	6.0 ; 10.5	4.5	3.0	Ho 6.2; Doo 6.1; Lv 5.0
1116	23	H	89. 4	6.7 c	8. 4	d F0	5.1 ; 9.2	4.1	2.5	H 3.3; Gla 4.0
”	”	H	105. 2	3.3 c			··· ; 8.1	3.0	5	AC : Δ 2.6; Fr 2.5
22	27	β18	5. 6	2.1 f?	1. 3	s B3p	6.4 ; 12.5	6.1	1	β 6.6
25	* 28/29	Σ	16. 4	1.0 c	3. 0	d A0	6.0 ; 6.7	0.7	ph	Σ 0.5 ; Δ 0.7 ; Gla 0.7 ; Es 0.5
37	* 42	Σ	3. 6	1.0 c	8. 9	g G0	5.4 ; 7.0	1.6	ph	Σ 1.4 ; Cmb 1.3 ; Δ 1.4 ; Gla 2.2
41	45	OΣ	146. 5	opt	39.	K0	5.4 ; 10.4	5.0	ph	OΣ 4.4
44	47	Σ	1. 0	1.0 m	10. 0	d F0	6.4 ; 7.2	0.8	36	Σ 0.9 ; Δ 1.1 ; Com 0.8 ; HΣ 1.0;
49	50	Σ	15. 5	1.0 c	39.	d G0	5.9 ; 7.8	1.9	ph	Σ 1.8 ; Δ 1.8; OΣ 1.0 [A 0.8

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
1163	**654**	OΣ	102.″8	1.3 f	1.″5	s B1p	6.4 ; 7.2	0.8	ph	Δ 1.0
74	60	β	62. 5	opt	120.	G0	5.1 ; 13.5	8.4	1	β 8.5
98	75	H	57. 1	n ?	1. 2	A2	5.3 ; 11.5	6.2	1	β 6.0
1209	81	β18	74. 7	opt	24.	var. Md	(1.7); 12.5	(10.8)	1.5	β 11.3 ; Doo 10.5
„	„	H	114. 6	opt			… ; 8.8	(7.1)	1.5	AC : Doo 7.4; OΣ 7.5
„	„	A	1. 0	n. m			… ; 10.2	(8.5)	…	
17	85	β18	11. 5	3.7 f	0. 5	s A2p	5.2 ; 12.2	7.0	1	β 7.2
62	**707**	Σ	1. 8	1.1 m	1. 4	d A5p	4.7 ; 7.0	2.3	ph	Σ 2.9 ; Δ 2.5 ; Gla 2.2
„	„	„	7. 6	1.0 c			… ; 8.1	3.4	ph	AC : Σ 3.9 ; Δ 3.2 ; Gla 3.8
68	10	H	11. 2	1.0 c	7. 5	d A2	5.9 ; 9.2	3.3	1	β 3.0
85	25	β18	1. 5	1.3 c	2. 2	g Ko	6.3 ; 10.4	4.1	3	β 4.6 ; Doo 4.4
89	28	Σ	11. 8	1.0 c	10. 9	d F5	5.9 ; 10.3	4.4	.7	Σ 4.5 ; Δ 4.4 ; Com 3.9 ; Ab 4.2
96	30	H	25.±	n ?	9. 4	A2	6.6 ; 12.1	5.5	0.2	H 6.5
1318	46	H	15.±	0.7 ?	4. 6	d B9	6.3 ; 11.2	4.9	2.2	Es 4.5 ; H 5.0
20	48	Σ	16. 9	1.0 f	1. 0	g K0	5.9 ; 10.9	5.0	ph	Σ 5.0 ; Δ 4.6 ; β 3.8
22	49	H	10. 5	1.0 c	2. 9	d B9	5.0 ; 7.7	2.7	ph	H 1.5 ; See 2.9
—	53	…	150.	n c	232.	d K0	5.9 ; 11.5	5.6	…	
28	54	Σ	7. 7	1.1 c	4. 4	g G5	5.0 ; 9.7	4.7	ph	Σ 4.6 ; Δ 4.9 ; OΣ 3.5
32	* 64	Σ	38. 5	1.0 c	15. 3	d F5	6.6 ; 7.4	0.8	ph	Σ 1.0 ; Δ 1.4 ; OΣ 0.0 ; Fr 0.7
40	68	β6	20. 8	1.0 f	—	(d) F5	6.3 ; 10.3	4.0	6	Δ 4.2 ; Doo 3.5 ; β 3.7
64	82	Σ	28. 5	1.0 c	7. 9	d A2	5.4 ; 9.2	3.8	ph	Σ 2.9 ; Δ 4.1
76	87	Es	12. 7	n ?	8. 1	K0	6.1 ; 13.7	7.6	2	Es 9.0; β 8.0
84	92	β18	5. 8	1.1 f	1. 5	g G0	6.6 ; 11.5	4.9	2.5	β 5.0 ; Doo 5.9 ; HΣ 4.5
86	90	Σ	4. 8	1.0 c	25.	d F5	5.8 ; 9.3	3.5	8.5	Σ 3.2 ; Doo 2.5 ; Δ 3.8 ; OΣ 2.5 ;
90	93	β18	19. 1	8.0 c?	5. 6	d A0	5.7 ; 12.3	6.6	1.5	β 6.9 ; Doo 6.7 [Gla 3.3
93	99	Σ	15. 4	1.0 m	35.	d F8	4.2 ; 9.8	5.6	ph	Σ 5.8; Δ 5.6 ; OΣ 4.3
98	**803**	β6	2. 9	1.3 f	0. 3	(d) A2	6.4 ; 10.3	3.9	8	Δ 4.6; OΣ 3.5; Ho 4.5; Lv 4.4; Hl 4.0
1401	* 04	Σ	2. 6	1.0 m	21.	d A2	3.7 ; 6.2	2.5	ph	Σ 3.8 ; Cmb 3.0 ; Δ 3.7 ; Gla 4.0
18	20	β6	1. 5	1.1m?	—	d F2	6.5 ; 8.4	1.9	6.5	Δ 2.2 ; Doo 2.0 ; OΣ 1.5 ; HΣ 2.2
40	34	Σ	28. 4	1.0 c	3. 0	g K0	3.9 ; 8.7	4.8	ph	Σ 4.5; Δ 4.0
„	„	H	67. 0	n ?			… ; …	6.2	1	AC : β 6.0
„	„	„	3. 0	n ?			10.1 ; 10.6	6.7	1	AD : β 6.5 [Gla 3.0
48	36	Σ	3. 2	1.0 c	2. 2	d B5	5.4 ; 8.3	2.9	ph	Σ 3.5; Cmb 3.5 ; Δ 2.7 ; OΣ 2.5 ;
„	„	„	25. 2	2.0 c			… ; 11.2	5.8	ph	AC : Σ 5.3; Cmb 5.5 ; OΣ 4.5
50	38	OΣ	20. 8	opt	13. 1	B8	3.7 ; 11.0	7.3	ph	Δ 7.1 ; Com 8.4 ; OΣ 8.0
„	„	H	34. 4	opt			… ; 11.0	7.3	ph	AC : Δ 6.9 ; Com 7.3 ; OΣ 7.5
„	„	„	127. 5	opt			… ; 8.9	5.2	ph	AD : Δ 3.9 ; Com 5.2 ; OΣ 5.5
59	46	Σ	1. 4	1.0 m	0. 9	d B9	7·3 ; 7.3	0.0	34	AB—C : Σ 0.2 ; Δ 0.6 ; OΣ 0·5 ;
„	„	A	0. 2	2.1 m			… ; 8.5	1.2	2	AB : A 1.3 [Gla 0.1
62	44	β18	11. 5	3.7 c	14. 3	d G5	6.3 ; 12.7	6.4	1.5	β 6.8 ; Bd 5.3
„	„	H	48. 8	opt			… ; 11.5	5.2	1.5	AC : β 4.8 ; Bd 4.2
66	49	OΣ	6. 7	1.1 c	1. 4	g K0	6.5 ; 11.2	4.7	3	OΣ 4.1; Δ 4.7
67	50	See	47.	n ?	5. 4	K0	4.8 ; 14.6	9.8	0.5	See 10.9
68	* 54	Edg	50. 6	6.7 ?	0. 7	g G0	4.1 ; …	7.2	1	AB : β 7.0
„	„	β	4. 0	6.7 ?			11.3 ; 12.1	8.0	1	AC : β 8.0
71	55	β18	0. 2	1.3 m	10. 0	d F0	5.8 ; 6.4	0.6	14	β 0.8 ; A 0.5 ; * A 1.1
„	„	Σ	14. 0	1.0 c			… ; 9.3	3.5	ph	AC : Σ 3.0 ; β 3.7 ; OΣ 3.0
89	65	Σ rej.	25.	1.2 ?	0. 6	g K0	6.1 ; 11.5	5.4	1	β 5.5
93	81	Σ	4. 4	1.0 c	4. 2	g Ma	5.7 ; 9.2	3.5	5	Σ 3.2; Δ 3.5
1510	* 90/91	Σ	12. 1	1.0 c	4. 4	d B5	5.4 ; 6.8	1.4	ph	Σ 1.4 ; Δ 1.5 ; Gla 2.0
12	* 87/88	Σ	0. 5	1.1 m	1. 8	d A2	5.2 ; 5.6	0.4	48	Σ 0.3 ; Cmb 0.5 ; Δ 1.2 ; Gla 0.2 ;
21	**906**	Σ rej.	25.	0.6 ?	5. 0	d A2	6.0 ; 10.9	4.9	4	Σ 5.0 ; β 4.7 [Ho 0.2; Lv 0.3
44	* 15	H	58.	opt	1. 0	F5	3.1 ; 11.1	8.0	1	β 8.0

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
1549	**917**	β6	2.″7	1.1 c	4.″1	g G5	5.5; 9.2	3.7	9.5	Δ4.2; Doo 4.2; Cin 3.3; β4.2; W3.2; LM 3.0; T 4.5; Col 4.0; Cg 5.1
59	27/28	Σ	0. 7	1.0 c	1. 5	d B8	6.1; 6.2	0.1	30	Σ0.0; Δ0.0; Gla 0.2
"	"	"	5. 2	1.3 c			…; 10.6	4.5	5	AC: Σ4.8; Δ4.4
65	36	β18	59. 0	n?	0. 9	d B8	2.1; 12.6	10.5	1	β10.6
"	"	"	68. 0	n?			…; 12.4	10.3	1	AC: β10.4
"	"	"	81. 9	opt?			…; 10.3	8.2	2	AD: β8.4; Com 8.9
"	"	"	10. 8	1.0 ?			…; 11.9	9.8	1	AE: β10.4
—	41	Es	21. 8	n?	23.	g K0	4.0; 12.3	8.3	1	Es 9.5
1601	61	β36	1. 1	32. c	7. 8	d F0	5.5; 11.1	5.6	1.5	β6.8; A 6.5
"	"	"	10. 9	opt			…; 12.7	7.2	1.5	AC: β7.6; A 7.5
02	55	β6	22. 1	opt?	—	Ma	6.3; 11.3	5.0	3	β5.2; Doo 4.6
07	64	Es	10. 8	n?	0. 4	s Aop	5.9; 13.2	7.3	1	Es 8.2
08	62	H	5. 1	1.3 c	22.	d F8	5.1; 10.5	5.4	2.5	Δ6.0; A 5.0
12	63	H	5. 3	1.0 m	72.	d F8	4.0; 7.3	3.3	1.5	A 4.0; See 4.0
14	67	OΣ	0. 5	1.1 m	1. 8	d A2	6.9; 7.2	0.3	14	OΣ0.6; Δ0.3
27	76	Ho	30. 8	1.2 ?	—	s A2	6.3; 12.0	5.7	3.5	Ho 5.5; Doo 6.6
33	79	Σ	3. 2	1.0 f	—	(d) A0	6.8; 7.8	1.0	12	Σ1.3; Δ1.0; Gla 1.6
40	83	β6	0. 4	1.1m?	—	d B9	6.5; 7.1	0.6	28.5	Δ0.2; Doo 1.5; β0.8; A0.6; Cin 2.0; LM 1.8; T 1.0; Lv 1.3; Bry 1.5
50	92	Clark	0. 7	2.1 m	25. 5	d G5	5.7; 8.3	2.6	5	Da 4.0; β2.5; A 3.7; *A 3.1
59	94	See	0. 3	2.1 ?	—	(g) K0	5.2; 7.1	1.9	3	See 2.6; A 2.0
61	97	H	5. 8	1.0 c	12. 0	d F0	5.9; 9.2	3.3	2	Gla 3.4
73	**1003**	J	5. 4	2.1 c	6. 5	g Mb	4.0; 10.2	6.2	1	J 6.2; See 9.0
"	"	"	39. 9	n?			…; 10.3	6.3	1	AC: β6.1
86	19	Σ	3. 5	1.0 c	4. 4	d A0	5.7; 8.9	3.2	5	Σ3.5; Δ3.5
89	23	β36	0. 9	6.1m?	—	d G0	6.5; 11.3	4.8	1	β5.7
92	24	β18	2. 4	1.3 c	21.	d G0	6.3; 10.7	4.4	3	β5.4; Doo 4.6
12936	33	A	0. 3	2.1 m	—	d B8	6.8; 8.1	1.3	2	A 1.4
1703	35	Σ	2. 4	1.3 f	0. 3	s B9p	4.4; 8.5	4.1	ph	Σ4.3; Δ3.6; Ho 6.0
09	44	β36	0. 6	32. c	4. 4	d B5	4.7; 9.5	4.8	1	β5.7
11	46	Σ	15. 0	1.0 c	3. 5	d A2	5.0; 9.5	4.5	ph	Σ4.4; Δ4.0; Gla 4.3
15	47	OΣ	26. 1	2.0 c	9. 8	d B5	6.2; …	4.9	2	Δ4.8
"	"	A	4. 0	n?			11.1; 13.8	2.7	2.5	BC: A 3.0; β2.7
20	48	β18	1. 1	32. c	11. 1	g G5	6.1; 11.7	5.6	3.5	β7.0; Doo 6.4; Lv 7.0
32	68	Σ	20. 3	1.0 f	—	(d) A2	6.5; 8.1	1.6	10	Σ1.7; Δ1.5
33 *	65	Σ	11. 1	1.0 c	5. 1	d A0	6.5; 6.8	0.3	ph	Σ0.5; Cmb 0.5; Δ0.6; Gla 0.5
47	77	Σ	1. 5	1.0 m	—	d F5	6.8; 7.8	1.0	14	Σ1.0; Δ1.2; OΣ1.5; A 1.0
61	86	Σ	0. 6	1.0 m	3. 3	d A2	6.6; 6.8	0.2	27	Σ0.1; Δ1.2; β0.0; A 0.0
"	"	"	22. 4	opt			…; 9.6	3.0	ph	AC: Σ3.4; Δ3.8; Gla 3.3
87	99	Σ	6. 1	1.0 m	19. 3	d G0	6.2; 8.9	2.7	ph	Σ2.2; Δ1.8; OΣ1.0
1800	**1110**	H	39.	opt?	5. 9	G5	6.3; 12.0	5.7	1	β5.5
02	12	Webb	55. 6	opt?	0. 2	K0	6.1; 8.1	2.0	5.5	Kn 3.0; Es 1.0; β1.8
18	23	Σ	20. 0	1.0 f	1. 5	d B2	5.0; 9.9	4.9	ph	Σ5.3; Δ4.5
25	27	β36	4. 3	6.1 c?	2. 8	g K0	6.3; 13.5	7.2	1	β7.8
"	"	"	19. 3	opt			…; 13.2	6.9	1	AC: β7.1
34	31	β18	0. 8	6.1 m	2. 7	d B1	4.0; 7.8	3.8	1	β4.2
41	41	β36	6. 4	6.1 c?	3. 7	d B9	5.6; 13.2	7.6	1	β8.4
43	48	H	56.	opt	4. 7	A0	4.7; 12.2	7.5	1	β7.5
48	45	H	67.	opt	4. 9	B5	4.4; 10.0	5.6	ph	β4.2
59	53	H	64.	opt	3. 0	B3	5.4; 11.4	6.0	0.5	Cg 6.2
64	60	OΣ	6. 8	1.1 f	0. 5	(d) B8	5.9; 10.8	4.9	3	OΣ5.2; Δ4.9
65	61	S	57. 7	1.0 c	3. 9	d B9	6.5; 7.1	0.6	14	OΣ0.6; Δ0.8

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
1871	**1163**	Σ	3.″2	1.0 f	—	(d)B3	6.5; 8.8	2.3	5	Σ 2.5; Δ 2.6
86	74	Σ	8. 9	1.0 c	4.″2	d B3	5.0; 9.1	4.1	ph	Σ 5.1; Δ 4.9
87	* 78	Σ	0. 3	1.4 m	5. 4	d B8	3.9; 6.5	2.6	1	Σ 3.0 [*A. 0.3
1900	88	0Σ	0. 7	1.1 m	10. 7	d A3	5.9; 6.5	0.6	44	0Σ 0.3; Com 0.6; A 0.6; Lv 0.6;
21	**1203**	Σ	12. 4	1.0 f	2. 2	d B1	2.9; 9.3	6.4	ph	Σ 6.6; Δ 5.7; Ho 6.0
"	"	H	32. 6	n?			···; 11.2	8.3	1	AC: β 8.4
"	"	S	89. 3	opt			···; 9.7	6.8	1	AD: β 6.6
"	"	S	119. 5	n. f			···; 10.4	7.5	1	AE: β 7.3
24	02	H	8. 3	1.0 f	1. 2	d B8	5.5; 9.9	4.4	2.5	Δ 4.0; A 5.2
27	* 05	0Σ	1. 7	1.1 c	1. 7	g K0	5.3; 8.1	2.8	3.5	0Σ 3.1; Δ 2.9
33	10	S	75. 1	n. c	15. 8	F5p	5.5; 10.4	4.9	6	0Σ 4.8; Com 4.5
36	09	Ho	21. 7	opt?	4. 5	Bop	6.1; 11.9	5.8	1.5	Ho 6.3; Doo 5.3; Cg 6.5
39	* 11/12	Σ	6. 7	1.0 c	3. 5	g G5	4.9; 6.3	1.4	ph	Σ 2.0; Δ 1.6; Gla 2.0
50	* 20	Σ	8. 8	1.0 c	3. 9	d B1	3.0; 8.0	5.0	ph	Σ 5.2; Δ 5.0; Gla 5.2
52	* 30	Σ	0. 8	1.1 c	1. 6	g F8	5.7; 6.5	0.8	29	Σ 0.9; Δ 1.9; 0Σ 0.5; Gla 0.5
66	29	0Σ	1. 6	1.3 f	0. 6	(d)Ao	6.4; 9.5	3.1	5	0Σ 2.7; Δ 3.5
75	31	H	52.	opt	13. 0	K5	3.2; 12.0	8.8	2	β 10.0; Com 8.7
98	43	0Σ	11. 9	1.0 f	0. 6	d B8	5.7; 10.9	5.2	3	0Σ 6.0; Δ 4.7
2013	52	β18	25. 0	opt?	2. 3	F5	5.7; 12.6	6.9	1	β 7.1
14	60	Σ	17. 9	1.0 f	—	(d)B0	7.0; 7.0	0.0	ph	AB: Σ-0.1; Δ-0.2; Gla 0.0
"	"	"	48. 9	4.0 f			···; ···	3.2	2	BC: Σ 2.9
"	"	"	5. 4	4.0 f			10.2; 10.6	3.6	1	BD: Σ 3.4
"	"	"	22. 6	4.0 f			(10.2); 10.2	3.2	1	BE: Σ 2.9
40	79	Σ	3. 6	1.0 c	13. 5	d Fo	6.0; 8.5	2.5	6	Σ 2.8; Δ 2.7; 0Σ 2.0
43	80	0Σ	4. 4	1.1 c	2. 4	g Ko	6.2; 9.9	3.7	4.5	0Σ 3.1; Δ 3.6
73	**1303**	0Σ	15. 0	1.2 c	3. 0	g Go	4.3; 11.6	7.3	1	0Σ 7.5
"	"	H	91. 5	nc?			···; 10.1	5.8	0.2	AC: Sh 5.5
81	08	β40	7. 4	1.0 ?	11. 6	d A3	6.5; 13.1	6.6	1	β 7.2
"	"	"	55. 2	n?			···; 12.7	6.2	1	AC: β 6.0
[632]	09	A	0. 1	2.1 ?	0. 5	(d)Fo	5.9; 6.3	0.4	10	A 0.3
2084	11	β18	0. 8	1.3 c	3. 6	g G5	5.1; 7.6	2.5	10.5	β 3.0; Doo 3.0; Δ 2.5; HΣ 3.0;
"	"	"	32. 2	opt			···; 12.7	7.6	1	AC: β 7.6 [A 3.5; T 3.0
2102	* 18	Σ	6. 2	1.0 c	15. 7	g K0	5.2; 7.6	2.4	4.5	Σ 3.0; Δ 2.0; 0Σ 3.4
06	* 21/22	H	62. 5	1.0 c	16. 5	d G0	6.5; 7.1	0.6	ph	Δ 0.5
09	* 25	Σ	83. 4	6.7 c	400.	d G5	4.5; ···	5.2	ph	Σ 5.1; 0Σ 4.7; Ab 5.5; A 5.0
"	"	0Σ	3. 9	6.7 m			9.7; 11.0	1.3	9	BC: 0Σ 1.7; Com 1.8; Ab 2.0; A 1.0; Ol 1.2; *A 1.4
30	48	H	56. 8	opt	8. 6	K0	5.1; 8.5	3.4	ph	0Σ 2.5; Δ 3.0; Σ 3.4; Fr. 2.7
—	52	Es	32. 1	n?	—	(d)A0	6.2; 10.2	4.0	1	Es 2.8
46	71	0Σ	0. 5	1.1 m	3. 6	d B9	6.4; 7.0	0.6	14	0Σ 0.5; Δ 0.9
47	69	Σ	19. 3	1.0 c	4. 2	d B9	5.5; 8.3	2.8	ph	Σ 2.1; Δ 2.2; Gla 3.0 [T 3.7
49	* 70	β6	2. 0	1.1 f	1. 2	g K5	6.2; 9.2	3.0	10.5	Δ 3.1; Doo 3.4; β 3.9; 0Σ 2.5; HΣ 2.8;
50	* 66	Ho	32. 9	6.7 c	13. 1	(g)K2	6.1; 12.2	6.1	1.5	Ho 7.0; Doo 6.7; A 6.5
59	74	β6	0. 7	1.1 c	6. 2	d F0	6.3; 6.9	0.6	22	β 0.0; A 0.5; See 0.9
"	"	H	36.	n?			···; 11.2	4.9	1	AC: β 4.4
"	"	"	45.	1.1 c			···; 8.1	1.8	3	AD: β 1.4
62	78	Σ	28. 8	1.0 c	2. 9	d B8	6.3; 8.3	2.0	10	Σ 1.8; Δ 2.0; Gla 2.0
63	79	0Σ	4. 4	1.1 c	9. 3	d F5	5.8; 9.5	3.7	5	0Σ 2.8; Δ 3.7
72	81	Hu	0. 2	1.3 m	2. 8	d A2	5.8; 5.8	0.0	12	Hu 0.0; *A 0.0
77	* 87	Σ	339.	nc	11. 2	A3	4.4; 5.4	1.0	ph	Σ 1.0; Δ 1.1
83	89	H	77. 0	6.7 c	10.	d A2	4.2; 9.2	5.0	1.5	β 5.0; A 5.0
97	**1401**	H	39. 6	opt	9. 3	A5	6.0; 12.1	6.1	0.2	H 7.0

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
2207	**1402**	β36	0.″5	2.1 m	--	d B8	5.9 ; 8.7	2.8	5.5	β 2.9 ; Doo 3.2 ; A 3.8
10	06	Σ	14. 2	1.0 c	2.″9	d F5	6.5 ; 8.2	1.7	ph	Σ 2.0 ; Δ 1.6; Gla 2.0
12	* 11/12	Σ	337.	n c	10. 8	F0	3.6 ; 4.0	0.4	ph	Σ 0.3 ; Δ 0.3 ; Gla 0.3
13	10	β6	1. 0	1.0 m	—	d A2	6.7 ; 7.1	0.4	37	Cin 0.4: Doo 0.4; Lv 0.1; See 0.6; [Cg 0.0
20	17	Σ	10. 1	1.0 f	0. 8	d B1	5.8 ; 6.8	1.0	ph	Σ 1.1 ; Δ 1.2 ; Gla 1.2
29	24	Σ	8. 9	1.0 f	—	(d) B8	6.8 ; 7.2	0.4	ph	Σ 0.2 ; Δ 0.4 ; Gla 0.6
30	22	Σ	1. 7	1.1 m	10. 7	d F0	5.8 ; 8.1	2.3	7.5	Σ 2.5 ; Δ 2.3 ; OΣ 3.5 ; *A 3.3
44	38	Σ rej	29.	0.7 ?	6. 1	d A2	6.2 ; 9.3	3.1	1.5	Σ 3.0; β 2.7
48	41	H	124.	n ?	—	d B9	5.9 ; 9.9	4.0	1	β 3.5
50	42	Σ	3. 0	1.0 c	4. 7	d B8	7.0 ; 7.1	0.1	40	Σ 0.0 ; Cmb 0.3 ; Δ 0.2 ; Gla 0.1
51	45	H	25.	0.6 ?	2. 2	d B9	5.7 ; 10.8	5.1	1	β 4.9
„	„	„	50.	n ?			… ; 11.9	6.2	1	AC : β 6.0
66	57	β18	30. 4	2.5 c	20.	g K5	1.1 ; 13.0	11.9	1	β 12.5
„	„	Σ	109.	opt			… ; …	9.5	ph	AC : Σ 10.2
„	„	β36	2. 3	opt			10.6 ; 13.6	12.5	1	AD : β 12.6
67	58	H	69. 4	1.3 c	6. 6	d A3	4.4 ; 7.7	3.3	ph	Δ 3.8 [Cg 3.5
68	49	β18	1. 4	2.1 m	1. 2	d B9	5.7 ; 9.7	4.0	5.5	β 4.8; Doo 4.2; A 5.3; Cin 4.5; T 4.5;
69	60	Σ	12. 7	1.0 f	0. 4	d A0	6.7 ; 7.7	1.0	ph	Σ 1.0; Δ 1.0 ; Gla 0.6
77	62	Σ	17. 8	2.0 c	3. 4	d B9	6.3 ; 11.2	4.9	5	Σ 4.7 ; Δ 5.0
79	66	β40	0. 2	6.1 m	11. 2	d F0	5.7 ; 7.4	1.7	2.5	β 2.0 ; *A 2.0
„	„	Σ	1. 5	1.1 m			… ; 7.6	1.9	4	AC : Σ 2.4 ; *A 2.0
„	„	β	23. 6	opt			… ; 13.5	7.8	1	AD : β 8.2
80	67	β36	3. 9	2.1 c?	2. 1	g K0	5.3 ; 11.3	6.0	1	β 7.0
84	70	Σ	3. 1	1.0 m	—	d F0	7.2 ; 7.3	0.1	40	Σ 0.0 ; Δ 0.2 ; HΣ 0.0 ; Gla 0.2
87	74	β6	32. 3	opt	6. 7	A5	5.3 ; 11.4	6.1	1.5	β 6.0 ; Doo 5.8
13009	86	A	0. 4	1.1m?	—	d A3	7.3 ; 7.3	0.0	10	A 0.0
2304	90	H	43.	n c ?	6. 0	A0	5.7 ; 10.7	5.0	3	β 4.9 ; Doo 4.4
13	97	S	62. 8	1.0 f	2. 3	d B5	4.3 ; 7.1	2.8	ph	Δ 2.2 ; Fr 2.7
30	* 1505/06	Σ	9. 1	1.0 c	3. 3	(F5)	6.7 ; 6.8	0.1	ph	Σ 0.5 ; Δ 0.4; Gla 0.3
68	37	H	30. 7	opt	1. 8	G5	6.3 ; …	5.3	1.5	β 5.4 ; Doo 5.0
„	„	β18	6. 2	opt?			11.6 ; 13.7	7.4	1	AC : β7.2
86	55	β36	12. 8	2.2 ?	0. 7	d A0	5.6 ; 12.4	6.8	1	β 7.0
2406	68	Δ	1. 2	1.3 m	1. 8	d A2	4.5 ; 7.6	3.1	4.5	Δ 3.3; A 5.5
„	„	Σ	25. 6	1.0 c			… ; 10.4	5.9	ph	AC : Σ 7.0 ; β 4.7
25	89	OΣ	0. 4	1.1m?	2. 8	d A2	6.6 ; 6.9	0.3	12	OΣ 1.4 ; Δ 0.0
26	80	β18	28. 5	opt	10.	K0	4.3 ; 11.5	7.2	1	β 7.4
32	82	H	66.	n f	1. 0	B9	5.5 ; 9.0	3.5	…	(B. D.)
33	86	β36	6. 3	2.1 c	2. 5	g K0	6.0 ; 12.4	6.4	1	β 6.9
35	92	Σ	6. 4	1.0 m	11. 6	d A0	5.1 ; 7.8	2.7	ph	Σ 3.9 ; Δ 2.5
13022	93	Hu	5. 4	1.1 ?	17.	d F5	6.1 ; 11.0	4.9	0.5	Hu 5.5
2445	99	OΣ	2. 7	1.1 m	1. 8	d F5	6.0 ; 9.5	3.5	9.5	OΣ 3.7 ; Δ 3.9 ; Com 4.1
47	96	H	21.	n f ?	—	A0	6.4 ; 11.3	4.9	1.5	β 4.5 ; A 5.7
48	95	H	38. 8	1.0 f	0. 4	d B3	5.9 ; 7.5	1.6	5	Δ 1.5
„	„	„	54.	n f			… ; 10.2	4.3	4	AC : Δ 3.8
55	**1603**	S	79. 8	opt?	1· 3	G0p	4.2 ; 7.8	3.6	4	Δ 3.2
59	05	β18	29. 3	1.6 f?	1. 4	s F5p	3.0 ; 13.2	10.2	1	β 10.8
„	„	„	42. 9	1.0 f?			… ; 11.4	8.4	1	AC : β 8.5
„	„	„	46. 3	1.0 f?			… ; 11.7	8.7	1	AD : β 8.8

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem	μ	Sp.	Magn.	Δm	W	Estimates
2460	**1604**	β6	0.″4	1.1 c	23.″	d F2	6.0 ; 6.6	0.6	15	Δ 0.3 ; β 1.8 ; Cin 1.0
„	„	„	54. 4	opt			… ; 8.0	2.0	3	AC : β 1.6
67	* 09/10	Σ	21. 3	1.0 f	—	(d) A0	6.6 ; 6.9	0.3	ph	Σ 0.7 ; Δ 1.0 ; Gla 0.3
80	* 22/23	Σ	181.	n f	0. 8	B3p	5.4 ; 6.2	0.8	ph	Σ 1.0 ; Δ 1.0 ; Gla 0.6
81 ⎫	19	Σ	14. 0	1.0 f	—	(d) B8	6.5 ; …	1.4	10	Σ 1.2 ; Δ 1.4 (A—BC)
[761] ⎭	„	A	0. 5	1.0 f			7.9 ; 10.1	2.2	2	BC : A 3.0
—	30	Es	7. 7	1.0 ?	—	g G5	6.3 ; 10.3	4.0	2	Es 3.7
„	„	„	26. 9	0.6 ?			… ; 11.4	5.1	2	Es 4.7
95	37	β36	6. 2	2.1 c	17. 8	d F0	5.0 ; 11.8	6.8	1	β 7.4
„	„	H	89. 8	6.7 c			… ; 9.4	4.4	6.5	AC : β 3.4; Com 4.3; Eng 4.6
2509	42	OΣ	0. 5	1.1 m	5. 4	d A2	7.0 ; 7.6	0.6	34	OΣ 0.6 ; Δ 0.7; HΣ 0.5 ; Gla 0.4
13037	50	Hu	1. 5	1.3 ?	0. 8	d B9	6.4 ; 9.6	3.2	2.5	Hu 4.5 ; A 3.9
2528	60	S	110.	opt?	—	B3p	6.0 ; 9.2	3.2	0.5	S 3.0
30	57	Σ rej	52. 5	opt?	1. 2	B9	5.2 ; 9.2	4.0	1	β 3.5
31	59	Edg.	12. 9	2.2 ?	1. 1	d B3	5.5 ; 12.1	6.6	1	β 6.8
„	„	H	34. 9	opt?			… ; 9.0	3.5	1	AC : β 3.0 | HΣ 0.5; Gla 0.3; A 0.8 |
35 *	64	OΣ	1. 1	1.0 m	6. 6	d F0p	5.9 ; 6.5	0.6	45	OΣ 0.8 ; Doo 0.8; Δ 1.1 ; Com 1.9;
43	69	Σ	1. 6	1.0 f	—	(d) B2	6.8 ; 7.1	0.3	30	Σ 0.3 ; Δ 0.6 ; Gla 0.3
44	70	Σ	11. 7	1.0 c	7. 2	d A3	6.1 ; …	2.6	4.5	Σ 2.5 ; β 2.4 ; A 2.7
„	„	β36	0. 4	1.0 m			8.7 ; 9.3	0.6	14	BC : β 0.2 ; Lv 1.0 ; A 0.5
46	71	Σ	21. 5	opt	1. 4	B8	5.8 ; 8.0	2.2	8	Σ 1.7 ; Δ 2.7
48	86	Σ	34. 0	opt	17.	F8	5.2 ; 8.8	3.6	ph	Σ 3.4 ; Δ 3.5 ; Com 4.5 ; A 3.3
71	90	Hu	0. 1	2.1 m	—	d B9	7.1 ; 7.7	0.6	12	Hu 0.5 ; * A 0.5
73 *	91	Σ	1. 7	1.0 f	—	g F5	6.3 ; 7.9	1.6	8	Σ 1.5 ; Δ 2.1
81	96	Σ	12. 8	1.0 c	3. 2	d B8	4.5 ; 9.5	5.0	ph	Σ 6.3 ; Δ 5.5 ; A 7.0
84	98	Σ	7. 0	1.0 f	1. 5	g K0	4.7 ; 8.5	3.8	ph	Σ 3.8 ; Δ 3.7 ; Gla 3.5
88	***1701**	OΣ	0. 6	1.1 m	—	d A2	6.8 ; 7.2	0.4	14	OΣ 0.2 ; Δ 0.7
„	„	Hl	6. 7	1.3 f			… ; 12.2	5.4	0.5	AC : Hl 6.5
91	06	Σ	14. 6	1·0 c	1. 6	d A2	5.2 ; 8.1	2.9	ph	Σ 2.2 ; Cmb 3.0 ; Δ 2.7 ; Gla 2.1
„	„	„	12. 5	opt			… ; 10.9	5.7	5	AC : Σ 6.0 ; Δ 5.9
94	05	Σ	3. 0	1.0 f	2. 1	d B8	4.6 ; 7.2	2.6	ph	Σ 2.9 ; Δ 2.8
97	08	Bar	46. 6	n ?	46.	G0	0.2 ; 14.2	14.0	1	Bar. 15.0
„	„	β	78. 1	n ?			… ; 13.9	13.7	1	AC : β 13.8
„	„	β	126. 2	n ?			… ; 12.4	12.2	1	AD : β 12.3
„	„	Furuhjelm	720.	n c			… ; 9.8	9.6	…	
2605	13	Σ	9. 1	1.0 f	0. 2	s B8p	0.3 ; …	7.1	ph	β 7.3 ; Σ 7.7 ; Com 8.6 : Gla 7.4
„	„	β18	0. 3	1.0 m			7.4 ; 7.6	7.3	12	BC : β 0.9 ; A 0.0
„	„	β18	44. 4	1.4 f			(0.3); 12.4	12.1	1	AD : β 12.2
23	26	OΣ	4. 4	1.3 c	17. 0	g K0	4.8 ; 10.0	5.2	3.5	OΣ 5.8 ; Δ 5.4 ; A 6.3
27	29	β	29. 1	opt	86.	G0	4.9 ; 12.8	7.9	1	β 8.3
„	„	„	40. 4	opt			… ; 11.9	7.0	2	AC : β 7.0; Com 7.5
„	„	Σ	104.	opt			… ; 9.7	4.8	ph	AD : Σ 3.5 ; Δ 4.7
35 *	34	Ho	3. 9	1.3 opt?	—	d A5	6.5 ; 11.4	4.9	1	Ho 5.3 ; Doo 6.0
37 *	36	Σ	23. 4	1.0 f	0. 7	g F0	6.6 ; 9.1	2.5	5	Σ 2.0 ; Δ 2.5
39	35	H	36.	1.0 f	1. 8	d B5	3.7 ; …	7.2	1	β 7.0
„	„	β18	3. 7	1.0 f			10.9 ; 11.3	7.6	1	AC : β 7.6
„	„	H	36.	1.0 f			(3.7); 10.6	6.9	1	AD : β 6.7
44	41	Σ	8. 7	1.0 c	4. 9	g K0	6.2 ; 10.2	4.0	5	Σ 3.9 ; Δ 3.8

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
2660	**1747**	See	28."9	opt	39."	G0	5.9; 12.5	6.6	0.5	See 7.8
66 *	53/54	S	39. 7	1.0 ?	—	(d) B8	6.2; 6.3	0.1	ph	β 0.1
70	59	β6	4. 2	1.1 f	—	(d) B9	6.3; 10.3	4.0	6.5	Δ 4.7; Doo 3.4; β 3.3; Bd 3.8
77	62	H	4. 1	1.3m?	2. 0	d A0	4.7; 9.6	4.9	0.2	H 5.0
81	64	H	32.	n ?	1. 2	B3	5.7; 11.9	6.2	1	β 6.0
"	"	"	38.	opt?			...; 11.4	5.7	1	AC: β 5.2
90	73	β18	7. 9	1.3 c	2. 7	g K5	5.2; 11.3	6.1	1	β 6.6
"	"	β40	27. 2	8.0 c			...; ...	7.8	1	AC: β 8.2
"	"	"	4. 4	n c			13.0; 14.6	9.4	1	AD: β 10.0
92	70	Σ	31. 7	1.0 f	0. 7	d B3	5.1; 7.2	2.1	ph	Σ 2.0; Δ 1.2; Gla 2.1
95 *	71	H	3. 3	1.0 c	3. 0	g G0	5.5; 6.7	1.2	ph	See 2.3
"	"	"	58. 8	n ?			...; 9.6	4.1	...	(B.D.)
99 *	79	Σ	31. 1	1.0 f	—	(g) K0	6.5; 8.0	1.5	10	Σ 1.5; Δ 1.5
2703	80	S	61. 7	opt	25.	G0	5.1; 8.5	3.4	ph	OΣ 2.0; Σ 3.0
05	78	Σ	5. 9	1.0 f	—	d A0	6.1; 7.7	1.6	12	Σ 1.8; Δ 1.5; Gla 1.2
06 }	82	Wn	1. 6	1.0 m	8. 8	d F5	6.8; ...	0.8	14	OΣ 0.3; A 0.1 (A—BC)
13055 }	"	A	0. 2	1.0 m			7.6; 7.6	0.8		BC: A 0.1
2712	88	Da	0. 9	1.0 f	0. 6	s B1	3.7; 5.1	1.4	9	Da 1.0; Δ 2.0; OΣ 1.0; A 2.2; *A 1.2
"	"	H	111.	1.0 ?			...; 8.7	5.0	0.2	AC: H 6.0
13059	**1800**	A	0. 2	1.3 ?	—	d B9	6.8; 7.4	0.6	10	A 0.6
2729	08	OΣ	10. 1	1.0 f	1. 6	d B3	5.3; 10.4	5.1	3	OΣ 4.8; Δ 5.0
34	10	H	38.	opt?	1. 8	d B3	4.8; 11.2	6.4	1.5	β 6.4; Doo 6.1
"	"	"	59.	6.7 f			...; 11.1	6.3	1.5	AC: β 6.5; Doo 5.6
"	"	"	74.	n ?			...; 11.4	6.6	1.5	AD: β 6.4; Doo 6.8
35	11	Kn	2. 7	1.1 c	1. 4	d B2	4.7; 8.4	3.7	7	Doo 4.6; Δ 3.7; A 4.5
39	12	H	28. 7	opt	3. 0	F5	6.1; 7.6	1.5	2	Cin 1.5
51 *	21	Σ	4. 8	1.0 c	3. 9	d A0	5.9; 6.7	0.8	ph	Σ 0.8; Cmb 1.0; Δ 1.4; Gla 1.0
57	25	OΣ	75. 0	opt?	3. 6	K0	6.8; 8.2	1.4	ph	Δ 1.0; Σ 1.1
66	26	Da	0. 8	1.0 f	—	(d) B9	6.8; 7.0	0.2	12	Da 0.3; Δ 0.3
69	29	β6	2. 8	1.4 c	9. 4	g G0	3.0; 9.5	6.5	3	Δ 8.0; A 7.5; See 7.5
"	"	H	65. 5	n ?			...; 11.4	8.4	1	AC: β 8.5
75	34	Σ	12. 7	1.0 c	2. 9	g K5	5.0; 10.1	5.1	6	Σ 5.2; Δ 5.1; Com 5.8 [A1.8
80	39	Σ	1. 0	1.0 m	3. 8	d B3	4.7; 5.8	1.1	23	Σ 1.5; Cmb 2.2; Δ 0.8; β 1.3; HΣ 1.0;
83	42	Σ	1. 8	1.0 c	0. 9	d B3	5.9; 7.0	1.1	22	Σ 1.3; Cmb 1.5; Δ 1.0; Gla 1.0
89	47	Σ	9. 8	1.0 f	0. 9	d B9	6.0; 6.4	0.4	ph	Σ 0.5; Δ 0.9; Gla 0.3
96 *	51/52	β18	33. 2	opt	0. 3	s B0	2.5; 13.9	11.4	1	β 11.5
"	"	Σ	52. 7	1.0 f			..; 6.9	4.4	ph	AC: Σ 4.8; Gla 5.0
13067	57	Hu	1. 3	1.3 ?	6. 9	d B9	6.1; 9.6	3.5	0.5	Hu 4.0
2804	61	β36	2. 2	1.3 m	2. 8	d B2	5.3; 9.4	4.1	2.5	β 4.5; Doo 5.3; A 4.8
13	65	H	36.	1.0opt?	0. 3	s F0	2.7; 10.2	7.5	0.2	H 8.5
18	73	H	27. 5	0.6 ?	—	(d) B3	6.2; 10.1	3.9	1	β 3.6
21 *	79/80	Σ	4. 2	1.0 c	1. 1	s Oe5	3.7; 5.6	1.9	ph	Σ 2.0; Cmb 2.0; Δ 2.0; Gla 2.0
"	"	"	28. 1	1.0 f			..; 10.9	7.2	ph	AC: Se 7.0
25	83	OΣ	3. 0	1.1 c	2. 5	d B8	5.6; 9.5	3.9	3	OΣ 4.2; Δ 4.3
33	87/88	Σ	35. 8	1.0 f	0. 7	d B1	4.7; 5.6	0.9	ph	Σ 0.9; Δ 0.9
37 *	93	Σ	θ' Orionis withim 30".	1.0 f	0. 5	s Oe5			ph	
"	94						C = 5.4	...		
"	95						D = 6.8	...		
"	96						B = 7.9	...		
"	"						A = 6.8	...		
							E = 11.2	...		EC: Σ 6.6; Δ 5.5
							F = 10.3	...		CF: Σ 6.1; Δ 5.9

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
2839	***1897**	Σ	52.″7	1.0	2.″0	d B1	5.4; 6.8	1.4	ph	Σ 1.3; Δ 2.0; Gla 1.2
41	92	Da	2. 0	1.3	0. 3	d B3	4.7; 8.2	3.5	8.5	Da 4.0; Δ 3.7; Lv 4.0
42	98	Σ	4. 2	1.0	—	(d) B5	6.5; 8.2	1.7	10	Σ 2.0; Doo 1.8; Δ 1.5; Gla 1.7
43	* 99	Σ	11. 3	1.0	0. 5	s Oe5	2.9; 7.3	4.4	ph	Σ 4.1; Cmb 4.0; Δ 4.0
45	**1902**	Σ	0. 6	1.0 m	3. 3	d B8	6.3; 6.5	0.2	34	Σ 0.1; Δ 0.6; OΣ 0.5; Gla 0.1
49	01	Hn	18. 9	n ?	0. 8	(d) F0	5.3; 12.7	7.4	0.5	Hn 8.5
"	"	"	19. 0	1.2 ?			…; 11.4	6.1	1	AC: β 6.2
54	11	Σ	5. 1	1.0 c	2. 4	d B3	5.7; 8.8	3.1	5	Σ 3.2; Δ 3.0
57	14	β36	0. 1	2.1 m	1. 6	d A2	6.1; 6.5	0.4	12	β 0.4; A 0.3
"	"	Σ	12. 3	1.0 f			…; 8.6	2.5	ph	AC: Σ 1.7; OΣ 1.3; Δ 1.6
"	.	β6	31. 4	opt			…; 11.0	4.9	6	AD: β 5.9; Com 4.8
—	* 25	β.p.m.	97.	0.0 c	53.	d K0	6.4; 9.5	3.1	1.5	β 2.9; Lau 2.7
83	* 31/32	β12	0. 2	2.1 m	0. 1	d B0	4.3; 5.1	0.8	15	β 1.5; A 0.4; * A 2.0
"	"	Σ	11. 0	1.0 f			…; 9.2	4.9	ph	AC: Σ 5.9; Δ 5.3
"	"	Σ	12. 8	1.0 f			…; 6.9	2.6	ph	AD: Σ 3.1; Δ 2.6
"	"	"	41. 6	1.0 f			…; 6.7	2.4	ph	AE: Δ 2.1
87	45	Σ	25. 8	1.0 c	4. 9	d A	6.7; 7.4	0.7	ph	Σ 0.5; Δ 1.0
89	44	β6	0. 6	1.1 f?	3. 0	d B9	6.6; 7.4	0.8	10	Δ 1.5; Doo 0.3
"	"	H	89.	1.6 f?			…; …	2.4	6	AC: Δ 2.5; Doo 1.7; Gla 2.0
"	"	β6	1. 2	1.6 f?			9.0; 9.6	3.0	5.5	AD: Δ 2.9; Doo 2.2; Gla 2.4
"	"	H	76. 2	0.6 ?			(6.6); 7.3	0.7	15	AE: Δ 1.2; Gla 0.6
"	"	H	126.	1.6 ?			…; 8.5	1.9	5	AF: Δ 1.7
"	"	β	60. 3	n ?			…; 10.3	3.7	1	AG: β 3.2
"	"	β	41. 7	n ?			…; 13.0	6.4	1	AH: β 6.2
96	46	β12	0. 2	1.3 m	3. 1	d B3	5.5; 5.8	0.3	22	β 0.2; A 0·6; * A 0.0
2902	* 48/49	Σ	2. 5	1.0 f	1. 0	s B0	2.0; 4.2	2.2	ph	Σ 3.7; Cmb 2.5; Δ 3.4; Gla 3.3
"	"	H	60.	1.0 f?			…; 9.9	7.9	ph	AC: H 8.0
13	59	β36	0. 6	1.1 f	—	(d) F0	6.7; 7.8	1.1	5	β 1.0; A 1.3
28	67	A	0. 1	6.1 m	—	d F5	6.4; 7.3	0.9	10	A 0.9
"	"	"	99. 0	n ?			…; …	3.0	2	AC: A 3.1
"	"	"	1. 0	n ?			9.4; 12.6	6.2	0.5	AD: A 6.6
43	78	Σrej	17. 5	0.7 ?	—	(d) F0	6.2: 9.5	3.3	1	β 3.0
48	* 82/83	S	93. 8	1.0 c	44.	d F8	3.8; 6.3	2.5	ph	
57	86	Σ	6. 8	1.0 c	9. 0	g K0	6.5; 9.0	2.5	5	Σ 2.3; Δ 2.5
—	87	Jk.	16. 1	0.6 ?	7. 0	g G5	5.9; 10.9	5.0	0.5	Jk 6.0
59	92	H	25. 0	0.6opt?	0. 7	d A2	6.4; 10.1	3.7	3	β 3.3; Es 3.4
68	95	β6	38. 9	opt	3. 7	K0	4.6; 11.8	7.2	1.5	β 7.0; Doo 7.5
"	"	H	47. 8	opt			…; 11.6	7.0	1.5	AC: β 7.0; Doo 6.8
69	93	H	17. 9	8.0 c?	2. 2	d B5	5.2; 12.1	6.9	1.5	β 7.4; Doo 7.0
"	"	"	25. 0	opt?			…; 11.8	6.6	1.5	AC: β 7.2; Doo 6.3
72	97	OΣ	0. 5	1.3 c	2. 6	d B9	6.2; 7.7	1.5	9	OΣ 1.5; Δ 1.8; β 0.8
"	"	"	75. 5	0.6 f?			…; 7.6	1.4	11	AC: OΣ 1.0; Δ 1.5; β 0.3; Fr 1.5
76	* 99	Σ	1. 7	1.0 m	2. 4	d A3	6.0; 6.1	0.1	30	Σ 0.0; Δ 0.4; Gla 0.1
—	**2018**	Es	15. 0	0.7 ?	—	g Ma	6.4; 11.3	4.9	1	Es 5.6
3008	21	β6	2. 7	1.0 c	5. 4	g G5	5.6; 8.3	2.7	11	Δ 3.4; Doo 3.0; Cin 2.5; β 2.0; Lv 2.4; T 3.5; J 2.4; Cg 2.5

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
3022	**2034**	β36	15."0	0.7 ?	2."2	d A0	4.5 ; 10.4	5.9	1	β 6.0
30	37	β	43. 4	n ?	1. 1	K0	5.0 ; 13.4	8.4	1	β 8.5
48	61	β	39. 8	n ?	3. 0	Ma	0.9 ; 14.3	13.4	1	β 13.5
"	"	"	62.	n ?			··· ; 14.0	13.1	1	AC: β 13.2
"	"	"	77.	opt			··· ; 13.3	12.4	1	AD: β 12.5
53	67	S	39. 9	opt	60.	G5	6.5 ; 8.2	1.7	ph	β 1.0; OΣ 1.2
"	"	"	28. 0	opt			··· ; 11.2	4.7	2	AC: β 4.0; Com 5.1
73	96	β36	1. 6	2.1 c	5. 1	g G5	6.5 ; 10.8	4.3	3	β 4.8; Doo 4.7
"	"	H	33. 3	1.5 c			··· ; 9.5	3.0	1	AC: β 2.5; Doo 2.4
74	95	OΣ	2. 1	1.0 m	10. 5	d Aop	2.7 ; 6.6	3.9	5	OΣ 4.8; Δ 4.6; A 4.5; Ho 4.0
"	"	H	35. 3	opt			··· ; 10.5	7.8	ph	AC: Σ 8.0; Ho 6.0
"	"	H	125. 0	opt			··· ; 10.1	7.4	ph	AD: Σ 6.5
78 *	99	OΣ	0. 5	1.3 m	3. 6	g G5	5.9 ; 7.8	1.9	2	OΣ 1.8
79	**2100**	H	37. 2	4.0 f	1. 3	d A5	6.1 ; 10.2	4.1	1	β 3.6
89	11	Ho	9. 8	opt	3. 0	B8p	6.1 ; 11.9	5.8	1	Ho 6.4; Doo 5.7
99	23	H	39. 4	1.1 c	4. 7	d A5	6.3 ; ···	2.5	3	Δ 2.3
"	"	Hu	0. 5	1.1 c			8.8 ; 9.7	3.4	1	BC: Hu 1.0
3111 }	24	β36	16. 8	opt	3. 5	d A2	4.4 ; 13.5	9.1	1.5	AC—B: β 10.1; A 10.0
[1070] }	"	A	0. 3	2.1 ?			··· ; 6.2	1.8	1	AC: A 2.3
16	28	β6	1. 8	1.3 f	0. 6	d B8	5.0 ; 8.4	3.4	15	Kn 4.5; Doo 3.5; Δ 3.7; Cin 3.0; T 3.5; Lv 4.0; Cg 4.0; β 4.0
21	37	β18	17. 6	n ?	—	F8	6.4 ; 12.6	6.2	1	β 6.3
32	40	See	21. 3	n ?	10. 4	G5	5.2 ; 12.8	7.6	0.5	See 9.0
33	46	OΣ	9. 8	1.2 c	2. 7	g Ma	6.3 ; 11.3	5.0	2.5	OΣ 3.7; Δ 5.2
70	63	H	44.	n ?	2. 2	A2	5.5 ; 10.7	5.2	1	β 4.7
81 *	75/76	Σ	8. 0	1.0 c	6. 6	d A0	6.1 ; 6.8	0.7	ph	Σ 1.2; Δ 0.8
82	73	β36	0. 5	6.1 c?	2. 0	d B1	5.8 ; 9.2	3.4	2	β 4.1; A 4.0
"	"	"	18. 3	n ?			··· ; 14.0	8.2	1	AC: β 8.6
85 *	74	Σ	29. 2	1.0 c	2. 7	d A0	5.9 ; 7.0	1.1	ph	Σ 1.0; Δ 1.0; Gla 1.0
3206	93	H	85. 5	n ?	1. 5	B9	5.7 ; 9.1	3.4	0.5	β 2.9
20	**2202**	Clark	1. 1	1.1 f	—	(d) B9	6.2 ; 8.1	1.9	7	Da 2.5; Δ 2.1; β 1.5
38	17	Σ	11. 0	1.0 c	4. 6	d F0	6.9 ; 7.5	0.6	ph	Σ 1.0; Δ 0.8; Gla 0.8
39	16	β12	0. 9	1.4 c	6. 5	g Ma	3.2 ; 8.1	4.9	2	β 6.6; Doo 5.5; Ho 6.0
41	20	H	32. 0	opt	22.	F5	5.2 ; 10.9	5.7	1	Com 5.6
48	24	β18	1. 4	6.1 f?	1. 2	d A0	5.8 ; 10.9	5.1	1	β 6.0
55	27	H	51.	n ?	2. 1	K0	4.1 ; 13.0	8.9	1	β 9.0
60	34	β18	3. 8	1.1 f ?	—	(d)A2	6.0 ; 9.9	3.9	1.5	β 3.9; Doo 5.0
61	37	A	0. 2	1.3 m	—	d B9	6.8 ; 6.8	0.0	10	A 0.0
71	47	β6	62. 8	opt?	6. 3	d A2	5.3 ; 10.2	4.9	1	β 4.2
"	"	"	119. 9	3.3 c?			··· ; ···	3.5	1	AC: β 3.0
"	"	"	4. 7	3.3 c?			8.8 ; 10.5	5.2	1	AD: β 5.1
76	53	Ho	3.	1.3 ?	2. 0	d A0	6.0 ; 10.9	4.9	1.5	Ho 7.0; *A 6.5
77	57	Σ	0. 8	1.1 m	0. 7	d A2	6.3 ; 7.6	1.3	12	Σ 1.5; Δ 1.2; OΣ 1.8
87	54	H	34. 3	opt	30.	G0	6.0 ; 10.3	4.3	0.5	H 4.0
3322	85	OΣ	5. 6	1.1 f	0. 4	d A2	6.0 ; 10.8	4.8	2.5	OΣ 3.8; Δ 4.9
30	86	β36	122.	opt	12. 8	Ma	3.2 ; ···	6.9	1.5	β 6.8; A 7.0
"	"	"	0. 8	opt			10.1 ; 10.8	7.6	1.5	AC: β 7.7; A. 8.0
38	93	H	31.	2.0 f ?	1. 1	g K2	5.5 ; 11.7	6.2	2	β 4.5; Es 8.3
"	"	"	95. 4	3.3 f ?			··· ; 8.5	3.0	0.5	AC: β 2.5

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
3349	* 2298/99	Σ	13.″8	1.0 f	1.″3	d A5	4.5 ; 6.6	2.1	ph	Σ 2.7; Δ 2.2; Gla 2.5
57	**2306**	β18	0. 7	1.1 f	—	(d) B8	7.0 ; 7.7	0.7	14	β 0.3; Cin 2.0; Lv. 0.8; Col 1.0; J 1.0
59	09	Σ	23. 3	1.0 c	6. 6	d B8	6.0 ; 10.2	4.2	10	Σ 4.0; Δ 4.0; Com 4.6
88	28	Σ	21. 0	1.0 f	—	(d) A0	6.4 ; 8.9	2.5	5	Σ 2.3; Δ 2.5
97	43	OΣ	112. 5	1.6 f	2. 2	d B5	4.1 ; ···	4.7	5	β 4.7; Δ 4.5; Fr 3.6
„	„	β36	0. 1	1.6 f			8.8 ; 9.1	5.0	···	BC: β 0.1; A 0.2
„	„	„	22. 6	n ?			(4.1); 14.5	10.4	1	AD: β 11.0
„	„	„	53. 9	n ?			··· ; 13.8	9.7	1	AE: β 9.8
„	„	„	56. 7	opt?			··· ; 12.4	8.3	1	AF: β 8.5
„	„	„	92. 1	n ?			··· ; 13.0	8.9	1	AG: β 9.0
3402	* {56	Σ	7. 2	1.0 c	3. 2	d B2p	4.7 ; ···	0.5	ph	
„	{57/8	„	2. 4	1.0 c			5.2 ; 5.6	0.9	ph	
„	„	β18	25. 7	2.0 c			(4.7); 12.0	7.3	1	AD: β 7.5
22	* 66	OΣ	7. 5	1.0 c	6. 6	(d) K0	6.2 ; 10.1	3.9	5.5	OΣ 3.1; Δ 3.9; Ab 3.7
27	70	Σ	16. 2	1.0 f	—	(d) B0	5.9 ; 8.7	2.8	ph	Σ 2.2; Δ 3.0
40	78	OΣ	33. 3	opt?	—	K0	6.2 ; 10.2	4.0	4	Δ 3.6
53	87	See	24. 8	n ?	0. 9	B1	4.4 ; 12.6	8.2	0.5	See 9.6
„	„	„	28. 9	n ?			··· ; 12.1	7.7	0.5	AC: See 9.1
69	***2404**	Σ	10. 2	0.7 ?	1. 6	d A0	6.4 ; 11.0	4.6	10.5	Σ 4.2; Δ 4.4; Com 4.7; Jk 4.5
3503	23	H	17. 2	1.0 ?	2. 4	g G5	6.1 ; 7.6	1.5	0.5	Sh 1.5
10	33	H	9. 1	1.0 f	—	(d) B8	6.4 ; 8.6	2.2	5	β 1.5; See 3.8
18	38	OΣ	0. 8	1.1 c	2. 5	d B8	6.1 ; 7.7	1.6	11	OΣ 1.8; Δ 1.9; A 1.5; Lv 1.4
26	49	β18	2. 7	2.1 f	—	(d) A2	5.9 ; 10.8	4.9	3.5	β 5.4; Doo 6.5; HΣ 5.5
42	56	Σ	2. 7	1.1 m	0. 8	s Oe5	4.8 ; 7.9	3.1	6.5	Σ 2.8; Δ 3.5; OΣ 3.0
„	„	Σ	16. 5	1.0 f			··· ; 10.1	5.3	6	AC: Σ 5.2; Δ 5.8; OΣ 4.5
„	„	H	40. 0	1.5 f			··· ; 9.7	4.9	0.5	AD: Da 5.0
59	70	Σ	1. 5	1.0 m	1. 6	d A2	5.4 ; 6.0	0.6	37	Σ 0.9; Δ 0.7; Cmb 0.7; OΣ 1.0; Es 0.2
„	„	„	8. 6	1.0 c			··· ; 7.5	2.1	ph	AC: Σ 2.2; Δ 1.8; Cmb 1.5; OΣ 1.8;
68	73	S	111. 5	1.0 f	2. 0	g G5	3.2 ; 9.2	6.0	ph	β 6.3 [Es 0.8
75	78	Lam	32. 0	opt	6. 5	K0	4.7 ; 11.0	6.3	2	L 6.5
82	81	S	18. 2	1.0 f	—	(d) F0	6.6 ; 7.6	1.0	2	Cin 1.0
85	83	H	55. 3	opt	15. 8	G0	5.3 ; 8.3	3.0	ph	Δ 2.5; OΣ 3.0; Σ 2.6
87	85/86	Σ	5. 0	1.0 c	12. 7	d F5	6.3 ; 6.3	0.0	ph	Σ 0.0; Δ 0.2; Es 0.1
96	* 91	Clark	10. 0	1.0 m	131.	d A0	-1.6 ; 8.4	10.0	ph	. . .
3601	99	OΣ	0. 4	1.1 m	5. 6	d A0	6.8 ; 7.1	0.3	19	OΣ 0.5; Doo 0.5; Δ 0.1
03	97	Ho	4. 3	1.1 ?	—	(d) B5	6.5 ; 10.1	3.6	4.5	Ho 4.0; Doo 3.3; See 4.9
08	**2501**	H	5. 4	1.0 f	1. 2	d B3	6.1 ; 8.0	1.9	2	See 3.0
25	* 20	Σ	0. 9	1.1 m	4. 7	g F5	5.7 ; 6.9	1.2	14	Σ 1.2; Δ 1.5; OΣ 1.5; *A 1.2
36	22	Clark	1. 0	1.3 c	1. 9	d B5	5.4 ; 7.8	2.4	4	J 2.5; Δ 2.7
47	29	β36	10. 8	25. c?	4. 2	d A0	5.2 ; 13.4	8.2	1	β 8.6
50	30	β18	5. 6	1.3 c	17. 6	d F2	5.8 ; 11.0	5.2	1.5	β 5.4; Doo 6.2
52	28	β6	1. 8	1.0 f	—	d A0	6.5 ; 7.7	1.2	7	Doo 1.2; Cin 1.0; Lv 1.3; J 1.2;
„	„	S	30. 3	1.0 f			··· ; 10.5	4.0	0.5	AC: S 4.0 [Sel 2.0
„	„	Doo	30. 2	n ?			··· ; 12.2	5.7	0.5	AD: Doo 6.0
53	39	Σ	22. 2	1.0 c	8. 9	d F2	6.1 ; 9.6	3.5	5	Σ 3.3; Δ 3.3
78	60	OΣ	0. 5	1.3 m	13. 4	g G0	4.8 ; 6.4	1.6	5	OΣ 1.1; Δ 2.1
„	„	β	23. 5	opt			··· ; 10.7	5.9	ph	AC: β 7.9
92	64	Σ	5. 7	1.0 m	11. 2	d F0	4.8 ; 7.5	2.7	ph	Σ 2.3; Δ 2.3; Gla 3.0
95	67	See	10. 6	n ?	—	Mb	6.5 ; 13.1	6.6	1	See 7.8; Cg 7.0
97	70	Σ	1. 1	1.0 f	—	(d) A3	6.9 ; 7.2	0.3	20	Σ 0.1; Δ 0.6

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
3713	**2588**	S	45.″	4.0 f	1.″1	d A2	5.8 ; 10.1	4.3	0.5	S 4.0
”	”	”	53.	opt?			… ; 10.8	5.0	0.2	AC : S 6.0
21	90	H	11. 2	1.0 c	6. 8	d F5	4.6 ; 9.2	4.6	4.5	Doo 4.4 ; Cin 3.8 ; See 5.2
25 *	93	Σ	3. 2	1.0 f	0. 8	g G5	5.3 ; 7.6	2.3	ph	Σ 3.3 ; Δ 3.0
47	**2610**	β36	3. 0	2.1 f?	1. 7	g K0	6.0 ; 11.1	5.1	1	β 6.0
52	15	OΣ	21. 5	2.0 f	1. 7	g K2	5.9 : 11.6	5.7	1	β 5.7
61	18	…	7. 4	1.0 f	0. 2	s B1	1.6 ; 8.3	6.7	0.5	See 8.3
—	20	Es	16. 4	n ?	—	(d) F0	6.5 ; 12.2	5.7	1	Es 6.5
76	28	See	13. 7	n ?	—	B5	6.3 ; 13.5	7.2	1	See 8.7 ; Cg 7.4
93 *	**44**	Σ	2. 9	1.0 c	5. 6	d A2	6.9 ; 7.0	0.1	25	Σ 0.1 ; Δ 0.2 ; Es 0.1
97	50	H	87. 2	n f	0. 9	s G0p	3.7 ; 10.4	6.7	1	β 6.5
”	”	”	91. 0	opt			… ; 7.4	3.7	10	AC : β 4.5; Com 3.2; Δ 3.2; Gla 4.5;
3811	54	OΣ	90. 3	0.6 ?	—	(d) B9	6.5 ; 7.5	1.0	ph	Δ 1.0 [Fr 2.3
32	70	Δ	6. 1	1.0 c	4. 7	d B3	6.4 ; 10.5	4.1	6	Δ 3.9 ; Doo 4.0
”	”	Σ	37. 8	1.1 c			… ; 8.9	2.5	2	AC : Σ 2.3
39	78	β6	0. 5	1.3 c	2. 4	d B3	5.6 ; 6.8	1.2	9.5	Δ 1.2 ; β 1.3 ; Cin 2.7 ; Sp 1.3
”	”	Σrej	17. 8	1.0 f?			… ; 9.3	3.7	1	AC : β 3.4
44	84	OΣ	3. 8	opt	11. 1	K0	5.6 ; 10.7	5.1	5.5	OΣ 5.7 ; Com 6.5 ; β 6.5 ; HΣ 5.5 ;
62	97	β12	1. 8	6.1 c	5. 3	g K0	4.5 ; 10.4	5.9	1.5	β 7.6 ; A 6.2 [Ho 6.0
66	99	β6	29. 5	2.0 f?	—	(d) B3	6.0 ; 11.3	5.3	1	β 5.3
76	**2711**	Σ	1. 1	1.0 m	9. 0	d F5	7.1 ; 7.3	0.2	44	Σ 0.0 ; Cmb 0.5 ; Δ 0.2 ; OΣ 0.5 ;
”	”	OΣ	16.	1.2 ?			… ; 12.0	4.9	1	AC : OΣ 3.9 ; Hu 6.0 [Gla 0.2
—	14	Jk	32.	n ?	1. 1	d A0	4.1 ; 13.0	8.9	1.5	β 9.5 ; Jk 8.9
3905	25	Ho	22. 3	opt	10. 7	K0	6.0 ; 11.5	5.5	1	Ho 6.0 ; Doo 5.4
21	31	A	2. 8	1.3 ?	—	(g) K5	6.1 ; 10.0	3.9	0.5	A 5.0
25	33	H	20.	1.0 f	—	(d) B3	6.4 ; 8.2	1.8	2	Doo 1.0 ; W 2.5
31	44	β36	3. 8	1.3 ?	1. 9	g G5	6.5 ; 11.6	5.1	1.5	β 5.8 ; A 7.0
48	72	Σ	2. 4	1.3 f	1. 0	d A5	6.3 ; 10.3	4.0	5	Σ 4.5 ; Δ 4.6
51	63	Σ	9. 5	1.0 c	6. 8	d A2	3.7 ; 9.8	6.1	ph	Σ 7.1 ; Δ 6.3
54	64	H	27. 2	1.0 ?	0. 2	(g) K5	5.1 ; 6.5	1.4	ph	Doo 1.5
70	77	Σ	7. 1	1.0 m	2. 6	d F0	3.5 ; 8.0	4.5	ph	Σ 5.0 ; Doo 4.5 ; Δ 4.5
73 *	83/84	Σ	14. 7	1.0 c	6.	d B8	5.6 ; 6.5	0.9	ph	Σ 1.3 ; Δ 1.2 ; Es 0.5
80	81	H	8.	1.0 f	1. 6	s Oe	4.9 ; 9.8	4.9	3	β 4.5; Doo 4.5
”	”	”	14.	opt			.. ; 10.1	5.2	1.5	AC : β 5.2 ; Doo 5.0
”	”	”	85.	0.6 ?			… ; 7.6	2.7	1	AD : β 2.7 ; Doo 2.0
86	93	β18	10. 5	1.2 c	8. 9	g K0	5.2 ; 11.2	6.0	4	β 6.4 ; OΣ 6.5 ; HΣ 5.5
”	”	”	36. 0	opt			… ; 12.2	7.0	1	AC : β 6.8
94 1/2	95	β	17. 7	opt	6. 9	K2	5.2 ; 12.0	6.8	1	β 7.0
4052	**2844**	β6	16. 9	opt	5. 9	B9p	5.6 ; 10.4	4.8	3.5	En 4.0 ; Doo 4.4 ; β 4.9
59	46	H	42. 8	1.5 c	13. 2	d F5	5.3 ; 9.8	4.5	0.5	Fks 4.2
74	51	β6	4. 0	1.3 c	4. 5	d A5	5.3 ; 10.2	4.9	6.5	Δ 5.8; Doo 4.2; β 5.5; OΣ 4.5; A 5.0
[1586]	52	A	2. 8	6.1 c	22. 7	d F0	4.2 ; 10.8	6.6	0.5	A 8.3
4075	54	Lam	34. 6	opt	6. 5	K0	4.6 ; 12.6	8.0	1	β 8.0
76	53	β18	2. 4	1.1 m	0. 8	d F0	5.7 ; 9.1	3.4	10	β 5.3; Doo 3.9; Δ 3.0; A 4.6; Cin 6.0;
80 *	59	β6	0. 8	1.1m?	0. 7	g F5	6.1 ; 7.7	1.6	6	Δ 2.0; β 1.3 [W 3.0
”	”	Σ	20. 2	1.0 f			… ; 8.7	2.6	5.5	AC : Σ 2.2; Δ 2.7; β 2.2
”	”	β	23. 4	1.0 f?			… ; 10.3	4.2	1	AD : β 3.9
”	”	”	31. 0	opt?			… ; 11.6	5.5	1	AE : β 5.6

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
4083	**2861**	β36	13.″9	25. c?	4.″9	g K0	5.1 ; 13.3	8.2	1.5	β 8.5; A 9.2 [Gla 1.0; Ol 1.1
98	68	Σ	2. 3	1.0 m	32.	d F8	6.2 ; 7.5	1.3	19	Σ 1.6; Doo 1.8; Δ 1.5; Com 2.1;
”	”	En	20. 6	2.0 c			... ; 11.6	5.4	1.5	AC: En 4.8; Com 6.2
”	”	”	33. 6	opt			... ; 12.2	6.0	1.5	AD: En 5.3; Com 6.7
4109	79	Σ	11. 5	1.0 c	3. 2	g G5	6.6 ; 8.5	1.9	12	Σ 1.8; Δ 1.9; Gla 1.8
18	83	Σ rej	23.	1.0 c	18. 3	d F5	6.1 ; 9.1	3.0	0.5	β 2.7
22	* 90/91	Σ	4. 4	1.0 m	21.	d A0	2.0 ; 2.8	0.8	ph	Σ 1.0; Δ 1.0; Gla 1.0
”	”	”	72. 5	1.0 c			... ; 9.0	7.0	ph	AC: Σ 6.8; Gla 7.0
29	98	OΣ	1. 9	1.0 c	6. 3	d F0	6.5 ; 8.2	1.7	7	OΣ 1.6; Δ 1.7
30	96	OΣ	0. 4	1.1 c	3. 2	g K0	5.8 ; 6.3	0.5	19	OΣ 0.6; Δ 1.0; Gla 0.2
47	***2909**/**10**	S	9. 0	1.0 c	11. 1	d F2	5.9 ; 6.0	0.1	ph	See 0.1
62	21	Σ	19. 6	1.0 f	1. 6	d B5	5.6 ; 9.1	3.5	5	Σ 3.0; Δ 3.4
64	24	H	98.	opt	4. 4	G5	5.6 ; 11.7	6.1	3	Δ 6.0; β 5.2
86	46	H	55.	opt	6. 8	A2	5.0 ; 10.0	5.0	1	β 4.5
87	* 43	Schaeb.	4. 6	1.0 m	125.	d F5	0.5 ; 12.5	12.0	...	
93	50	Σ	1. 4	1.0 m	3. 0	d A0	6.4 ; 6.7	0.3	50	Σ 0.3; Cmb 0.5; Δ 0.6; Gla 0.1; A 0.3
97	48/49	H	10. 4	1.0 c	2. 7	{d B8	4.5 ; ...	0.1	ph	β 0.0; Cin 0.0
”	”	β36	6. 4	16. ?		{d B3	4.6 ; 13.3	8.7	1.5	BC: β 9.8; A 10.5
4207	60	See	9. 2	0.7 ?	—	(g) K0	6.1 ; 10.2	4.1	0.5	See 5.2
[1653]	82	A	0. 6	1.3 ?	0. 4	g G5	6.6 ; 8.2	1.6	1	A 2.0
4226	85	OΣ	6. 2	1.0 c	6. 6	g G5	3.7 ; 9.4	5.7	ph	OΣ 4.5; Δ 4.7; Ho 5.0
33	90	β	41. 3	opt	63.	K0	1.2 ; 12.6	11.4	1	β 11.5
”	”	H+β	116. 7	”			... ; 9.2	8.0	1	A—CD: β 8.0
40	93	See	26. 6	n ?	1. 4	K5	4.8 ; 12.3	7.5	0.5	See 8.7
49	**3013**	Σ	22. 6	opt	4. 0	K2	5.3 ; 10.9	5.6	ph	Σ 6.1; Δ 5.8
”	”	H	93. 9	opt			... ; 10.7	5.4	0.2	AC: Sh 5.1
50	09/10	Σ	16. 5	1.0 c	3. 6	d A0	6.1 ; 6.8	0.7	ph	Σ 0.8; Doo 0.9; Δ 0.9; Gla 0.6
60 *	21	β36	4. 0	6.1 f	2. 0	g F2	6.2 ; 13.1	6.9	1	β 7.5
69	29	Σ	3. 3	1.0 c	12. 5	d F5	5.8 ; 7.3	1.5	11.5	Σ 2.1; Cmb 2.0; Doo 2.0; Δ 1.6; Gla 1.5
81	34	See	27. 6	1.2 ?	1. 5	d B2	4.6 ; 11.9	7.3	0.5	See 8.5
90	45	β36	4. 6	2.5 ?	0. 7	s G0p	3.5 ; 12.0	8.5	1.5	β 9.8; A 9.8
92	48	See	4. 4	3.0 ?	—	(g) G0	6.5 ; 13.7	7.2	0.5	See 8.8 [Hl 2.0; Sp 1.0
4310	64	β6	0. 5	1.1 m	35.	d G0	5.8 ; 6.4	0.6	26	Δ 1.1; Doo 0.5; A 0.2; Cin 1.2; β 0.8;
55	98	OΣ	0. 3	1.3 m	17. 8	d F8	7.1 ; 7.4	0.3	16	OΣ 0.2; β 0.2; *A 0.2
59	**3112**	H	46. 6	opt	3. 9	F8	6.0 ; 6.8	0.8	5	Δ 1.0
61	10	H	76.	opt	19. 0	K0	5.4 ; 8.7	3.3	1	Com 3.6
”	”	”	112.	”			... ; 8.9	3.5	1	AC: Com 3.8
77	27	Σ	2. 8	1.3 c	7. 2	g K0	6.4 . 10.3	3.9	10	Σ 4.5; Δ 4.6; Com 4.4
83	32	H	45.	nf?	1. 7	A0	6.2 ; 11.6	5.4	1	β 5.0
”	”	”	109.	n ?			... ; 10.8	4.6	1	AC: β 4.0
4421	64	Σ	3. 5	1.0 c	2. 1	d B9	6.6 ; 7.2	0.6	40	Σ 0.9; Cmb 0.9; Δ 0.6; Gla 0.8
32	73	Es	47. 7	n ?	5. 6	A2	4.9 ; ...	7.5	1	Es 8.0
”	”	”	7. 5	n ?			12.4 ; 13.2	8.3	1	AC: Es 9.0
40	74	Σ	30. 9	1.0 f	—	(d) A0	5.9 ; ...	1.5	ph	AB: Σ 2.3; A 3.0
”	”	A	1. 2	1.0 ?			7.4 ; 11.0	5.1	4	BC: A 3.7; Doo 4.5
”	”	”	14. 2	n ?			(7.4); 13.8	7.9	0.5	AD: A 8.5

Table 1. Continued.

B.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
4456	**3188**	Σ	31.″5	1.0 c	2.″5	g G0	4.4; 9.8	5.4	ph	Σ 5.7; Δ 5.2
"	"	"	67. 0	3.3 c			···; 8.6	4.2	ph	AC: Σ 2.5
64	94	Ho	5. 2	1.3 ?	1. 4	d B3	5.5; 11.4	5.9	1	Ho 6.7; Doo 6.4 [Ho 0.7
77	*3209/10	Σ	1. 1	1.0 m	14. 7	d G0	5.6; 6.2	0.6	40	Σ 0.7; Δ 1.2; A 0.5; Gla 0.8; Jk 0.6;
"	"	"	5. 3	1.0 m			···; 6.1	0.5	ph	AC: Σ 0.5; Δ 0.4; Gla 0.4; Ab 0.7
80	11	β36	1. 8	6.1 c?	2. 7	g Ko	4.7; 10.4	5.7	1.5	β 7.0; A 6.4
"	"	A	33. 2	n?			···; 12.5	7.8	0.5	AC: A 8.4
"	"	H	70. 1	1.3 c			···; 7.5	2.8	2	AD: A 3.0
81	21	Σ	2. 8	1.1 c	1. 8	d F0	6.4; 9.6	3.2	6	Σ 3.7; Δ 3.5; Ab 4.1
"	"	"	48. 6	4.0 f			···; 10.2	3.8	6	AC: Σ 3.4; Δ 3.5; Ab 3.6
99	28	β36	1. 4	6.1 c?	3. 3	d F0	6.4; 11.4	5.0	1	β 5.9
"	"	"	64. 6	1.6 opt?			···; 9.0	2.6	0.5	AC: β 2.2
4501	36	Σ	44. 3	opt	2. 7	K5	6.2; 9.8	3.6	ph	Σ 3.0; Δ 3.5
29	49	β36	29. 1	3.3 c	7. 4	g K2	3.8; 13.3	9.5	1.5	β 10.3; A 10.3
70	78	Σ	0. 4	1.1 m	4. 9	d A0	6.9; 7.4	0.5	35	Σ 0.7; Δ 0.5; OΣ 0.5; Com 1.0; A 0.3
81	87	S	73. 0	opt	1. 0	K5	6.2; 8.3	2.1	ph	OΣ 1.4; Ab 2.3
[1776]	90	A	0. 9	2.1 ?	2. 1	g K5	6.3; 10.1	3.8	0.5	A 5.0
4587	91	Ho	32. 2	n?	—	F0	5.9; 11.8	5.9	1	Ho 7.0; Doo 6.0
97	**3304**	S	121.	opt	13. 4	K2	5.8; 9.8	4.0	5	Com 4.0
4600	06	H	31. 4	1.0 c	4. 3	g Ko	5.2; 9.8	4.6	1	β 4.2
01 *	10/11	Σ	4. 5	1.0 c	1. 1	d A2	6.3; 6.3	0.0	ph	Σ 0.5; Δ 0.2; Gla 0.3
02 *	12/13	Σ	5. 8	1.0 c	9. 5	d A3	7.1; ···	1.2	ph	A—(B+C): Σ 1.1; Δ 0.9; OΣ 0.5; Gla 0.5; ph. A—(B+C) = 0.5
[1731]	"	A	0. 1	1.0 c			8.3; 8.4	1.3	10	BC: A 0.1
4608	15	S	40. 6	1.0 c	6. 0	g K0	5.6; 7.8	2.2	3	β 1.8
09	23	β36	7. 0	10. c	16.	g G0	3.5; 14.2	10.7	1.5	β 11.7; A 12.5
12	21	β	72. 1	opt?	7. 0	A5	5.4; 9.8	4.4	1	β 3.8
34	37	A	0. 2	1.3 c	3. 2	d F0	7.0; 7.1	0.1	10	A 0.1
"	"	Σ	18. 2	1.0 c			···; 10.6	3.6	1	AC: Σ 3.6
38	52	OΣ	1. 8	1.1 c	3. 3	d A5	6.3; 9.4	3.1	6	Δ 3.3; OΣ 2.5; HΣ 3.5
55	57	H	58. 4	opt	8. 7	Ma	5.6; 10.5	4.9	5	Com 4.7
—	67	Inn	0. 6	1.1 ?	2. 5	d Ao	5.8; 6.7	0.9	1	Inn 1.0
68	81	β6	0. 5	1.1 m	—	d A5	6.8; 7.1	0.3	41	β 0.0; Doo 0.2; A 0.3; Cin 0.2; Sp 0.0; W 0.8; Lv 0.2
77 *	95/96	Σ	10. 3	1.0 c	19. 8	d F5	6.0; 7.1	1.1	ph	Σ 1.0; Δ 1.2; Gla 1.0
4708	**3425**	β6	4. 3	1.1m?	—	g K5	6.6; 10.3	3.7	5.5	Δ 4.0; β 2.4; Cin 2.5; Lv 3.2; Jo 3.3
10	28	Σ	20. 5	1.0 c	4. 1	g G5	6.5; 9.7	3.2	6.5	Σ 2.5; Δ 4.1; β 2.5; Gla 2.8
"	"	S	63. 3	1.0 c			···; 7.8	1.3	ph	AC: Δ 1.3; β 2.0
"	"	"	82. 4	6.7 c			···; 9.2	2.7	ph	AD: Δ 2.3; β 2.5
11	29	S	133.	n c	3. 6	A2	6.3; 7.6	1.3	ph	Δ 1.3
14	30	β6	1. 4	1.1 m	50.	d G5	5.3; 7.2	1.9	6	β 2.1; A 1.5; Cin 2.5; W. 2.0; *A 3.3
19	33	H	52.	n?	9. 6	G5	5.0; 9.8	4.8	···	Cord. Durchm.
34	41	H	32.	opt	8. 1	K0	5.0; 12.0	7.0	1	β 6.8
46	59	S	77. 9	3.3 f	0. 7	g G0	4.7; 8.8	4.1	1	β 3.6
47	61	H	42. 4	opt	24.	K0	4.2; 11.3	7.1	ph	OΣ 7.2
60	72	Σ	4. 7	1.0 c	2. 5	d F5	6.6; 7.3	0.7	15	Σ 1.0; Δ 0.8
63 *	74/75	Σ	30. 4	1.0 c	5. 4	g G5	4.2; 6.6	2.4	ph	Σ 2.1; Cmb 2.5; Δ 2.3; Gla 2.6
71 *	82	Sp	0. 2	1.0 m	19. 6	g F8	3.8; 5.3	1.5	5.5	Sp. 1.5; β 2.0; HΣ 1.0; A 2.0; *A 1.5
"	"	Σ	3. 2	1.0 m			···; 6.8	3.0	ph	AC: Σ 3.7; Gla 3.5; Ab 4.1
"	"	Hn	20. 0	2.0 c			···; 12.1	8.3	1.5	AD: β 8.8; A 9.0
86	92	Clark	12. 4	1.2 c	4. 0	d A0	4.4; 11.9	7.5	1.5	β 7.5; A 9.0
4822	3519	S	82.	nf	1. 3	d A3	5.8; 10.4	4.6	1	AB: β 4.0
13169	"	Hu	3. 8	2.1 ?			···; 11.5	5.7	0.5	AC: Hu 7.5

Table 1. Continued.

B.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
4823	**3521**	H	43.″	nf?	2.″2	Ma	6.3 ; 10.7	4.4	3	β 4.2; Es 3.5
—	22	v.Maan.	84.	n c	55.	d K0	6.1 ; 13.0	6.9	ph	
28	23	β18	0. 4	2.1 m	4. 5	d A2	5.8 ; 7.6	1.8	2.5	β 2.2; Doo 2.2; Cin 2.0; A 2.0
„	„	H	45. 0	opt			··· ; 10.5	4.7	1	AC; β 4.1;
„	„	β	49. 9	n?			··· ; 11.5	5.7	1	AD: β 5.2
38	29	H	34.	opt	4. 7	K0	6.3 ; 12.0	5.7	1	β 5.3 [Gla 0.2; A 0.2; Ho 0.0
39	* 32	Σ	1. 5	1.0 m	5. 1	g K0	6.2 ; 6.5	0.3	57	Σ 0.5; Cmb 0.5; Δ 0.4; OΣ 0.0;
59	* 52/53	Σ	4. 3	1.0 c	3. 8	d A3	6.7 ; 6.9	0.2	ph	Σ 0.1; Δ 0.5
62	56	See	23. 8	n ?	12. 7	A2	4.9 ; 12.2	7.3	0.5	See 8.5
66	69	OΣ	10. 7	1.0 c	50.	d A5	3.1 ; ···	7.6	ph	OΣ 7.2; A 6.4
„	„	Hu	0. 9	1.0 m			10.7 ; 11.1	8.0	10	BC: A 0.3
70	72	H	11. 4	1.0 c	5. 4	d A3	4.3 ; 11.0	6.7	5	Δ 6.5; OΣ 6.7; HΣ 7.0
74	75	H	90.	6.7 c	6. 4	g G5	5.7 ; 9.6	3.9	1	β 3.4
83	87	Σ	4. 6	1.0 f	0. 7	d A2	6.0 ; 8.2	2.2	9	Σ 2.1; Cmb 2.3; Δ 2.4; Gla 2.4
91	89	H	103.	opt	10. 5	A5	6.0 ; 8.6	2.6	1.5	β 2.3; Com 3.0
[1869]	94	A	0. 2	1.3 ?	7. 2	d A0	4.3 ; 4.6	0.3	10	A 0.2
—	**3607**	Inn	0. 4	1.1 ?	3. 9	d B8	7.3 ; 7.5	0.2	2	Inn 0.2
4923	16	Σ	4. 5	1.0 m	7. 0	d F8	4.9 ; 8.2	3.3	ph	Σ 3.2; Δ 4.1; OΣ 2.5; Lv 4.0
29	* 17	Σ	7. 2	1.0 c	16. 2	d F5	6.9 ; 7.2	0.3	ph	Σ 0.4; Doo 0.6; Δ 0.8; Gla 0.2;
„	„	Ho	27. 3	opt			··· ; 12.8	5.9	1	AC: Ho 6.0; Doo 6.7 [Ho 0.2
30	* 24	H	54. 7	4.0 c	12. 3	d F5	4.7 ; 10.9	6.2	1	β 6.0
—	28	Inn	2. 0	1.3 ?	4. 0	g K5	4.8 ; 8.9	4.1	0.5	Inn 5.2
63	44	H	17. 7	opt?	3. 8	A3	5.6 ; 9.9	4.3	ph	
84	65	H	62. 1	opt	34.	A0	3.8 ; 11.4	7.6	ph	OΣ 6.0; β 6.6 [Ho 0.5
5011	86	Σ	1. 4	1.0 m	5. 8	d A5	6.4 ; 6.6	0.2	43	Σ 0.3; Cmb 0.2; Δ 0.2; Gla 0.1;
12	89	H	23.	2.0 c	6. 9	d A0	6.3 ; 12.0	5.7	1	β 5.8
14	90	Σ	2. 7	1.0 c	13. 7	d A2	4.0 ; 5.8	1.8	ph	Σ 2.7; Δ 2.2; Gla 2.4; Ho 3.0
23	97	OΣ	5. 7	1.1 c	14. 0	d F2	6.1 ; 10.7	4.6	5	OΣ 4.1; Δ 4.6; Com 5.2; Ab 4.5
30	**3701**	Σ	1. 7	1.0 m	4. 8	d F2	6.5 ; 6.8	0.3	45	Σ 0.2; Cmb 0.5; Δ 0.4; Gla 0.2;
—	18	Inn	2. 5	1.3 ?	2. 3	g Ma	5.0 ; 8.9	3.9	0.5	Inn 5.0 [Es 0.2
[1910]	24	A	0. 1	2.1 ?	—	(d) A2	7.3 ; 7.3	0.0	10	A 0.0
5062	31	β6	3. 0	1.3 c	6. 1	g K0	4.6 ; 9.5	4.9	7	Δ 5.8; Doo 5.7; OΣ 4.0; HΣ 5.7;
										A 7.3; β 6.2; Hl 6.0; En 5.1
90	43	S	87.	opt	13. 6	G5	5.6 ; 7.8	2.2	ph	OΣ 1.8; Δ 1.8; Ab 1.9; Fr 1.6
97 ⎱	44	β18	10. 8	1.2 c	4. 9	d A0	7.2 ; 11.7	4.5	1.5	AC—B: Doo 5.4; β 5.0; A 5.8
[1922] ⎰	„	A	0. 1	2.1 c			··· ; 7.2	0.0	10	AC: A 0.0
5100	45	Inn	0. 8	1.0 c	4. 3	d B8	6.7 ; 6.8	0.1	11	Inn 1.5; See 0.0
03	54	Σ	0. 9	1.0 m	5. 6	g G0	5.9 ; 6.8	0.9	53	Σ 0.8; Δ 1.8; OΣ 1.5; Com 1.3;
										Gla 0.6; **Jk** 0.6; A 0.8; Ho 2.0
04	57	Σ	22. 8	1.0 c	12. 0	d F0	3.8 ; 9.1	5.3	ph	Σ 5.2; Δ 5.2; OΣ 5.0 [Lv 0.8;
[1926]	58	A	1. 6	1.3 ?	9. 7	d A5	6.3 ; 9.7	3.4	1	A 4.3
5105	55	H	25.	1.0 c	4. 1	g Ko	5.9 ; 10.8	4.9	1	β 4.6
10	59	H	66. 6	3.3 c	12. 6	d F5	4.8 ; 8.3	3.5	3	Doo 3.0
13	64	H	62.	1.5 c	6. 6	g K0	6.0 ; 9.8	3.8	6	Δ 3.6; Fr 2.8
22	70	See	4. 1	4.9 ?	3. 3	g Ko	5.7 ; 12.9	7.2	0.5	See 8.8
23	75	β36	5. 0	10.0 c	109.	d F8p	3.3 ; 13.0	9.7	1.5	β 11.0; A 11.0
31	79	H	37. 0	1.5 c	2. 4	g K0	5.3 ; 9.4	4.1	ph	Δ 4.5; OΣ 3.0
34	92	H	34. 9	opt	3. 9	A2	6.4 ; 11.3	4.9	6	OΣ 5.0; Com 4.7
36	***3806**	Σ	5. 0	1.0 c	4. 2	d F0	7.1 ; 7.2	0.1	20	Σ 0.0; Δ 0.3
45	11	Σ	24. 7	1.0 f	—	(d) F2	6.9 ; 8.1	1.2	12	Σ 1.0; Δ 1.2; Es 1.0
13189	15	Hu	5. 8	6.1 m	76.	d K0	5.5 ; 12.5	7.0	0.5	Hu 8.5
5154	18	H	41.	1.5 c	4. 2	d A0	6.2 ; 9.5	3.3	ph	Δ 2.3; OΣ 2.6
56	22	S	51. 8	1.1 f	—	d A0	6.4 ; 8·4	2.0	3	β 1.6

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
5175	***3852**	H	63.″4	opt	15.″0	F5	**3**.8 ; 9.2	5.4	1	Com 5.4
91	69	H	30.	opt	8. 2	K0	6.6 ; 12.5	5.9	1	β 6.0
5212 *	88	OΣ	11. 3	1.0 c	32. 0	d F0	3.9 ; 11.4	7.5	2	OΣ 8.0; β 7.8 [A 0.0; *A 0.3
23	94	OΣ	0. 4	1.1 m	0. 9	d A2	5.2 ; 5.4	0.2	37	OΣ 0.6; Com 1.8; β 0.0; Gla 0.1;
35	**3909**	Clark	0. 5	1.1 m	7. 6	d A2	5.7 ; 6.1	0.4	26	Da 0.2; Com 0.5; β 0.5; Jk 0.0; A 0.4
63	31	β6	3. 0	1.1 f	—	(d) A2	6.3 ; 10.1	3.8	4	Cin 5.0; Doo 4.0; β 3.5; W 4.5
5301	62	Ho	14. 4	opt?	—	A0	6.7 ; 12.4	5.7	1	Ho 6.3 ; Doo 5.6
03 *	63	β36	10. 9	0.7 ?	—	(d) A0	6.2 ; 11.7	5.5	2	β 5.3; Doo 6.2; A 6.4
〃	〃	H	21. 5	1.0 f			… ; 7.0	0.8	ph	AC : β 0.2; Doo 0.5; A 0.2
26	79	H	28.	2.0 c	12. 3	d F5	6.2 ; 12.0	5.8	2	β 5.0; Es 7.3
28	80	Anders.	7. 9	6.1 c	11. 7	g K2	4.6 ; 12.6	8.0	1.5	Hl 10.0; β 8.5
31 *	82	Σ	176. 9	n c	25.	d B8	1.3 ; …	6.3	ph	
〃	〃	Hd	3. 9	n m			7.6 ; 11.4	10.1	…	
42	94	β18	50. 7	opt	23.	K0	3.8 ; 13.1	9.3	1	β 9.4
13195	98	Hu	0. 2	2.1 ?	6. 7	d F5	6.9 ; 7.6	0.7	2	Hu 0.8
5356	***4021**	Σ	16. 7	1.0 c	7. 1	d A3	6.6 ; 7.2	0.6	ph	Σ 0.9; Δ 1.0; Gla 0.7 [Lv 0.4
65	28	OΣ	0. 4	1.1 m	0. 9	d F0	7.2 ; 7.5	0.3	44	OΣ 0.2; Δ 0.7; Gla 0.1; A 0.1;
71	39	OΣ	6. 7	1.3 c	47.	d F5	5.9 ; 11.2	5.3	3	OΣ 5.8; Δ 5.5
75	40	Hn	1. 4	1.3 f	—	(d) F5	6.6 ; 9.7	3.1	2	Com 3.8; A 4.2 [Ho 1.0; Lv 2.3
88 *	57/58	Σ	2. 5	1.0 m	36.	g K0	2.6 ; 3.8	1.2	ph	Σ 1.5; Cmb 1.5; Δ 1.0; Gla 1.1; Jk 2.0;
5408	73	β6	2. 3	1.0 f	—	d A0	6.7 ; 8.2	1.5	5	Cin 2.2; Doo 1.2; β 1.4; Lv 2.1
12	79	H	60. 3	opt	25.	F2	6.5 ; 10.2	3.7	ph	OΣ 2.0
18	85	β	7. 8	1.0 ?	—	(g) K0	6.4 ; 12.3	5.9	1	β 6.3
〃	〃	H	210.	opt			… ; 6.6	0.2	ph	AC: β 0.0
13203	**4100**	Hu	0. 4	2.1 m	15. 4	g K0	4.6 ; 6.6	2.0	1	Hu 2.5
5436	01	H	39.	opt?	1. 4	A0	5.9 ; 12.2	6.3	1	β 6.1
53	18	H	10. 6	1.0 c	4. 8	d B9	5.7 ; 9.7	4.0	ph	J 4.0; Cin 3.7 ; Lv 3.0; See 5.0
58	24	H	40.	opt	1. 5	B9	5.8 ; 12.2	6.4	2	β 7.0; Es 6.0
59	22	Σ	2. 5	1.1 c	4. 5	g K5	6.5 ; 9.2	2.7	4	Σ 3.5; Δ 2.8
66	32	H	23. 0	opt	14. 2	A5	4.8 ; 11.2	6.4	2	Com 7.8 ; Es 6.8
80	45	β36	18. 3	opt?	0. 9	K2	5.3 ; 13.6	8.3	1.5	β 9.0; A 9.0
84	48	Σ	2. 3	1.0 c	4. 6	d A0	5.8 ; 7.9	2.1	9	Σ 2.7; Cmb 3.3; Δ 2.2; Gla 2.2
91	57	β6	1. 3	1.1 m	—	d F8	6.5 ; 8.1	1.6	8	Cin 1.3 ; Doo 1.9; β 1.8; Lv 1.7
92	56	β36	3. 0	6.1 c?	2. 7	g K5	6.2 ; 12.3	6.1	2	β 7.0; Doo 8.0; A 7.0
5535	89	β18	10. 9	opt	13. 4	A2	5.6 ; 12.0	6.4	2.5	β 6.8; Com 7.2; A 7.0
37	91	Δ	288.	n c	33.	F0	5.3 ; 7.1	1.8	ph	Δ 2.0
39	93	Σ	6. 7	1.0 c	4. 4	g K0	6.4 ; 7.3	0.9	12	Σ 1.1; Δ 1.0; Gla 1.1
48	**4203**	S	200.	n c	4. 8	B9	5.4 ; 7.5	2.1	0.5	S 2.0
63	18	Σ	71. 6	opt	—	A0	6.5 : …	1.2	10	AB: Σ 1.1; Δ 1.2
〃	〃	〃	6. 3	opt			7.7 ; 7.2	0.7	20	AC: Σ 0.8; Δ 0.8
72	29	Σ	1. 8	1.0 m	5. 5	d A2	7.0 ; 7.6	0.6	40	Σ 0.8; Cmb 0.7; Δ 0.8; Gla 0.6
75	37	H	27.	2.0 f?	2. 0	d A2	5.8 ; 11.4	5.6	1	β 5.7
90 *	49	S	35. 2	1.1 c	16. 0	d Ko	6.2 ; 8.5	2.3	3	β 1.9
5603 *	59/60	Σ	6. 1	1.0 m	7. 7	d A0	4.5 ; 6.3	1.8	ph	Σ 2.0; Cmb 2.2; Δ 1.7; Gla 1.8;
05	65	β36	0. 9	2.1 c	10. 3	d F2	6.1 ; 9.8	3.7	2	β 4.5 ; A 4.6 [Ho 2.0
39	94	β18	46. 7	6.7 c	6. 2	d A5	5.1 ; 12.6	7.5	2	β 7.6; A 8.5; Doo 7.5
52	**4301**	β36	0. 9	10. m	13. 0	g K0	2.0 ; 9.2	7.2	1.5	β 9.1 ; A 9.0
[2084]	05	A	3. 6	1.1 ?	13. 5	(g) K0	5.7 ; 9.2	3.5	1	A 4.5

Table 1. Continued.

B.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
5660	**4309**	Ho	8.″4	3.7 c	7.″3	d A2	6.1 ; 12.4	6.3	1	Ho 6.5; A 7.0
76	19	β18	1. 7	2.1 c	39.	d G5	5.7 ; 10.2	4.5	3	β 5.4; Doo 4.8
—	31	Inn	2. 0	2.1 ?	—	(d)A0	6.4 ; 10.8	4.4	0.5	Inn 4.5
13212	32	A	4. 7	6.1 ?	0. 4	(d)A2	5.6 ; 12.9	7.3	0.5	A 8.5
5699	45	0Σ	128. 3	opt	29.	G 0	6.3 ; 6.9	0.6	ph	Δ 0.8; Fr 0.6
5702	47	β6	0. 5	1.1 f	—	(d)A0	6.6 ; 7.2	0.6	38	Δ 0.6; Doo 1.0; Cin 0.6; Sp 0.6; En 1.4; Lv 0.7; T 0.5; J 0.4
05	51	Ho	3. 1	1.1 f	2. 7	g K0	6.5 ; 10.2	3.7	3	Ho 3.4; Doo 4.4
22	63	Σ	12. 9	1.0 c	19.	d F2	6.6 ; 8.0	1.4	10	Σ 1.3; Δ 1.5
29	68	H	101.	opt	12. 1	A5	4.6 ; 9.1	4.5	6	Com 4.4; β 4.0
32	69	β18	1. 2	6.1 m	2. 8	d F0	6.0 ; 10.9	4.9	1.5	β 5.9; A 6.0
„	„	H	67. 0	opt?			··· ; 8.3	2.3	4	AC: β 1.9; A 2.5
34	* 74/75	Σ	1. 7	1.0 m	74.	d G0	4.4 ; 4.9	0.5	ph	Σ 0.9; Cmb 0.7; Δ 0.4; Gla 0.5; Jk 0.3; Ab 0.4; A 1.0; Lv 0.7
35	77	Σ	7. 0	1.0 c	2. 7	g Ko	3.7 ; 9.2	5.5	ph	Σ 6.4; Cmb 6.5; Δ 5.8; Ho 7.0
65	99	Σ	2. 1	1.1 m	17. 6	d F5	4.1 ; 6.8	2.7	ph	Σ 3.2; Cmb 3.5; Δ 2.7; Com 3.7; Gla 3.5; Jk 3.0; Ho 3.5; A 3.3;
73	**4405**	H	5. 1	1.3 c	10. 9	d A5	4.1 ; 9.4	5.3	1	Cin 5.5; Doo 6.0 [Lv 3.0
75	08	H	58. 5	opt	15. 8	F2	5.6 ; 11.0	5.4	ph	Com 4.1; 0Σ 2.8; β 4.2
79	* 14	Σ	29. 5	1.0 c	74.	d K0	6.6 ; 7.6	1.0	ph	Σ 1.0; Cmb 0.5; Δ 1.5; Gla 1.2
90	18	Σ	94. 7	opt	2. 7	K0	5.2 ; 7.8	2.6	ph	Σ 2.0; Δ 2.2; Gla 2.6 |Gla 3.3|
93	22	Σ	5. 3	1.0 c	5. 1	d A2	5.3 ; 8.4	3.1	ph	Σ 2.0; Cmb 3.5; Δ 3.3; 0Σ 2.0;
5800	28	J	8. 0	1.0 c	5. 3	d A0	5.8 ; 8.7	2.9	4.5	J 2.0; Doo 3.0; Cin 2.7
11	39	0Σ	0. 6	1.3 m	7. 9	d F5	5.7 ; 7.1	1.4	16.5	0Σ 1.3; Δ 1.4; Com 2.4; β 2.2; A 1.5; *A 1.3
12	37	Σ	15. 3	1.0 m	39.	d G0	6.3 ; 8.5	2.2	10	Σ 2.0; Cmb 2.5; Δ 2.2; Com 1.7; Gla 2.3
20	* 43/44	H	9. 7	1.0 c	13. 6	d G0	5.8 ; 5.9	0.1	ph	Cin 0.0; Gla 0.1; See 0.5 [Gla 1.4
33	* 56	Σ	3. 0	1.0 f	1. 2	d B3	6.1 ; 7.2	1.1	23	Σ 1.3; Cmb 1.5; Δ 1.0; Com. 1.1;
„	„	H	54.	opt			··· ; 8.6	2.5	3	AC: Com 3.2; Gla 2.2
41	65	Σ	1. 2	1.0 m	3. 6	d A3	6.4 ; 6.7	0.3	53	Σ 0.4; Cmb 0.0; Δ 0.7; A 0.0; Ho 0.0;
„	„	H	21.	opt			··· ; 11.1	4.7	4	AC: Δ 4.9; β 4.9; Ho 3.5 [*A 0.4
54	81	Σ	2. 0	1.0 c	2. 7	d A2	6.8 ; 7.7	0.9	10	Σ 1.0; Δ 1.2
55	84	Σ	5. 0	1.1 c	3. 6	g K0	6.3 ; 10.7	4.4	9	Σ 4.2; Cmb 7.5; Δ 3.5
58	* 86	Σ	10. 4	1.0 m	59.	d G0	6.6 : 8.2	1.6	ph	Σ 2.1; Cmb 2.0; Δ 2.2; 0Σ 2.0;
70	90	β36	8. 2	3.7 c	3. 7	d A0	6.4 ; 12.4	6.0	1.5	β 5.9; A 7.0 |Com 2.7; A 1.1|
95	**4512**	0Σ	38. 0	4.0 opt	0. 4	g K5	6.2 ; 10.8	4.6	3	Δ 4.3; A 4.5
5921	27	Σ	74. 2	3.3 c	15. 6	d F8	4.5 ; 8.7	4.2	ph	Σ 3.7; Δ 3.7
24	29	H	84.	opt	17. 2	G0	6.3 ; 8.8	2.5	0.5	β 2.1
26	31	β18	1. 3	1.3 m	—	d A5	5.9 ; 9.2	3.3	9	β 4.0; Doo 4.0; HΣ 3.8; A 3.7;
29	34	β18	77. 1	opt	51.	A2	2.2 ; 13.1	0.9	1	β 11.0 |Ho 4.0; Lv 3.0|
35	43	H	15.	1.0 f	—	(d)A3	6.2 ; 11.0	14.8	5.5	0Σ 4.5; β 5.2; HΣ 4.0; Ho 5.7
—	* 45	Es	45. 2	n ?	0. 7	s F2	6.1 ; 9.8	3.7	2	Es 2.5
62	* 60/61	Σ	3. 7	1.0 c	1. 8	d A0	6.8 ; 8.3	1.5	11	Σ 2.3; Δ 1.7; Gla 1.9; A 1.4 (AD—B)
„	„	„	62. 9	1.0 f			··· : 6.8	0.0	ph	AD—C: Σ 0.5; Fr 0.4
[2150]	„	A	0. 2	2.1 c			··· ; 8.3	1.5		AD: A 1.9
—	79	Inn	0. 4	1.1 ?	5. 3	d A0	6.9 ; 7.4	0.5	2	Inn 0.5
—	80	Jk	14. 2	2.2 ?	7. 0	g K0	6.5 ; 13.0	6.5	1	Jk 7.7; Doo 6.9
83	81	β18	4. 2	1.3 f	—	(g)K0	6.0 ; 10.9	4.9	3	β 5.8; Doo 4.3
98	88	β36	11. 6	n?	—	K0	6.4 ; 13.1	6.7	1.5	β 7.1; A 7.2
6018	***4602**	Σ	3. 7	1.0 c	3. 7	d Fo	6.1 ; 7.4	1.3	5	Σ 1.5
13223	10	Hu	1. 9	2.1 ?	10. 1	g K0	6.3 ; 10.6	4.3	0.5	Hu 5.4

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
6067	**4639**	H	63.″4	opt	1.″9	K0	6.3; 8.5	2.2	3	Δ 2.0
94	61	β18	0. 7	1.1 m	—	d F5	6.7; 8.1	1.4	8.5	β1.2; Doo2.0; A1.5; Lv1.3; W2.0
6102	66	Σ	11. 4	1.0 c	5. 1	g K5	5.9; 9.0	3.1	ph	Σ2.3; Cmb2.5; Δ2.2; OΣ2.5; Gla2.5
11	73	OΣ	8. 3	1.0 c	5. 5	d A0	5.7; 10.1	4.4	5	OΣ 4.1; Δ 4.3; Gla 4.1
13	* 77/78	Σ	20. 0	1.0 f	1. 8	d F0	6.7; 7.0	0.3	ph	Σ 0.5; Cmb 0.8; Δ 0.8; Gla 0.4
27	91	β18	1. 2	1.3 c	12. 9	d G5	6.2; 8.8	2.6	4.5	β 2.1; Doo 3.1; Cin 2.1; Lv 2.5
31	96	β36	4. 8	opt	9. 2	B8	5.3; 12.8	7.5	1.5	β 8.3; A 9.0
33	97	Ho	9. 0	3.7 c	14. 4	g K0	4.9; 12.2	7.3	2.5	Ho 8.0; Doo 8.6; A 8.5; β 7.3
34	* 98	Σ	8. 7	1.0 c	11. 9	d F2	7.0; 7.0	0.0	ph	Σ 0.1; Cmb 0.3; Δ 0.2; Gla 0.2
47	**4708**	Σ	19. 3	1.0 c	18. 0	d F8	6.5; 9.3	2.8	11	Σ2.8; Δ3.0; OΣ1.8; Com3.2; Gla2.2
48	* 07	H	65. 9	3.3 c	1. 6	g F5	4.8; 8.3	3.5	ph	OΣ 3.2; Sh 3.0
58	19	Σ	1. 1	1.0 m	2. 2	d A5	6.6; 7.8	1.2	33	Σ1.2; Cmb1.8; Δ1.6; OΣ1.0; Com1.6;
80	* 51/52	Σ	145.	n c	2. 8	d A0p	5.4; ···	1.3	ph	Σ 1.2; Δ 1.4 [A 0.7
”	”	β36	1. 7	32. c		d A3	6.7; 13.3	6.6	1	BC: β 7.7
83	57	H	24. 0	1.0 c	24.	d A0	3.1; 8.2	5.1	ph	Δ 5.5 [LM4.0; Lv5.0; T4.4
85	58	β6	1. 8	1.3 m	25.	d G0	6.5; 10.3	3.8	12	Δ3.8; Doo4.5; β2.7; A5.3; Cin3.5;
6212	* 91/92	Σ	20. 4	1.0 c	1. 6	g K0	5.2; 6.7	1.5	ph	Σ1.5; Cmb1.5; Δ1.9; OΣ1.5; Gla1.7
39	*4821/22	Σ	5. 4	1.0 m	12. 3	d F5	6.0; 6.1	0.1	ph	Σ 0.0; Δ 0.2; Gla 0.2; Ol 0.1
42	24	H	85.	6.7 c	11. 2	d A5	6.3; 9.8	3.5	1	β 3.0
43	* 25/26	Σ	2. 3	1.0 m	56.	d F0	3.7; 3.7	0.0	ph	
”	”	β36	53. 1	n ?			···; 15.1	11.4	1	AC: β 11.5
”	”	H	102. 7	opt			···; 12.0	8.3	2	AD: β 8.6; Ab 8.2
45	29	β18	3. 6	1.3 c	7. 8	d A0	5.5; 10.3	4.8	2.5	β 5.4; Doo 5.0; Ab 5.9
84	77	Σ	33. 6	opt	2. 1	K0	6.6; 9.7	3.1	ph	Σ 2.3; Δ 2.6; Gla 1.9
87	69	H	42.	opt	9. 4	A0	5.8; 11.7	5.9	1	β 5.7
92	84	Σ	195.	n c	2. 3	K5	6.5; 7.0	0.5	ph	Σ 0.8; Δ 0.6; Gla 1.1
96	94	Σ	1. 4	1.1 m	7. 8	g K0	5.2; 7.5	2.3	13	Σ2.8; Cmb2.1; Doo3.0; Δ2.8; Ho2.5
”	”	”	28. 6	1.0 c			···; 9.9	4.7	ph	AC: Σ 4.0; Cmb 3.3; Δ 4.4; Gla 4.1
6303	* 92/93	Σ	21. 7	1.0 f	2. 2	d A2	5.3; 5.8	0.5	ph	Σ 0.5; Δ 0.5
13	*4914/15	Σ	19. 9	1.0 c	24.	d A0p	2.9; 5.4	2.5	ph	Σ 2.5; Δ 2.6; Gla 2.8
18	17	Σ	3. 2	1.0 c	5. 4	d A2	6.0; 7.8	1.8	10	Σ 1.9; Δ 2.0; Gla 1.7
37	21	Σ	21. 2	1.0 c	2. 9	d A0	5.9; 11.0	5.1	5	Σ 5.2; Δ 5.2
42	25	Clark	1. 2	1.3 c	5. 5	g K0	6.2; 9.1	2.9	8	Hl 5.0; Δ 2.8; Cin 2.7; β 4.2; Sp 2.7;
”	”	β	33. 8	opt			···; 13.4	7.2	1	AC: β 7.0 [A 3.8
43	24	β36	5. 1	32. c	3. 7	g K0	5.1; 13.3	8.2	1.5	β 9.3; A 9.0
48	31	β36	1. 5	1.3 m	9. 8	d F0	4.9; 8.3	3.4	5	β 3.6; Doo 4.3; A 3.5 [Sel 0.0
63	35	β6	0. 8	1.0 c	14. 2	g G0	6.3; 6.5	0.2	38	Δ0.5; A0.0; Cin0.2; Sp0.5; β0.0; W0.0;
67	37	β18	0. 4	1.1 c	6. 3	d F0	7.0; 7.5	0.5	31	β0.2; Doo0.4; A0.4; Lv0.5; Cin1.0;
85	48	H	6. 5	1.1 c	8. 4	d A2	6.4; ···	5.3	1.5	β 5.5; A 6.7 [T 0.0
”	”	β36	0. 4	1.1 c			11.7; 11.8	5.4	1.5	AC: β 5.7; A 6.7
”	”	H	40. 3	opt			(6.4); 12.1	5.7	1.5	AD: β 4.8; A 6.5
86	45	β6	2. 6	2.1 c	2. 9	g K0	5.7; 10.5	4.8	1.5	β 5.7; Doo 5.6
89	50	β15	0. 5	1.3 c	3. 0	d A5	6.6; 8.1	1.5	4.5	β 2.0; Doo 1.9; HΣ 1.5; A 1.3
6405	63	Σ	7. 0	1.0 c	5. 8	d A0	4.5; 8.3	3.8	ph	Σ5.0; Cmb4.5; Δ3.6; Gla4.4; Ab4.3
”	”	H	70. 5	6.7 c			···; 9.8	5.3	8	AC: Δ 5.1; β 4.5; Gla 5.2; Ab 5.3
06	68/69	Σ	0. 5	1.0 m	45.	d F5	5.2; 5.3	0.1	45	Σ 0.0; Δ 1.2; Com 0.2; A 0.0; Lv 0.3

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
6410	**4971**	β18	1.″2	2.1 c	7.″9	d F0	6.0 ; 9.9	3.9	4	β 5.0; Doo 3.9
12	74	OΣ	108.	6.7 c	2. 8	d A0	6.5 ; 10.1	3.6	4	Δ 3.2
14	81	H	70. 9	opt	31.	F2	5.1 ; 12.3	7.2	1	β 7.0
22	* 90	H	6. 7	1.0 c	3. 9	d A0	6.8 ; 7.2	0.4	ph	Δ 0.7; Gla 0.3
30	98	H	48.	opt	9. 0	K5	5.8 ; 11.2	5.4	1	β 5.0
47	**5019**	H	73. 2	opt	152.	G5	4.8 ; 10.1	5.3	0.2	H 5.0
55	31	Σ	0. 7	1.1 m	3. 4	d A0	6.7 ; 7.3	0.6	29	Σ 0.7; Cmb 0.5; Δ 1.0; OΣ 0.5
82	* 54/55	Σ	14. 3	1.0 c	15. 0	d A2p	2.4 ; 3.9	1.5	ph	Σ 2.1; Cmb 2.0; Δ 1.9; Gla 1.7
98	* 74/75	OΣ	68. 9	1.3 c	6. 7	d F0	6.7 ; 7.0	0.3	ph	Δ 0.4
6501	80	Ho	21. 1	n c	7. 3	var. Md	(4.0); 10.6	(6.6)	1	Ho 6.8; Doo 7.4
08 }	85	Σ	181.	n c	9. 1	d A0	5.4 ; ...	2.2	2	Σ 2.0
10 }	„	„	1. 6	n c			7.6 ; 9.5	4.1	2	BC: Σ 2.0
09	88	Σ	30. 0	1.0 c	4. 1	d A5	6.1 ; 10.4	4.3	ph	Σ 5.3; Δ 5.5; Ab 4.2
18	99	H	78. 3	opt	6. 6	K0	5.7 ; 12.5	6.8	1	β 6.6
„	„	β	18. 9	n ?			... ; 13.8	8.1	1	β 8.5
23	**5102**	A	1. 4	6.1 c	22. 8	d G5	6.2 ; 11.3	5.1	1	A 5.7; Doo 6.4
34	06	β18	0. 4	1.1 c	6. 7	d A0	6.5 ; 6.6	0.1	12	β 0.6; A 0.0
„	„	„	23. 8	opt			... ; 12.8	6.3	1	AC: β 6.4
40	08	H	33.	opt?	4. 1	A3	6.2 ; 10.7	4.5	2	Es 3.8
45	14	H	70.	3.3 c	11. 0	(d) K0	6.5 ; 8.7	2.2	0.5	Doo 2.0 [Ab 1.9
46	* 20	S	10. 3	1.0 c	9. 2	d A2	5.9 ; 6.9	1.0	17	Cin 1.2; W 1.0; Gla 0.8; See 3.1;
66	27	Σ	1. 0	1.1 m	10. 4	d F0	5.1 ; 7.1	2.0	18	Σ 1.9; Cmb 2.3; Δ 2.0; OΣ 1.5; Com 3.5; β 3.5; Gla 2.0; A 3.2
73	33	Σ	1. 7	1.0 c	1. 7	g K5	6.9 ; 8.3	1.4	14	Σ 1.5; Δ 1.6; OΣ 1.0; Gla 2.0
78	38	β18	0. 2	1.3 m	11. 2	d F2	6.3 ; 6.4	0.1	14	β 0.0; A 0.1; Hl 0.0
86	44	Σ	4. 8	1.0 c	4. 7	d A2	5.7 ; 9.1	3.4	9	Σ 2.9; Cmb 4.7; Δ 3.1; OΣ 2.4
89	48	Σ rej	17. 9	1.0 f	1. 6	g F8	6.3 ; 10.0	3.7	1	β 3.4
99	59	Σ	3. 3	1.0 c	30.	g K0	5.8 ; 8.0	2.2	9	Σ 2.4; Cmb 2.8; Δ 2.6; Gla 2.5
6612	70	H	43.	n ?	5. 2	A0	6.2 ; 12.2	6.0	1	β 5.8
18	73	β18	1. 6	1.3 c	2. 3	g K0	5.9 ; 9.1	3.2	3.5	β 4.6; A 3.5; Hl 4.5
„	„	Σ rej	26. 9	1.0 f?			... ; ...	4.8	2.5	AC: β 5.4; A 4,5; Hl 5.5
„	„	β	1. 7	1.0 f?			10.7 ; 11.6	5.7	2	AD: β 6.4; A 5.0; Hl 7.0
30	85	OΣ	10. 2	1.0 m	47.	d F5	4.5 ; 10.9	6.4	3	OΣ 6.6; Δ 6.4
32	86	S	71.	3.3 c	3. 8	g K0	5.6 ; 8.8	3.2	6	Δ 3.0; Fr 2.4
62	**5226**	H	56.	n f	0. 4	Ma	4.8 ; 12.3	7.5	1	β 7.5
„	„	„	90.	opt?			... ; 11.4	6.6	1	AC: β 6.4
64	27	OΣ	74. 1	opt	19. 0	K0	6.4 ; 8.5	2.1	5	Δ 1.9 [Gla 0.5; Ab 1.0; Ol 0.3]
68	33	Σ	2. 3	1.0 m	16. 4	d F8	6.7 ; 7.3	0.6	40	Σ 1.2; Cmb 1.0; Doo 1.3; Δ 0.8;
70	35	H	126.	opt	38.	G0	2.8 ; 10.5	7.7	ph	HΣ 7.2; Com 7.5
6701	64	H	79. 2	6.7 c	3. 2	d A2	4.3 ; 9.5	5.2	1	β 4.7
36	**5300**	H	77.	opt	6.″8	Ma	5.4 ; 10.4	5.0	1	β 4.5
53	13	H	62. 6	opt	5. 9	A0p	4.9 ; 9.9	5.0	0.2	H 6.0
78	28/29	H	12. 6	1.0 c	6. 8	d A5	4.6 ; 6.6	2.0	ph	Σ 2.1; Gla 2.1
95	46	Σ	3. 4	1.0 m	18. 5	d F5	6.6 ; 8.3	1.7	12	Σ 1.7; Cmb 2.0; Δ 2.1; Gla 1.9
6802	50	Σ	38. 0	1.1 c	18.	d A5	4.8 ; 8.2	3.4	ph	Σ 2.6; Δ 3.5; Gla 3.0
03	56	β36	2. 9	6.1 c	55.	d F5	5.9 ; 12.5	6.6	1.5	β 7.8; A 8.2
„	„	„	36. 3	opt			... ; 12.4	6.5	1.5	AC: β 5.5; A 8.5
42	* 85/86	Σ	6. 0	1.0 c	7. 3	d A0	5.1 ; ...	2.2	ph	β 3.2; A 2.8; Gla 2.8
„	„	β36	0. 1	1.0 m			7.3 ; 7.4	2.3	27	BC: β 0.2; Doo 0.0; A 0.1; *A 0.0
51	93	Σ	1. 4	1.0 m	8. 2	d F2	6.8 ; 8.1	1.3	2.7	Σ 1.6; Cmb 1.5; Δ 1.6; Com 1.8; Gla 1.1; Ho 1.0; Ol 1.4

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
6857	*5397	H	35."1	1.0 c	5."8	d A0	7.0; ...	0.9	ph	Δ 1.3; Doo 0.6; Gla 0.4
"	"	β6	1. 4	1.0 c			7.9; 8.7	1.7	(27)	BC: Δ 0.9; Doo 1.2; A 1.2; Hd 2.0;
—	**5404**	β.p.m.	69.	n c	47.	d F8	4.1; 10.9	6.8	1	β 6.6 [Cin 1.1; Gla 0.7; Sel 1.5
76	07	β18	4. 0	2.1 c	4. 2	d B8	5.0; 10.8	5.8	2	β 6.3; See 9.0; Inn 4.0
80	09	Σ	3. 7	1.1 c	13. 4	g K0	5.0; 9.0	4.0	ph	Σ 4.5; Δ 4.2; Gla 4.6
87	* 14/15	Σ	25. 6	1.0 c	1. 9	d A0	7.0; 7.5	0.5	ph	Σ0.6; Cmb 0.5; Δ0.9; OΣ0.5; Gla0.5
95	22	Σ rej	26. 3	1.0 f	—	(d) B9	6.0; 9.4	3.4	1.5	Cin 2.5; β 3.5
6905	28	β12	2. 4	1.3 f	—	g K0	6.1; 10.5	4.4	2.5	β 4.8; Doo 5.0; A 5.0; See 6.6
10	29	H	53. 2	opt	14. 8	K0	3.8; 11.6	7.8	1.5	β 8.3; Ho 8.0
13	33	A	0. 2	1.3 m	8. 8	d A2	6.6; 6.8	0.2	15	A 0.2; Doo 0.0
15	35	β18	26. 1	opt	18. 2	F0	3.0; 12.6	9.6	1	β 10.2
19	30	H	57.	n f ?	2. 1	K2	4.4; 12.0	7.6	1.5	β 7.1; Doo 9.0
52	74	β6	1. 0	1.1 f?	—	(d) B9	6.7; 8.3	1.6	7	β 1.4; A 1.6; See 2.2
54	* 75/76	Σ	5. 8	1.0 c	1. 8	d A0	4.9; 5.8	0.9	ph	Σ 1.1; Cmb 0.7; Δ 1.0; Gla 0.7
55	77/78	Σ	1. 1	1.0 m	6. 1	d A2	4.5; 4.8	0.3	53	Σ 0.4; Cmb 0.5; Δ0.2; A 0.5; Ho 1.0;
88	92	Σ	3. 0	1.0 m	8. 3	d F2	6.3; 8.8	2.5	7	Σ 2.2; Cmb 3.5; Δ 2.8 [Lv 0.0]
89	97	H	9. 0	1.0 c	21.	d F5	5.2; 6.9	1.7	ph	Se 1.0; Cin 2.0; W 1.5; Gla 1.3; See 2.8
90	**5503**	Hn	2. 6	1.3 c	3. 0	g K0	6.6; 11.2	4.6	1.5	β 4.9; Doo 5.8
93	* 05/06	Σ	2. 6	1.0 c	4. 9	g K0	2.7; 5.1	2.4	ph	Σ 3.3; Cmb 3.5; Δ 3.4; OΣ 3.2; Gla 3.8; Ho 3.0
7009	21	S	60. 7	opt	3. 3	K0	5.8; ...	2.6	4	β 2.0; Doo 2.2; A 2.1; Gla 2.8
"	"	β18	2. 7	opt			8.4; 10.6	2.2	5	BC: β3.0; Doo2.5; Cin2.7; See3.2; A2.9
12	* 23	β6	1. 3	1.0 c	6. 6	d A2p	5.8; 6.6	0.8	44	Δ0.9; Gla0.8; A0.6; Sp0.7; Cin1.8; En 1.2; W 2.0; T 1.1; Lv 1.2;
"	"	β36	18. 3	opt?			...; 14.2	8.4	1.5	AC: β 9.1; A 9.5 [Doo 0.9
"	"	"	25. 9	opt?			...; 13.7	7.9	1.5	AD: β 8.5; A 8.5
"	"	β18	27. 3	8.0 c?			...; 12.2	6.4	1.5	AE: β 7.1; A 6.0 [Ho 0.7
14	24	Σ	1. 2	1.0 c	11. 8	d F5	6.4; 7.5	1.1	27	Σ1.6; Cmb1.0; Δ1.4; OΣ1.0; Gla1.5;
18	* 31	H	231.	n c	13. 5	A3	2.9; 5.2	2.3	ph	Sh 2.0
31	* 38	Σ	3. 7	1.0 c	11. 3	d F5	6.2; 6.6	0.4	45	Σ0.7; Cmb0.5; Δ0.6; Gla0.4; Es0.1
32	37	Σ rej	16. 3	0.6 ?	1. 9	d F2	6.4; 10.1	3.7	5	Σ 4.0; Es 2.0; β 3.3
34	* 44	Σ	7. 0	1.0 m	16. 8	d G5	4.8; 6.8	2.0	ph	Σ1.9; Cmb2.3; Δ2.0; OΣ1.5; Com2.5; Gla 2.4; A 2.0; Ho 4.0; Lv 2.5
49	50	OΣ	0. 6	1.1 m	1. 0	g G0	6.9; 7.6	0.7	45	OΣ0.7; Δ0.9; Com1.1; HΣ0.5; Gla0.8;
60	* 68	H	10. 8	1.0 m	203.	d K5	5.9; 8.1	2.2	ph	Δ 9.0 [Lv 0.8
65	69	OΣ	4. 5	1.1 f	0. 1	(d) A0	6.1; 10.1	4.0	4.5	OΣ3.5; Δ4.3; Ab4.1; Ho4.0
68	73	H	86.	opt?	6. 9	K0	5.7; 9.1	3.4	0.5	β 2.9 [W 0.5; Lv 0.0
70	77	β6	0. 8	1.0 m	4. 7	d A5	6.3; 6.7	0.4	41	β0.0; Doo0.2; A0.5; See1.1; Cin0.5;
77	* 82	Σ	19. 4	1.0 c	13. 1	(d) K0	6.0; 10.1	4.1	7	Σ 4.2; Δ 4.0; Gla 3.7
79	83	β36	9. 3	3.7 c	39.	d F5	6.0; 12.6	6.6	2	β 6.9; Doo 6.6; A 7.5
96	94	β6	0. 4	1.3 c	3. 0	g K0	6.2; 7.6	1.4	15	Δ2.3; OΣ0.8; HΣ 1.5; A 1.0; Sp 2.5;
7103	97	OΣ	35. 5	1.1 c	3. 8	d A0p	6.2; 8.8	2.6	5	Δ 2.4; Fr 2.2 [W 1.0; T 2.7; β0.9]
11	***5610**	Σ	9. 6	1.0 f	—	(d) F0	7.0; 7.3	0.3	ph	Σ 0.0; Cmb 0.0; Δ 0.2; Gla 0.1
20	* 18	Σ	2. 8	1.0 m	40.	d G0	5.3; 6.0	0.7	ph	Σ0.9; Cmb0.5; Δ0.8; Com1.0; Gla1.0;
26	27	β36	6. 0	2.1 c	6. 3	d A0	5.6; 12.7	7.1	1	β 7.7 [Es 0.4; Lv 0.5
[2350]	33	A	0. 1	2.1 ?	8. 7	d A0	6.8; 6.8	0.0	10	A 0.0
7140	40	H	56.	n f	1. 7	K0	6.0; 10.7	4.7	1	β 4.1
50	52	H	59.	1.5 c	6. 1	d A0p	4.7; ...	4.9	7	β 5.0; Com 4.7; A 5.0; W 6.0
"	"	β18	1. 8	1.5 c			9.6; 9.8	5.1	(14)	BC: β 0.4; A 0.0; W 0.7 [Fr 0.7
62	* 59	Σ	24. 8	1.0 c	64.	d G5	6.8; 7.6	0.8	ph	Σ0.9; Cmb0.5; Δ0.8; OΣ1.0; Gla0.8;
81	74	OΣ	126.	opt	—	K5	6.2; 8.7	2.5	2	OΣ 2.5; Hu 1.5
94	81	Σ	105.	1.0 c	15. 5	g K0	3.6; 8.1	4.5	ph	Σ4.2; Δ4.3; OΣ 4.0; Gla 4.9; Fr 3.8
97	88	See	20. 3	n ?	—	K0	6.3; 13.5	7.2	0.5	See 8.4

Table 1. Continued.

G.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
7213	5694	Σ	10.″0	1.0 c	64.″	d G0	5.2 ; 9.8	4.6	ph	Σ 5.0; Cmb 6.5; Δ 5.2; 0Σ 4.0
19	**5703**	β	47. 2	n ?	2. 8	F5	6.1 ; 8.7	2.6	0.5	β 2.2
22	10	β6	2. 2	1.3 c	12. 5	g K0	5.5 ; 9.5	4.0	8	Δ 4.6; Doo 5.3; 0Σ 3.5; A. 4.0; β 4.6; Lv 5.0; Hl 5.5; T 4.9
51	27/28	Σ	1. 0	1.0 m	24.	d G0	5.6 ; 6.1	0.5	65	Σ 0.5; Cmb 0.7; Δ 0.8; 0Σ 1.0; Gla 0.5; A 0.5; Ho 0.7; Lv 0.1
58	* 33/34	Σ	108.	1.3 c	17. 0	d F0	4.5 ; ...	2.7	ph	Σ 2.7; Fr 1.9; Gla 1.9; Ab 1.6
59	„	„	1. 3	1.3 m			7.2 ; 7.7	3.2	(57)	BC: Σ 0.6; Lv 0.4; Δ 1.3; 0Σ 1.0; Com 0.4; Gla 0.3; A 0.8
94	56	S	11. 4	1.0 c	9. 9	d A5	6.2 ; 8.3	2.1	4	Gla 2.3; Sc 1.7; Ab 2.4
7301	65	S	9. 1	1.0 c	4. 3	d A3	7.0 ; ...	0.8	ph	
„	„	See	0. 2	1.0 c			7.8 ; 7.8	0.8	...	B=C
[2381]	74	A	0. 1	2.1 ?	2. 8	d A2	5.7 ; 5.7	0.0	10	A 0.0
7314	87	β	41. 3	opt	6. 6	K0	4.0 ; 11.4	7.4	1	β 7.2
18	* 88/89	Σ	2. 6	1.0 m	6. 9	d F0	4.2 ; 5.1	0.9	ph	Σ 1.0; Cmb 1.5; Δ 1.4; Gla 1.0
34	*5815/16	Σ	11. 8	1.0 c	3. 3	(d)F8	6.5 ; 6.6	0.1	ph	Σ 0.1; Δ 0.1; Gla 0.2
—	24	Inn	2. 5	1.1 ?	3. 0	g K0	5.1 ; 8.6	3.5	0.5	Inn 4.0
49	31	0Σ	15. 2	1.0 f	—	(g)G5	6.3 ; 10.2	3.9	6.5	0Σ 3.1; Δ 3.5; Gla 4.4
52	* 33/34	Σ	6. 0	1.0 f	1. 4	d B8	5.1 ; 6.0	0.9	ph	Σ 0.9; Cmb 1.1; Δ 1.0; Gla 1.4
60	42	Hu	0. 2	1.3 m	9. 1	d A2	5.2 ; 5.2	0.0	12	Hu 0.0; A 0.0
62	* 29	Σ	30. 1	1.0 c	25.	d G5	6.9 ; 7.6	0.7	ph	Σ 0.9; Δ 1.1; Gla 0.9
67	50	β18	0. 5	1.1 f	—	g G5	7.0 ; 7.5	0.5	36	β 0.7; Doo 0.7; Δ 0.0; HΣ 1.5; A 0.5; Sp. 0.0; En 0.4; Lv 1.0; T 0.5
68	49	Σ	0. 7	1.3 m	10. 5	d A0	4.0 ; 6.5	2.5	8.5	Σ 3.0; Δ 3.0; 0Σ 3.0; Com 3.1; A 3.0
[2386]	53	A	3. 5	2.1 ?	17.	(d)G5	5.8 ; 11.4	5.6	0.5	A 7.1
7372	54	H	61. 5	opt	13. 9	K0	2.8 ; 13.0	10.2	ph	β 8.4; Doo 11.5
86	67	Σ	30. 6	1.0 c	9. 1	d A2	3.7 ; 9.9	6.2	ph	Σ 6.2; Cmb 6.0; Δ 5.7; 0Σ 6.5; [Gla 6.4
7402	87	β18	1. 3	2.1 m	1. 1	d A2	5.8 ; 10.3	4.5	3	β 5.8; Doo 4.5
03	93	Ho	29. 2	8.0 c?	19. 1	d K0	6.4 ; 12.3	5.9	1	Ho 6.5; Doo 5.7
18	**5904**	β6	2. 4	1.0 c	3. 4	d B3	4.8 ; 6.8	2.0	8	Cin 2.6; Lv 1.8; See 3.1; W 2.0; T 4.7; [Sel 3.5; Teb 2.5; Sc 4.0
[2396]	13	A	3. 5	1.3 ?	2. 3	d F2	6.1 ; 11.0	4.9	0.5	A 6.4
—	15	Hu	0. 4	2.1 ?	4. 5	d B5	6.1 ; 7.8	1.7	1	Hu 2.0
7431	28	See	38. 4	n ?	3. 3	B3	4.0 ; 13.4	9.4	0.5	See 10.5
42	36	H	95. 2	opt	8. 4	F2	5.5 ; 9.8	4.3	0.5	Fks 4.0
44	44	β18	49. 9	opt?	3. 9	B2	3.0 ; 9.2	6.2	1.5	β 6.0; Doo 6.5
53	47	Clark	2. 1	32. c	10. 9	g K0	4.2 ; 10.8	6.6	3.5	Doo 7.2; β 7.3; HΣ 8.0
80	68	S	79.	opt	80.	F8	5.4 ; 10.4	5.0	ph	HΣ 5.0; Lv 3.2; Fks 3.6
87	* 77/78	Σ	1. 1	1.0 m	7. 5	d (F8)	4.8 ; 5.0	0.2	70	Σ 0.3; Δ 0.2; Com 0.1; Gla 0.2; A 0.1; Lv 0.3; *A 0.3
„	„	„	6. 7	1.0 m			... ; 6.7	1.9	13.5	AC: Σ 2.3; Δ 1.9; Com 1.9; Gla 1.6; Lv 2.5; Ab 1.6; *A 2.4
93	* 84/85	β18	0. 9	2.5 c	3. 1	s B1	2.9 ; 8.5	5.6	2	β 6.8; Hl 7.0; A 8.0
„	„	H	13. 6	1.0 c			... ; 5.1	2.2	ph	AC: Δ 2.4; Gla 1.8
95	89	β18	1. 4	1.1 m	—	d F5	6.5 ; 8.5	2.0	2.5	β 2.7; Doo 2.1; A 2.3; Lv 2.3
„	„	Σrej	28. 5	1.0 f			... ; 10.4	3.9	3	AC: β 3.6; Lv 3.3
„	„	β	52. 2	opt			... ; 11.1	4.6	3	AD: β 4.0; Lv 3.7
7502	**6002**	β6	3. 3	1.1 c	6. 5	d A0	5.7 ; 9.6	3.9	8.5	Δ 4.3; β 4.3; Cin 4.0; Lv 4.5; T 4.5
14	08/09	Σ	31. 2	opt	4. 5	G5:	5.3 ; 6.5	1.2	ph	Σ 1.0; Cmb 1.0; Δ 1.2; Gla 0.9
31	* 18	β36	3. 1	32. c	33.	(d)K0:	4.9 ; 12.0	7.1	1.5	β 8.4; A 9.0
32	29	H	4. 4	1.0 c	6. 6	d B9	5.8 ; 8.0	2.2	8	Cin 1.9; Gla 2.5; Sc 2.0; See 2.7; Inn 2.0
33	26/27	β	0. 7	1.1 c	3. 4	d B3	4.6 ; 5.9	1.3	26	Δ 2.5; Gla 1.9: A 0.8; Sp 0.3; Cin 1.8; LM 2.0; T 3.0; β 1.0; Hl 3.0; Lv 1.5
„	„	H	38.	opt	—		... ; ...	2.3	ph	AC: Gla 2.4; A 3.0; Sp 2.8; Cin 2.9; Lv 3.4
„	„	Mh	1. 1	opt	1. 4	d A	6.9 ; 7.6	0.7	24	CD: Mh 1.0; A 1.0; Sp 1.0; Cin 0.9; [Lv 0.7
44	43	0Σ	5. 3	1.1 f	—	g K0	6.4 ; 10.6	4.2	4	0Σ 4.0; Δ 4.2; Ho 4.0

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
7552	**6052**	Σ	2.″7	1.1 c	7.″5	d F2	6.4 ; 9.9	3.5	4	Σ 3.6; Δ 4.5; Ab 3.3
53	50	Σ rej	23.	0.6 ?	4. 5	g K5	6.0 ; 10.9	4.9	6	Σ 5.0; β 3.7; Es 4.8
63	* 63/64	Σ	1. 3	1.0 m	31.	d G0	5.8 ; 6.7	0.9	ph	Σ 1.1; Cmb 1.0; Δ 1.0; Gla 0.9; Ab 1.1; Ho 1.0; Lv 1.2; A 1.0
"	"	OΣ	21. 1	opt			… ; 13.1	7.3	1	AC: OΣ 7.5
"	"	Σ	43. 7	opt			… ; 11.0	5.2	ph	AD: Σ 5.5; Δ 4.9; Gla 4.2; Ab 5.0
70	74	H	55. 9	opt	2. 8	A0	5.7 ; 12.5	6.8	1.5	β 6.5; Doo 7.2
"	"	"	88. 6	opt			… ; …	4.0	1.5	AC: β 4.0; Doo 2.5
"	"	"	13. 2	opt			9.7 ; 11.1	5.4	1	AD: β 5.0
"	"	"	126. 4	opt			(5.7) ; 9.2	3.5	1	AE: β 3.0
72	* 77	H	23. 3	1.0 c?	6. 7	d F2	5.7 ; 7.1	1.4	ph	Cin 1.1 ; See 1.0
81	84	H	20. 5	1.0 c	3. 4	d B1	3.1 ; 8.5	5.4	ph	Gla 5.2; Sh 5.0
92	92	β36	6. 5	2.0 ?	3. 2	d B5	3.9 ; 12.3	8.4	1.5	β 9.7; A 9.7
96	95	H	38. 3	opt	6. 2	F0	3.8 ; 9.5	5.7	5	Com 5.9; Δ 5.0; OΣ 5.0; Fr 4.8
99	**6105 06**	H	6. 6	1.0 c	12. 4	d G0	5.9 ; 6.6	0.7	ph	Cin 1.4; Gla 0.7; See 1.4
7608	07	Σ	372.	opt	4. 9	K5; Ma	5.2 ; 5.4	0.2	ph	AB: Σ 0.3; Δ 0.7; Ab 0.1
"	"	H	66.	opt			… ; 11.6	6.4	2	AC: β 5.7; Ab 6.7
"	"	"	104.	opt			(5.4) ; 10.6	5.2	ph	BD: β 5.2; Ab 5.4
12	10	H	36. 4	opt	2. 2	A2	6.2 ; 9.1	2.9	ph	OΣ 2.2; Δ 2.4; Fr 2.1
13	* 12/13	H	4. 0	1.0m?	2. 4	d B5	5.2 ; 5.9	0.7	ph	β 0.3; Gla 0.3; See 0.5
24	17	β18	1. 9	6.1 c	7. 8	d A0p	4.5 ; 9.9	5.4	2	β 7.0; Doo 6.2; A 6.1
"	"	"	33. 8	opt			… ; 11.0	6.5	4	AC: β 6.5; Com 7.2; Doo 6.8; A 6.8
31	* 34	Mh	2. 6	1.0 c	3. 4	s Ma	1.2 ; 6.4	5.2	6	Δ 6.1; Gla 6.0
32	30	Σ	0. 9	1.1 m	4. 7	g G5	6.0 ; 7.0	1.0	24	Σ 1.2; Δ 1.4; OΣ 1.0; Gla 0.8; Es 1.5
33	37	Σ	4. 6	1.0 c	7. 3	d F0	6.5 ; 9.5	3.0	8	Σ 2.7; Δ 3.1; Gla 2.8
34	32	OΣ	4. 6	1.0 c	6. 1	g G5	2.9 ; 8.8	5.9	ph	OΣ 6.0; Δ 6.7
48	47	β18	32. 4	opt?	6. 6	K0	4.4 ; 12.8	8.4	1	β 8.5
49	49	Σ	0. 8	1.1 m	9. 7	d A0	4.1 ; 5.5	1.4	22	Σ 2.1; Cmb 1.7; Δ 1.5; Com 1.8; [Gla 1.7; Lv 1.4
53	* 50	Hu	(6. 0)	1.0 ?	2. 5	g K0	6.4 ; 11.7	5.3	0.5	Hu 6.6
72	62	Σ	16. 2	1.0 c	2. 9	d A0	5.6 ; 8.5	2.9	ph	Σ 2.5; Δ 2.2; Gla 2.7
7702	* 84/85/86	Σ	3. 7	1.0 c	2. 5	d A2	5.6 ; 6.6	1.0	ph	Σ 1.0; Δ 1.2; Gla 1.1; OΣ 1.0
03		"	90. 4	1.3 c			… ; 5.6	0.0	ph	AC: Σ 0.0; Gla 0.2
11	94/95	Σ	69. 6	1.3 f	2. 0	d A0	5.7 ; 6.8	1.1	ph	Σ 1.0; OΣ 1.0; Gla 1.2
14	**6200**	Σ	22. 3	opt	4. 5	Ma	5.1 ; 10.5	5.4	ph	Σ 6.7; Δ 5.5; OΣ 3.0; Ab 5.8
17	12	Σ	0. 9	1.0 m	61.	d G0	3.1 ; 6.2	3.1	19	Σ 3.5; Cmb 4.5; Δ 3.9; Com 4.0; Gla 3.5; A 3.1; Ho 3.0; Lv 3.5
18	16	β12	1. 7	2.1 ?	2. 6	d A0	6.4 ; 10.5	4.1	2	β 5.0; A 5.7; See 4.7
38	20	Σ rej	113.	opt	10. 0	K0	3.6 ; 12.5	8.9	1	β 9.0
47	28	H	80. 0	opt	1. 6	K2	5.4 ; 9.4	4.0	ph	Δ 3.4; OΣ 2.9
58	32	Σ	22. 2	opt	3. 7	A2	6.1 ; 9.3	3.2	ph	Σ 3.3; Δ 3.0
68	46	Σ	5. 6	1.0 c	3. 7	d A0	6.0 ; 9.9	3.9	ph	Σ 4.8; Δ 4.6
77	55	OΣ	0. 8	1.1 c	2. 8	d A0	5.7 ; 7.3	1.6	10	OΣ 1.9; Δ 2.0; Com 2.0
79	54	β18	1. 8	1.3 m	7. 6	d A2p	4.9 ; …	4.8	11	β 4.8; Doo 4.7; A 4.2; HΣ 4.5; Lv 4.5; [(A—BC)
[2454]	"	A	0. 2	1.3 m			9.7 ; 9.7	4.8	(10)	BC: A 0.1
7792	* 67	Ku	2. 7	1.1 c	21.	d F2	6.1 ; 9.7	3.6	3.5	β 3.3; Lv 3.6; Hu 6.0
7801	91	β12	0. 7	1.0 m	0. 6	d A0	6.2 ; 6.5	0.3	33	Doo 0.3; β 1.1; Ho 0.0; W 0.2; Lv 0.3; [A 0.0
03	94	H	5. 6	1.0 c	2. 2	d B8	6.7 ; 7.1	0.4	10	Gla 0.4
04	93	β18	2. 5	2.1 c	10. 7	g K2	5.6 ; 11.1	5.5	2.5	β 7.2; Doo 5.8; OΣ 6.0
05	92	Σ rej	18. 0	2.0 c	3. 2	g K0	6.3 ; 11.4	5.1	1	β 5.0

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
7834	**6319**	Σ	0.″8	1.0 m	5.″8	d F0	7.0 ; 7.3	0.3	42	Σ 0.5; Δ 0.0; Com 0.2; β 0.5; A 0.5
36	26	Σ	19. 1	1.0 c	2. 5	d A0p	6.2 ; 10.6	4.4	ph	Σ 4.8; Δ 3.9
37	29	Σ	1. 3	1.0 m	—	d A0	6.7 ; 7.5	0.8	20	Σ 1.2; Δ 1.3; Gla 0.6
45	41/42	Σ	292.	opt	5.4;14.6	A0; K2	5.9 ; 6.2	0.3	ph	Σ 0.5; Δ 0.2
46	22	β	77. 6	opt	1. 5	G5	4.4 ; 11.4	7.0	1	β 6.8
47	43	β15	1. 5	1.3 c	3. 7	g K5	6.6 ; 10.4	3.8	8	β 4.4; Doo 4.4; Lv 4.4; Com 3.0
52	52	Perry	1. 7	1.3 c	2. 0	d A0	6.2 ; 9.3	3.1	1	β 3.3
55	55	H	48. 6	opt	5. 4	A3	4.9 ; 10.6	5.7	4	Σ 6.0; Com 5.4
65	61	Σ	20. 1	1.0 c	5. 5	d A2	6.3 ; 9.0	2.7	8	Σ 2.2; Δ 3.2; Gla 1.8
68	64	Ho	24. 2	n ?	13. 1	K2	5.7 ; 12.3	6.6	1	Ho 7.5; Doo 7.9
13362	67	A	0. 4	1.3 ?	3. 2	d A0	6.3 ; 7.9	1.6	1	A 2.0
7878	* 69/70	Σ	3. 3	1.0 m	10. 9	d F5	5.8 ; ···	0.1	ph	Σ 0.1; Δ 0.0; Gla 0.1; Lv 0.1
”	”	β	12. 2	25. c			5.9 ; 13.3	7.5	1.5	AC: β 8.0; A 8.5
85	78	β36	0. 3	1.0 m	9. 2	d A2	3.1 ; 3.7	0.6	23	β 0.5; Com 1.4; A 0.6; Lv 0.5
”	”	”	93.	opt			··· ; 12.6	9.5	1	AC: β 9.6
”	”	”	100.	opt			··· ; 11.2	8.1	1	AD: β 8.1
86	77	{Ho	19. 4	0.6 ?	3. 0	d A5	6.1 ; 10.6	4.5	2	AC—B: Ho 6.0; Doo 5.0; Es 6.2
13364	”	{Hu	0. 1	2.1 m			··· ; 6.1	0.0	12	AC: Hu 0.0; A 0.0
94	83	Es	17. 0	1.2 ?	2. 3	d B9	6.3 ; 11.3	5.0	3	Es 4.7; β 4.7
7905	***6401/02**	H	5. 5	1.0 m	123.	d K0	5.3 ; 5.3	0.0	ph	Gla 0.5; A 0.0; See 0.5
07	04	β18	4. 2	1.3 f	—	g K0	6.2 ; 11.1	4.9	4.5	Δ 5.1; β 5.0; Hu 5.5; Cin 4.0
09	6399	Σ	5. 3	1.0 f	—	(d) A2	6.1 ; 9.8	3.7	7	Σ 3.8; Δ 3.5; Es 3.6
14	* 6406/07	Σ	4. 6	1.0 c	2. 9	g Mb	3.5 ; 5.6	2.1	ph	Σ3.1; Cmb 4.5; Δ2.5; OΣ1.5; Gla3.5;
”	”	β	23. 5	opt?			··· ; 14.9	11.4	1	AC: β 12.0 [A 2.2; Ho 3.0
”	”	”	84. 7	opt			··· ; 11.1	7.6	1	AD: β 7.6
22	* 10	Σ	25. 8	opt	16. 5	A2	3.2 ; 8.6	5.4	ph	Σ 5.1; Gla 5.2; Ab 6.5
26	14	H	20. 5	2.0 f	1. 5	d B8	5.8 ; 11.3	5.5	···	(H)
[2488]	15	A	0. 5	2.1 ?	6. 5	g K0	5.0 ; 7.2	2.2	2	A 3.0
7928	24/25	H	10. 3	1.0 c	7. 2	g K0	5.4 ; 6.9	1.5	ph	Se 1.2; Cin 2.3; Gla 1.2
57	46	H	50.	opt	3. 6	A0	4.4 ; 9.0	4.6	ph	Gla 3.6 |Sp 1.3; W 1.2; Lv 1.1|
43	35	β6	1. 7	1.0 c	2. 1	d A0	6.4 ; 7.6	1.2	16.5	Δ1.1; Doo 2.0; Gla 1.4; Ho1.5; Cin1.2;
”	”	β18	11. 4	1.2 c			··· ; 11.8	5.4	3.5	AC: β 5.8; Ho 5.5; Cin 3.7
44	31	OΣ	4. 3	1.3 c	2. 2	d B3	4.6 ; 9.5	4.9	3.5	OΣ 5.4; Δ 5.0; Ho 5.0
—	41	A	5. 0	2.1 ?	21. 2	d G0	6.6 ; 13.0	6.4	0.5	A 7.5
76	58	OΣ	163.	opt	106.	G0	5.4 ; 10.4	5.0	ph	OΣ 4.3; β 4.6
89	72	Hn	3. 9	1.3 c?	4. 5	g K0	6.0 ; 10.9	4.9	2	Com 5.8; Doo 5.6; Ho 5.5
98	82	Σ	4. 0	1.1 c	3. 4	d B9	6.3 ; 10.3	4.0	9	Σ 4.5; Cmb 5.0; Δ 3.5
8003	* 84/85	Σ	3. 6	1.0 c	3. 8	d A0	4.5 ; 5.5	1.0	ph	Σ 1.1; Δ 1.2; Gla 1.0; Ho 1.0
13373	88	Hu	0. 2	1.3 ?	4. 3	(d) F8	7.1 ; 7.2	0.1	2	Hu 0.1
8007	91	OΣ	32. 5	1.5 c	5. 3	g G5	6.5 ; 9.6	3.1	3	Δ 2.7
13	99	H	50. 6	opt?	3. 7	A5	6.4 ; 11.8	5.4	1	β 5.0
”	”	”	52. 6	opt?			··· ; 12.1	5.7	1	AC: β 5.5
31	**6512**	β12	0. 9	2.1 m	—	g G5	6.5 ; 9.9	3.4	5	β 4.2; Doo 4.2; A 3.6
38	16	Σ	0. 6	1.0 m	21.	d G5	6.0 ; 6.2	0.2	60	Σ 0.3; Δ 0.4; Com 0.1; Gla 0.3; A 0.0
[2510]	24	A	0. 1	2.1 ?	3. 9	g G0p	6.3 ; 6.3	0.0	10	A 0.0 [Lv 0.4
8062	36	β36	3. 9	10. c	1. 5	g G0	3.0 ; 11.9	8.9	1	β 11.0
63	44	H	53.	1.5 c?	3. 8	d B8	5.6 ; 9.5	3.9	5	Cin 3.0; β 3.5; Gla 3.7
67	48	Σ	41. 0	1.0 c	1. 7	d A2	6.0 ; 7.8	1.8	ph	Σ 1.7; OΣ 2.0; Gla 2.0
76	* 54/55	Σ	61. 7	1.0 c	16. 0	d A5	5.0 ; 5.0	0.0	ph	Σ 0.0; Gla 0.2

Table 1. Continued.

B.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
8082	**6559**	Σ	10.″1	1.0 c	2.″8	d A2	5.9; 9.2	3.3	ph	Σ 3.5; Δ 3.1; HΣ 3.0; Gla 3.4
93	75	H	111.	3.3 c	4. 7	g K0	6.4; 8.6	2.2	2.5	0Σ 1.8; Sh 1.5
99	73	β18	1. 3	2.1 m	56.	d F8	5.3; 9.8	4.5	5.5	β 5.7; Com 5.0; A 6.7; Ho 5.0; Cin 5.5;
″	″	...	780.	n c			...; 10.1	4.8	...	[*A 4.7
8114	* 92	Σ	16. 1	1.0 c	5. 2	g K0	6.6; 9.1	2.5	7	Σ 2.3; Δ 2.5; Gla 2.3
15	91	0Σ	112. 8	opt	9. 0	K0	6.4; 7.8	1.4	ph	Δ 1.0; Fr 0.9
20	94	β18	1. 3	2.1 c	9. 6	d F5	5.6; 9.6	4.0	3.5	β 4.2; Doo 4.3; A 5.3
36	*6609/10	Σ	20. 5	1.0 c	1. 2	d A0	6.2; 6.6	0.4	ph	Σ 0.3; Δ 0.6; Gla 0.4
37	11	H	38.	1.5 f?	—	(d)A3p	6.2; 9.8	3.6	1	β 3.1
62	* 23	Σ	29. 8	1.0 c	81.	d G5	3.5; ...	6.7	ph	Σ 7.2; 0Σ 5.5; β 6.2; Ab 7.3
″	″	Clark	1. 8	1.0 m			10.2; 10.8	7.3	(36)	BC: Da 0.5; 0Σ 1.0; Com 0.9; β 0.1; A 0.4; Lv 0.7
63	27	Σ	0. 7	1.3 c	2. 9	d A0	5.8; 7.5	1.7	14	Σ 2.0; Δ 1.8; 0Σ 1.5; HΣ 1.0; Gla 2.0;
64	26	Σ	7. 5	1.0 c	1. 9	g K0	6.6; 10.2	3.6	5	Σ 3.2; Δ 3.6 [A 1.2
78	45	Stone	10. 0	1.0 f	—	(d)A0	6.8; 8.0	1.2	5	Cin 1.0; Doo 1.4; Gla 1.3
82	* 36/37	Σ	30. 8	1.0 c	27.	d F5	4.9; 6.1	1.2	ph	Σ 1.2; Δ 1.2; 0Σ 0.5; Gla 1.6
8210	65	0Σ	0. 6	1.1 m	2. 2	g K0	7.2; 7.5	0.3	17	0Σ 0.3; Com 0.2; Ho 0.2
35	77	β6	1. 8	1.3 c	4. 8	g K0	5.2; 8.5	3.3	11.5	Δ 3.3; Doo 2.7; 0Σ 3.2; HΣ 4.0; Lv 3.5; β 3.7; T 3.3
36	81	H	20. 5	1.0 c	6. 1	d A0	6.0; 9.1	3.1	3.5	Cin 2.5; Gla 2.8; β 3.6
″	″	″	34.	6.7 c			...; 11.8	5.8	1	AC: β 5.6
41	89	Σ	1. 0	1.0 f	—	d A2	6.8; 7.0	0.2	30	Σ 0.2; Δ 0.4; Gla 0.1
44	93/94	H	5. 6	1.0 c	2. 6	g K5	5.3; 7.1	1.8	ph	Cin 2.0; Gla 1.3; See 1.9
74	**6705**	β18	20. 8	2.0 c	2. 7	g K5	2.4; 12.8	10.4	1	β 11.0
″	″	″	47. 8	opt?			...; 12.8	10.4	1	AC: β 10.5
″	″	″	56. 6	opt?			...; 12.8	10.4	1	AD: β 10.5
″	″	″	97. 5	n?			...; 11.8	9.4	1	AE: β 9.5
″	″	″	124. 7	n?			...; 11.1	8.7	1	AF: β 8.8
84	14	β36	6. 7	2.5 f	1 4	s B5p	3.9; 12.5	8.6	1.5	β 9.8; A 10.0
″	″	H	55.	1.0 f			...; ...	4.1	ph	AC: β 3.8; Δ 3.4; 0Σ 3.5; En 3.7
″	″	β18	8. 4	1.4 f			8.0; 12.3	8.4	(1)	CD: β 4.0
″	″	β	45. 9	n?			(3.9); 11.1	7.2	1	AE: β 7.0
85	16	β18	8. 0	2.2 ?	1. 2	d B0	5.7; 12.3	6.6	1	β 6.8
″	″	β36	14. 1	n?			...; 13.3	7.6	1	AC: β 8.0
99	23	β36	1. 0	2.1m?	2. 6	d A2	4.5; 8.4	3.9	4	β 4.0; Doo 4.2; A 4.9
8302	* 29/30	Σ	6. 0	1.0 c	3. 0	d A3	5.1; 5.2	0.1	ph	Σ 0.0; Cmb 0.2; Δ 0.2; Gla 0.1
03	* 33/34	Σ	0. 4	1.3 m	4. 5	d F0	5.3; 6.0	0.7	46	Σ 0.7; Cmb 1.0; Δ 1.2; Com 1.4;
09	37	Ho	13. 3	0.7 ?	—	(g)K5	6.3; 12.0	5.7	0.5	Ho 7.0 [Gla 0.7; Lv 0.8
13	42	See	33. 3	n?	1. 5	s F8p	4.3; 12.9	8.6	0.5	See 9.7
40	* 52	Σ	3. 9	1.0 m	110.	d K0	4.3; 6.0	1.7	ph	Σ 2.0; Δ 1.7; Com 2.1; Gla 2.1; Ab 2.1; A 2.1; Lv 1.8; Ho 1.0
47	53	Σ	27. 5	opt	2. 4	A0	6.2; 8.4	2.2	11	Σ 1.9; Δ 2.0; Gla 2.6; Es 2.0
48	* 58	Σ	6. 8	1.0 f	—	(d)A0	7.0; 7.4	0.4	ph	Σ 1.0; Cmb 0.8; Δ 0.9; Gla 0.6
59	71	Newcomb	25. 3	3.3 c	10. 3	d A3	3.7; 13.3	9.6	3	HΣ 10.0; β 10.0
″	″	H	51. 7	opt			...; 10.7	7.0	1	AC: β 6.8
69	76	H	40. 9	nf?	—	A0	6.5; 10.2	3.7	2.5	Cin 3.0; β 2.8
71	80	β6	4. 0	1.0 c	4. 0	g K0	5.7; 8.5	2.8	6	Cin 3.0; Doo 2.9; Lv 2.6; See 3.4
72	75	Clark	1. 7	1.3 m	11. 7	d F8	5.2; 9.1	3.9	10	Da 4.5; Doo 4.2; Com 4.5; β 5.9; 0Σ 3.6; A 5.4; Ho 5.0
77	* 81/82	Σ	13. 8	1.0 c	2. 9	d A3	5.9; 6.0	0.1	ph	Σ 0.0; Δ 0.0; Gla 0.2
80	95	Σ	1. 5	1.0 m	4. 0	d F2	6.0; 7.2	1.2	27	Σ 1.5; Δ 1.6; Com 2.2; A 1.0; Lv 0.9
82	87	Clark	23. 4	2.0 f	1. 7	d B3	4.3; 11.4	7.1	1.5	β 7.2; A 8.0
88	97	β18	7. 2	1.3 c	18. 6	d F5	5.7; 11.3	5.6	1.5	β 6.0; Doo 6.2

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
8390	**6798**	β6	0.″7	1.0 m	5.″5	d A2	7.0 ; 7.2	0.2	29	Δ 0.4; Doo 0.4; β 0.0; Lv 0.1; T 0.3
91	92	OΣ	2. 1	1.3 c	2. 1	d A0	6.3 ; 10.2	3.9	3	OΣ 4.1; Δ 4.2
95	**6801**	H	42.	opt?	3. 7	K0	5.1 ; 10.4	5.3	1.5	β 4.8; Doo 5.1
98	* 03	Σ	1. 2	1.0 m	1. 6	d F2	6.6 ; 7.3	0.7	20	Σ 1.1; Δ 1.1; Gla 0.6 [Cin 6.5
8413	12	H	16. 9	1.0 f	0. 6	s B8p	4.0 ; 10.3	6.3	6.5	β 7.0; Δ 6.7; Ho 6.0; Lv 6.7; See 6.5;
"	"	β26	25. 2	2.0 f?			‥; 11.9	7.9	4	AC: β 9.0; Δ 8.5; Ho 8.0; See 8.0
"	"	H	48. 3	1.5 f			…; 9.7	5.7	ph	AD: β 5.5; Δ 4.2; Gla 4.5; Ho 5.0; Lv 5.0
"	"	"	50. 1	1.5 f			…; 9.4	5.4	ph	AE: β 5.5; Δ 4.6; Gla 5.6; Ho 5.0;
22	14	Ho	0. 5	6.1 c	2. 4	d A2	5.9 ; 9.5	3.6	3	Ho 4.0; Doo 4.2 [Lv 5.2
29	23	β26	5. 6	2.1 f	1. 0	d B1	6.0 ; 12.3	6.3	2	β 6.5; See 8.9; Bd 7.0
41	* 09/10	Σ	20. 6	1.0 m	13. 2	d F5	5.8 ; 6.2	0.4	ph	Σ 0.7; Δ 0.7; Gla 0.5
67	48	β18	0. 5	1.1 m	0. 7	d B0	7.4 ; 7.7	0.3	18	β 0.0; A 0.0; Doo 0.8; *A 2.0
"	"	H	16. 4	1.0 f			…; 7.7	0.3	12	AC: β 0.3; A 0.2
"	* "	β26	8. 3	opt			…; 13.6	6.2	1.5	AD: β 6.3; A 7.0
76	49	β18	96.	n ?	3. 4	F0	6.4 ; …	4.3	2	AB: β 3.4; A 4.7
"	"	β36	0. 8	n ?			10.7 ; 11.3	4.9	1.5	AC: β 4.2; A 5.6
"	"	β18	5. 0	n ?			(10.7) ; 11.0	4.6	2	AD: β 4.0; A 4.8
80	59	See	25. 7	1.4 ?	5. 1	g K0	2.8 ; 12.7	9.9	0.5	See 11.5
"	"	"	40. 1	n ?			…; 13.7	10.9	0.5	See 12.0
"	"	"	58. 1	n ?			…; 11.7	8.9	0.5	See 10.0
81	57	H	39.	opt	6. 3	K0	5.6 ; 11.6	6.0	1	β 5.8
96	66	H	28.	2.0 f	1. 5	g G5	4.9 ; 11.5	6.6	1	β 6.7
98	69	Σ	113.	opt	89.	K0	3.4 ; 10.9	7.5	ph	Σ 8.7; Δ 8.0
8529	* 96	Clark	2. 4	1.0 c	2. 2	g K0	5.1 ; 7.6	2.5	ph	Da 3.5; A 3.0; See 4.5
35	98	Clark	0. 4	1.1 m	—	d F5	6.8 ; 6.9	0.1	22	Da 0.2; Lv 0.2; *A 0.0
42	**6901**	Ho	17. 1	n ?	—	K2	6.5 ; 12.6	6.1	1	Ho 6.5; Doo 6.3
48	04	Σ	0. 5	1.1 m	1. 5	d A0	6.6 ; 7.6	1.0	13	Σ 1.0; β 0.7; Gla 2.0; A 1.0; Lv 1.5
49	09	β6	1. 8	1.0 c	4. 6	d A5	6.9 ; 7.1	0.2	53	Sp 0.0; Doo 0.1; Gla 0.1; See 0.5; Cin 0.2; Lv 0.4; T 0.0; Sel 0.0; Sc 0.0
62	* 18	Σ	3. 9	1.0 f	1. 3	d A0	5.5 ; 7.6	2.1	ph	Σ 2.3; Cmb 2.7; Δ 2.5; Gla 2.2
64	26	Washingt	41. 7	1.0 c	10. 0	d A0	6.8 ; 7.9	1.1	2	Gla 1.0
69	24	β40	5. 0	1.0 ?	1. 2	d B3	6.4 ; 12.5	6.1	3	β 6.2; Lv 7.5
"	"	"	61. 5	n ?			…; 8.8	2.4	0.5	AC: β 2.0
74	23	Σ	3. 1	1.0 c	6. 4	d A2	4.9 ; 7.6	2.7	ph	Σ 3.0; Δ 2.9; OΣ 2.5; Gla 2.6
"	"	"	89.	1.3 c			…; 7.7	2.8	ph	AC: Σ 2.4; Gla 2.4
78	20	OΣ	0. 5	1.3 m	3. 2	s A0p	4.4 ; 6.2	1.8	7	OΣ 1.7; Δ 2.4; *A 1.7
95	41	Σ	19. 5	2.0 c	2. 8	d B5	6.5 ; 11.5	5.0	6	Σ 5.3; Δ 4.5; Ab 5.6
97	44	See	25. 5	n ?	3. 5	A0	5.2 ; 13.3	8.1	0.5	See 8.9
8605	46	Σ	12. 3	1.0 c	3. 0	d B3	5.8 ; 8.9	3.1	ph	Σ 3.3; Δ 3.2; Gla 2.7
36	67	OΣ	38. 9	4.0 f	—	(d) B8	6.3 ; 10.1	3.8	6	Δ 3.3; Gla 3.7
40	68	β36	7. 4	2.1 f?	0. 7	d B8	5.4 ; 12.0	6.6	2	β 7.3; Doo 7.5; A 7.2
62	80	OΣ	0. 6	1.0 m	2. 0	g K0	6.4 ; 6.6	0.2	19	OΣ 0.3; Doo 0.0; Δ 0.3
63	* 81	OΣ	1. 2	1.0 m	8. 2	d G0	6.8 ; 7.0	0.2	34	OΣ 0.4; Δ 0.2; Com 0.2; Lv 0.2
69 }	83	Σ	25. 6	1.0 f	0. 8	g K0	6.2 ; 8.8	2.6	ph	AC—B: Σ 2.2; Δ 3.2; Gla 3.2; A 3.0
[2657] }	"	A	0. 1	2.1 ?			…; 6.2	0.0	10	AC: A 0.0
—	87	Jk	26. 9	n ?	14. 6	d F2	5.4 ; 12.9	7.5	1	Jk 9.0; Doo 8.3
8670	89	β6	2. 4	1.3 c	2. 7	d B9	6.5 ; 11.0	4.5	7.5	Δ 4.8; Doo 5.5; Lv 5.4; Cin 4.8;
79	99	A	0. 1	2.1 m	—	d F8	7.1 ; 7.4	0.3	10	A 0.2 |β 5.0; W 4.5; LM 5.0|
81	97	Σ	7. 3	1.1 c	2. 5	d B8	5.5 ; 10.0	4.5	ph	Σ 5.2; Δ 4.9; OΣ 3.3
92	7001	Σ	43.	opt	34.	A0	0.1 ; 10.1	10.0	ph	Σ 9.5; Δ 7.8; Gla 9.3
"	"	Wn	47.	opt			…; 10.9	10.8	1.5	AC: Wn 11.0; Com 10.3

Table 1. Continued.

B.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
8699	**7007**	Σrej	24.″5	opt	—	K0	6.1 ; 11.0	4.9	2.5	β 4.5; Doo 5.0; Com 5.2
8707	10	Σrej	25.	0.6 ?	7. 0	g K0	6.4 ; 10.1	3.7	3.5	Σ 3.5; Ab 4.2; Cg 5.0; β 3.0
25	20	H	52. 5	1.5 f	1. 4	d F0	4.7 ; 9.7	5.0	1	β 4.5
—	32	Jk	20.	n?	2. 3	g G5	5.1 ; 12.6	7.5	0.5	Jk 8.6
48	33	Σ	25. 1	1.0 f	—	(d)B5	6.4 ; 7.8	1.4	12	Σ 1.5; Δ 1.5; Gla 1.1
66	46	See	12. 5	n?	2. 4	K2	5.8 ; 13.3	7.5	2	See 9.1; Cg 8.3; β 7.5
76	48	Σ	2. 2	1.0 m	1. 5	d A0	6.3 ; 6.8	0.5	20	Σ 0.4; Cmb 0.6
79 *	59	Σ	13. 2	1.0 c	3. 1	d A0	5.9 ; 7.3	1.4	ph	Σ 1.8; Δ 1.1; Gla 1.2
„	„	β	27. 5	opt			… ; 11.4	5.5	1	AC: β 5.6
83 *	51/52	Σ	3. 0	1.0 m	5. 9	d A3	5.1 ; 6.0	0.9	ph	
85 *	53/54	Σ	2. 5	1.0 m	5. 9	d A5	5.1 ; 5.4	0.3	ph	
[2703]	55	A	3. 3	6.1 ?	0. 4	(d) F5	5.8 ; 12.1	6.3	0.5	A 7.9
8786	61	β18	45.	opt	34.	F5	4.3 ; 11.5	7.2	1	β 7.0
„	„	H	61.	opt			… ; 9.7	5.4	1	AC: β 5.0
88 *	56/57	β	26. 9	opt?	2. 7	d A3	4.3 ; 13.8	9.5	3.5	β 11.0; A 10.5; Lv 11.0
„	„	β	43. 3	opt?			… ; 14.0	9.7	3.5	AC: β 9.4; A 9.8; Lv 10.5
„	„	Σ	43. 7	1.0 c			… ; 5.7	1.4	ph	AD: Σ 1.3; OΣ 1.0; Gla 1.5; Fr 1.1
„	„	β	61. 6	n?			… ; 12.4	8.1	1.5	AE: β 8.0; A 8.8
8818	78	See	17. 0	n?	2. 6	K0	5.4 ; 12.6	7.2	1	See 8.7; Cg 7.4
25	75	Σ	1. 8	1.1 c	1. 0	g K0	6.3 ; 9.1	2.8	8	Σ 2.8; Δ 2.8; Gla 3.5; Es 2.5
27	83	H	22. 5	opt	—	K0	6.2 ; 12.3	6.1	1	β 6.2
„	„	„	114.	opt			… ; 8.0	1.8	3	AC: β 1.4
33	88	β	21. 4	n?	4. 5	F0	6.2 ; 13.0	6.8	1	β 7.0
37	89	β18	14. 3	nf	0. 6	s Nb	6.8 ; 11.2	4.4	5.5	β 4.8; Lv 4.1; Cg 4.3
60	99	Σ	3. 5	1.0 f	—	g K2	7.0 ; 8.0	1.0	ph	Σ 1.2; Cmb 1.1; Δ 1.4; Gla 1.8
62	***7100**	β	36. 2	opt?	1. 4	d B2	5.8 ; 11.6	5.8	(ph)	β 5.5
„	„	H	58. 5	4.0 f			… ; 10.7	4.9	6.5	AC: β 4.5; Com 4.8; OΣ 3.5
„	„	β	17. 8	nf ?			(10.7); 11.7	5.9	1	AD: β 5.7
64 *	02	Ho	19. 0	2.0 f ?	2. 5	d A2	5.2 ; 12.0	6.8	1	Ho 7.5; Doo 8.3
68 *	06	Σ	45. 7	1.0 f	0. 7	s B8p	(3.4) ; 7.8	(4.4)	ph	Σ 3.7; Δ 4.1; OΣ 2.7; Gla 3.8; Fr 3.9
„	„	β	46. 3	nf ?		(var.)	… ; 13.0	9.6	1.5	AC: β 10.0; A 9.7
„	„	A	64.	n ?			… ; 13.5	10.1	0.5	AD: A 10.8
„	„	β	66.	nf ?			… ; 9.4	6.0	5.5	AE: β 6.2; Δ 5.9; OΣ 4.7; A 6.2; Fr 5.1
„	„	β	86.	nf ?			… ; 9.7	6.3	4.5	AF: β 6.0; Δ 6.4; A 5.5; Fr 5.3
79	16	β36	1. 8	2.1 f ?	1. 8	g G5	5.0 ; 10.1	5.1	2	β 5.5; A 5.9; See 8.9
„	„	H	28. 2	1.0 f			… ; 10.7	5.7	1.5	AC: β 5.0; See 7.8
8906	25	Σ	30. 3	opt	8. 6	K0	4.8 ; 8.1	3.3	ph	Σ 3.0; Δ 3.4; OΣ 2.5; Gla 3.3
08 *	33	β18	35. 4	opt?	0. 4	G0	4.6 ; …	6.8	2	β 6.5; Doo 8.0; Ho 6.0
„	„	„	7. 0	opt?			11.4 ; 11.5	6.9	2	AC: β 6.5; Doo 8.3; Ho 6.1
14 *	41/42	Σ	21. 6	1.0 c	5. 0	d A5	4.5 ; 5.4	0.9	ph	Σ 0.2; Δ 0.3; Gla 0.4
16	40	OΣ	1. 5	2.1 f	1. 1	g G0	6.1 ; 10.9	4.8	1	OΣ 5.2
„	„	„	45. 5	1.0 f			… ; 7.8	1.7	ph	AC: OΣ 2.0
23	46	Ho	8. 2	3.7 f	0. 7	g K0	5.6 ; 13.0	7.4	2	Ho 7.0; Doo 7.4; β 8.9
„	„	„	23. 2	2.0 f ?			… ; 12.0	6.4	2	AC: Ho 6.0; Doo 5.4; β 7.4
26	54	β36	1. 5	6.1 c	14. 3	d F5	5.9 ; 11.5	5.6	1.5	β 6.8; A 6.5
33	62	β18	0. 6	2.1 m	22. 1	d G0	5.3 ; 8.3	3.0	9	β 3.6; Doo 2.7; Com 4.2; A 3.1; Lv 2.6
36 *	65	Ho	6. 2	1.1 f	0. 8	g F5	5.4 ; 10.5	5.1	1	Ho 5.4; Doo 5.3
40	72	Σ	18. 6	opt	12. 0	F5	5.4 ; 9.3	3.9	ph	Σ 3.5; Δ 3.9; OΣ 3.0; Gla 2.6

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
8955	**7178**	Clark	13.″7	1.0 f	0.″7	d A0p	3.3 ; 11.6	8.3	1.5	OΣ 8.8; A 9.5
63	79	Σ	18. 7	1.0 c	3. 1	d B5	6.2 ; 9.0	2.8	5	Σ 2.3; Δ 2.9
65	94	Hd	0. 6	1.0 m	2. 1	d A2	3.3 ; 3.7	0.4	23	Hd 1.0; β 0.6; A 0.5; See 0.0
"	"	H	75.	0.5 ?			... ; 9.5	6.2	1	AC: β 6.0
75	7203	H	7. 4	1.0 c	4. 5	g G5	6.1 ; 10.1	4.0	2	Cin 3.5
"	"	"	20.	opt			... ; 11.4	5.3	1	AC: Cin 4.7
77	7191	Σ	16. 6	1.0 c	4. 3	g K0	6.5 ; 9.1	2.6	ph	Σ 2.5; Δ 2.8; Gla 3.3
—	7212	Jk	25. 6	1.2 ?	—	(d) B3	6.2 ; 11.9	5.7	1.5	β 5.5; Jk 7.1
95	7217	See	34. 5	n?	10. 0	K0	3.9 ; 12.8	8.9	0.5	See 10.0
97	7199	Σ	5. 6	1.0 c	2. 0	d A0	6.7 ; 7.3	0.6	ph	Σ 0.8; Δ 0.9; Gla 0.6
99	**7215**	H	42.	opt	9. 1	A5	5.1 ; 10.8	5.7	1	β 5.5
9005	25	H	37. 2	1.0 c	2. 8	g K0	5.8 ; 7.2	1.4	ph	Gla 2.3; β 2.0
06	30	H	47.	n?	1. 5	A0p	5.9 ; 12.3	6.4	1	β 6.2
11 }	29	Σ	4. 8	1.0 c	3. 0	g K2	6.5 ; ...	3.9	7	A—BC: Σ 2.7; Δ 3.5; Ab 2.9
— }	"	Hu	0. 2	1.0 c			10.4 ; 10.5	4.0	5	BC: Hu 0.2
20	35	β26	4. 9	2.5 c	10. 2	d A0	3.0 ; 11.3	8.3	2.5	β 9.0; OΣ 8.8; Hl 12.0
22	39	S	6. 2	1.0 c	16.	d B8	6.0 ; 8.6	2.6	5	Cin 1.7; Doo 3.1
53	61	Σ	3. 7	1.1 m	10. 5	d F0	5.1 ; 9.0	3.9	8.5	Σ4.1; Cmb5.2; Δ4.2; OΣ3.5; Com6.1
78	72	Σ	17. 3	1.0 c	19. 0	d G5	6.9 ; 8.0	1.1	14	Σ 1.3; Δ 1.0; OΣ 1.0; Gla 1.5
9116	85	β6	0. 7	1.1 f	2. 9	d B9	6.9 ; 7.5	0.6	20	Δ 1.3; Doo 1.0; A 0.2; T 1.0; Ho 0.2
"	"	OΣ	120. 7	opt			... ; 7.6	0.7	ph	AC: Δ 0.8; A 1.1; Fr 0.5
18	87	H	36.	n f	0. 7	B8	5.1 ; 12.6	7.5	1	β 7.3
37	* 93/94	Σ	10. 4	1.0 m	65.	d G5	6.6 ; 6.8	0.2	ph	Σ 0.5; Cmb 0.5; Δ 0.2; Gla 0.2
44	98	Σ	27. 8	1.0 f	0. 3	d B3	4.5 ; 8.5	4.0	ph	Σ 4.1; Δ 3.8; Gla 3.3
49	**7300**	OΣ	89. 6	1.3 f	2. 0	s G5	5.7 ; 7.7	2.0	8	Δ 1.8; β 1.5
64	07	Σ	8. 1	1.0 f	1. 8	d A0	5.5 ; 8.6	3.1	9	Σ 3.0; Cmb 2.5; Δ 3.2; Gla 3.4
66	06	H	39.	opt?	0. 4	B5	4.6 ; 11.8	7.2	1	β 7.0
67	05	OΣ	0. 8	1.0 f	0. 9	d B9	6.8 ; 7.2	0.4	29	OΣ 0.1; Doo 0.5; Δ 0.6; Gla 0.4
"	"	"	47. 8	1.5 f			... ; 9.9	3.1	2	AC: OΣ 2.2; Com 3.5
84	17	H	46.	opt	28.	K2	6.3 ; 12.0	5.7	1	β 5.5
85	11	Σ	2. 4	1.1 c	1. 4	g G5	6.4 ; 9.6	3.2	5	Σ 3.8; Δ 3.5
86	14	H	101. 6	opt?	1. 1	K0	4.5 ; 8.5	4.0	3	Cin 3.0; β 3.8
89	19	Σ	3. 3	1.1 c	1. 5	g K0	5.4 ; 8.6	3.2	9	Σ 4.0; Δ 3.3; Gla 3.6
94	18	β6	1. 8	1.3 f	1. 3	d B0	5.4 ; 8.9	3.5	12	Δ3.8; Doo3.9; OΣ3.5; Ho4.0; Lv3.3; [β3.5; T3.6
9207	31	S	59.	1.1 f	1. 8	d F0	5.4 ; 8.2	2.8	4.5	OΣ 2.4; Δ 2.4; β2.8
16	39	H	47.	n ?	0. 6	B8	6.4 ; 11.7	5.3	1	β 4.8
60	60	H	16. 7	opt	—	K0	6.2 ; 8.5	2.3	2.5	See 3.0; Inn 4.0
77	69	Σ	336.	opt	1. 9	A0	6.0 ; 6.9	0.9	ph	Σ 0.8; Δ 1.0; Gla 0.8
94	85	H	25.	opt	10. 6	K0	5.3 ; 10.2	4.9	4	HΣ 4.5; β 5.0
9300	86	OΣ	27. 9	opt	66.	F8	6.2 ; 11.0	4.8	7	OΣ 4.4; Com 4.9; β 3.9
08	91	Σ	22. 6	opt	5. 7	K5	6.0 ; 10.7	4.7	ph	Σ 4.8; Δ 5.0; OΣ 4.0; Gla 4.0
30	98	H	8. 0	1.0 c	5. 0	g K0	5.6 ; 8.8	3.2	5	Doo 2.5; Cin 3.0; Gla 3.1; β 2.2
55	**7412**	Σ	34. 9	opt	2. 4	K5	6.4 ; 11.5	5.1	ph	Σ 4.2; Δ 4.0; Com 5.2
74	* 17/18	Σ	34. 2	1.0 f	1. 0	g K0	3.2 ; 5.3	2.1	ph	Σ 2.3; Δ 2.4; OΣ 2.0; Gla 2.4; Fr 2.3
—	19	Jk	15.	2.2 ?	—	d A0	6.0 ; 12.6	6.6	0.5	Jk 7.7
"	"	"	15.	2.2 ?			... ; 12.6	6.6	0.5	Jk 7.7

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
9404	**7429**	β18	21."4	opt	27."	K0	4.7 ; 12.4	7.7	3	β 8.5; Lv 8.5
"	"	"	21. 1	opt			··· ; 12.4	7.7	3	AC: β 8.5; Lv 8.5
16	37	β36	9. 5	3.7 f?	0. 5	d B8	4.9 ; 13.0	8.1	1.5	β 8.4; A 9.2
17	40	β18	2. 9	2.1 c	7. 5	d B9	4.7 ; 9.8	5.1	2	β 6.1; See 7.0; Cin 5.5
32	25	Σrej	25. 3	0.7 ?	4. 4	d A2	6.4 ; 9.5	3.1	1	Σ 3.0
40	45	β36	3. 7	1.3 ?	—	(d)A2	6.5 ; 11.7	5.2	1.5	β 6.4; A 6.2
—	47	Jk	28.	1.2 ?	1. 7	d B5	4.3 ; 11.7	7.4	0.5	Jk 8.5
48 *	48	Σ	76. 6	3.3 f	—	(g)K5	6.6 ; 8.3	1.7	ph	Σ 2.0; Δ 1.4; Gla 2.2
—	56	Jk	9. 0	2.2 ?	—	(g)G5	6.2 ; 12.9	6.7	0.5	Jk 7.8
"	"	"	19. 0	1.2 ?			··· ; 11.5	5.3	0.5	Jk 6.3
58	63	H	91. 8	opt	2. 0	K0	5.8 ; 8.6	2.8	ph	OΣ 1.8; Δ 2.3; Fr 2.1
70	66	H	21. 0	1.2 ?	2. 6	d B5	6.3 ; 11.2	4.9	1	β 4.7
75	70	See	0. 1	2.1 ?	3. 0	d A0	6.8 ; 7.3	0.5	10	See 0.5
85	69	β36	3. 6	32. c	25.	d F5	4.6 ; 12.2	7.6	1.5	β 9.3; A 9.5
"	"	OΣ	29. 9	opt			··· ; 10.6	6.0	1	AC: OΣ 6.0
86	74	H	48. 8	n?	0. 2	B3	5.2 ; 12.0	6.8	1	β 6.6
96	76	H	36.	opt	8. 5	g K0	5.5 ; 12.3	6.8	1	β 6.6
"	"	"	46.	1.1 c			··· ; 8.6	3.1	3	AC: β 3.8; Gla 2.3
—	79	Jk	20.	n?	3. 6	g G0	4.4 ; 12.6	8.2	0.5	Jk 9.5
04	80	H	43.	nf?	2. 3	A0	5.5 ; 12.9	7.4	1	β 7.2
9506	77	H	25.	opt	14. 4	K0	6.6 ; 9.8	3.2	0.5	AB: β 2.9
"	"	"	56.	opt			··· ; ···	3.4	0.5	AC: β 2.9
"	"	"	10.	opt			10.0 ; 12.3	5.7	1	AD: β 5.3
12	81	Ho	0. 7	6.1 f	—	(d)A2	6.1 ; 10.3	4.2	2.5	Ho 5.5; Doo 4.6
16	85	Σrej	15. 3	1.0 ?	—	(d)B3	6.5 ; 9.7	3.2	3.5	β 2.3; Doo 3.0
19	89	β12	0. 2	1.3 ?	6. 2	d F0	5.8 ; 5.8	0.0	10.	β 0.0
31 *	97	OΣ	0. 6	1.3 c	1. 3	g F5	5.6 ; 7.2	1.6	6	OΣ 1.2; Δ 2.1; HΣ 1.5
54	**7500**	Σ	18. 0	1.0 c	1. 5	d A2	6.4 ; 8.4	2.0	9	Σ 2.3; Δ 1.7; Gla 1.9
60 *	03/04	Σ	37. 3	1.0 m	21.	d G0	6.3 ; 6.4	0.1	ph	Σ 0.2; Δ 0.6; OΣ 0.5; Gla 0.2
69 *	08	β18	0. 5	2.1 c	1. 5	s K0	6.6 ; 9.4	2.8	5.5	Doo 3.0; β 3.2; OΣ 3.0; HΣ 2.5
76	12	Ho	15. 5	0.7 ?	—	(d)A0	6.0 ; 11.8	5.8	1	Ho 6.5; Doo 7.0
"	"	"	33. 6	n?			··· ; 11.9	5.9	1	AC: Ho 5.5; Doo 5.8
05	28	Σ	1. 7	1.0 m	6. 5	d A0	3.0 ; 7.4	4.4	12.5	Σ 4.9; Cmb 5.2; Δ 4.5; OΣ 4.5;
9607	29	Σ	14. 7	1.0 f	—	(d)A0	6.5 ; 7.0	0.5	ph	Σ 0.8; Gla 0.8 [Gla 5.6; Ho 5.0
09	30	H	35. 0	opt	1. 2	K0	6.3 ; 8.7	2.4	6	Δ 2.2; OΣ 2.2; Fr 1.8
17 }*	34	Σ	25. 7	1.0 c	45.	d F5	5.1 ; 8.5	3.4	ph	AB: Σ 3.0; Δ 3.2; OΣ 2.8
}	"	"	720.	nc			··· ; ···	3.1	5	AC: Σ 2.4; Δ 2.9
02 }	"	"	3. 0	nc			8.2 ; 8.5	3.4	"	CD: Σ 0.0; Cmb 0.7; Δ 0.4
19	35	Ho	3. 1	2.1 c	4. 0	g K2	6.4 ; 11.8	5.4	1.5	Ho 6.5; β 6.3
"	"	β40	9. 7	n?			··· ; 13.9	7.5	1	AC: β 7.8
"	"	H	33. 4	opt			··· ; 8.1	1.7	8	AD: β 1.0; OΣ 1.6; Ho 1.5
—	38	Inn	2. 5	1.3 ?	20.	d F0	6.1 ; 10.0	3.9	0.5	Inn 4.5 [Lv 0.5
34 *	44	Σ	1. 5	1.0 f	1. 1	g F2	6.2 ; 6.7	0.5	50	Σ 0.8; Cmb 0.5; Δ 0.6; Gla 0.4;
38	43	H	25.	1.2 ?	1. 6	d B9	5.7 ; 11.6	5.9	1	β 6.0
43	46	Clark	0. 2	1.3 m	3. 0	d A2	5.5 ; 6.1	0.6	30	β 1.2; Δ 1.0; A 0.3; Lv 0.5; *A 1.0
"	"	Σ	8. 4	1.0 c			··· ; 8.7	3.2	ph	AC: Σ 2.6; Gla 3.3
48	*7394*	H	60. +	n?	2. 7	Mb	6.6 ; 13.2	6.6	0.2	H 7.5
49	**7553**	Ho	19. 0	opt	4. 3	F0	5.6 ; 12.8	7.2	2	Ho 7.6; Doo 7.8; β 7.9 [HΣ 0.2
50	50	OΣ	0. 5	1.1 m	11. 9	d F5	7.1 ; 7.5	0.4	24	OΣ 1.0; Doo 1.3; Δ 0.1; Com 1.5 ;

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
9661	**7555**	Es	11.″4	0.7 ?	1.″6	g G5	6.2 ; 11.2	5.0	3	Es 5.1; β 4.9; Ab 5.8
—	60	Jk	15.	2.2 ?	27. 0	d G0	5.2 ; 12.6	7.4	0.5	Jk 8.5
77	66	H	54.	opt	10. 2	Ma	5.4 ; ···	4.5	1.5	β 3.8; Eng 5.0
„	„	„	21. 8	opt			9.9 ; 11.3	5.9	1	AC: β 5.7
82	72	Σ	13. 5	1.0 f	—	(d) B5	6.5 ; 10.1	3.6	8	Σ 2.9; Δ 3.6; Gla 3.8
90	78	H	18.	opt	43.	K0	6.3 ; 10.7	4.4	1	β 4.0
97	84	H	46. 5	opt	2. 2	K5	6.0 ; 11.9	5.9	1	β 5.7
9707 ÷	93/94	Σ	35. 5	1.0 c	2. 2	d B3	5.8 ; 6.5	0.7	ph	Σ 1.0; Δ 0.9; Gla 1.1
13	82	Σ	2. 7	1.1 c	9. 0	g K0	4.0 ; 7.0	3.0	ph	Σ 3.6; Δ 3.5; Gla 3.8 ;
18	98	β18	12. 3	1.2 c	6. 3	d A0	6.0 ; 11.7	5.7	1.5	β 6.0; Doo 5.6
19	99	Σ	1. 9	1·0 c	6. 0	d F0	6.9 ; 7.7	0.8	12	Σ 1.1; Δ 1.0; Gla 1.0
24	**7602**	OΣ	12. 3	1.0 c	49.	d K0	3.9 ; 11.4	7.5	3	OΣ 7.4; Δ 8.1
32	07	OΣ	9. 8	1.0 f	0. 3	(d) B9	6.5 ; 9.1	2.6	4	OΣ 2.3; Δ 2.3
„	„	„	16. 2	1.0 f			··· ; 11.0	4.5	3	AC: OΣ 4.1; Δ 4.0
44	11	OΣ	75. 2	6.7 c	5. 2	d A0	6.1 ; 9.5	3.4	4	Δ 3.0
52	15	β18	7. 0	6.1 c	5. 0	g K0	4.0 ; 11.7	7.7	1.5	β 8.0; A 10.2
„	„	H	46. 1	opt			··· ; 10.7	6.7	1	AC: β 6.5
„	„	„	49. 5	opt			··· ; 10.7	6.7	1	AD: β 6.5
„	„	β	61. 7	n ?			··· ; 11.5	7.5	1	AE: β 7.5
65	19	Σ	3. 3	1.0 c	5. 1	d A3	4.9 ; 7.4	2.5	ph	Σ 2.5; Cmb 3.3; Δ 2.1; Gla 1.9
82	38	OΣ	0. 4	1.3 c	1. 5	d A2	6.9 ; 8.5	1.6	5	OΣ 1.8; β 1.2
„	„	Σ	3. 2	1.0 c			· · ; 8.7	1.8	5	AC: OΣ 1.8; β 1.5
87	42	Σ	2. 3	1.0 f	—	(d) B5	6.6 ; 7.6	1.0	22	Σ 1.1; Cmb 1.0; Δ 1.5; Gla 1.0
97	45	H	28. 9	n ?	1. 5	g Mb	5.6 ; 12.2	6.6	1	AB: β 6.8
„	„	„	114.	1.6 ?			··· ; ···	3.3	0.5	AC: β 2.8
9800	„	„	23. 0	1.6 ?			8.9 ; 8.9	3.3	0.5	AD: β 2.8
33	57	OΣ	0. 6	1.1 m	10.	d F0	5.9 ; 6.3	0.4	49	OΣ 0.4; Doo 0.3; Δ 0.6; Com 0.3;
51	62	OΣ	47. 7	1.5 c	4. 1	g K2	6.2 ; 9.9	3.7	4	Δ 3.3 [Gla 0.3; Lv 0.5
54	60	H	41. 7	opt	2. 0	K0	5.3 ; ···	3.7	ph	Δ 3.2; Fr 3.3; β 2.3
„	„	β18	8. 9	opt			9.0 ; 13.2	4.2	1	BC: β 3.9
„	„	β40	10. 1	n ?			(9.0); 14.4	5.4	1	BD: β 5.4
82	78	H	29. 2	0.6 ?	1. 2	d B0	5.7 ; 10.6	4.9	1	Es 5.6
84	80	β6	2. 3	1.3 c	4. 5	g Ma	6.6 ; 10.4	3.8	11.5	Δ 4.4; Doo 3.5; β 4.6; OΣ 3.5; HΣ 3.7;
9907	82	OΣ	96. 6	opt	4. 7	G5	6.7 ; 8.0	1.3	5	Δ 1.3 [Lv 4.5
26	93	Σ	4. 4	1.0 c	5. 1	d F5	6.5 ; 8.7	2.2	7	Σ 2.1; Δ 2.2; Gla 2.3
35	95	Σ	4. 9	1.0 m	4. 7	d A2	6.2 ; 9.9	3.7	6	Σ 3.9; Δ 3.6; Ab 3.9
55	**7705**	Σ	11. 4	1.0 c	11. 7	d F2	6.5 ; 8.6	2.1	ph	Σ 2.3; Δ 2.3; OΣ 1.7; Gla 2.3; Fr 2.3
„	„	„	70. 7	opt			· · ; 7.2	0.7	36	AC: Σ 1.1; Δ 0.5; OΣ 0.7; Com 0.8;
										Gla 1.1; Fr 0.8 |Gla 0.1|
82 *	17	Σ	3. 3	1.0 f	—	(d) A0	6.8 ; 7.2	0.4	44	Σ 0.3; Cmb 0.7; Δ 0.4; OΣ 0.5;
10017	23	Σ	2. 4	1.1 m	—	d A0	6.5 ; 9.6	3.1	9	Σ 3.1; Cmb 3.8; Δ 3.4; Gla 3.3
25	26	Clark	3. 8	1.1 c	2. 5	g K2	6.4 ; 10.2	3.8	3	Da 5.5; Δ 4.1; OΣ 3.5
31	33	β18	9. 4	3.7 c?	2. 1	g K2	6.3 ; 12.4	6.1	3.5	β 6.5; HΣ 5.8; A 6.5
—	36	β.p.m.	212.	n c	10.	d A0	5.0 ; 6.6	1.6	ph	β 2.0
33	38	β26	27. 1	n ?	1. 5	B9	6.4 ; ···	6.8	1.5	β 7.3; A 7.0
„	„	„	8. 1	n ?			13.2 ; 13.9	7.5	1.5	AC: β 7.8; A 8.0
36 *	35	H	36. 5	n ?	0. 4	g K0	4.0 ; 13.2	9.2	1	β 9.3
„	„	Σ	106. 8	1.3 f			··· ; 7.1	3.1	ph	AC: Σ 2.8; Δ 1.9
„	„	„	338.	n f			··· ; 5.1	1.1	ph	AD: Σ 1.3; Δ 1.0
40	39	β18	0. 8	2.1 f	0. 4	d B3	4.9 ; 8.4	3.5	2	β 4.1; A 4.5

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
10041	**7737**	OΣ	0.″6	1.1 c	2.″4	d B8	7.1 ; 7.4	0.3	14	OΣ 0.2; Δ 0.6
”	”	”	11. 8	1.0 c			··· ; 9.8	2.7	4	AC: OΣ 2.5; Δ 2.4
49	43	A	2. 4	6.1 ?	13. 1	(d) G5	5.8 ; 12.1	6.3	0.5	A 8.0
54	47	β26	43. 4	n ?	1. 6	s G0p	4.6 ; 14.0	9.4	1	β 9.5
”	”	H	44. 3	opt			··· ; 10.0	5.4	1	β 5.0
57	54	H	7. 5	1.0 c	5. 9	g G5	3.8 ; ···	7.5	4	Hl 9.0; β 8.3; Δ 8.6; See 8.0
”	”	Clark	1. 1	1.0 c			11.3 ; 11.4	7.6	···	BC: Hl 1.0; β 0.3; See 0.0
70	61	H	53. 7	opt	1. 1	K0	5.5 ; 8.1	2.6	6.5	Com 2.7; β 3.3; Lv 2.8
76	60	β18	5. 8	1.1 c	3. 3	g K0	6.4 ; 10.9	4.5	10	β 4.5; Doo 4.7; Δ 4.3; OΣ 3.0; HΣ 4.0;
77	59	β18	12. 6	opt?	1. 2	K5	5.5 ; 11.2	5.7	3	β 6.4; Doo 6.8; HΣ 5.0 Lv 5.2
85	50	Σ	7. 3	1.0 c	2. 8	d B9	4.4 ; 8.1	3.7	ph	Σ 4.0; Δ 3.4; Gla 4.0
86	64	H	4. 6	1.0 f ?	—	(d) A0	6.8 ; 9.4	2.6	1.5	Cin 2.0; Doo 2.0; See 4.3
”	”	”	27. 4	1.0 f ?			··· ; 7.6	0.8	ph	AC: Cin 0.5; Doo 0.8; Gla 1.0
10100	67	Σ	2. 7	1.0 c	1. 1	d B2p	6.0 ; 7.7	1.7	17	Σ 2.2; Cmb 1.7; Δ 2.3; Gla 2.1
04	73	Lam	56. 3	opt	1. 7	A0	4.8 ; 11.8	7.0	1	β 6.8
12	* 76	Σ	205.	n c	3. 4	g G0	3.3 ; ···	2.9	ph	AB: Σ 3.5; Δ 3.3
06	* 75	Bar	0. 8	2.1 c		d B9	6.2 ; 9.3	3.1	2	BC: β 4.2; Ho 3.0
35	* 81	Σ	2. 9	1.0 c	2. 1	d A0	6.0 ; 7.1	1.1	14	Σ 1.4; Cmb 2.0; Δ 1.1; Gla 1.1
40	84	Σ	3. 3	1.0 c	2. 1	d A0	6.5 ; 7.9	1.4	9	AC—B: Σ 2.2; Δ 1.5; Ab 2.2; A 2.0
[3251]	”	A	0. 2	2.1 c			··· ; 8.1	1.6	1	AC: A 2.0
10163 *	91	β36	6. 5	6.1 c?	9. 2	g K5	6.4 ; 14.6	8.2	1.5	β 9.0; A 9.5
”	”	β18	7. 6	1.3 c			··· ; 12.1	5.7	3.5	AC: β 6.2; HΣ 5.5; A 7.0
70	**7803**	Σ	33. 1	4.0 f	0. 8	d A0	6.1 ; 10.7	4.6	7	Σ 4.5; Δ 4.1; Gla 4.0
80	02	Ho	0. 9	2.1 c	6. 0	g K0	6.4 ; 10.1	3.7	3	Ho 4.7; Doo 4.0
”	”	OΣ	96.	opt			··· ; 7.7	1.3	7	AC: Δ 1.2; Fr. 1.3
94	05	β36	4. 3	2.1 f	0. 3	g K5	5.9 ; 12.0	6.1	1.5	β 6.9; Doo 6.5
10207	14	β6	3. 2	1.1 c	1. 6	d B8	5.2 ; 8.3	3.1	12.5	Δ 3.6; Doo 3.0; A 4.3; See 2.9; Kn 4.3;
”	”	β26	38. 1	n ?			··· ; 13.5	8.3	0.5	AC: A 9.0 [Cin 4.4; T 3.7; Hl 4.0
28	22	H	4. 0	1.0 c	2. 7	d F0	5.1 ; 7.2	2.1	3.5	Doo 2.7; Δ 2.0
”	”	β6	55. 2	n ?			··· ; 13.0	7.9	1.5	AC: Doo 7.7; β 8.2
37	18	A	0. 2	1.3 ?	1. 3	d A0	7.1 ; 7.4	0.3	10	A 0.2
46 *	29/30	H	22. 0	1.0 c	9. 0	d A2	6.1 ; 6.6	0.5	ph	Sh 1.0
56	27	Σ	26. 2	1.0 c	2. 3	d A0	6.4 ; 8.3	1.9	10	Σ 1.8; Δ 2.0; Gla 1.5
66	36	β6	0. 8	1.3 c	1. 7	d A0	6.1 ; 8.0	1.9	10	OΣ 2.0; HΣ 3.2; A 2.9; Δ 1.5; Lv 2.1; T 2.0; Hl 4.0
”	”	β26	16. 7	25. f			··· ; 13.3	7.2	5.5	AC: β 8.2; HΣ 6.5; A 7.5; Lv 8.9
89	45	β18	4. 6	1.3 c	30.	d G5	5.8 ; 10.6	4.8	3.5	β 5.2; Doo 4.6; A 5.3
98	44	β18	17. 2	opt	1. 0	B3	4.9 ; 13.1	8.2	1	β 8.0
”	”	”	56. 2	opt			··· ; 9.0	4.1	3	AC: β 4.5; Doo 3.2 [Ho 4.5
10301	47	Clark	2. 5	1.3 f	1. 3	s F8p	6.3 ; 10.6	4.3	7.5	Da 5.0; OΣ 3.8; HΣ 4.5; A 5.8; Δ 4.7;
05 *	49	Σ	0. 8	1.1 c	2. 1	d A2	6.5 ; 8.1	1.6	16	Σ 1.8; Cmb 2.0; Δ 1.9; OΣ 1.6; Gla 1.9
15	51	S	55. 7	opt	3. 7	Ma	5.6 ; 10.3	4.7	ph	β 4.7; OΣ 3.0; Gla 4.5
63	82	β6	0. 6	1.3 m	11. 3	d F5	4.0 ; 5.3	1.3	11.5	Δ 1.4; A 1.7; Ho 1.3; Lv 2.0; Sp 2.0
”	”	H	27. 6	opt			··· ; 12.1	8.1	3	AC: β 8.6; Lv 9.1
”	”	Σ	32. 4	opt			··· ; 10.9	6.9	ph	AD: Σ 7.7
67	84	β18	30. 5	opt	2. 7	K0	4.5 ; 10.5	6.0	2	β 6.4; Ho 6.0; Cg 6.0
72	89	Hu	0. 1	2.1 m	2. 2	d B5	5.8 ; 6.4	0.6	11	Hu 1.3; *A 0.5

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
10386	**7897**	H	55.″9	opt	9.″4	K0	5.4 ; 11.6	6.2	1	β 6.0
”	”	”	72. 9	opt			··· ; 11.5	6.1	1	AC: β 5.9
90	96	OΣ	214.	n c	22.	G5	5.2 ; 9.1	3.9	6	Δ 3.5; OΣ 2.6; β 3.5
”	”	”	10. 3	opt			··· ; 12.0	6.8	5.5	AC: Δ 6.9; OΣ 7.3; Com 6.9; β 8.5;
95	99	β26	7. 3	opt?	2. 5	B2	5.9 ; 12.2	6.3	1	β 6.8 [Ho 6.0
10401	**7906**	β26	28. 9	opt	6. 4	B8	3.9 ; 12.8	8.9	1	β 9.5
”	”	H	42. 2	opt			··· ; 11.9	8.0	1	β 8.0
”	”	β	47. 9	opt			·· ; 12.8	8.9	1	β 9.0
”	”	”	51. 6	opt			··· ; 12.5	8.6	1	β 8.7
”	”	”	80. 6	opt			··· ; 10.9	7.0	1	β 6.8
23	11	OΣ	0. 6	1.0 c	1. 8	d B8	6.6 ; 6.8	0.2	34	OΣ 0.3; Δ 0.4; Com 0.0; Gla 0.3
”	”	”	68. 9	3.3 c			··· ; 8.5	1.9	5	AC: OΣ 1.3; Com 1.2; Gla 2.6
30	17	Ho	1. 2	2.1 m	3. 7	d A0	6.1 ; 9.6	3.5	2.5	Ho 4.5; Doo 5.0; β 3.0
37 *	21	Σ	2. 7	1.0 c	1. 8	g K0	5.9 ; 8.0	2.1	7	Σ 2.1; Δ 2.5; Gla 2.5
40	22	H	48.	n ?	1. 7	B9	6.4 ; 10.5	4.1	2	β 3.3; Es 5.0
53	24	H	75. 4	nf?	0. 1	s A2p	1.3 ; 11.6	10.3	1	β 10.4
76	29	β18	2. 7	6.1 f	0. 6	d B3	5.4 ; 11.4	6.0	3.5	β 7.6; HΣ 6.5; A 7.2
”	”	”	25. 3	opt?			··· ; 11.6	6·2	1.5	AC: β 6.5; A 6.5
”	”	”	32. 8	opt?			··· ; 11.7	6.3	1.5	AD: β 6.5; A 6.0 [Ho 5.0
10506	42	Σ	6. 6	1.1 c	2. 7	g K0	4.3 ; 9.2	4.9	ph	Σ 5.2; Δ 4.6; OΣ 3.5; Gla 4.8;
09	* 47/48	Σ	11. 9	1.0 c	21.	g G5	4.5 ; 5.5	1.0	ph	Σ 1.0; Cmb 1.2; Δ 1.3; OΣ 0.5; Gla 1.2
12	49	β18	37. 7	opt	49.	K0	2.6 ; 12.1	9.5	3	β 9.0; Com 10.5; OΣ 10.2
20	53	β6	1. 6	1.3 f	0. 7	d A0	5.6 ; 9.0	3.4	11	Δ 3.6; T 3.8; OΣ 4.0; HΣ 3.0;
—	55	Es	68. 6	opt	24. 1	G0	4.6 ; 9.0	4.4	2	Es 3.7 |Lv 4.0; Sp 3.8|
27	56	β18	9. 6	1.0 c	4. 6	g K0	5.2 ; 10.9	5.7	2	β 5.8; Doo 5.6; Ho 5.7
”	”	β36	12. 3	opt			··· ; 11.3	6.1	3	AC: β 7.0; HΣ 5.5
30	64	H	32.	25. c	3. 5	g K0	6.4 ; 13.1	6.7	1	β 6.5 [A 1.0; Ho 1.5; Lv 1.7
33	63	OΣ	0. 6	1.1 m	1. 2	d B5	4.8 ; 5.9	1.1	17	OΣ 1.0; Δ 1.1; HΣ 1.5; Gla 1.0;
”	”	S	85. 2	6.7 f			··· ; 9·5	4.7	ph	AC: OΣ 3.7
35	57	β	100. 5	opt	82.	K0	3.6 ; 10.7	7.1	2	β 7.6; Com 7.0
43	66	Ho	14. 0	3.7 c?	3. 1	g K5	6.7 ; 12.4	5.7	1	Ho 5.6; Doo 5.5
—	69	Es	18. 3	n ?	2. 5	K0	5.7 ; 13.6	7.9	1	Es 9.0
46	73	β	65. 8	n ?	11. 0	F5	6.0 ; 14.1	8.1	1	β 8.1
48	75	OΣ	81. 8	opt	—	K0	6.3 ; 9.1	2.8	3	Δ 2.5
58	77	H	20. 5	1.0 f	0. 5	d B2	4.9 ; 10.6	5.7	4	Δ 6.0; β 4.8; Es 6.0
59	82	Σ	0. 7	1.1 m	9. 0	d F2	6.4 ; 7.2	0.8	39	Σ 1.3; Cmb 1.9; Δ 0.0; A 0.8; Lv 1.0;
60	78	Σ	3. 9	1.0 c	2. 4	d B9	6.4 ; 8.4	2.0	7	Σ 2.0; Δ 2.1: Gla 2.8 [See 1.0
69	83	β6	20. 3	2.0 c?	1. 9	d B3	6.5 ; 11.4	4.9	4	Δ 5.0; Doo 2.8; OΣ 4.5; W 4.8
72	89	H	2. 0	1.0 c	10. 8	g G5	6.4 ; 8.0	1.6	7	Cin 2.0; Ho 2.0; Doo 1.8; Gla 1.5;
10605	**8010**	Σ	2. 1	1.0 c	6. 5	g G0	6.3 ; 7.7	1.4	12	Σ 1.5; Δ 1.6; Gla 1.8 [See 4.0
06	09	OΣ	5. 7	1.1 f	1. 9	d B8	6.5 ; 10.6	4.1	2.5	OΣ 3.4; Δ 4.0
09	12	H	39. 5	opt	4. 5	A2	5.5 ; 12.3	6.8	1	β 6.6
16	15	β36	2. 0	2.1 c	2. 0	g K2	5.7 ; 10.3	4.6	3.5	β 5.7; Doo 4.9; A 5.7
26	17	Howe	26. 1	1.0 c	8.	g K2	6.3 ; 10.8	4.5	3	Cin 3.7; β 4.2
39	25	β36	6. 8	1.7 ?	3. 8	d F0	5.8 ; 12.4	6.6	1.5	β 7.0; A 8.3 [Gla 0.2
43 *	34	Σ	0. 3	1.3 m	21.	d F5	6.0 ; 6.5	0.5	44	Σ 0.5; Δ 0.8; OΣ 0.3; HΣ 0.5;
”	”	”	10. 8	1.0 c			··· ; 7.1	1.1	ph	AC: Σ 1.4; Δ 1.2; OΣ 1.3; Com 2.7;
54	37	OΣ	70. 9	1.6 f?	3. 3	d F2	6.5 ; 8.8	2.3	5	Δ 2.2; Fr 1.9 |Gla 1.4|
59	40	Σ	1. 9	1.0 f	1. 8	d B8	5.9 ; 6.7	0.8	34	Σ 1.3; Cmb 1.0; Δ 1.2; OΣ 0.5; [Gla 0.8

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
10663	**8044**	β	44.″6	opt	7.″5	Ma	6.0 ; 9.2	3.2	0.5	β 2.7
70	47	Σ	20. 2	1.0 f	0. 7	d Bop	4.9 ; 9.3	4.4	ph	Σ 4.3; Cmb 4.2; Δ 4.2; Gla 4.4;
„	„	H	26. 7	2.0 f			··· ; 11.3	6.4	3	AC: β 6.8; Cmb 7.2 [Es 4.5
73	50	See	0. 1	6.1 ?	—	(g)K0	6.6 ; 7.5	0.9	2	See 1.0
85	56	Σ	1. 5	1.0 m	14. 3	d F5	7.0 ; 7.6	0.6	36	Σ 0.7; Δ 0.9; 0Σ 0.5; Gla 0.4; Lv 1.0
86	53	OΣ	2. 5	1.3 f	0. 4	d B3	5.3 ; 9.2	3.9	3	0Σ 4.2; Δ 4.0
98	* 58/59	Σ	2. 6	1.0 f	1. 8	g F5	5.9 ; 7.3	1.4	ph	Σ 2.1; Δ 2.3; 0Σ 1.5; Gla 1.9
10705	64	β36	0. 2	1.3 c	5. 2	d B8	6.7 ; 7.3	0.6	21	β 1.3; Doo 0.0; A 0.9; Ho 0.0
13	65	Σ	1. 8	1.0 c	2. 2	d B9	6.2 ; 6.8	0.6	35	Σ 1.0; Δ 0.6; Gla 0.6; A 0.7
19	71	OΣ	57. 3	1.1 c	5. 1	d A8	6.4 ; 8.9	2.5	3	Δ 2.3
22	80	See	26. 3	0.6 ?	5. 9	g K4	4.6 ; 10.8	6.2	0.5	See 7.3
32	* 85/86	Σ	15. 6	1.0 m	520.	d K5	5.6 ; 6.3	0.7	ph	Σ 0.6; Cmb 1.1; Δ 1.2; Gla 0.6;
44	87	H	67. 0	opt?	6. 0	A	5.3 ; ···	5.4	1	β 5.0 [Ab 0.5; Lv 0.7
„	„	„	18. 2	n?			10.7 ; 11.7	6.4	1	β 6.2
56	89	Es	15. 6	n?	1. 4	K9	4.9 ; 13.2	8.3	1	Es 9.5
73	94	Σ	3. 5	1.0 c	2. 8	d A0	5.7 ; 7.8	2.1	ph	Σ 2.0; Δ 2.3; Gla 1.5; Ho 2.0
82	97	Kn	2. 1	6.1 c	17.	d F0	4.8 ; 10.2	5.4	3	Kn 6.2; A 6.8; Lv 7.2
„	„	β	43. 3	opt			··· ; 12.3	7.5	3	AC: β 7.2; Lv 8.0
„	„	Σ	366.	opt			··· ; 6.0	1.2	ph	AD: Σ 1.5
95	**8101**	Σ	17. 8	1.0 c	2. 2	d A	6.7 ; 7.7	1.0	ph	Σ 1.0; Cmb 1.2; Δ 1.3; Gla 0.8
10808	07	β6	1. 3	1.3 f	—	(d)A	6.4 ; 9.3	2.9	8	Δ 3.1; Doo 3.1; β 2.6; Lv 2.7
„	„	OΣ	134.	opt?			··· ; 7.1	0.7	ph	AC: Δ 0.8; Doo 0.3
29	23	OΣ	0. 4	1.1 m	32.	d F5	5.2 ; 5.7	0.5	37	0Σ 0.5; A 0.5; Ho 0.5; Lv 0.8; *A0.1
„	„	Σ	27. 4	opt			··· ; 10.4	5.2	ph	AC: Σ 5.6; Gla 5.7
32	19	Σ	1. 1	1.0 f	0. 5	d B2	6.1 ; 6.8	0.7	30	Σ 1.0; Δ 0.9; Gla 0.7; Es 0.9
46	30	Clark	1. 2	1.0 m	45.	d F0	3.9 ; 7.1	3.2	11.5	Δ 2.5; Com 4.3; A 5.1; Ho 4.5; *A4.2
„	„	„	15. 6	opt			··· ; 11.9	8.0	1	AC: β 8.4
63	33	H	0. 9	1.0 c	13. 2	d G	7.1 ; 7.3	0.2	4	0Σ 0.2
81	48	β9	2. 2	1.0 m	66. 5	d G5	6.5 ; 9.1	2.6	6	Cin 3.0; β 3.4; Doo 2.3; See 3.0;
„	„	„	74. 5	opt			··· ; 11.8	5.3	1	β 4.8 [LM 3.0
85	46	OΣ	15. 0	1.0 c	2. 9	d B3p	4.4 ; 10.1	5.7	1	0Σ 5.6
„	„	„	21. 2	opt			··· ; 10.1	5.7	1	AC: OΣ 5.6
98	53	β36	3. 8	1.3 f ?	—	(d)A	6.4 ; 11.2	4.8	1.5	β 5.3; Doo 5.9
10903	55	Ho	17. 1	n?	1. 6	A	6.2 ; 12.3	6.1	2	Ho 6.5; Doo 6.9; Hu 6.5; A 7.0
08	57	Ho	0. 3	1.1m?	1. 0	g K	6.6 ; 6.6	0.0	8	Ho 0.0; Doo 0.0
22	66	OΣ	1. 3	1.0 m	—	d G5	7.0 ; 7.5	0.5	17	0Σ 0.7; Δ 0.5; Ho 0.5
25 *	64	Σ	4. 5	1.1 f	1. 3	g K0	5.8 ; 10.3	4.5	10	Σ 4.3; Δ 5.0; Gla 5.1; Es 2.5
„	„	Bar	16. 0	n?			··· ; 13.9	8.1	0.5	AC: Bar 9.4
32	73	Σ	36. 2	1.5 c	11. 7	g K0	4.2 ; 9.2	5.0	ph	Σ 4.1; Δ 4.6; 0Σ 3.3; Gla 3.8; Fr 4.0
36	78	β18	31. 5	opt	5. 4	A	5.1 ; 13.5	8.4	1	β 8.5
„	„	H	67. 4	opt			··· ; ···	6.5	1	AC: β 6.3
„	„	„	6. 0	opt			11.6 ; 12.	7.		···
59	90	H	51. 8	opt	12. 6	A	5.7 ; 11.0	5.3	1	β 4.8 [Ho 6.2; Bd 6.7
62	94	β18	8. 5	1.2 c	4. 2	d A0	6.2 ; 12.0	5.8	5	β 6.0; Doo 6.2; HΣ 5.7; A 6.1;
66	93/89	Σ	365.	n?	4. 3	K;Gp	6.6 ; 6.7	0.1	ph	Σ 0.6; Δ 0.6; Gla 0.3
77	**8204**	See	21. 4	0.7?	2. 3	g G1p	3.9 ; 11.8	7.9	1.5	See 10.0; Bd 8.3; Doo 8.7
—	06	Es	19. 2	1.2?	0. 9	d A	6.4 ; 11.2	4.8	1	Es 5.5
83	09	S	32. 6	n?	1. 1	B0	5 8 ; 10.8	5.0	5	Lv 4.5; β 5.5
„	„	„	54.	n?			··· ; 9.9	4.1	3	AC: Lv 3.1; β 4.1
11005	23	H	41.	6.7 f	0. 4	g Mb	6.2 ; 11.2	5.0	1	β 4.6
„	„	„	41.	n?			··· ; 12 1	5.9	1	AC: β 5.7

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
11011	**8224**	OΣ	12."3	opt	2."0	Ma	6.4 ; 12.2	5.8	7	OΣ 4.3; Δ 4.8; Gla 6.5
14	25	β18	29. 8	opt?	1. 7	K4	4.8 ; 11.6	6.8	1.5	β 7.0; W 7.8
26	32	β6	34.	opt	1. 6	G0	3.1 ; 11.0	7.9	1	β 7.9
"	"	H	54.	opt			... ; 11.5	8.4	1	AC: β 8.5
46 *	38	Σ	13. 5	1.0 c	1. 3	d B1	3.3 ; 7.8	4.5	ph	Σ 5.0; Δ 4.6; Gla 5.0
72	58	Hu	0. 2	1.3 m	2. 3	d A3	6.6 ; 7.2	0.6	12	Hu 0.5; *A 0.5
77	60	H	68.	opt	0. 9	B5p	4.7 ; 9.0	4.3	3	Lv 3.0; β 4.5
88	61	β6	2. 0	1.3 c	5. 7	g K0	6.5 ; 10.3	3.8	3.5	Δ 4.4; Ho 4.0; W 4.3
95	63	Σ	31. 0	1.0 f	2. 6	d A0	6.3 ; 9.2	2.9	ph	Σ 2.4; Δ 3.0; Gla 2.5
11103	65	Σ	39. 1	1.0 c	5. 3	d A0	6.3 ; 7.6	1.3	ph	Σ 1.4; Δ 1.3; Gla 1.4
15	70	H	26. 0	opt	11. 6	F	5.8 ; 11.6	5.8	1.5	β 6.0; Doo 6.2
58	85	See	5. 1	6.1 c	13. 1	g K0	5.3 ; 12.3	7.0	1.5	See 7.5; β 8.1
60	81	β36	1. 5	32. f	0. 5	s Oe5	6.0 ; 12.4	6.4	1.5	β 7.7; A 7.7
"	"	Σ	11. 6	1.0 f			... ; 7.7	1.7	12	AC: Σ 1.6; Δ 1.7; Gla 1.9
"	"	"	19. 9	1.0 f			... ; 7.8	1.8	12	AD: Σ 1.7; Δ 1.7; Gla 1.8
64	84	Clark	2. 7	1.3 c	5. 3	g Ma	5.4 ; 10.0	4.6	3.5	Δ 5.3; OΣ 4.1; Ho 6.0
"	"	H	54. 4	opt?			... ; 9.7	4.3	5	AC: Δ 4.2; OΣ 2.7; Fr 4.0; Ho 4.0
84	91	S	65. 6	opt	5. 2	A	6.1 ; 10.0	3.9	2.5	Cin 3.0; S 4.0
11205	**8308**	S	140.	n f	2. 6	K0	2.5 ; 8.5	6.0	ph	Δ 6.0; β 6.1
"	"	β	82.	n f			... ; 11.2	8.7	1	AC: β 8.8
08	07	S	153.	n c	3. 7	B9	5.6 ; 7.7	2.1	0.5	S 2.0 [Gla 1.4; Lv 1.4
14 *	09, 10	Σ	5. 5	1.0 m	34.	d F5	4.7 ; 6.1	1.4	ph	Σ 1.0; Cmb 1.0; Δ 1.3; OΣ 1.0; HΣ 1.5;
"	"	β	35. 5	opt			... ; 11.8	7.1	3	AC: β 7.5; Lv 7.2
"	"	H	217.	opt			... ; 6.7	2.0	ph	AD: Gla 1.4; Sh 2.2
22	15	β18	0. 2	1.3 m	3. 4	d F5	4.8 ; 5.2	0.4	33	β 0.6; HΣ 1.0; A 0.5; Lv 0.2; *A 0.1
"	"	Σ	11. 0	opt ?			... ; 10.0	5.2	ph	AC: Σ 6.4; Gla 6.7; Lv 6.1
27	16	β18	19. 1	1.0 f ?	0. 2	g Ma	4.0 ; 10.9	6.9	1.5	β 7.2; Doo 7.3
"	"	"	41. 1	n f			... ; 11.3	7.3	1.5	AC: β 7.7; Doo 6.5
39	22	H	115.	opt	39.	A5	3.0 ; 12.6	9.6	1	β 9.7
11301	48	H	20.	1.0 c?	3. 7	d B9	5.7 ; 9.6	3.9	1	β 3.6
"	"	"	24.	opt			... ; 10.8	5.1	1	AC: β 4.9 [Ab 1.1
23	57	Σ	20. 0	opt ?	1. 6	B3	6.0 ; 6.8	0.8	ph	Σ 1.0; Cmb 1.0; Δ 0.9; Gla 0.8;
27	63	Σ	21. 6	opt	1. 0	F2	6.2 ; 9.5	3.3	ph	Σ 2.8; Δ 3.1; Gla 2.8
34 *	61	Σ	2. 3	1.0 m	1. 8	d A2	7.0 ; 7.3	0.3	35	Σ 0.2; Δ 0.4; Gla 0.3; Ab 0.3
35	64	Σ	22. 2	1.0 c	7. 0	d F8	6.6 ; 8.3	1.7	10	Σ 1.5; Δ 2.0; Gla 1.5
91	75	OΣ	1. 3	1.1 f	1. 1	d B2	6.0 ; 8.3	2.3	4	OΣ 2.2; Δ 2.5
11410	86	β6	1. 8	1.0 f	1. 5	d A	5.9 ; 6.5	0.6	33	Cin 1.1; Doo 0.3; β 0.4; See 0.5; W 1.6;
28	92	H	51. 1	opt	7. 6	F3	5.7 ; 11.4	5.7	1	β 5.4 [Lv 1.7; Sc 1.0; Gla 0.4
34	96	S	4. 4	1.0 f	0. 8	d A	7.2 ; 7.3	0.1	20	Gla 0.2; See 0.0
59	**8407**	β18	0. 5	2.1 c	3. 8	d A0	5.6 ; 8.0	2.4	1	β 2.5; Doo 2.8
69	12	H	21. 3	1.2 ?	—	(g) G	6.4 ; 11.3	4.9	3	β 4.9; Ab 4.6; Es 5.7
83 *	17	Σ	5. 6	1.0 m	23.	d A3	4.6 ; 6.5	1.9	ph	Σ 1.8; Δ 1.8; Gla 1.5
99	28	β18	19. 7	opt	1. 2	s Oe5	5.2 ; 11.0	5.8	1	β 5.9
11514 *	23	Σ	13. 7	1.0 c	15.	d F6	7.1 ; 7.4	0.3	ph	Σ 0.8; Δ 0.6
26	49	β	27. 4	opt	9. 1	K	5.7 ; 12.6	6.9	1	β 7.1
"	"	"	72. 7	opt			... ; 11.1	5.4	1	AC: β 4.9
40	56	Σ	22. 7	8.0 f	—	(g) G2	6.4 ; 12.4	6.0	9	Σ 6.0; Δ 5.9; Gla 6.3
59	63	H	23. 2	opt	14. 4	A	5.4 ; 10.3	4.9	4	Δ 5.0; β 3.5; Es 5.9

Table 1. Continued.

β.G.C.	H.R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
11576	**8480**	H	5.″1	1.0 c	6.″7	g G5	5.6 ; 7.4	1.8	7	Cin 1.7; W 1.4; Gla 1.7; See 2.1
82	74	Σ	14. 8	1.0 c	5. 8	d F2	5.6 ; 8.3	2.7	6	Σ 2.0; Δ 2.8; Ab 2.9
95	85	H	27. 8	1.0 c	5. 0	g K5	4.6 ; 9.3	4.7	2.5	Cin 5.0; β 4.6; Es 5.0
„	„	„	70.	opt			··· ; 9.6	5.0	0.5	AC: Ö 5.3
11617	93	Σ	28. 8	1.0 c	3. 1	d A0	6.2 ; 8.6	2.4	10	Σ 2.1; Δ 2.4; OΣ 1.0; Gla 3.5; Ab 2.7
41	**8510**	Σ	15. 3	1.0 c	9. 3	d F0	6.3 ; 8.5	2.2	9	Σ 2.2; Δ 2.2; Gla 2.2; Es 1.5
46	13	H	6. 3	1.3 c	1. 9	d B6	5.4 ; 11.0	5.6	5	Δ 5.3; β 6.5; Lv 6.5
„	„	„	9. 9	opt			··· ; 11.3	5.9	3	AC: β 6.5; Lv 6.1
63	18	H	49. 4	opt	12. 3	A	4.0 ; 11.6	7.6	0.5	Mu 8.5
66	22	Ho	73.	n?	0. 6	B8	4.9 ; ···	4.9	3	Ho 4.3; Doo 4.7
„	„	„	2. 3	n?			9.8 ; 10.7	5.8	1	AC: Ho 6.0; Doo 6.0
„	„	„	41. 9	n?			(4.9); 11.3	6.4	1	AD: Ho 7.0; Doo 7.1
„	„	„	60. 3	n?			··· ; 11.2	6.3	1	AE: Ho 7.0; Doo 7.0
69	23	H	48. 2	opt?	2. 0	B5	4.7 ; 10.8	6.1	1	β 5.9 [Gla 3.4; Δ 2.6
90	32	Σ	2. 4	1.1 m	35.	d F5	6.2 ; 8.9	2.7	10	Σ 3.2; Cmb 3.5 OΣ 2.3; Com 3.4;
„	„	„	56. 5	opt			··· ; 8.4	2.2	ph	AC: Σ 1.9; Cmb 1.7; OΣ 1.2; Fr 1.7
91	33	β6	0. 4	1.1 m	2. 5	d A0	6.5 ; 6.7	0.2	57	Δ 0.0; Doo 0.0; Com 0.3; β 0.4; A 0.2; Ol 0.2; Cin 0.1; Sp 0.0; LM 0.2;
• **11715**	* 44/45	H	10. 0	1.0 m	23. 2	d G0	6.4 ; 6.6	0.2	ph	Sh 0.5; Δ 0.3; Gla 0.2 [Lv 1.1; T 0.0
„	„	„	46. 6	n?			··· ; ···	7.1	1	AC: β 6.9
„	„	β	1. 8	n?			13.5 ; 14.6	1.1	3	CD: β 1.0
16	48	β26	2. 6	2.1 c	30.	d F7	5.9 ; 10.8	4.9	4	β 6.2; HΣ 5.0; A 6.8; Hl 7.0
28	49	Σ	4. 5	1.0 f	—	(d)A	6.4 ; 9.7	3.3	5	Σ 3.6; Δ 3.1
43	* 58/59	Σ	3. 6	1.0 m	20.	d F2	4.4 ; 4.6	0.2	ph	Σ 0.1; Cmb 0.3; Δ 0.4; Gla 0.3; Lv 0.1; Ol 0.1
63	66	Σ	1. 1	1.0 m	14. 8	d F5	5.9 ; 6.6	0.7	39	Σ 1.4; Cmb 2.0; Δ 0.7; OΣ 1.5; Gla 0.2; A 0.9
72	* 71	Σ	40. 8	1.0 c	1. 2	s G0p	3.8 ; 6.3	2.5	ph	Σ 2.3; Gla 2.2; Δ 2.7
„	„	β	19. 3	opt		(var)	··· ; 13.2	9.4	1	AC: β 10.0
86	85	β18	30. 1	opt	15.	A	3.9 ; 11.5	7.6	1	β 8.0
11828	* 95	Σ	0. 8	1.0 c	14.	d F2	6.6 ; 7.0	0.4	44	Σ 0.5; Δ 0.6; Com 0.2; OΣ 0.5; Gla 0.2
34	98	Σ	9. 2	1.0 c	6. 3	d A0	6.3 ; 9.0	2.7	8	Σ 2.3; Δ 2.9; OΣ 2.0; Gla 2.3
39	***8603**	Σ	22. 4	1.0 f	1. 8	d B3	5.8 ; 6.5	0.7	ph	AB: Σ 0.5; Δ 1.0; Com 0.8; Gla 0.6
„	„	„	28. 1	1.0 f			(6.5); 10.4	4.6	12	AC: Σ 4.2; Δ 5.0; Com 4.6; Gla 3.5
„	„	A	1. 5	1.0 ?			(10.4); 13.8	8.0	1	CD: A 4.4
„	„	Σ	66. 4	6.7 f			(6.5); 9.1	3.3	9	AE: Σ 2.5; Δ 3.4; Com 3.2; Gla 2.6
[3754]	12	A	0. 2	2.1 m	6. 9	d F8	6.6 ; 8.2	1.6	2	A 1.8
11863	19	H	86. 6	1.3 c	6. 0	g K	6.3 ; ···	0.9	12	β 0.8; Gla 0.9
„	„	„	4. 3	1.3 c			7.2 ; 8.1	1.8	4	BC: β 0.5; See 1.1
77	22	S	61. 3	opt?	0. 9	Oe5	4.9 ; 10.0	5.1	ph	OΣ 3.1; β 5.1; Es 4.6
78	21	H	29. 5	opt	5. 1	Mb	5.5 ; 10.8	5.3	1	β 5.3
95	31	Ho	0. 5	1.1 c	30.	d G4	6.4 ; 6.9	0.5	18	Ho 0.0; Doo 0.4; Lv 0.6
11905	34	β	64. 3	opt	7. 7	B8	3.6 ; 11.3	7.7	1	β 7.7
10	40	S	70. 0	opt	2. 1	B2	5.2 ; 10.1	4.9	1	β 4.2
14	45	Σ	2. 5	1.0 c	2. 5	d F	6.9 ; 7.8	0.9	17	Σ 0.8; Δ 1.4; Gla 1.4
24	50	H	90.	opt	3. 6	G0	3.1 ; ···	6.0	4	β 6.1; Com 6.1; Lv 5.7
„	„	β36	0. 2	opt			9.1 ; 9.5	0.4	12	BC: β 0.0; Lv 0.5
28	52	OΣ	0. 5	1.1 c	3. 1	d F	6.9 ; ··	0.8	5	OΣ 0.7; Hu 1.2
„	„	Hu	0. 1	1.1 c			7.7 ; 9.4	2.5	1	BC: Hu 2.0
36	* 54	Σ	2. 6	1.0 c	1. 5	g K4	6.3 ; 8.5	2.2	8	Σ 2.2; Δ 2.3; OΣ 2.7; Gla 2.6
„	„	β	10. 7	opt			··· ; 11.7	5.4	1	AC: β 5.5
38	56	OΣ	14. 6	1.0 f	1. 0	g K	5.2 ; 10.6	5.4	3	OΣ 5.4; Δ 5.3
57	65	H	12. 3	1.2 c	54.	d F5	4.3 ; 11.7	7.4	8	Com 8.0; Δ 8.0; β 7.8; HΣ 7.0; Lv 8.3

Table 1. Continued.

B.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
11967	**8673**	Σ	30."7	opt	3."6	B9	5.7; 9.6	3.9	ph	Σ 3.2; Δ 3.3
97	* 87	Σ	2. 9	1.0 m	12. 9	d F5	7.1; 7.2	0.1	20	Σ 0.0; Δ 0.2
12019	99	β18	29. 6	opt	10. 8	K	5.2; 11.5	6.3	1.5	β 7.0; Doo 5.4
21	96	Σ	2. 0	1.0 m	12. 2	(d) G0	6.1; 7.2	1.1	16	Σ 1.3; Δ 1.2; Gla 1.1; Es 1.0; Ab 1.7
32	**8702**	OΣ	3. 4	1.3 c	6. 4	g K0	5.0; 9.6	4.6	4	OΣ 4.7; Δ 5.1; β 5.5
36	08	β6	1. 0	1.1 m	1. 6	d A0	5.9; 7.6	1.7	16	Δ 2.0; Com 2.3; β 1.5; HΣ 1.5; A 1.8; [Lv 1.8]
"	"	H	26. 4	opt			...; 10.4	4.5	2.5	AC: Δ 4.7; β 2.7
46	16	β6	0. 8	1.3 m	1. 8	g G5	6.1; 7.9	1.8	10.5	Δ 2.0; Doo 1.2; Ho 3.0; Lv 1.8; Cin 2.0; [LM 2.5; T 2.0; Cg 2.5]
61	23	H	50.	opt	2. 4	A	5.6; 8.4	2.8	5	Δ 2.6; Fr 2.3
65	24	Σ	3. 9	1.0 m	0.	d A3	6.6; 8.8	2.2	9	Σ 2.3; Cmb 2.3; Δ 2.7; Gla 2.7
68	25	Σ	27. 5	1.0 f	0. 9	d B3	5.5; 10.9	5.4	6	Σ 6.0; Δ 5.1; Com 5.9
"	"	"	63. 5	opt			...; 9.2	3.7	ph	AC: Σ 3.0; Δ 2.9; Fr 2.8
71	28	See	29. 9	1.6 ?	37.	d A3	1.3; 13.5	12.2	0.5	See 13.8
90	37	OΣ	0. 4	1.1 m	42.	d G0	7.2; 7.3	0.1	26	OΣ 0.5; Δ 0.0; β 0.1; A 0.1
94	39	OΣ	0. 9	1.1 m	4. 8	d F0	6.2; 7.2	1.0	21	OΣ 1.5; Com 2.0; Gla 0.8; Lv 1.8; Ol 0.7
96	42	Bar.	3. 8	2.1 c	10. 4	g K0	5.6; 12.0	6.4	2	β 7.6; *A 7.9
12111	53	Σ	3. 3	1.0 f	0. 5	d A0	6.7; 8.7	2.0	7	Σ 2.5; Δ 2.3; Gla 2.3
25	66	β36	0. 3	6.1 m	6. 2	d A2	5.2; 7.9	2.7	3	β 3.2; A 3.5
28	68	Σ	7. 4	1.0 c	1. 9	d A	6.4; 9.9	3.5	7	Σ 3.2; Δ 3.5; Gla 3.6
30	70	OΣ	21. 7	opt?	1. 5	A	6.5; 9.9	3.4	4	Δ 3.2
34	75	H	98. 4	opt	23.	Ma	2.6; 10.0	7.4	3	β 8.5; Lv 6.9
38	77	OΣ	33. 9	1.5 c	2. 3	d A	6.7; 9.2	2.5	5	Δ 2.6; OΣ 1.5
42	83	H	55.	opt	10. 9	K	6.3; 11.8	5.5	1	β 5.1
43	82	A	0. 2	1.3 m	12. 4	d F0	6.3; 6.3	0.0	10	A 0.0
"	"	Σ	262.	opt			...; 7.4	1.1	ph	AC: Σ 1.0
73	98	Σ	8. 4	1.0 f	—	(d) A	6.3; 7.4	1.1	24	Σ 1.2; Cmb 1.2; Δ 1.2; Gla 1.0; Ab 1.3
79	**8804**	H	48.	opt	3. 0	K	5.6; 10.6	5.0	1.5	Cin 6.5; β 5.1
13641	08	Hu	0. 2	1.3 m	3. 4	d B3	6.9; 7.0	0.1	12	Hu 0.5; A 0.0
12188	15	Σ	32. 5	4.0 f	0. 4	g Mb	5.4; 10.8	5.4	ph	Σ 4.6; Δ 4.8; Gla 5.2
96	19	OΣ	1. 1	1.3 m	2. 8	g G5	4.6; 7.7	3.1	10.5	OΣ 2.3; Δ 3.3; Com 4.2; Lv 2.0
12230	33	Σrej	33. 5	n ?	0. 5	G6	6.0; 9.1	3.1	2	β 3.0; Mill 2.5
42	36	β18	3. 3	1.3 c	5. 2	g K	6.4; 11.0	4.6	3	β 4.8; Doo 5.0; Cin 4.7; Bd 6.4
45	38	H	35.	n ?	1. 9	F5	6.4; 10.3	3.9	4	β 3.5; Es 3.5; Ab 3.5
57	41	Σ	49. 6	1.5 c	36.	g K0	4.5; ...	5.3	ph	Gla 4.3; Σ 4.7
"	"	β36	0. 2	1.5 c			9.8; 9.9	5.4	22	BC: β 0.1; A 0.1; Lv 0.2
"	"	β	64. 9	opt			(4.5); 13.4	8.9	1	AD: β 9.0
"	"	"	19. 2	opt			(9.8); 12.2	7.7	1.5	AE: β 8.0; A 9.0
85	60	β18	7. 5	1.3 c	3. 8	g Ma	5.0; 11.2	6.2	4	β 7.7; HΣ 5.5; *A 8.0
89	65	Ho	1. 1	32. m	4. 7	d A	5.2; 10.7	5.5	2.5	Ho 6.0; Hu 6.5; β 7.3; Doo 6.2
92	66	Σ	13. 3	1.0 c	31.	d G5	5.4; 7.6	2.2	ph	Σ 2.0; Δ 2.1; Gla 2.0
96	68	H	10. 6	1.0 c	19. 4	d F1	5.7; 10.8	5.1	5.5	Δ 4.9; Cin 4.5; A 6.0; Lv 5.3
12304	72	Σ	2. 3	1.1 m	6. 7	g G5	5.0; 7.5	2.5	8	Σ 2.6; Δ 2.6; OΣ 2.0; Gla 3.5
05	75	OΣ	79.	opt	20.	K1	6.4; 10.0	3.6	6	Δ 3.3; Fr 2.8
13	84	Σ	13. 1	1.0 f	—	(d) A	6.2; 10.4	4.2	3	Σ 3.5; Δ 4.4
16	86	β9	12. 6	1.2 f	0. 6	(d) A	6.4; 11.5	5.1	4	β 5.2; Doo 4.5; OΣ 5.0
25	87	β18	0. 4	2.1 c	2. 2	d B8	5.5; 7.4	1.9	7.5	β 2.7; Δ 2.0; OΣ 2.0; HΣ 1.5; A 3.0
29	90	Hu	0. 3	1.3 m	11. 2	d A3	5.6; 6.7	1.1	1	Hu 1.3

Table 1. Continued.

β.G.C.	H. R.	1st Obs.	d	Rem.	μ	Sp.	Magn.	Δm	W	Estimates
12337	**8897**	H	42.″	opt	7.″5	K	6.5 ; 11.1	4.6	1	β 4.0
12405	**8926**	OΣ	1. 3	2.1 c	2. 8	d B3	4.9 ; 9.1	4.2	3.5	Δ 4.5; β 5.0; A 6.0
”	”	H	75. 7	1.3 c			… ; …	2.2	7	AC: β 1.5; Δ 2.4; A 2.0
”	”	Da	1. 4	1.3 c			7.1 ; 8.5	3.6	(10)	CD: β 1.4; Δ 1.5; A 1.7
”	”	H	27.	opt			(7.1); 10.9	3.8	1	CH: β 3.5
”	”	”	43. 5	opt			(4.9); 9.8	4.9	3	AE: β 4.0; Δ 4.8
”	”	”	66. 9	n c?			… ; …	4.9	3	AF: β 4.0; Δ 4.5
”	”	”	10. 8	opt			9.8 ; 9.8	4.9	3	AG: β 4.0; Δ 4.7
32	43	β18	0. 4	1.1 m	5. 3	g K2	5.8 ; 6.1	0.3	49	β 0.0; Doo 0.3; Δ 0.5; OΣ 1.0; HΣ 0.5;
41	50	β6	21. 7	opt	—	K	6.3 ; 11.4	5.1	4	Δ 5.5; Doo 4.4 [A 0.0; Lv 0.3
65	58	H	33.	opt?	3. 5	A	5.7 ; 10.2	4.5	1	β 3.9
68	62	OΣ	0. 4	1.3 m	4. 0	d B9	6.3 ; 7.0	0.7	29	OΣ 0.9; Δ 1.2; Gla 0.5; *A 0.7
92	73	OΣ	14. 5	1.0 c	10. 5	d A	6.2 ; 10.3	4.1	0.5	OΣ 3.4
97	76	H	46. 6	opt	8. 4	A	4.3 ; 11.5	7.2	1	β 7.0
”	”	”	103. 1	opt			… ; 11.5	7.2	1	AC: β 7.0
12511	82	H	122.	0.6 ?	1. 9	g G	5.0 ; 7.4	2.4	2	Gla 2.3 [Cg 6.2
23	88	β9	5. 6	1.3 c	10. 5	d A	4.6 ; 9.6	5.0	9	Δ 6.0; β 5.8; Lv 4.8; Cin 4.1; T 5.5;
25	89	β18	2. 6	1.3 f	—	g Ma	6.9 ; 10.8	3.9	3.5	β 4.4; Doo 4.0; W 5.0
32	97	Clark	1. 4	1.3 c	8. 0	g K0	5.1 ; 7.9	2.8	9.5	Δ 3.1; β 4.2; OΣ 3.0; HΣ 2.5; A 3.0; Ho 3.0
35	99	H	9. 1	1.0 c	8. 0	d F5	6.3 ; 9.0	2.7	2.5	Se 2.0; Cin 2.8; Sc 3.5; See 4.2
43	***9002**	H	5. 7	1.0 c	12. 0	d F2	5.8 ; 6.7	0.9	17	Cin 1.0; Δ 1.2; See 0.8
62	11	β18	0. 8	1.3 c	3. 0	d B3	6.0 ; 8.4	2.4	4.5	β 2.7; A 2.2; Cin 3.0; *A 2.5
64	12	S	173.	n c	9. 5	K	5.6 ; 8.7	3.1	0.5	β 2.6
71	16	β12	3. 3	6.1 c	14. 6	d A	4.6 ; 11.4	6.8	1.5	β 8.4; A 8.0
”	”	H	74. 3	3.3 c			… ; 9.0	4.4	1	AC: β 3.8
73	17	OΣ	0. 5	1.1 m	2. 1	d A0	7.0 ; 7.9	0.9	12	OΣ 0.7; Δ 1.2; Com 1.1; A 1.0
”	”	”	48. 8	opt?			… ; 8.3	1.3	7	AC: OΣ 1.0; Δ 1.3
75	* 18	OΣ	1. 6	1.1 c	1. 0	d A2p	5.7 ; 8.1	2.4	4	OΣ 2.5; Δ 2.5
81	26	H	13.	opt?	—	A2	6.4 ; 11.3	4.9	1.5	Cin 4.0; See 6.4
12608	38	β18	5. 5	1.3 m	36.	d K2	6.6 ; 11.6	5.0	1	β 5.2
23	44	H	6. 8	1.0 f	—	(d) A2	6.8 ; 7.2	0.4	ph	
63	66	Es	8. 7	n ?	11. 3	g Md (var)	5.3 ; 13.3	8.0	1	Es 9.1
”	”	”	27. 2	n ?			… ; 10.6	5.3	2	AC: Es 4.9 [A 5.7
64	67	β18	1. 4	6.1 c	8. 7	g K0	5.1 ; 9.8	4.7	4	β 5.8; Cin 4.6; LM 4.6; Cg 5.7;
66	71	Σ	3. 0	1.0 f	1. 3	d B2	5.1 ; 7.0	1.9	7	Σ 2.1; Δ 2.4; Gla 1.5
75	74/75	Σ	3. 7	1.0 m	10. 6	d F8	6.5; 6.6	0.1	ph	Σ 0.0; Δ 0.5; Com 0.4; Gla 0.2; A 0.5; Lv 0.4
12701	88	β18	0. 6	6.1 m	130.	d G0	5.9 ; 9.9	4.0	11	β 5.8; Doo 4.8; HΣ 4.0; A 5.4; Lv 4.5; *A 5.2
”	”	OΣ	33. 0	opt			… ; 9.8	3.9	ph	AC: OΣ 2.8; Δ 3.0; HΣ 4.0; A 3.0;
04	* 94	Σ	15. 1	1.0 c	1. 8	g F5	6.0 ; 7.4	1.4	ph	Σ 1.3; Δ 1.4 [Lv 2.0
29	***9105**	OΣ	5. 1	1.0 c	2. 4	d A	6.1 ; 9.8	3.7	6	OΣ 2.6; Δ 3.6; Ho 4.5
55	* **5**	Σ	0. 8	1.1 m	26.	d G5	6.5 ; 7.3	0.8	55	Σ 1.1; Cmb 1.0; Δ 1.5; OΣ 1.2; Gla 0.7; Ho 1.0; A 0.7; Lv 0.6

Remarks to Table 1.

An asterisk in the second column of table 1 refers to a remark.

Sources for spectra: Contrib. from the Mt. Wilson Observatory (Mt. W.); Fr. C. Leonard, Lick Obs. Bull. 343 (L). Remaining spectra without indication of source are from the Harvard Observatory (Annals and Circulars). *Comp.* = composite; a "+" joining the spectra also means that the spectrum is composite.

H. R.

219. Sp. F8; K5 (Mt. W)
230. Sp. F0; F0 (L)
282/3. Sp. B9; A0p (L)
310/11. Sp. A2; A0
313/14. Sp. F2; F2
361. Sp. A5 (A); F8 (B)
424. Sp. F8 (A); F0 (B) (L)
426. Sp. K0 (A); G0 (B)
462. Δm counted as 2.0, since the photometric measure was originally overlooked.
530. Sp. F5; A2. Absol. magn. —3.8. Apparently giant of sp. F5.
545/6. Sp. A0p; B9 (L)
595/6. Sp. B9; A3 (L)
603. Sp. K0; B9 (L)
610. From proper motion equal chances for *giant* and *dwarf*
628/9. Sp. A0; A2
642. Sp. F8; F2 (L)
764. Sp. F3; F5 (Mt. W)
804. Sp. A2; F3 (Mt. W)
854. Sp. comp. G0+A5
890/1. Sp. B8; B9 (L)
887/8. Sp. A0; A0 (L)
915. Sp. comp. F5+A3
1065. Sp. A0; A2 (L)
1178. Never observed since Σ
1205. Sp. comp. K0+A0
1211/12. Sp. G5; A2 (L)
1220. Sp. B3; B8 (Mt. W)
1230. Sp. F8; A2
1321/2. Sp. G0; G0
1325. Sp. K0; B9; Mdp (L). O2 Eridani
1370. Sp. K5+A0
1366. From proper motion equal chances for *giant* and *dwarf*; magn. B=12.2, but counted as 12.0
1387. Sp. A3; A2
1411/12. Sp. F0; K0
1505/6. Sp. G5; F0p (L); counted as *giant* G5, instead of F5 (H. D.)
1609/10. Sp. A0; A0
1622/23. Sp. B3p; K0
1664. Sp. F0; A2
1691. Sp. F5 (H. D.), but classified as *giant* from hypothetical parallax
1701. Sp. A2+G

H. R.

1734. Counted, although classified as opt?
1736. Sp. comp. F0+A; assumed *giant*
1753/4. Sp. B8; B8
1771. Sp. G0; A3; K0
1779. Sp. K0; K
1821. Sp. B9; B9 (L)
1851/2. Sp. B0 (A); B5 (C) (Mt. W)
1879/80. Sp. Oe5; B1 (L)
1893—6. Θ' Orionis. Three fainter companions of magn. 15.6; 16.1; 16.6 were not counted.
1897. Sp. B1; B1
1899. Sp. B0; B9 (Mt. W)
1925. From Burnham's Measures of Proper Motion Stars; as these measures were not taken into account in deriving the *coefficient of perception,* the value of z=0.0 was assumed; in the count the star was, however, included; as will be explained in section 6, *mean* values of z for groups of stars were assumed, thus finally the star received a weight different from zero.
1931/2. Sp. B0 (A); B3 (E)
1948/9. Sp. B0 (A); B0 (B) (L)
1982/3. Sp. F8; G5 (Harv.); or F6; K5 (Mt. W)
1999. Sp. F0; F0 (L); abs. magn. hyp. = —5.3; counted as A3 (Harv.)
2099. Invisible since OΣ, but spectrum composite, G5 + A5, which confirms duplicity.
2175/6. Sp. A2; A5 (L)
2174. Sp. A0; A0
2298/9. Sp. A3; F8 (L)
2356—8. Sp. B2p; B3; B1p (ABC) (L)
2366. Increase of distance; assumed *dwarf* from hypothetical parallax.
2404. Hyp. abs. magn. = —1.1; uncertain whether *moving* or *optical.*
2491. Sp. A0; F0 (Mt. W)
2520. Sp. F5 + A2; assumed *giant.*
2593. Sp. G5 + A2

H. R.
2644. Sp. A2; A0 (L)
2783/4. Sp. B8; A
2859. Sp. F5 + A0; assumed *giant*
2890/1. Sp. A0; A0 + F5; Mdp (L)
2909/10. Sp. F2; F2
3021. Sp. comp. F2 + A0; assumed *giant.*
3209/10. Sp. F9 (AB); G0 (C) (Mt. W)
3310/11. Sp. A5; A2 (L)
3312/3. Sp. A3 (A); G (BC)
3395/6. Sp. G0; K0 (L)
3474/5. Sp. G5; A5
3482. Sp. F9 (AB); F5 (C) (Mt. W)
3532. Sp. G9; K0 (Mt. W)
3552/3. Sp. A0 + F8; A5 (L)
3617. Sp. F3; F4 (Mt. W)
3624. Sp. F5 + A5
3806. Sp. F0; F0 (L)
3852. Sp. comp. F5 + A3
3888. Of class XI ac according to Miss A. Maury; the proper motion indicates, however, that this is a dwarf.
3963. Sp. A0 (A); A0 (B)
3982. Sp. B8 (A); K2 (B) (Mt. W)
4021. Sp. A5 + F5; A5 + F5 (L)
4057/8. Sp. K0; G5 (L)
4249. Companion not n H. D. which appears to indicate that it is of late type, and to confirm that this is a dwarf system.
4259/60. Sp. A0; A3 (L)
4374/5. Sp. F9; G2 (Mt. W)
4414. Sp. G9; K4 (Mt. W)
4443/4. Sp. G0; G0
4456. Sp. AB: B2; B8 (L)
4486. Sp. F8; K4 (Mt. W)
4545. Sp. comp. F2 + A2
4560/1. Sp. AC: A0; B9
4602. Sp. F0; F0 (L)
4677/8. Sp. F0; F0
4698. Sp. F2; F2 (L)
4707. Sp. F5; A3; assumed *giant*
4751/2. BC counted as an independent pair.
4791/2. Sp. K0; A3
4821/2. Sp. F5; F2 (L)
4825/6. Sp. F0; F2 (AB) (L)
4892/3. Sp. A2; A0
4914/5. Sp. B9p; F2 (L)
4990. Sp. A0; A2 (L)
5054/5. Sp. A2p; A2
5074/5. Sp. F0; F0
5120. Sp. A3; A5 (L)
5385/6. Sp. A0; F2 (L)
5397. Sp. A0; A0 (BC)
5414/5. Sp. A0; A0
5475/6. Sp. B9; A5 (L)
5505/6. Sp. G8; A1 (Mt. W)

H. R.
5523. Sp. AB: B9p; A0p (L)
5531. Sp. A3; F5
5538. Sp. F8; F5 (L)
5544. Sp. G6; K4 (Mt. W)
5568. Sp. K3; Ma (Mt. W)
5582. From proper motion equal chances of being giant or dwarf; counted with G-dwarfs.
5610. Sp. F0; F0 (L)
5618. Sp. G0; G0p (L)
5659. Sp. G6; G7 (Mt. W)
5733/4. Sp. F0 (A); G0 (BC) (Mt. W)
5788/9. Sp. F0; F0 (L)
5815/6. Sp. F8; F8 (L)
5833/4. Sp. B8; B9 (L)
5829. Sp. G5; G5
5977/8. Sp. F2; F5; G5 (L). Counted as d F2.
5984/5. Sp. AC: B2p; B1 (L)
6018. Abs. magn. — 2.2 (Mt. W), although K0; *counted as G-dwarf.*
6063/4. Sp. AB: F8; G0 (L)
6077. Sp. F5; F5
6112/3. Sp. B1; B1 (L)
6134. Sp. Ma; B3 (Mt. W)
6150. Distance given by Greenwich observers as 11.″5.
6184—6. Sp. A2 (AB); A0 (C)
6267. β. G. C. 7792 = Kustner 1 is identical with β.G.C. 13355 = = Hu 917
6369/70. Sp. F8; F8 (L)
6401/2. Sp. K0; K0 (L)
6406/7. Sp. Mb; F8p (L)
6410. Sp. A3; G0 (L)
6484/5. Sp. B9; B9 (L)
6554/5. Sp. A5; A5
6592. Sp. K2; F0 (Mt. W)
6609/10. Sp. A0; A0
6623. Sp. G5; Mb (BC) (Mt. W)
6636/7. Sp. F3; F7 (Mt. W)
6729/30. Sp. A0; G0 (L); or A3; G5 (Harv.)
6733/4. Sp. F2; F2 (L)
6752. Sp. K0; K4 (Mt. W)
6758. Sp. A2; A0 + F2p (L)
6781/2. Sp. A3; A3 (Mt. W and Harv.)
6803. Sp. F2; A0
6809/10. Sp. F5; F5
6848. 8.″3 is the distance CD
6896. Sp. K0 + A0
6918. Sp. A0 + F2; A0 (L); or A0 + G (Harv.)
6981. Sp. F8; F8 (L)
7059. Sp. A0 + F2; A2 + F5 (L)
7051/2. Sp. A3; F0 (L)
7053/4. Sp. A5; A5 (L)
7056/7. Sp. AD: A3; A3

H. R.

7100 and 7102. The photometric measure in H. A. 69 p. II is ascribed to *H. R.* 7102 = ν2 Lyrae = Ho 440; it seems, however, improbable that this difficult companion was measured; probably the pair which was measured by Wendell was the nearby H. R. 7100 = ν1 Lyrae = H V 40, AB.
7106. Sp. B8p; B9 (Mt. W)
7133. Sp. G0 + A3
7141/2. Sp. A5; A5
7165. Mt.W. sp. = F8, which corresponds better with the giant nature of the star.
7293/4. Sp. G6; G4 (Mt. W)
7417/8. Sp. K0 + A0; B9 (Harv.); or Gp comp.; B9p (L)
7448. Sp. K5; K0
7497. Sp. F5; A3; assumed *giant*
7503/4. Sp. G2; G3 (Mt. W)
7508. Sp. K0 + A0
7534. Sp. F6; K4 (Mt. W)
7544. Sp. F2; A2; assumed *giant*
7593/4. Sp. B3; B
7717. Sp. B9p; B9p (L)
7735. Sp. K0 + B8 (A); B9 (C); A2 (D)
7775 and 7776 form a triple system, in which, however, only BC was counted as an independent pair. The spectra are: G0 + A0 (A); B9 (BC).
7781. Sp. A0; F2 (L)
7791. The magnitude of B was assumed in the count = 14.0
7829/30. Sp. A2; A3
7849 Sp. A2 + G
7921. Sp. K0 + A
7947/8. Sp. K0; F8 (L)
8034. Sp. F5 (AB); F5 (C) (L)
8058/9. Sp. F5; A3
8085/6. Sp. K7; K8 (Mt. W)
8164. Sp. K0; A0
8238. Sp. B1; A2 (Mt. W)
8309/10. Sp. F8; F8 (L) (AB)
8361. Sp. A2 + G
8417. Sp. A3; F7 (Mt. W)
8423. Sp. F6; G3 (Mt. W)
8544/5. Sp. G0; G0 (L)
8558/9. Sp. F2; F2 (Mt. W)
8571. Sp. AB: G0p; B8 (L)
8595. Sp. F2 + A5
8603. Sp. B3p (A); B5 (B); B5 (E)
8654. Sp. AB: K4; G8 (Mt. W)
8687. Sp. F5; F5 (L)
9002. Sp. F2; F2 (L)
9018. Sp. A2p + G
9094. Sp. F5; A2
5. Sp. G4; G7 (Mt. W)

H. R. 1318. Photometric measures in *H. A.* **11** give $\Delta m = 3.74$, in *H. A.* **69** II $\Delta m = 2.44$; there must be some mistake in one of these values, or the companion is variable. The adopted value was derived from the estimates and agrees with the later photometric measure.

H. R. 2943. ***Procyon*** = β. G. C. 4187. Estimated $\Delta m = 13.0$, correction assumed = — 1.0.

After the statistical discussion was completed, a number of pairs for which the classification was uncertain were remeasured by the writer in 1924; for several of these pairs the classification was changed after the measures; in table 1 the changed classification is adopted, although the counts were made with the old classification. Below is given a list of the pairs where the counted and the finally adopted classification differed; a **NB** calls attention to a serious change of the classification which should have influence on the count; a few pairs classified according to some originally overlooked measures of Burnham and Leavenworth are also added, being marked with an asterisk

β. G. C.	Classif. count.	Classif. adopt.	β. G. C.	Classif. count.	Classif. adopt.	β. G. C.	Classif. count.	Classif. adopt.
* 466	c?	c	3338 AC	f	f?	6753	?	opt.
* 989	?	opt.?	3397 AB	?	f	7068	?	opt.?
* 1468 AB	f	? **NB**	„ AF	?	opt. ?	7140	f?	f **NB**
* „ AC	f	? **NB**	4383 AB	?	f?	7495 AC	f?	f
1859	?	opt.?	4499 AC	?	opt.? **NB**	7886	?	opt. **NB**
2368 AB	opt. ?	opt.	4612	?	opt. ?	* 7943 AC	c?	c
2447	opt. ?	f? **NB**	4822	opt.	f	8013 AB	?	opt.?
2448 AC	f?	f **NB**	4823	?	f?	„ AC	opt.	opt.?
2530	?	opt.?	4828 AD	opt.	?	* 8868 AC	opt.	f?
2531 AC	?	opt.?	5436	?	opt. ?	* „ AE	opt.	f? **NB**
* 2813	f	opt.? **NB**	5458	opt. ?	opt.	* „ AF	opt.	f? **NB**
2959	?	opt.? **NB**	5895	f	opt. **NB**	*10453	f	f?
3338 AB	f	f?	6540	?	opt. ?	*11227 AC	f?	f **NB**

3. Classification according to Relative Motion and Absolute Magnitude.

The 5th column of table 1 contains remarks on the character of relative motion. Although Burnham's General Catalogue contains measures sufficient for the classification of the majority of the stars of our list, the conclusions arrived at by Burnham needed a revision from the standpoint of the increased knowledge of proper motions; it is sufficient to say that since the completion of the General Catalogue of Double Stars such a fundamental work as Boss's Preliminary General Catalogue appeared. Therefore each star was treated individually; the measures given in Burnham's General Catalogue, and in doubtful cases more recent measures were compared, and in the light of the proper motion adopted the conclusion on the character of relative motion was drawn. The sources of double star measures used for this purpose were relatively completely represented up to 1923, except the *Astronomical Journal*, many volumes of which were partly lost, partly not received because of the circumstances of the war; it may be mentioned that in the chronological order the most recent publication consulted was *Lick Observatory Bulletin* 348, containing measures by R. G. Aitken, made in the years 1913—1922; also a few measures of wide pairs, made by the writer in 1924, were used for the catalogue, although for the statistical discussion these measures came too late. The chief publications referred to were: Publications, Observations, Bulletins etc. of the Flower, Greenwich, Lick, Washburn and other Observatories; Measures of Proper Motion stars, by S. W. Burnham; the *Monthly Notices, Astronomische Nachrichten, Astronomical Journal*. It may be remarked here that the majority of objects for which the classification is doubtful or unknown are wide pairs to which little attention is paid by double star observers; therefore long lists of double star measures added generally very little to our classification. The most useful for our purpose proved to be the so-called "measures of proper motion stars". As to the wide pairs, their importance in a statistical investigation like this is not less than the value of close or moving pairs.

It must be pointed out that the classification adopted here cannot be regarded as definitive; the purpose in view was to obtain a trustworthy material for *statistical* treatment; for a few individual stars the classification may afterwards turn out to be wrong, which however is of no importance in drawing the statistical conclusions.

For the majority of pairs where little change is observed or where the relative change differs little from rectilinear motion, the classification is a question of probability; and for statistical purposes it is sufficient that this probability be near 1.

The general meaning of the letters by which the classification is denoted in the 5th column of table 1 has been explained above. Here it may be added that *relatively fixed (f)* were called stars showing no sensible relative change since the epoch of discovery, and for which either no proper motion was available, or when the proper motion assigned to the brighter component was small — say, less than 1″.5—2″.0 per century. *Optical* were classified stars for which the observed relative change could not be attributed to orbital motion on reasonable assumptions as to the probable mass, parallax and absolute magnitude, and for which the change was either greater than the *possible* errors of measurement, or within the possible limits of observational errors, considerably surpassing however the *probable* error, and agreeing with the direction and amount of the proper motion.

In more doubtful cases a *?* is added to the classification. The reliability of the classification may be judged from the time elapsed since discovery, the amount of the proper motion and the separation of the components, i. e. from the data of the 3d, 4th and 6th columns of table 1.

A classification according to absolute magnitude and sufficient for our purposes may be obtained by the separation of the *giant* and *dwarf* series within each spectral type; besides these two predominant divisions it is necessary to introduce a class of *supergiants*, stars of exceptional luminosity and low density (*β Orionis, ε Aurigae*).

To the *supergiants* belong certainly the stars with the *c*-characteristic of Miss A. Maury, i. e. having *narrow* lines; generally stars whose probable luminosity exceeds absolute magnitude -7 ($\pi = 1''$) were in table 1 classified as supergiants.

The normal B and A stars are here called dwarfs notwithstanding their high luminosity; the reason was that they owe their luminosity chiefly to the high surface brightness, the density being much greater than the density of true giants and approaching the density of the dwarfs of later types.

Giants occur certainly among the spectral classes F8 to M, their proportion increasing with the advancing spectral type; taking into account that there are found many composite spectra in the Henry Draper catalogue where an F-spectrum predominates over a spectrum of type A, it appears that earlier F-giants must also exist, or, rather, that many stars classified in the *H.D.* as F2 or F5 may be giants.

The subdivision according to absolute magnitude in table 1 was executed by using the following data: a) *the hypothetical parallaxes;* in addition to the hypothetical parallaxes given by Jackson and Furner [1]) and by Jackson [2]), hypothetical parallaxes for several stars were computed which were less reliable but which were most useful in the discrimination between giant and dwarf systems; in several cases where no change was observed an upper limit to the hypothetical parallax could be assigned which was quite sufficient for our purposes; the list of these hypothetical parallaxes is given in table 2; b) the proper motion and spectral type; instead of using an empirical formula like Kapteyn's formula, which gives the probable parallax' as the function of proper motion and apparent magnitude, table 3 was constructed; this table gives the absolute magnitude as the function of apparent magnitude and proper motion for a constant tangential velocity equal to 20 km/sec; the allowance for other possible values of the tangential velocity is made by using the following table of corrections to be added to the absolute magnitude:

tang. velocity, km/sec	3	8	20	50	125
Correction, st. mg.	+4	+2	0	—2	—4.

With the aid of this table and knowing the mean absolute magnitudes of giants and dwarfs for a given spectral type the discrimination between giants and dwarfs may be performed fairly well in the majority of cases, especially if it is taken into account that dwarfs show a preference for high velocities,

1) *The Hypothetical Parallaxes of 556 Visual Double Stars,* Monthly Notices **81**, pp 2—31 (1920).

2) *The W. Struve (Σ) Double Stars,* ibidem **83**, pp 4—32 (1922). *The Otto Struve (OΣ) Double Stars*; *Hypothetical Parallaxes of Some Aitken and Hussey Double Stars,* ibidem, **83**, pp. 436—444 (1923).

giants — for low ones. Only in exceptional cases nothing can be inferred from the proper motion and spectrum; these cases correspond to a giant of high velocity, or to a slowly moving dwarf[1]). c) In many doubtful cases where the two above mentioned methods gave no definitive answer the spectroscopic parallaxes of *Mt. Wilson Contributions* 199 could be used. d) In several cases the principle of *spectral* parallaxes proposed by Fr. C. Leonard was applied[2]). Stars without proper motion, to which neither of the above mentioned methods could be applied, were generally classified as giants if of spectral type Go or later; the reason was that the unknown proper motion must probably be small; if earlier than Go, the stars were classified as dwarfs.

The greatest difficulty of classification present the G-stars, because the proportion of giants and dwarfs among the naked-eye stars of this class seems to be nearly equal, and the difference in absolute magnitude is relatively small; the frequency of erroneous classification must, however, be small even in this case, as may be judged from the following: in a preliminary treatment the limiting absolute magnitude from table 3, separating giants from dwarfs of spectrum F8 to G0, was assumed equal to — 2.5; afterwards it appeared[3]) that to obtain statistically correct results this limit ought to be placed at — 3.5; the change of the limit necessitated the change of classification for only two stars, β. G. C. 7334 and 12021, which were preliminarily classified as giants, but finally counted as dwarfs.

Table 2.

List of Hypothetical Parallaxes.

The data of this table are generally of low weight, and in many cases give only the upper limit of the hypothetical parallax.

β.G.C.	π_h	β.G.C.	π_h	β.G.C.	π_h	β.G.C.	π_h
153	0″.010	836	0″.039	1650	$\geqslant$ 0″.025	1900[4])	0″.018
180	.004	1612	.075	1834	.013	2207	.011

1) The method of deriving the parallax from proper motion and spectrum is being investigated by W. Luyten; his results, referring to proper motions exceeding 50″ per century, could, however, not be used for our purposes.

2) *Lick Observatory Bulletin* **343** (1923); used also by P. Doig (J. B. A. A.).

3) From a consideration of Kapteyn's Luminosity-Curve and the data of *Groningen Publications* **30.**

4) OΣ 65; the period may be 70 years ±, a = 0″.35 ±.

Table 2. Continued.

β.G.C.	πh	β.G.C.	πh	β.G.C.	πh	β.G.C.	πh
2213	0″.007	6185	0″.040	12289	0″.031	6363 [5])	<0″.005
2268	.025	6239	.032	13203	.011±	6880	.033
2571	.003	7070	.013	438	≤ .016±	6905	< .011
2712	.007	7360	.012±	768	< .008	7544	≤ .019
2804	.034	7402	.033	1689	≤ .050	7599	.060
2896 [1])	.007	7613 [2])	.070	1692	.050±	7907	< .017
3261	.012±	7801	.009±	1720	≤ .008	7928	< .014
3469	.035	8031	.014±	2623	≤ .010	8860	< .008
4076	.030	8390	.014	2957	< .008	10180	< .077
4668	.027	8441	.060	3422 [4])	.045	10572	< .004
4714	.060±	8467	.017	4708	≤ .022	10605	≤ .005
5491	.031	10372	.012	5820	≤ .022	11088	≤ .008
5732	.028±	10430	.013	5983	< .030	11158	≤ .044
5812	.070	12046	.013	6342	< .011	12096	≤ .025±
6094	.025	12090 [3])	> .010				

Table 3.

Absolute Magnitude ($\pi = 1''$) for Tangential Velocity = 20 km/sec.

Appar. Magn.	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Centennial Proper Motion								
1″	−13.0	−12.0	−11.0	−10.0	−9.0	−8.0	−7.0	−6.0
2	−11.5	−10.5	− 9.5	− 8.5	−7.5	−6.5	−5.5	−4.5
3	−10.6	− 9.6	− 8.6	− 7.6	−6.6	−5.6	−4.6	−3.6
4	−10.0	− 9.0	− 8.0	− 7.0	−6.0	−5.0	−4.0	−3.0
5	− 9.5	− 8.5	− 7.5	− 6.5	−5.5	−4.5	−3.5	−2.5
7.5	− 8.9	− 7.9	− 6.9	− 5.9	−4.9	−3.9	−2.9	−1.9

1) β 1007; assumed P = 52 years, a = 0″.24 ±; may be also P = 26 y., a = 0″.12 ±.

2) Spectrum B5; adopted change of 0″.3 in 26 years apparently due to errors of measurement.

3) Period must be short, less than 55 y.; probable period 30 y.; spectrum G0, proper motion 42″, certainly dwarf.

4) OΣ 143; the hypothetical parallax was derived from the measures 1852—1898; recent measures make the change somewhat doubtful.

Epoch	P.A	d″	Obs.	n
1852.4	104°.4	7″.55	OΣ	4
1867.3	102 .9	7 .87	Δ	3
1898.7	102 .1	8 .07	Hu	4
1921.1	106 .7	7 .41	Ab	3
1924.2	100 .4	7 .95	ö	3

5) Proper motion 14″, sp. G0; apparently a giant with enormous velocity.

Table 3. Continued.

Appar. Magn.	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Centennial Proper Motion								
10. ″	—8.0	—7.0	—6.0	—5.0	—4.0	—3.0	—2.0	—1.0
12.5	—7.5	—6.5	—5.5	—4.5	—3.5	—2.5	—1.5	—0.5
15.	—7.1	—6.1	—5.1	—4.1	—3.1	—2.1	—1.1	—0.1
20.	—6.5	—5.5	—4.5	—3.5	—2.5	—1.5	—0.5	+0.5
25.	—6.0	—5.0	—4.0	—3.0	—2.0	—1.0	0.0	+1.0
30.	—5.6	—4.6	—3.6	—2.6	—1.6	—0.6	+0.4	+1.4
40.	—5.0	—4.0	—3.0	—2.0	—1.0	0.0	+1.0	+2.0
50.	—4.5	—3.5	—2.5	—1.5	—0.5	+0.5	+1.5	+2.5
60.	—4.1	—3.1	—2.1	—1.1	—0.1	+0.9	+1.9	+2.9
80.	—3.5	—2.5	—1.5	—0.5	+0.5	+1.5	+2.5	+3.5
100.	—3.0	—2.0	—1.0	0.0	+1.0	+2.0	+3·0	+4.0

4. The Magnitudes.

The magnitude estimates belonging to different double star observers were collected from every available series of measures where *independent* estimates were made; athough the estimates reproduced in table 1 represent the existing observational data not completely, they contain probably about 90 % of all independent estimates. All estimates of the same observer were joined into one general mean, only this mean value being given in table 1; in forming the mean each independent publication received equal weight without regard to the number of nights of observation; this method was adopted because estimates made by the same observer on different nights seem to be not quite independent from one another, especially if separated by a short interval of time. An exception was made for some Aitken's estimates in *Lick Observatory Bulletin* **348**, which arrived after the reduction was completed; these estimates are marked in table 1 with an asterisk and received independent weight in the derivation of final magnitudes. When the combined light of two close companions was estimated by some observer, the original estimate was as a rule corrected to obtain the individual differences of magnitude for each companion separately. Very few of the collected estimates were rejected because a misprint or some other mistake was suspected. In table 1 the estimated *difference of magnitude* is given because only this quantity is of importance for our purposes.

The sources for the estimates were: Burnham's *General Catalogue of Double Stars*, Parts I and II, where only the Σ-estimates may be regarded as completely represented; *Poulkova Observations* IX. X (OΣ); *Publications de Poulkovo*, Série II, vol. XII (HΣ); *Misure Micrometriche di Stelle Doppie e Multiple*, by Ercole Dembowski (Δ); *Mesures micrométriques d'étoiles doubles*, Séries I—V, par S. Glasenapp (Gla); *Cambridge Observations* vol. XXIV p. 1, chiefly observations by J. Glaisher in 1839—1844 (Cmb); Publications of the *Washburn Observatory* vol. X_4 and XIV_1, by G. Comstock (Com); Publications of the *Lick Observatory* vol. I, by S. W. Burnham (β), vol. XII, by R. G. Aitken (*A*); *Lick Observatory Bulletins* 1—348, estimates by Aitken, Olivier (Ol); *Publications of the Flower Observatory*, vol. I p. 3, vol. II p. 3, vol. III p. 3, vol. IV p. 1, by E. Doolittle (Doo); *Publications of the Yerkes Observatory*, vol. I. II, by Burnham (β); *Monthly Notices of the Royal Astronomical Society*, vol. **66** to **83**; *Astronomische Nachrichten*, Band 120 to latest (1923); *Astronomical Journal* vol. XII. XVI. XVII. XVIII. XXIX. XXX and latest; these periodicals together with Burnham's General Catalogue furnished estimates by the following observers in addition to those mentioned above: G. W. Hough (Ho); F. P. Leavenworth (Lv); Leavenworth and Muller (LM); Cincinnati Observers: O. Stone, H. A. Howe, W. Upton, H. C. Wilson, H. V. Egbert (Cin); H. C. Wilson (W); Franz (Fr); W. Herschel, J. Herschel (under the same letter H); South (S); G. Abetti (Ab); T. J. J. See (See); Espin (Es); R. Jonkheere (Jk); Boothroyd (Bd); Cogshall (Cg); Tarrant (T); Sellors (Sel); A. Hall (Hl); Schiaparelli (Sp); Dawes (Da); Secchi (Se); Franks (Fks); and many others. The estimates by the Herschels and by South were frequently omitted if later estimates were available.

A comparison between the estimates of F. G. W. Struve and photometric measures of double stars was made by E. C. Pickering[1]); certain systematic differences were found, the most important of which is a dependence of the estimate upon the angular separation: the difference of magnitude for close pairs is usually *overestimated*; as will be shown later on, the same

1) *Harvard Annals* **11** (1879) pp. 184—189.

effect, and almost in the same degree, is revealed by other observers. The tables given by Pickering are somewhat inconvenient for use, especially because the effect of distance is there not clearly separated from the effect of the difference of magnitude; therefore a new discussion of the material was made, the result of which is represented by tables 4, 5 and 6. The photometric measures used for comparison were those given in *Harvard Annals* vol. **11** part I, pp. 105—189 [1]), and *Harvard Annals* vol. **69** part II, pp. 180—199 [2]); the observations given in *Harvard Annals* **11,** part II, pp. 277—290 [3]) were not used because it appeared that the systematic errors of this series were not less than for simple eye-estimates.

The systematic corrections given in tables 4 and 6 were found by successive approximations. Modern observers deal chiefly with close and difficult pairs, whereas the photometric measures at Harvard were made on the more easy pairs (chiefly the Σ and H double stars); therefore many observers have too few stars in common with the Harvard measures, and their systematic corrections could not be directly determined; the only way of deriving the corrections in such a case is to compare the estimates of the observer with another observer whose corrections are already known.

The systematic correction of an estimated difference of magnitude may generally be assumed to depend upon three arguments, m_A — the magnitude of the brighter component, $\Delta m = m_B - m_A$ — the difference of magnitude, and d — the angular separation; in the following the effect of m_A is neglected, i. e. it is assumed that differential estimates of magnitude are independent of the apparent magnitude; for a limited group of stars like the naked-eye stars which form the subject of the present discussion this is probably a fair approximation. As to the effect of distance, it appeared that for different observers its character was similar; therefore the following form of the correction was assumed: $\text{corr.} = p(\Delta m) + f(d, \Delta m)$, p being the *personal equation* of the observer, depending on Δm only, and

1) *Bright Double Stars,* photometric observations, by E. C. Pickering, A. Searle and W. Upton.

2) *Observations of Double Stars,* by O. C. Wendell.

3) *Unequal Double Stars.*

Table 4.

Correction of the Estimated Difference of Magnitude, Δm, for Personal Equation.

Σ. (324)

Δm	Corr.
0.0...0.5	0.0
0.6...1.4	−0.1
1.5...1.7	0.0
1.8...3.3	+0.1
3.4...4.7	0.0
4.8...5.0	−0.1
5.1...5.3	−0.2
5.4...5.5	−0.3
5.6...5.7	−0.4
5.8...6.4	−0.5
≥6.5	−0.6

Δ. (231)

Δm	Corr.
0.0...0.1	0.0
0.2...0.4	−0.1
0.5...1.0	−0.2
1.1...1.3	−0.1
1.4...1.6	0.0
1.7...2.4	+0.1
2.5...4.0	+0.2
4.1...5.0	+0.1
≥5.1	0.0

Gla. (161)

Δm	Corr.
0.0...4.2	0.0
4.3...4.4	−0.1
4.5...4.8	−0.2
4.9...5.1	−0.3
5.2...5.9	−0.2
≥6.0	0.0

OΣ. (260)

Δm	Corr.
0.0...0.3	0.0
0.4...0.8	+0.1
0.9...1.2	+0.2
1.3...1.5	+0.3
1.6...1.7	+0.4
1.8...1.9	+0.5
2.0...2.2	+0.6
2.3...4.0	+0.7
4.1...4.4	+0.6
4.5...4.6	+0.5
4.7...4.8	+0.4
4.9...5.0	+0.3
5.1...5.3	+0.2
5.4...5.7	+0.1
5.8...6.2	0.0
≥6.3	−0.1

β. (116)

Δm	Corr.
0.0...0.1	0.0
0.2...0.3	+0.1
0.4...1.0	+0.2
1.1...4.5	+0.3
4.6...4.9	+0.2
5.0...5.2	+0.1
5.3...5.4	0.0
≥5.5	−0.1

A. (93)

Δm	Corr.
0.0...0.1	0.0
0.2...1.6	+0.1
1.7...1.9	0.0
2.0...2.2	−0.1
2.3...2.6	−0.2
2.7...3.2	−0.3
3.3...4.3	−0.4
4.4...5.0	−0.5
5.1...5.8	−0.6
≥5.9	−0.7

Doo. (75)

Δm	Corr.
0.0...1.9	0.0
2.0	+0.1
2.1	+0.2
2.2...4.5	+0.3
4.6...4.7	+0.2
4.8...4.9	+0.1
5.0...5.1	0.0
5.2...5.3	−0.1
5.4...5.5	−0.2
5.6...5.8	−0.3
5.9...6.0	−0.4
6.1...6.3	−0.5
≥6.4	−0.6

Cmb. (115)

Δm	Corr.
0.0...0.2	0.0
0.3...1.9	−0.1
2.0...2.9	−0.2
3.0...4.9	−0.3
5.0...5.9	−0.5
≥6.0	−1.0

Ho. (66)

Δm	Corr.
0.0...0.9	+0.2
1.0...1.9	+0.1
2.0...2.9	−0.2
3.0...3.9	−0.1
4.0...4.9	−0.2
5.0...5.9	+0.2
6.0...6.9	−0.2
≥7.0	−1.4

Cln. (48)

Δm	Corr.
0.0...2.9	0.0
3.0...4.9	+0.6
5.0...5.9	0.0
≥6.0	−1.5

Com. (66)

Δm	Corr.
0.0...0.9	0.0
1.0...3.9	−0.5
4.0...4.9	−0.2
5.0...5.9	−0.3
6.0...6.9	−0.5
≥7.0	−1.0

HΣ. (40)

Δm	Corr.
0.0...0.9	+0.2
1.0...1.9	+0.4
2.0...2.9	+0.2
3.0...3.9	0.0
≥4.0	+0.2

Fr. (20)

Δm	Corr.
0.0...0.9	+0.2
1.0...2.9	+0.3
≥3.0	+0.4

Lv. (84)

Δm	Corr.
0.0...2.9	0.0
3.0...3.9	+0.6
4.0...4.9	+0.1
5.0...5.9	−0.2
6.0...6.9	−0.5
≥7.0	−0.7

LM. (8)

Δm	Corr.
0.0...2.9	0.0
≥3.0	+0.5

W. (23)

Δm	Corr.
0.0...4.9	0.0
5.0...5.9	−0.5
≥6.0	−1.0

H, S, Sh. (37)

Δm	Corr.
0.0...5.9	0.0
≥6.0	−1.2

See. (65)

Δm	Corr.
0.0...2.9	0.0
≥3.0	−1.1

Es. (41)

Δm	Corr.
0.0...0.9	0.0
1.0...1.9	+0.3
2.0...2.9	+1.0
3.0...4.9	+0.4
≥5.0	−0.8

Bd. (11)

Δm	Corr.
0.0...0.9	0.0
1.0...5.9	+0.5
≥6.0	−0.8

Cg. (18)

Δm	Corr.
0.0...2.9	0.0
3.0...4.9	−0.2
≥5.0	−0.5

Hl. (12)

Δm	Corr.
0.0...1.9	0.0
≥2.0	−0.8

All other **Observers.**

Δm	Corr.
0.0...4.9	0.0
5.0...5.9	−0.5
≥6.0	−1.0

Ab. (16)

Δm	Corr.
0.0...1.9	0.0
≥2.0	−0.2

T., Sp. (19) (10)

Δm	Corr.
≥0.0	0.0

Sel. (15)

Δm	Corr.
0.0...3.9	0.0
≥4.0	−1.0

Da. (9)

Δm	Corr.
0.0...2.9	0.0
≥3.0	−0.5

Table 5.

Weights Adopted. Unit of weight corresponds to p. e. ± 0.50 st. mg.

Δm uncorrected	Σ	Δ	Gla.	OΣ	β	A	Doo.	Ho.	Lv.	Cmb.	Cin.	HΣ	Com.	Fr.	H, S, Sh.	Ab.	See	Es.	All other
0.0 ... 0.9	10	10	10	4	2	10	5	3	10	10	10	10	10	5	1	5	10	5	2
1.0 ... 1.9	5	5	2	2	3	2	1	3	2	10	2	1	1	2	0.5	2	2	2	1
2.0 ... 2.9	2	3	2	1	0.5	1	0.5	3	0.5	2	0.5	1	5	2	0.5	1	2	1	1
3.0 ... 3.9	1	4	2	0.5	1	2	3	1	2	2	2	1	1	2	0.5	1	2	2	0.5
4.0 ... 4.9	3	2	2	1	1	1	2	1	4	2	1	3	5	1	0.5	1	0.5	2	0.5
⩾5.0	3	2	4	1	1	0.5	0.5	0.5	2	2	0.5	2	1	1	0.2	1	0.5	1	0.5

f—a function common to all observers and depending upon the distance and *Δm*. It may be remarked that in comparing estimates of two observers the function *f* disappears, so that the difference of the personal equation can thus be derived without taking into account the angular separation. On the contrary, the function *f* can be derived only from a direct comparison with the photometric measures.

For lack of space it is not possible here to go into details about the computations from which tables 4—6 resulted; only the general outlines of the method will be given.

Among the double star observers there were only three for which the number of estimates checked by photometric measures was sufficient to allow a successful direct comparison; these observers were: Σ, Δ and Gla.; we shall call them the *first group* of observers. Without regard to distance the personal equation of these observers was assumed equal to the mean difference *photom.-estim.*; this assumption is legitimate because the mean angular separation of the pairs measured by all three observers is practically the same; for great values of *Δm*, where the photometric data are scarce, the observers were also compared with one another; the resulting *smoothed* corrections are given in table 4. It may be remarked that for Δ and Gla photometric measures relating only to stars of the *H. R.* were used, whereas for Σ measures of fainter stars were also added; this produced, however, no sensible difference.

The following observers, constituting the *second group*, had relatively few stars measured at Harvard, but a sufficient number in common with the first group: OΣ, β, A, Doo, Ho, Lv, Cmb, HΣ, Com; for these observers the personal equation was derived

Table 6.

Correction of the Difference of Magnitude for Effect of Distance together with the residual correction.

In this table Δm is supposed to be corrected for personal equation (see table 4); the corrections given below are applied equally for all observers.

1) $d \leqslant 0.''99$

Δm	0.0 ... 0.6	0.7 ... 1.1	1.2 ... 1·8	1.9 ... 2.1	2.2 ... 2.3	2.4 ... 3.3	3.4 ... 4.0	4.1 ... 4.8	4.9 ... 5.7	5.8	5.9	6.0 ... 6.8	6.9 ... 7.1	7.2 ... 7.9
Corr.	0.0	—0.1	—0.2	—0.3	—0.4	—0.5	—0.6	—0.7	—0.8	—0.9	—1.0	—1.1	—1.2	—1.3

2) $d = 1''.00 ... 3''.99$

Δm	0.0 ... 0.6	0.7 ... 1.4	1.5 ... 2.1	2.2 ... 2.3	2.4 ... 3.5	3.6 ... 4.4	4.5 ... 5.5	5.6	5.7 ... 6.5	6.6 ... 7.0	7.1 ... 7.6	7.7	7.8 ... 8.5	8.6 ... 8.8	8.9
Corr.	0.0	—0.1	—0.2	—0.3	—0.4	—0.5	—0.6	—0.7	—0.8	—0.9	—1.0	—1.1	—1.2	—1.3	—1.4

3) $d) = 4''.0 ... 7''.9$

Δm	0.0 ... 2.1	2.2 ... 5.0	5.1	5.2 ... 5.7	5.8 ... 5.9	6.0 ... 6.3	6.4 ... 7.0	7.1 ... 8.0	8.1	8.2 ... 9.0	9.1	⩾9.2
Corr.	0.0	—0.1	—0.2	—0.3	—0·2	—0.3	—0.4	—0.5	—0.6	—0.7	—0.8	—1.0

4) $d = 8''.0 ... 31.''4$

Δm	0.0 ... 4.2	4.3 ... 4.8	4.9 ... 6.6	6.7 ... 7.6	7.7	7.8 ... 8.6	8.7	⩾8.8
Corr.	0.0	+0.1	0.0	—0.1	—0.2	—0.3	—0.4	—0.5

4) $d > 31''4.$

Δm	0.0 ... 0.9	1.0 ... 2.7	2.8 ... 3.9	4.0 ... 7.2	7.3	7.4 ... 8.2	⩾8.3
Corr.	0.0	+0.1	+0.2	+0.3	+0.2	+0.1	0.0

from a comparison with the observers of the first group, the few photometric comparisons being also used.

The *third group* of observers, including all not mentioned above, for which individual corrections are given in table 4, had too few estimates in common even with the first group; the corrections were determined from a comparison with the estimates of both the first and the second groups, together with the photometric measures available.

Finally several observers had too few estimates in common with other observers (only stars of our list, i. e. naked-eye stars being used in the comparison); for these observers a common personal equation given at the end of table 4 was adopted; this personal equation probably corresponds with what is called "an average observer".

The figures in parentheses in table 4 indicate the number of stars from which the personal equation was derived.

The *relative weights* given in table 5 were computed: for Σ, Δ, Gla and OΣ — from the average residuals: *corrected estimate minus photometric measure*; for the remaining observers — from the differences between their corrected estimates and the estimates and measures from which the personal equation was derived (taking into account the average residual of the latter). No smoothing was undertaken among the values of table 5. Since in deriving the personal equation of an observer, say, of the second group the standard estimates adopted for comparison were in the majority of cases *averages* of two or three observers of the first group, the error in the adopted average residual of the standard estimates had little influence on the resulting probable error of estimates of the second group[1]), and the adopted weights probably do not differ much from the true ones. The somewhat smaller weights for modern observers are probably partly due to the choice of more difficult pairs. But the chief cause of the different accuracy attained by different observers must be attributed to the method of securing the estimate.

An interesting feature revealed by the majority of observers

1) If Δ is the average difference of two series of estimates, and if Δ_1 and Δ_2 are the true average errors of these series, we have $\Delta_1 = \pm\sqrt{\Delta^2 - \Delta^2_2}$; if Δ_2 is small in comparison with Δ_1, an error in the adopted value of Δ_2 produces little change in the resulting value of Δ_1.

is a minimum value of the weight for a certain intermediate value of Δm between 2.0—4.0, the weight increasing from this value in both directions; the explanation is that whereas small differences of magnitude are easily estimated by the eye, and whereas for great differences of magnitude the estimates are checked by the knowledge of the limiting magnitude of the telescope, for moderate differences it is difficult to find a suitable standard of comparison.

A few words may be said on the method of reducing the magnitudes to a standard scale; it is doubtlessly erroneous to apply corrections depending only on the apparent magnitude without distinguishing between the fainter and the brighter member of a pair; the magnitude scale kept in mind by some observer may be substantially correct, and nevertheless great systematic errors may enter into the estimate of a faint star near a bright one; an interesting example is furnished by table 4. One of the observers — G. Comstock — gave instead of the original estimates magnitudes already "reduced to the Harvard Scale" by applying corrections derived from a comparison with Harvard photometric measures; nevertheless the personal equation as revealed by table 4 is in this case one of the greatest; it must be regretted that Comstock gave no particulars as to the proceeding adopted by him, but in all appearence this was simply a correction depending on the apparent magnitude. In a similar way Otto Struve compared his estimates with the estimates of his father and with those of Dembowsky and found that their scales were substantially similar[1]); whereas table 4 indicates that between Σ and $O\Sigma$ and Δ and $O\Sigma$ the difference in the personal equation is one of the greatest of the table.

After the personal equation for each observer was established the correction for distance could be studied. For this purpose the estimates of Δm of stars measured at Harvard were corrected for personal equation and mean values computed; the mean values were grouped according to distance and difference of magnitude and the residuals from the photometric data were

1) Poulkovo Observations vol. IX, pp. (155), (156). The difference Σ—$O\Sigma$ and Δ—$O\Sigma$ as derived by O. Struve appears to be approximately a linear function of the magnitude, whereas from table 4 these differences appear to be strongly curvilinear.

examined; it appeared that the final correction could be represented by the equation

$$\text{corr.} = f(d, \Delta m) = k \,.\, \Delta m + r,$$

k being a coefficient depending on the distance, and r — a *residual correction*, generally small, depending on Δm only; the origin of this residual correction lies in the incompleteness and smoothing of the data from which the personal equation was derived; as to k, this coefficient has the character of a correction of the *unit* of the scale, the difference of magnitude assumed as unit by the observer being equal to $1 + k$ (r neglected). The values of k found graphically by putting $r = \text{const.}$ were:

for $d = 2.''0 \ldots 3.''9$,	$k = -0.158$;
$4.\ 0 \ldots 7.\ 9$,	$k = -0.043$;
$8.\ 0 \ldots 15.\ 4$,	$k = +0.007$;
$15.\ 5 \ldots 31.\ 4$,	$k = +0.000$;
$32.\ \ldots 63.\ $,	$k = +0.055$;
$> 63.\ 5$,	$k = +0.047$.

These values were smoothed and extrapolated graphically and finally the following coefficients were adopted:

d	k
$0''.1 \ldots 0''.99$	—0.20
$1\ .0 \ldots 3\ .9$	—0.15
$4\ .0 \ldots 7\ .9$	—0.05
$8\ .0 \ldots 31\ .4$	0.00
$> 31\ .4$	+0.05.

The only doubtful value which could not be based on observational evidence is the first; only a slight difference was adopted for k above and below $1''$ distance because it seemed probable that the effect of decreasing distance must be partly counterbalanced by the more powerful instruments used in measuring close pairs; yet the factor k may be regarded as a quantitive equivalent of the difficulty of perceiving a faint companion close to a bright primary[1]).

1) Numerically this coefficient represents only a part of the relative difficulty, since the observer in making the estimate takes care "to allow for the effect of the bright companion which will always make the faint star appear fainter than it really is". (R. G. Aitken. the *Binary Stars*, p. 53).

Table 6 gives the corrections for distance computed from the linear formula $k\Delta m$ with the values of the coefficient given above, the above mentioned *residual correction* being also added; the apparently linear form of the distance correction makes its extrapolation over values of Δm not covered by the photometric measures tolerably reliable.

The use of the corrections in reducing the estimates to the Harvard scale may be illustrated by the following example:

β.G.C.	d	Estimates		Personal equation	1st Corr.	Weight
7717	0″.9	Σ	3.5	0.0	3.5	1
		Cmb	4.5	—0.3	4.2	2
		Δ	3.9	+0.2	4.1	4
		Com	4.0	—0.2	3.8	5
		Gla	3.5	0.0	3.5	2
		A	3.1	—0.3	2.8	2
		Ho	3.0	—0.1	2.9	1
		Lv	3.5	+0.6	4.1	2
				Mean	3.7	Sum 19
				Corr. for dist.	—0.6	
				Concluded Δm	**3.1**	

How the systematic corrections here adopted answer the observational data may be judged from tables 7 and 8. The first table gives the individual residuals of the mean estimates corrected according to the method described, as compared with the photometric measures; the second table — the mean residuals grouped according to distance and apparent magnitude. The data of these tables were derived from the stars which in table 1 in the column of weight have the remark *ph.* It may be remarked that in several triple or multiple stars, where two companions were too close to be measured separately at Harvard, the estimates and measures may not be directly comparable; in these cases corrections depending on an approximate difference of magnitude of the close components were applied either to the photometric measures or to the estimates to make them correspond with the individual or combined magnitudes respectively; similar corrections were also generally applied to the estimates of table 1, as mentioned above.

Table 7.

Individual Residuals: *Harvard Photometric Measure* minus *Average Corrected Estimate.*

The residuals phot.-est. are given in units of 0.1 stellar magnitude; *W* denotes the *weight* of the average estimated Δm.

β.G.C.	W	Res.	β.G.C.	W	Res.	β.G.C.	W	Res.	β.G.C.	W	Res.
19	6	−5	1711	7	+1	2821	0.5	+13	4710	5.5	−7
165	4	−5	1733	40	−2	2833	20	+1	"	3.5	+1
274	9	−4	1761	7	−7	2839	10	−2	4711	5	0
329	6	0	1787	9	+9	2843	7	+4	4747	1	−3
360	9	+2	1818	5	0	2857	12	+9	4763	9	−2
361	1	−2	1848	1	+7	2883	5	−5	4771	4	−1
426	17	−2	1875	7	−1	"	4	−3	4859	20	+1
439	44	0	1886	5	−8	"	3	+1	4866	1.5	+10
520	20	0	1921	5.5	+5	2887	15	−1	4923	8	−5
570	34	0	1939	9	−4	2902	9	−6	4929	38	−1
574	29	+2	1950	9	0	"	0.2	+8	4984	2	+10
647	7	+1	2014	30	−1	3053	5	+3	5014	8	−3
648	13	−1	2102	4.5	0	3074	3.5	+3	5090	11	+1
655	10	+2	2106	10	+3	"	3	+12	5104	6	+2
713	5	+3	2109	5.5	−1	3181	15	−1	5131	2.5	−6
732	6	+2	2130	8	0	3185	12	+2	5154	4	+6
"	7	+2	2147	7	+3	3238	25	−1	5303	17	+4
870	5	−6	2177	10	+1	3349	7	−4	5356	25	−2
882	1.5	−7	2210	9	−1	3427	6	−1	5388	26	0
993	44	0	2212	30	+1	3559	24	+6	5412	1	+10
1008	20	+2	2220	12	−1	3568	1	−5	5418	2	+2
1028	7	−1	2229	30	0	3585	5.5	0	5453	5	0
1061	24	−1	2266	3	−1	3587	25	0	5537	3	−5
1070	12	+1	2267	4	−10	3678	1	−16	5603	14	−1
1125	35	+1	2269	20	+3	3692	7	+2	5699	15	−1
1137	22	+2	2313	5	+1	3725	5	−5	5734	59	−1
1141	1	−3	2330	30	−3	3811	5	+2	5735	7.5	+1
1149	12	+1	2406	4	−1	3951	5	−3	5765	14	−1
1163	5	0	2435	4	−2	3954	1	−1	5775	7	+13
1262	7	+1	2467	25	−2	3970	7	−2	5779	22	+2
"	7	−1	2480	20	+1	3973	15	0	5790	7	+2
1320	6	+2	2548	12	−4	4122	12	−1	5793	11	+1
1322	2.5	+1	2581	5.5	−7	"	7	0	5820	30	−1
1328	5.5	+1	2584	7	+1	4147	10	0	5858	15	−5
1332	19	−1	2591	9	+5	4197	12	+1	5921	5	+1
1364	4	+2	2594	5	0	4226	3.5	+9	5962	15	−4
1393	6	+3	2605	9	−1	4249	5	−1	6102	10	+6
1401	9	−6	2627	3	+2	4250	35	0	6113	40	−3
1440	5	+3	2666	2	0	4440	4	−11	6134	40	−2
1448	9	+2	2692	9	+5	4456	5	−3	6148	1	−2
"	6	+7				"	2	+15	6180	11	0
1450	4	0	2703	2	+3	4477	35	+1	6183	2	−4
"	4	+1	2751	27	−1	4501	5	−2	6212	24	−1
"	6	+3	2757	10	+5	4581	3	+2	6239	32	+1
1471	2.5	−1	2789	30	−1	4601	30	−3	6284	7	+6
1510	12	−1	2796	7	−5	4602	29	−2	6292	22	−1
1703	7.5	+5	2821	9	−1	4677	7	+1	6296	9	+8

Table 7. Continued.

β.G.C.	W	Res.	β.G.C.	W	Res.	β.G.C.	W	Res.	β.G.C.	W	Res.
6303	20	+1	7608	2	−5	8574	7	+1	10373	30	−1
6313	7	−2	7612	6	+3	"	4	+2	10506	8	+2
6405	12	−4	7613	22	+3	8605	7	−1	10509	26	0
6422	20	0	7634	3	−2	8669	7	+4	10533	0.5	0
6482	11	−4	7672	7	+4	8681	5.5	−3	10643	19	−4
6498	10	0	7702	14	+1	8692	9	+12	10670	11	0
6509	6	−8	"	20	−1	8779	12	0	10698	9	−5
6670	3	+3	7711	9	0	8788	11	0	10732	50	0
6778	4	−2	7714	6.5	−3	8860	22	−1	10773	10	+3
6802	8	−1	7747	5	+2	8868	8	+1	10782	5	−4
6842	4	−5	7758	5	0	8906	8	−1	10795	30	0
6857	20	+2	7768	5	−7	8914	30	+5	10808	15	+2
6880	7	+1	7836	7	−1	8916	1	−10	10829	7	−2
6887	44	0	7845	20	0	8940	7.5	+3	10932	8.5	+5
6954	30	+2	7878	40	+1	8977	7	−4	10966	30	−3
6989	6.5	+1	7905	30	−3	8997	30	−1	11046	9	−4
6993	10	−7	7914	12	−7	9005	2.5	−10	11095	8	0
7018	0.5	+2	7922	8	+3	9116	17	0	11103	12	−1
7034	22	0	7928	3.5	+1	9137	40	−2	11205	3	−3
7060	3	+1	7937	2	+8	9144	9	+1	11214	27	+3
7111	40	+2	7976	2	−2	9277	25	+1	"	2.5	+3
7120	48	+1	8003	15	0	9308	8	0	11222	9	−10
7162	47	+1	8067	8	−2	9355	6	+5	11323	37	0
7194	10	−2	8076	20	−1	9374	10	−5	11327	8	+3
7213	8	−5	8082	8	0	9448	9	−1	11483	12	+1
7258	8	+4	8115	10	+3	9458	7	+3	11514	20	−3
7318	22	−3	8136	30	0	9560	34	−2	11690	19	+4
7334	30	0	8162	6	+3	9607	20	−3	11715	21	0
7352	27	0	8182	16	+2	9617	6	0	11743	52	+1
7362	25	−2	8244	4.5	+2	9643	4	+2	11772	7	−2
7372	1.5	+10	8284	6	+1	9707	17	−1	11839	40	0
7386	12	+3	8302	40	+1	9713	7	−2	11877	3.5	−1
7480	4.5	+3	8340	21	+2	9765	9	+5	11967	5	+4
7493	5	0	8348	35	−3	9854	6.5	+1	12068	6	+4
7514	30	+3	8377	30	0	9955	11	−3	12143	5	+2
7533	7.5	−9	8413	7.5	+8	10085	9	0	12188	9	+4
7563	39	0	"	9.5	−1	10086	17	+2	12257	5	+4
"	8	0	8441	30	−1	10106	5	−8	12292	7	+1
7572	4	+3	8498	5	−7	10246	0.5	−5	12675	60	−2
7581	4	+4	8529	3	0	10315	3.5	0	12701	10	+3
7599	14	−2	8562	9	0	10363	3	−5	12704	10	+1
7608	25	−1									

The residuals of table 7 grouped according to the *weight* gave the following values for the *probable error* of an estimated difference of magnitude:

limits of weight	$\leqslant 1.9$	2.0 ... ... 3.9	4.0 ... ... 7.9	8.0 ... ... 15.	16 31	$\geqslant 32.$
true p. e.	± 0.51	± 0.36	± 0.26	± 0.23	± 0.13	± 0.07
theor. p. e.	± 0.45	± 0.30	± 0.21	± 0.15	± 0.11	± 0.08
true-theor. p. e.	$+0.06$	$+0.06$	$+0.05$	$+0.08$	$+0.02$	$-0.01.$

The "true probable error" of this table was computed on the assumption that the probable error of the photometric measures is on the average ± 0.06 st. mg. The "theoretical probable error" was computed from the formula

$$\text{theor. p. e.} = \pm \frac{0.5}{\sqrt{\text{w}}},$$

because the unit of weight in table 5 was chosen so that it should correspond to a probable error of ± 0.50 st. mg. The true probable error generally surpasses the theoretical, as might be expected. The following empirical formulae may be used for the computation of the true probable error of a Δm in table 1:

$$\text{p. e.} = \pm \left(\frac{0.50}{\sqrt{\text{w}}} + 0.06\right) \quad \text{for w} \leqslant 15, \text{ and}$$

$$\text{p. e.} = \pm \frac{0.50}{\sqrt{\text{w}}} \quad \text{for w} \geqslant 16.$$

The residuals of table 8 are generally within the limits of the accidental error and show only slight traces of systematic errors; in any case, the systematic errors of the adopted corrections do not surpass 0.1 stellar magnitude and are probably considerably smaller; since our magnitudes are written only to the first decimal, the representation of the photometric measures by our corrected estimates must be regarded as very satisfactory. Of course, without the limits of distance and Δm covered by table 8[1]) greater systematic deviations may be expected, hardly, however, exceeding 0.5 st. mg. in the most extreme cases.

The magnitudes of the components given in the 8^{th} column of table 1 were computed with the aid of the difference of magnitude so that the combined magnitude be equal to the value given in the *Harvard Revised Photometry*, if the components are not there given separately; a difficult question was the limit of distance below which the magnitude of the *H.R.* could be regarded as the combined magnitude of the components; the

1) Inferior limit of distance effectively at 2″.

Table 8.

Mean Residuals: *Harvard* minus *Average Corrected Estimate.*

The residuals are given in stellar magnitudes; the number of pairs used for comparison is given in parentheses.

Corrected estimate, Δm	0.0...0.9	1.0...1.9	2.0...2.9	3.0...3.9	4.0...4.9	5.0...5.9	6.0...6.9	7.0...7.9	$\geqq$ 8.0	All
d $<$ 3″.9	+ 0.01 (7)	— 0.03 (9)	— 0.05 (11)	— 0.17 (6)	—	—	—	—	—	— 0.06 (33)
4″.0 ... ... 7″.9	— 0.04 (20)	+ 0.13 (7)	— 0.20 (6)	— 0.03 (6)	— 0.04 (8)	+ 0.10 (1)	— 0.20 (1)	—	—	— 0.03 (49)
8″.0 ... ...31″.4	— 0.01 (43)	+ 0.03 (21)	— 0.07 (18)	+ 0.07 (18)	— 0.10 (13)	+ 0.03 (17)	+ 0.03 (6)	— 0.57 (3)	—	— 0.01 (139)
$\geqq$ 31.″5	+ 0.03 (30)	+ 0.09 (14)	+ 0.07 (23)	— 0.01 (14)	+ 0.08 (22)	— 0.10 (10)	+ 0.08 (6)	+ 0.10 (7)	+ 0.18 (5)	+ 0.05 (131)
All distances	+ 0.00 (100)	+ 0.05 (51)	— 0.02 (58)	— 0.00 (44)	+ 0.00 (43)	— 0.01 (28)	+ 0.04 (13)	— 0.10 (10)	+ 0.18 (5)	+ 0.004 (352)

remarks in the *H.R.* helped in deciding the question; where no remarks were found, components less than 40″ distant were generally regarded as represented in the *H.R.* by their combined magnitude; this limit is perhaps even too low.

In the case of stars measured photometrically the adopted difference of magnitude is the mean of the magnitudes published in volumes 11, 50 and 69 of the Harvard Annals; the values in each volume received equal weight; *H.A.* 50 was used only if *independent* magnitudes for both components were given there; it may be remarked that in several cases where the magnitudes in *H.A.* 50 are given separately for both components, they are based on the estimates by Struve or those from Burnham's General Catalogue; these differences of magnitude were here substituted by the magnitudes derived from all available estimates, according to the method described in this section.

5. Relative Completeness of the Statistical Data.

To allow for the incompleteness of the statistical data a certain quantity p, called the *coefficient of perception,* must be determined; this quantity represents the ratio of the known objects to the total number existing; a general method of determining p under different observational conditions has been proposed by the writer[1]); the method consists in an *independent* survey of the same objects by two or more observers; although in the case of double stars such a survey may be made with success (e. g. by an observer unacquainted with the double star discoveries already made), the waste of time in such an undertaking would be enormous; in the meanwhile satisfactory estimates of the coefficient of perception for different classes of double stars may be obtained in an indirect way.

In our preceding paper: "On the Luminosity-Curve of Components of Double Stars" the coefficient of perception was derived on the assumption that stars of the same spectral type differing by their apparent magnitude are physically similar and have a similar distribution of relative luminosities[2]); the material there used was collected for another purpose[3]) and did not allow of a more detailed treatment. The consequence was that the effect of selection depending on the *difference* of magnitude could not be taken into account and only *relative* coefficients of perception were obtained[4]).

To obtain information regarding the *absolute* selection of double stars in our list we shall make use of the following two methods: 1) a comparison of the observed and theoretical number of *optical* companions within given limits of distance and apparent magnitude; 2) a comparison of the number of double stars discovered by different observers with the total number of double stars of a given distance and difference of magnitude known at present.

It is a psychological fact that in a survey ("Durchmusterung") the purpose of which is the discovery of certain objects or phenomena, the discovery is never complete; according to the difficulty of observing the objects may be divided into three

---

1) Über korrespondierende statistische Beobachtungen, *Astronomische Nachrichten* **5238** (1923); also in the introduction to *T. P.* $\mathbf{25}_1$. where the method is discussed in its application to statistics of meteors, but where the considerations may easily be generalized.

2) *T. P.* $\mathbf{25}_5$, pp 7—11.

3) Hypothetical Parallaxes, by Jackson and Furner.

4) Loc. cit. p. 11.

groups: 1) objects (or phenomena) which under the given circumstances of observation cannot be recorded at all; 2) difficult objects which can be observed, but which are recorded *incompletely*, the incompleteness increasing with the difficulty of observing; 3) easy objects which can be recorded completely; if nevertheless an incompleteness is revealed also by this group, no dependence upon the difficulty of observing can exist. The existence of the second group is of especial importance for our considerations; it appears that there cannot be found a kind of phenomena where the transition from *completeness* to *impossibility of observing* is abrupt. In the particular case of double star discoveries about one-half of the *observed* physical pairs belongs to categories of distance and difference of magnitude for which the completeness of the data is *less* than 90 % [1]; the *true* number of such pairs must be many times greater; were the statistical treatment limited only to the portion of the material completely represented, about 50 % of the pairs should be rejected and the limits of distance and Δm would be unduly restricted. On the other hand, the inclusion into the counts of the material incompletely represented, without allowing for the incompleteness, would only impair the results, depriving them of any physical meaning. An investigation on the *coefficients of perception* or the degree of completeness of the double star discoveries must therefore precede the general statistical treatment.

Difficulty of observing is not the only factor influencing the completeness of a list of double stars; the *choice* of the observer is here also of great importance, chiefly for wide pairs. Discoverers of double stars put ordinarily some upper limit for the distance of pairs recorded by them; this limit was differently chosen by different observers, e. g. 32″ by F. G. W. Struve and 5″ by R. G. Aitken; many observers worked without any distinct limit, and for bright stars the limit was frequently surpassed; moreover, many pairs figuring in double star catalogues have been originally noted for other purposes, e. g. for the determination of relative proper motion; therefore the wide pairs form a somewhat heterogeneous material; it is a happy circumstance that for such pairs an objective method of determining the de-

---

1) This sentence refers to stars of the Harvard Revised Photometry; for fainter stars the incompleteness may be greater.

gree of completeness is presented by the consideration of the number of optical pairs. As to the close pairs, the only factor influencing the selection of the material is the difficulty of observing; it is certain that every companion less than 5″ distant if seen by any observer has been noted; for the naked-eye stars the limit below which no *conscious* rejection of any pairs has been made, may be placed somewhat higher — say, practically at about 8″ or 10″.

Table 9 gives the *theoretical number of optical companions* which should be found within given limits of the distance near the stars of the Harvard Revised Photometry north of declination — 31°. This table has been constructed in the following way. The total number of entries in the *H. R.* north of decl. — 31° was found equal to 6563; according to zones of galactic latitude and declination this number was found to be distributed as follows:

Gal. Lat.	± 0° ... ± 20°	± 20° ... ± 40°	± 40° ... ± 90°	Total
Declin.				
—31° ... —15°	474	314	311	1099
—15° ... 0°	340	294	394	1028
0° ... + 90°	2032	1246	1158	4436
Total	2846	1854	1863	6563

Table 9.

Theoretical Number of Optical Companions to the Stars of the H. R. north of declination — 31°.

magn. Harv. Scale	<7.0	7.1...8.0	8.1...9.0	9.1...10.0	10.1...11.0	11.1...12.0	12.1...13.0	13.1...14.0
d								
< 3.″9	0.006	0.02	0.07	0.15	0.5	1.1	2.5	5.
4.″0 ... 7. 9	0.02	0.06	0.2	0.45	1.4	3.2	7.5	15.
8. 0 ... 15. 9	0.1	0.25	0.8	1.8	5.5	13.	30.	60.
16. 0 ... 31. 9	0.5	1.0	3.2	7.2	22.	52.	118.	240.
32. 0 ... 63. 9	1.9	4.	13.	29.	86.	210.	470.	940.
64. 0 ... 127.	7.5	16.	51.	115.	345.	840.	1880·	3750.

The number of stars within different limits of galactic latitude was determined by counting the number of stars which within a given hour of right ascension fell within the limits of δ roughly corresponding with the adopted limits of galactic latitude.

The mean density per square degree of stars within given limits of the visual magnitude and galactic latitude was taken from *Groningen Publications* **27**, table *V*; for each zone of the galactic latitude the probable number of optical companions was computed separately; the figures of table 9 represent the sum for the three galactic zones. Such a method of computation is to be preferred to the less complicate process of adopting a mean density of the stars of the background over the whole sky, since the density of the stars of the *H. R.* cannot be assumed to be independent of the galactic latitude; the averaging of the density would give a number of optical companions smaller than the true one.

Tables 10, 11 and 12 represent the distribution of the companions of table 1 according to the character of relative motion. Table 10 contains the data for all stars. The letters are the symbols occurring in the 5th column of table 1; their meaning is explained in the 2nd section. The figures following the letters denote the frequency of occurrence of each symbol within given limits of distance and magnitude. For the sake of simplicity the symbols *m* (moving) and *c* (common proper motion), both relating to physical companions, are joined and denoted by the same letter *c*; the letter *f* (fixed), in the majority of cases indicating also a probably physical relation of the components, is nevertheless given separately as the probability of the physical relation is here less than for the *m* or *c* components. From the frequency of the different symbols the *probable number of physical and optical components* respectively is derived within each class of distance and magnitude; these numbers are given in table 10 generally followed by the qualification "*phys.*" or "*opt.*" Below the observed number of optical companions the theoretical number is given, accompanied by the abbreviation "*theor.*"; in table 10 the theoretical number is directly taken from table 9. In heavy type is printed the value of *p*, the *coefficient of perception* (selection) defined at the beginning of this section; the values of *p* in table 10 are generally computed from the ratio *observed*: *theoretical* number of optical companions; however, values exceeding 1 were substituted everywhere by 1.0 which corresponds to completeness. Within given limits of distance and magnitude the coefficient *p* was put also equal to 1 when completeness was found for fainter magnitudes within the same limits of distance.

Table 10.

Distribution of the Companions according to the Character of Relative Motion.

All pairs.

Distance	4″.0 ... 7″.9	8″.0 ... 15″.9	16″.0 ... 31″.9	32″.0 ... 63″.9	64″.0 ... 127″.
Magnitude ⩽ 7.0	c = 24 f = 2 } 26 phys. p ? opt. = 0 theor. = 0.0	c = 22 f = 7 } 29 phys. p = 1.0 opt. = 0 theor. = 0.1	c = 13 f = 8 ? = 1 } 22 phys. p = 1.0 opt. = 2 theor. = 1.5	c = 6 f = 6 ? = 1 } 5 phys. p = 1.0 opt. = 2 theor. = 1.9	c = 4 f = 1 } 5 phys. (p = 0.75) opt. = 1 theor. = 7.5
7.1 ... 8.0	c = 18 f = 5 } 23 phys. p ? opt. = 0 theor. = 0.1	c = 16 f = 8 } 24 phys. p = 1.0 opt. = 0 theor. = 0.2	c = 8 c? = 1 f = 9 f? = 1 ? = 1 } 20 phys. p = 1.0 opt. = 2 theor. = 1.0	c = 12 f = 5 } 17 phys. p = 1.0 opt. = 3 theor. = 4.0	c = 6 f = 3 f? + ? = { 4 phys. } 13 phys. { 2 opt. p = 0.75 opt. ? = 1 opt. = 9 } 12 opt., 16 theor.
8.1 ... 9.0	c = 15 f = 5 f? = 1 } 21 phys. p ? opt. = 0 theor. = 0.2	c = 18 f = 4 } 22 phys. p = 1.0 opt. = 0 theor. = 0.8	c = 14 f = 7 } 21 phys. p = 1.0 opt. = 5 theor. = 3.2	c = 9 f = 2 c? = 1 } 12 phys. p = 1.0 ? = 3 rej. opt.? = 1 opt. = 17 } 18 opt., 13 theor.	c = 13 c? = 1 f = 3 f? = 1 ? = { 4 phys. } 22 phys. { 2 opt. p = 0.33 opt. ? = 2 opt. = 13 } 17 opt., 51 theor.
9.1 ... 10.0	c = 24 f = 3 f? = 1 } 28 phys. p ? opt. = 0 theor. = 0.4	c = 14 c? = 1 f = 4 ? = 1 } 20 phys. p = 1.0 opt. = 1 theor. = 1.8	c = 18 c? = 1 f = 8 f? = 1 ? = { 2 phys. } 30 phys. p = 1.0 { 1 opt. opt ? = 1 opt. = 7 } 9 opt., 7.2 theor.	c = 11 c? = 1 f = 6 f? = 2 } 20 phys. p = 0.69 ? = 7 rej. opt.? = 1 opt. = 19 } 20 opt., 29 theor.	c = 10 f = 3 } 13 phys. c? = 1 ? = 8 opt.? = 1 } 10 rej. p = 0.18 opt. = 20 theor. = 115

Table 10. Continued.

Distance / Magnitude	4″.0 ... 7″.9	8″.0 ... 15″.9	16″.0 ... 31″.9	32″.0 ... 63″.9	64″.0 ... 127″.
10.1 ... 11.0	c = 19 f = 10 ? = 3 (phys.) } 32 phys. **p < 1** opt. = 0 theor. = 1.4	c = 14 f = 7 ? = { 2 phys. } 23 phys. { 1 opt. **p = 1.0** opt. = 5 } 6 opt. 5.5 theor.	c = 12 f = 12 f? = 4 ? = { 8 phys. } 36 phys. { 5 opt. **p = 1.0** opt. = 21 } 26 opt. 22 theor.	c = 2 f = 14 } 16 phys. c? = 1 f? = 3 ? = 10 opt.? = 5 } 19 rej. **p = 0.28** opt. = 24 theor. = 86	c = 2 f = 2 } 4 phys. c? = 2 ? = 3 opt.? = 2 } 7 rej. **p = 0.047** opt. = 16 theor. = 345
11.1 ... 12.0	c = 10 f = 3 f? = 1 ? = 3 } 17 phys. **(0.3) < p < 1** opt. = 0 theor. = 3.2	c = 10 c? = 1 f = 3 ? = { 4 phys. } 18 phys. { 3 opt. **p = 0.85** opt. ? = 1 opt. = 7 } 11 opt. 13 theor.	c = 8 c? = 1 f = 8 f? = 7 ? = { 9 phys. } 33 phys. { 7 opt. **p = 0.52** opt.? = 8 opt. = 12 } 27 opt. 52 theor.	c = 1 f = 3 } 4 phys. f? = 6 ? = 17 opt.? = 8 } 31 rej. **p = 0.18** opt. = 39 theor. = 210	rej.
12.1 ... 13.0	c = 8 f = 3 f? = 1 ? = { 6 phys. } 18 phys. **p = 0.40** { 1 opt. opt. = 2 } 3 opt. 7.5 theor.	c = 5 c? = 2 f = 2 f? = 1 ? = { 6 phys. } 16 phys. { 3 opt. **p = 0.27** opt. ? = 2 opt. = 3 } 8 opt. 30 theor.	c = 5 c? = 5 f = 1 } 11 phys. **p = 0.14** ? = 23 rej. opt.? = 1 opt. = 15 } 16 opt. 118 theor.	c = 2 f = 4 } 6 phys. f? = 1 opt.? = 4 ? = 19 } 24 rej. **p = 0.047** opt. = 22 theor. = 470	rej.
13.1 ... 14.0	c = 1 c? = 2 f = 1 ? = { 1 phys. } 5 phys. **p = 0.1±** { 1 opt. opt. = 0 } 1 opt. 15 theor.	c = 1 c? = 2 } 3 phys. **p < 0.1** ? = 11 rej. opt. = 0 theor. = 60	c = 2 f = 1 f? = 1 } 4 phys. **p = 0.050** ? = 10 rej. opt. ? = 4 opt. = 8 } 12 opt. 240 theor.	c = 1 phys. ? = 12 opt ? = 1 } 13 rej. **p = 0.006** opt. = 6 theor. = 940.	rej.

Table 11.

Distribution of the Companions according to the Character of Relative Motion.

Companions to *Bright Stars*, $m_A \leqslant 3.9$.

Distance	8″.0 ... 15″.9	16″.0 ... 31″.9	32″.0 ... 63″.9	64″.0 ... 127″.
Magnitude $\leqslant$ 7.0	c = 3, f = 1 } 4 phys. **p = 1.0** opt. = 0 theor. = 0.0	c = 1 phys. **p = 1.0** opt. = 0 theor. = 0.0	c = 1, f = 2 } 3 phys. **p = 1.0** opt. = 0 theor. = 0.1	c = 1 phys. **p = 1.0** opt. = 0 theor. = 0.3
7.1 ... 8.0	c = 3, f = 1 } 4 phys. **p = 1.0** opt. = 0 theor. = 0.0	phys. = 0 **p = 1.0** opt. = 0 theor. = 0.0	f = 2 phys. **p = 1.0** opt. = 0 theor. = 0.2	phys. = 0 **p = 1.0** opt. = 1 theor. = 0.6
8.1 ... 9.0	c = 1 = phys. **p = 1.0** opt. = 0 theor. = 0.0	c = 3, f = 1 } 4 phys. **p = 1.0** opt. = 1 theor. = 0.2	phys. = 0 **p = 1.0** opt. = 1 theor. = 0.5	c = 2, ? = 1 } 3 phys. **p = 1.0** opt. = 2 theor. = 2.0
9.1 ... 10.0	c = 1, f = 1 } 2 phys. **p = 1.0** opt. = 0 theor. = 0.1	c = 3 phys. **p = 1.0** opt. = 0 theor. = 0.3	f ? = 1 phys. **p = 1.0** opt.? = 1, opt. = 3 } 4 opt. 1.2 theor.	f=1 phys., ? = {1 phys. } 2 phys. ? = {1 opt., opt. = 6 } 7 opt. theor. = 4.6 **p=1.0**
10.1...11.0	c = 1 phys. **p = 1.0** opt. = 0 theor. = 0.2	f = 1 phys. **p = 1.0** opt. = 1 theor. = 0.9	f = 3 phys. **p = 1.0** opt. = 5 theor. = 3.6	f = 2 phys. opt.? = 1, opt. = 7 } 8 opt. 14 theor. **p = 0.57**
11.1...12.0	c = 2, f = 1, ? = 1 } 4 phys. **p = 1.0** opt. = 1 theor. = 0.5	? = 1 **p = 1.0** opt. = 1 theor. = 2.1	f? = 2 phys. **p = 1.0** ? = 3, opt. = 8 } 11 opt. 8.4 theor.	f = 2 phys. ? = 3, opt. = 6 } 9 opt. 34 theor. **p = 0.26**
12.1...13.0	phys. = 0 **p < 1** opt. = 0 theor. = 1	c = 4, ? = 1 } 5 phys. **p = 0.5** opt. = 2 theor. = 4.7	f = 2 phys. **p = 0.7** ? = 2, opt.? = 2, opt. = 8 } 12 opt. 19 theor.	? = 3, opt. = 5 } 8 opt. 75 theor. **p = 0.11**
13.1...14.0	phys. = 0 **p < 0.5** opt. = 0 theor. = 2.4	c = 2, f? + ? {2 phys. } 4 phys. f? + ? {2 opt., opt. = 1 } 3 opt. 9.6 theor. **p = 0.3**	phys. = 0 **p = 0.13** ? = 2, opt. = 3 } 5 opt. 38 theor.	? = 2, opt. = 2 } 4 opt. 150 theor. **p = 0.03**
$\geqslant$ 14.1 (14.1...15.1)	phys. = 0 **p < 0.2** opt. = 0 theor. = 5.	phys. = 0 opt. ? = 1, opt. = 1 } 2 opt. 19 theor. **p = 0.1**	phys. = 0 **p = 0.05** ? = 3, opt. = 1 } 4 opt. 76 theor.	rej.

Table 12.

Distribution of Companions according to the Character of Relative Motion.

Stars with $\mu \geqslant 30''$ (centennial) and $m_A \geqslant 4.0$

Distance	8″.0 ... 15″.9	16″.0 ... 31″.9	32″.0 ... 63″.9	64″.0 ... 127″.
Magnitude $\leqslant 7.0$	c = 2 phys. opt. = 0 theor. = 0.0	phys. = 0 **p = 1.0** opt. = 0 theor. = 0.0	phys. = 0 **p = 1.0** opt. = 0 theor. = 0.1	phys. = 0 opt. = 0 theor. = 0.3
7.1 ... 8.0	c = 2 phys. opt. = 0 theor. = 0.0	c = 1 phys. **p = 1.0** opt. = 0 theor. = 0.1	c = 2 phys. **p = 1.0** opt. = 0 theor. = 0.2	phys. = 0 opt. = 0 theor. = 0.6
8.1 ... 9.0	c = 3 phys. opt. = 0 theor. = 0.1	c = 1 phys. **p = 1.0** opt. = 0 theor. = 0.3	phys. = 0 **p = 1.0** opt. = 2 theor. = 0.6	phys. = 0 **p < 0.5** opt. = 0 theor. = 2.0
9.1 ... 10.0	c = 2 phys. opt. = 0 theor. 0.2	phys. = 0 **p = 1.0** opt. = 0 theor. = 0.5	c = 1 phys. **p = 1.0** opt. = 2 theor. = 1.5	c = 1 phys. **p = 0.2** opt. = 1 theor. = 4.6
10.1 ... 11.0	c = 1 phys. opt. = 0 theor. = 0.4	phys. = 0 **p = 1.0** opt. = 3 theor. = 1.4	phys. = 0 **p = 0.5** opt. = 2 theor. = 4.5	phys. = 0 **p = 0.2** opt. = 3 theor. = 14.
11.1 ... 12.0	c = 2 phys. opt. = 0 theor. = 1.0	c = 1 phys. **p = 0.3** opt. = 1 theor. = 3.1	phys. = 0 **p = 0.4** opt. = 4 theor. = 10.5	phys. = 0 **p < 0.03** opt. = 0 theor. = 34
12.1 ... 13.0	c = 1 phys. **p < 0.5** opt. = 0 theor. = 2.0	phys. = 0 **p = 0.4** opt. = 3 theor. = 7.1	phys. = 0 **p = 0.08** opt. = 2 theor. = 24	phys. = 0 **p = 0.01** opt. = 1 theor. = 75
13.1 ... 14.0	phys. = 0 **p < 0.2** opt. = 0 theor. = 4.8	phys. = 0 **p = 0.07** opt. = 1 theor. = 14.	phys. = 0 **p = 0.02** opt. = 1 theor. = 48.	phys. = 0 **p = 0.01** opt. = 2 theor. = 150

The *c* and *f* companions were generally assumed to be physical, and the *c?* and *f?* were also counted with them, whereas the *opt. ?* were counted with the optical companions; the companions of entirely unknown character denoted by a "?" were assumed to contain the same proportion of optical members as the companions whose probable nature was established; if this proportion was less than $\frac{1}{2}$, the "?" companions were included in the counts by assigning to them a weight equal to the probability of their being physical; if, however, the chances for being optical were greater than $\frac{1}{2}$, the "?" companions were rejected. Similarly were rejected all doubtful faint companions (c?, f?, opt.?) in wide pairs if the observed number of optical pairs was considerably greater than the number of physical ones; in such cases many of the doubtful companions may afterwards prove to be optical although classified as *c?* or *f?*. The value of p given in the table always refers only to the companions counted as physical or optical, without taking into account the rejected ones.

Tables 11 and 12 are constructed in the same manner as table 10. The former contains a summary for the pairs where the brightness of the principal component exceeds 3.9 in the Harvard Scale; the limit of the *combined* magnitude of these pairs must be placed at about 3.8; the total number of stars from the brightest to this limit was estimated at 4% of all stars of the *H. R.* and hence the *theoretical number of opticals* in table 11 was assumed 4% of the corresponding number in table 10.

The number of stars in the *H. R.* with proper motions exceeding 30″ and fainter than 4.0 magn. (3.9 combined) was estimated [1]) at 4% of the total number of the *H. R.* Hence the theoretical number of opticals in table 12 should equal the number of table 11; however allowance must be made for the effect of *sweeping* produced by the proper motion stars; during the 50—100 years covered by the observations the area within which stars could be at a distance $\leqslant r$ from the moving star is greater than the area of a circle with the radius r; rapidly moving stars may thus have a greater number of recorded optical companions which at different epochs have fallen within the distance limits assigned, than stars of small proper motion, and the theoretical numbers of opticals for the stars in table 12 were therefore multiplied: by 2 for $d = 8''.0 \ldots 15''.9$; by 1.5 for $d = 16''.0 \ldots 31''.9$; by 1.25 for $d = 32''.0 \ldots 63''.9$; and by 1.0 for $d \geqslant 64''$. The numerical values of these factors were estimated from the consideration of the effective difference of epochs of early and modern observers, an average value of the proper motion being assumed.

From a comparison of tables 10, 11 and 12 the following

1) From the data of *Groningen Publications* **30.**

conclusions may be drawn: 1) the companions to stars brighter than 3.9 magn. are represented in our list much more completely than the companions to fainter stars; 2) the completeness of the data for stars with large proper motion is practically the same as for the stars on the average. In allowing for selection the influence of the proper motion may therefore be neglected, whereas the magnitude of the primary must be taken into account. In the following the pairs were subdivided into two groups according to the brightness of the primary, those with $m_A \leqslant 3.9$ and those with $m_A \geqslant 4.0$. The rough subdivision seems to be quite sufficient for our purposes. The coefficients of perception (p) in tables 10, 11 and 12, being determined from the optical pairs, may be safely assumed to hold also for the physical companions since, when a pair is noted for the first time, the observer does not know in advance its nature; thus chance produces the selection among the physical and optical companions quite equally, and the resulting coefficients of perception must be equal.

The consideration of the number of optical companions gives sufficient information as to the selection only for relatively wide pairs, the separation of which exceeds, say, 8″. For the closer pairs another method of estimating the coefficient of perception has been used; the method seems to be less rigorous than the first method, but apparently leads to tolerably reliable results; the method is based on a comparison of the relative number of new pairs found by each observer since Herschel's time, the relative *difficulty* of observing pairs of given separation and difference of magnitude being taken into account.

Let us choose for the *measure of difficulty* a certain quantity c; generally we may put

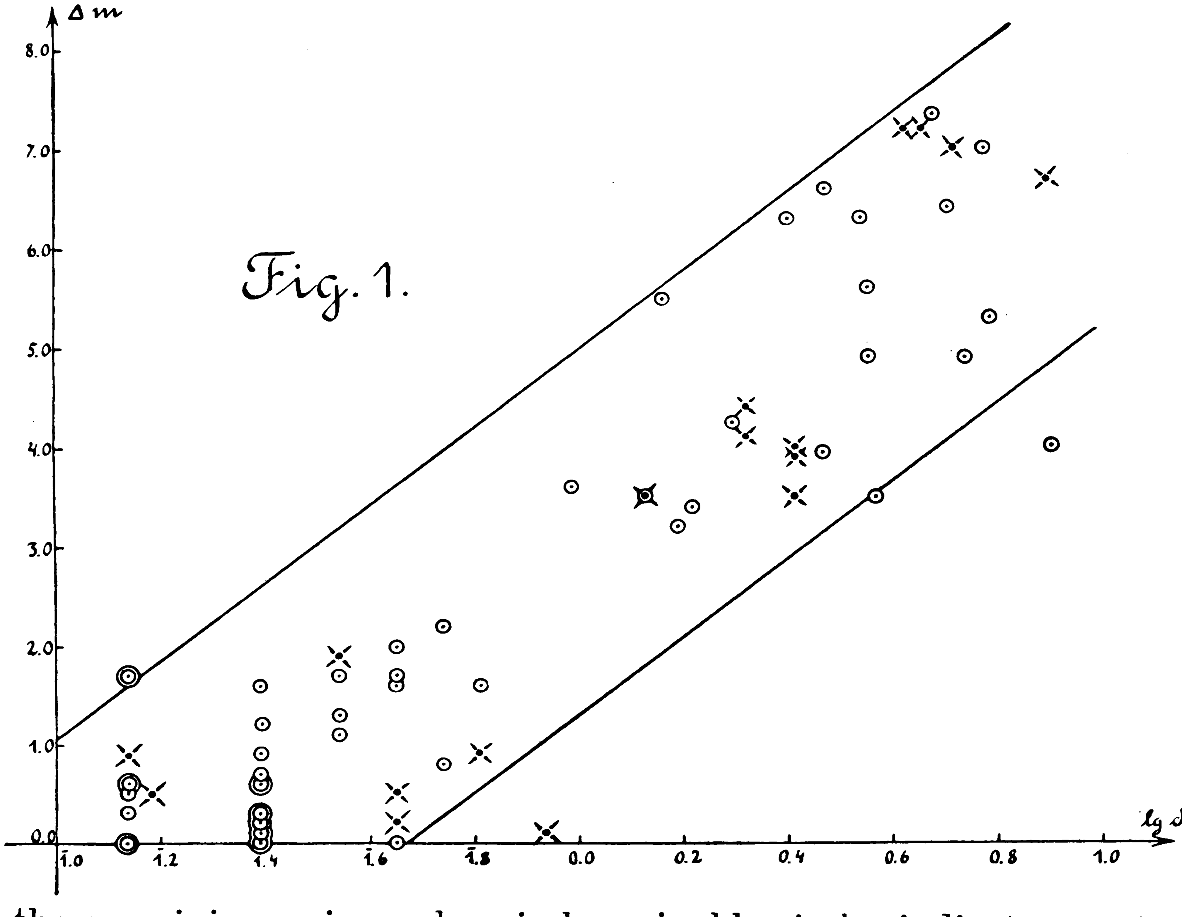
$$c = f\,(d, \Delta m, m_B) \ldots \text{(a)},$$

d being the distance, Δm — the difference of magnitude, and m_B — the magnitude of the fainter component. From the subsequent discussion it appeared that when m_B is not too near the *limiting magnitude* of the telescope, its influence on c may be neglected, so that as a first approximation we assume

$$c = f\,(d, \Delta m) \ldots \text{(a}'\text{)},$$

the difficulty of observing depending on the distance and the relative magnitudes only.

To obtain an idea of the general character of the function (a′) a list was prepared from table 1 containing pairs found by modern observers — Aitken, Hussey, Espin, Innes and See; a few pairs where the primary was fainter than 7.4 magn. (in triple systems) were omitted; the distance limit was adopted = 7″.9. The differences of magnitude of these pairs are plotted on fig. 1 with the *log d* as abscissae; the pairs found by the southern observers — Innes and See — are represented by crosses,



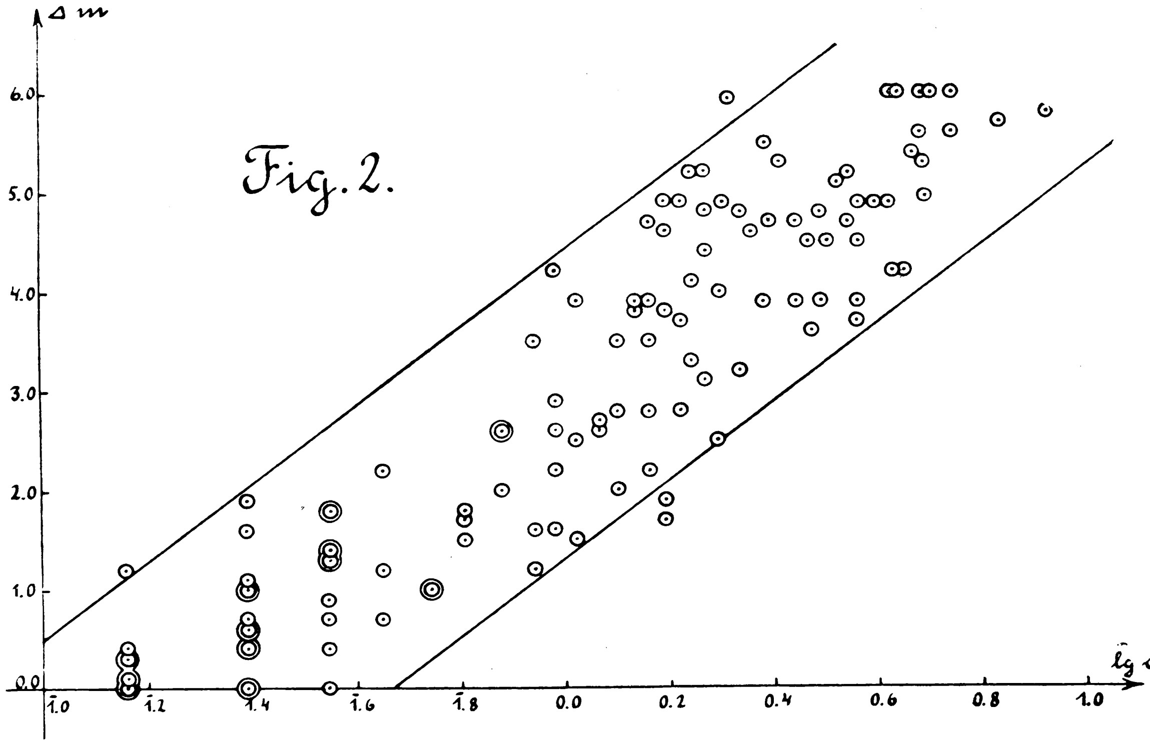
the remaining pairs — by circles; double circles indicate *multiple* points; little or no difference can be perceived in the distribution of the crosses and circles, whence we conclude that the entire material up to the limiting declination — 31° may be regarded as relatively homogeneous.

The material represented on fig. 1, relating to stars of the *H. R.*, is somewhat scarce; to make use of a more abundant material and to examine at once the question of a possible dependence of the function (a′) upon the apparent magnitude fainter pairs from Jonkheere's Catalogue were collected: the limit of the estimated magnitude of the primary was assumed = 7.8; in all 129 such pairs chiefly discovered by Aitken were found and plotted on fig. 2, the difference of magnitude being reduced to the photometric scale in a manner described above.

The distribution of the points on fig. 1 and 2 is practically indentical which settles the question upon the influence of apparent magnitude raised above; no perceptible influence of this kind seems to exist. The points on both figures are almost all found in the space limited by two parallel straight lines of the form

$$\Delta m - 4 \log d = \text{const} \ldots \text{(b)};$$

the constants of the limiting parallels of fig. 1 are 1.3 and 5.0;



for fig. 2 they are 1.3 and 4.4 respectively. By these lines the space on the figures is divided into three parts: 1) the vacant space below is the region where the data were *complete* before the modern searches were undertaken; the absence of new discoveries in this region indicates that practically all of these easy pairs are already known; 2) the space between the parallel lines is the region of modern discoveries where the previous knowledge was incomplete, and where the modern discoveries must also be partially incomplete; 3) the vacant space above is the region where the discovery of new pairs was impossible. It is only natural to assume as the *measure of difficulty* the constant of formula (b); then (a′) and (b) become identical and we finally have for the measure of difficulty the expression

$$c = \Delta m - 4 \log d \ldots \text{(b}'\text{)},$$

d being expressed in seconds of arc and Δm — in stellar magnitudes.

The straight lines on fig. 1 and 2 correspond with two extreme values of the *coefficient of perception*: $p = 1$ and $p = 0$; points lying between the two lines must have evidently an intermediate value of p, $0 < p < 1$. We will make the assumption that in this intermediate space the curves given by the equation $p =$ const. are also straight lines parallel to the two limiting lines; our assumption contains little of hypothetical element, since it is only a generalization in intermediate cases of a fact found to hold for the extremities, in other words — an interpolation. On our assumption the coefficient of perception will be a function of the measure of difficulty c only,

$$p = F(c) = F(\Delta m - 4 \log d) \ldots \text{(c)}.$$

The coefficient of perception considered here is the coefficient for the entire double star material as a whole, resulting from the consecutive and repeated searches of many observers; if $p_1, p_2, \ldots p_k$ are the coefficients of perception of individual observers, the *total* coefficient of perception will be given by

$$p = 1 - (1 - p_1)(1 - p_2) \ldots (1 - p_k) \ldots \text{(d)}.$$

If we suppose that the individual coefficients depend on $c = \Delta m - 4 \log d$ only, equation (c) resulting from (d) will be fulfilled also; therefore it is quite legitimate to assume as a plausible working hypothesis that for individual observers

$$p_i = F_i(\Delta m - 4 \log d) \ldots \text{(e)},$$

the form of the function F_i being of course different from the function F in equation (c).

The *measure of difficulty* expressed in stellar magnitudes, $c = \Delta m - 4 \log d$, has a certain physical and psychophysical meaning; it represents the combined action of *diffraction*, *chromatic aberration* of the objective, *atmospherical* dispersion of light and the physiological *effect of contrast* in the human eye upon the possibility of seeing a companion at a given angular distance from a brighter star.

The quantity c may be called the *objective* measure of difficulty; let us call c_1 the *subjective* measure of difficulty, depending on the instrument, observer and conditions of seeing; the difference $c_1 - c = a$ must *ceteris paribus* depend upon the aperture of the telescope; an estimate of the influence of the latter may by roughly made; let the aperture increase in the ratio D; were diffraction the only factor to be taken into account, a companion with a *given difference of magnitude* could be perceived now at a distance D times less[1]); thus we have

$$c_1 = \Delta m - 4 \log dD$$
$$c = \Delta m - 4 \log d; \text{ whence}$$
$$c_1 = c - 4 \log D \ldots \text{(f)};$$

an increase of the aperture in the ratio 1:2 would diminish the subjective difficulty by 1.2 stellar magnitudes; in practice, however, the gain must be less, since the angular measure of the chromatic aberration and of the atmospherical dispersion does not vary with the aperture of the telescope; therefore we may expect that generally

$$c_1 = c - k \log D \ldots \text{(f')},$$
k being less than 4.

As to the effect of contrast, probably the major part of it may be eliminated by the use of the greatest possible magnifying power; if, nevertheless, such an effect exists, its variation with the aperture must be nearly the same as the variation of diffraction and will not alter formula (f).

Table 13 gives the distribution of the discoveries of close pairs among the different observers; the pairs are classified according to the *measure of difficulty, c,* computed from Δm and d as given in table 1; it must be remembered that d is the distance at the time of discovery and that afterwards the distance and the corresponding value of c might have changed. Only pairs with $c > 1.0$ are included in table 13, since the easier pairs, with $c < 1.0$, are in all appearance completely recorded, as stated above, and need no estimate of the coefficient of perception, the latter being equal to 1.

The subdivision of the observers into groups in table 13 needs little explanation; the order may be regarded as approxim-

1) The periodicity of diffraction represented by the phenomenon of *rings* is here neglected; the use of various apertures by different observers will practically smooth out this periodicity.

Table 13.

Distribution of Discoveries among Different Observers.

$c = \Delta m - 4 \log d$ is the "measure of difficulty" of a pair.

Observer	Σ, H	OΣ	Miscell.	$\beta 6$	$\beta 9$–26	$\beta 36,40$	Ho	A, Hu, See, Innes	Total	Concluded p
c	a) Bright Stars, $m_A \leqslant 3.9$; $d \leqslant 7''.9$									
1.1 ... 2.0	0	0	2	0	0	0	0	0	2	1.00
2.1 ... 3.0	1	2	1	0	0	1	0	0	5	1.0
3.1 ... 4.0	3	1	3	0	0	0	0	0	7	1.0
4.1 ... 5.0	1	0	0	1	1	0	0	0	3	0.7
5.1 ... 6.0	0	0	0	0	3	4	0	0	7	0.4
$\geqslant 6.1$	0	0	(1)*)	0	0	4	0	0	4(5)	0.10 (6.1 ... 7.0)
								Sum	28(29)	
	b) $m_A \geqslant 4.0$; $d \leqslant 4''.9$									
1.1 ... 2.0	34	35	7	26	12	1	3	7	125	0.942
2.1 ... 3.0	9	18	14	20	23	8	3	26	121	0.798
3.1 ... 4.0	0	3	3	1	21	14	3	29	74	0.488
4.1 ... 5.0	0	0	2	0	10	15	3	8	38	0.168
5.1 ... 6.0	0	0	1	0	1	7	1	2	12	0.032
$\geqslant 6.1$	0	0	0	0	0	1	0	0	1	(0.004)
								Sum	371	
	c) $m_A \geqslant 4.0$; $d = 5''.0 ... 7''.9$									
1.1 ... 2.0	6	6	0	0	2	0	1	1	16	0.914
2.1 ... 3.0	4	1	1	0	8	3	1	1	19	0.726
3.1 ... 4.0	0	0	1	0	3	5	0	1	10	0.415
4.1 ... 5.0	0	0	0	0	0	3	0	2	5	0.141
5.1 ... 6.0	0	0	0	0	0	2	0	0	2	0.027
$\geqslant 6.1$	0	0	0	0	0	0	0	0	0	(0.004)
								Sum	52	

ately a chronological one, although not strictly so since occasionally two of the observers might have worked at the same time; the "miscellaneous" group contains observers widely differing in the epoch and instrumental equipment, as Jacob, Dembowsky, A. Clark, E. E. Barnard, Dawes, Holden, A. Hall and others. The discoveries of Burnham are divided into three groups according to the aperture of the telescope with the aid of which the discoveries were made.

The last column of table 13 gives p, the concluded value of the effective coefficient of perception resulting from the combined work of all observers up to the present. The method of

*) *Procyon.*

deriving this value will be explained below. By multiplying the total number of observed pairs by the factor $\frac{1}{p}$ the probable *true* number of the pairs may be obtained.

The values of p for $c < 3.0$ were estimated in not quite a rigorous way; but owing to the circumstance that these values of p, relating to comparatively easy pairs, cannot much differ from unity, our somewhat arbitrary estimate may, nevertheless, be accepted, since the error must be less — probably much less — than $1-p$.

The pairs with $c < 3.0$ were grouped according to the discoverers and the region in the sky as follows:

	Number				
	North of Declination 0°		Declination 0° to —31°		
c	Recent Discoveries (A, Hu, Es)	Preceding Discoveries	Recent Discoveries (A, Hu, See, Innes)	Preceding Discoveries	Total
1.1 ... 2.0	3	95	5	40	143
2.1 ... 3.0	14	86	13	32	145

The assumption was made that the coefficient of perception of the recent discoveries is the same in the northern and southern parts of the sky; let this coefficient be p_r, and let

p_n and p_s be the coefficients of perception of the preceding discoveries in the northern and southern parts of the sky respectively,

R_n and R_s — the ratios of the number of recent discoveries to the preceding ones in the two hemispheres respectively,

r — the ratio of the total number of double stars (*reduced to unit area*) found in the southern part of the sky to the corresponding number for the northern hemisphere.

Taking into account that the area between declination 0° and — 31° equals 0,515 of a hemisphere, we find for the ratio of densities r the following values:

$$c = 1.1 \ldots 2.0 \qquad r = \frac{45}{98.0,515} = 0\ 90;$$

$$c = 2.1 \ldots 3.0 \qquad r = \frac{45}{100.0,515} = 0.87.$$

Thus the number of double stars per unit area known at present in the zone from 0° to — 31° declination is about 90%

of the corresponding number in the northern hemisphere for $c = 1.1 \ldots 3.0$. We assume that the total coefficients of perception are in the same ratio, i. e. that

$$\frac{1-(1-p_s)(1-p_r)}{1-(1-p_n)(1-p_r)} = r \ldots \text{(g)};$$

we also have

$$R_n = \frac{(1-p_n)\,p_r}{p_n} \ldots \text{(h) and}$$

$$R_s = \frac{(1-p_s)\,p_r}{p_s} \ldots \text{(h')};$$

these equations are obtained in the following way. Let N be the true number of pairs, say, in the northern hemisphere; $N p_n$ is the number of the "preceding" discoveries, $N(1-p_n)\,p_r$ — the number of the "recent" ones; their ratio called R_n gives equation (h).

From the three equations (g), (h) and (h') the coefficients p_n, p_s and p_r can be determined, r, R_n and R_s being known; the solution is:

$$p_r = \frac{R_n(1+R_s) - r R_s(1+R_n)}{r(1+R_n) - (1+R_s)} \ldots \text{(i)}$$

$$p_n = \frac{p_r}{R_n + p_r}; \qquad p_s = \frac{p_r}{R_s + p_r} \ldots \text{(k)}.$$

In this way the following values were found:

c	r	R_n	R_s	p_r	p_n	p_s	Number $\delta > 0^0$ observed	Number $\delta > 0^0$ true	Number $\delta = 0^0 \ldots -31^0$ observed	Number $\delta = 0^0 \ldots -31^0$ true	Total obs.	Total true
1.1 ... 2.0	0.90	0. 03	0.125	0.41	0.93	0.77	98	102	45	52	143	154
2.1 ... 3.0	0.87	0.163	0.406	0.53	0.77	0.56	100	112	45	57	145	169

The true number was computed from the formula:

true number = *observed number* $\times \frac{1}{p}$, where $p = 1-(1-p_r)(1-p_n)$, or $1-(1-p_r)(1-p_s)$ respectively.

From this table it appears that for $c = 1.1 \ldots 2.0$ the probable number of undiscovered pairs is $154-143 = 11$, and for $c = 2.1 \ldots 3.0$ the corresponding number is $169-145 = 24$. Since these numbers are small in comparison with the number of known pairs, the arbitrary assumption that p_r is the same in the northern and southern hemisphere is of little consequence; that, nevertheless, this assumption is not fulfilled seems probable from the abnormal increase of p_r for $c = 2.1 \ldots 3.0$, whereas a smaller value for the more difficult pairs should be expected.

Taking into account that stars brighter than $m_A = 3.9$ seem to be very thoroughly examined for duplicity and that the majority of recent discoveries are made for $d < 5''$, the undiscovered pairs may be all assumed to belong to the second category of table 13; for the stars with $m_A > 3.9$ and $d < 5''.0$ we have, therefore, as a first approximation:

$c = 1.1 - 2.0$ . . . number observed $= 125$;
true number $= 125 + 11 = 136$;
$c = 2.1 - 3.0$ . . . number observed $= 121$;
true number $= 121 + 24 = 145$.

These values of the *true* number give us fairly good values of the coefficient of perception for each group of observers in table 13 and c between 1.1 and 3.0; only the coefficient of perception of the *recent* group will be somewhat uncertain. The coefficient of perception for an observer or group of observers i may be computed from the following formula:

$$p_i = \frac{n_i}{N - n_p} \ldots \quad (1),$$

where n_i is the number of discoveries made by i, n_p — the number of all *chronologically preceding* discoveries, and N — the true number of pairs of the given class. The chronological order is not strictly maintained in table 13 — of course it is almost impossible to place the discoveries rigorously in a chronological order if we do not wish to treat each pair individually — but for our purposes the approximation to a chronological sequence in table 13 may be regarded as quite satisfactory. The following values of the coefficient of perception result from the data of table 13:

Table 14.

$m_A \geqslant 4.0$; $d \leqslant 4''.9$

Observer	Σ+H	OΣ	Miscell.	β_6	β_{9-26}	$\beta_{36,40}$	Ho	A, Hu, See, Innes
c	Coefficient of perception							
1.1 ... 2.0	0. 25	0.34	0.10	0.43	0.32	(0.04)	(0.12)	(0.32)
2.1 ... 3.0	0.062	0.13	0.12	0.19	0.27	0.13	(0.06)	(0.45)

The last values, being of low weight, are given in parentheses. Our next task is to extend the knowledge of the coefficients of perception, gained for a limited range of c, over other values of c. A clue for solving this problem may be found in the observations of β made with different apertures. From an inspection of section b) of table 13 we may conclude that after rejecting one most difficult pair the limiting value of c for the different apertures was:

$$\beta_6 \ldots c \text{ limiting} = 3.0$$
$$\beta_{9-26} \ldots \text{,,} \quad \text{,,} \quad = 5.0$$
$$\beta_{36,40} \ldots \text{,,} \quad \text{,,} \quad = 6.0$$

However, taking into account the general variation of the number of discoveries with c, the difference of the values of c corresponding to *equal subjective difficulty* seems to be somewhat less, namely:

$$\left.\begin{array}{l} \beta_{9-26} - \beta_6 = +1.5 \text{ magnitudes;} \\ \beta_{36,40} - \beta_6 = +2.5 \quad \text{,,} \quad . \end{array}\right\} \text{(A).}$$

Taking for the effective aperture of β_{9-26} and $\beta_{36,40}$ 18 inches and 36 inches respectively, we have according to formula (f′) the following theoretical limits for the difference in c:

$$\beta_{18} - \beta_6 < +1.9 \text{ magnitudes;}$$
$$\beta_{36} - \beta_6 < +3.1 \quad \text{,,} \quad .$$

The estimated values (A) given above are in agreement with these theoretical limits and indicate that the real gain from the increase of the aperture is about 79% or 81%, on the average 80% of the gain required by geometrical optics; thus 20% is the loss of optical power due to chromatic aberration and atmospheric conditions.

We shall now take into consideration that the coefficient of perception depends upon two factors: the *subjective difficulty* and the *completeness of the search*; the latter we may imagine as represented by the number of stars examined under *favourable conditions.* It is therefore natural to imagine the coefficient of perception as the product of two factors, π determining the completeness of the search, and χ depending on the subjective difficulty; thus

$$p = \pi\chi \ldots \text{(m).}$$

The function $\chi(c_1)$ may be assumed equal to 1 for the easiest pairs, whence it decreases with increasing c_1 till the value zero is reached; π is assumed to be constant for a given search; generally $0 < \pi < 1$ and $\pi > p$.

Now we will make the assumption that for each of the three groups of Burnham's discoveries the function $\chi(c_1)$ was the same, the searches differing only by the value of π and the subjective difficulty c_1 of a given pair, which varies with the aperture.

The corrections for subjective difficulty are given under (A); adopting these corrections, we have the following table for the coefficient p, the subjective difficulty c_1 being reduced to the aperture of 36 inches:

	β_6		β_{9-26}		$\beta_{36,40}$	
c_1	4. 0	5. 0	2. 5	3. 5	1. 5	2. 5
p	0.43	0.19	0.32	0.27	(0.04)	0.13

instead of the limits of c_1 its mean value is given here.

On our assumption of the identity of $\chi(c_1)$ in the different groups, the ratio of the π for a given c_1 must be equal to the ratio of the corresponding p; thus we have:

for $c_1 = 4.0$, $p = 0.43$ (β_6) and $p = 0.22$ (β_{9-26}, extrapolated);
for $c_1 = 2.5$, $p = 0.32$ (β_{9-26}) and $p = 0.13$ ($\beta_{36,40}$);

$$\text{whence } \frac{\pi(\beta_6)}{\pi(\beta_{9-26})} = 2 \quad \text{and} \quad \frac{\pi(\beta_{36,40})}{\pi(\beta_{9-26})} = \frac{0.13}{0.32} = 0.4 \pm;$$

we also have $\pi(\beta_{9-26}) > p(\beta_{9-26})$, or $\pi(\beta_{9-26}) > 0.32$. This and the preceding ratios give

$$1 > \pi(\beta_6) > 0.64; \quad 1 > \pi(\beta_{36,40}) > 0.13.$$

Finally the following value for β_6 was adopted:

$$\pi(\beta_6) = 0.80; \text{ whence}$$
$$\pi(\beta_{9-26}) = 0.40;$$
$$\pi(\beta_{36,40}) = 0.15 \text{ (estimated).}$$

These values were chosen so that the ratio $\pi : p(c_1)$ should be greater for large values of c_1, which answers the supposed gradual decrease of $\chi(c_1)$ with increasing c_1.

The value for $\pi(\beta_6)$ cannot be much in error; the meaning of this quantity is that about $80^0/_0$ of the naked eye stars north of declination -31^0 were examined with the 6-inch under favourable conditions; allowing for the less favourable atmospheric conditions in the case of the most southern stars, our estimate of $\pi(\beta_6)$ seems to indicate that the northern stars were examined by Burnham completely. This conclusion corresponds with what we know about Burnham's searches.

The estimated values of π may be relied upon probably within 10%; by the way, the absolute values of π are of little importance, since an error in π will produce an opposite error in the estimate of the value of $\chi(c_1)$, the product p remaining unaltered; the numerical determination of the values of π and χ

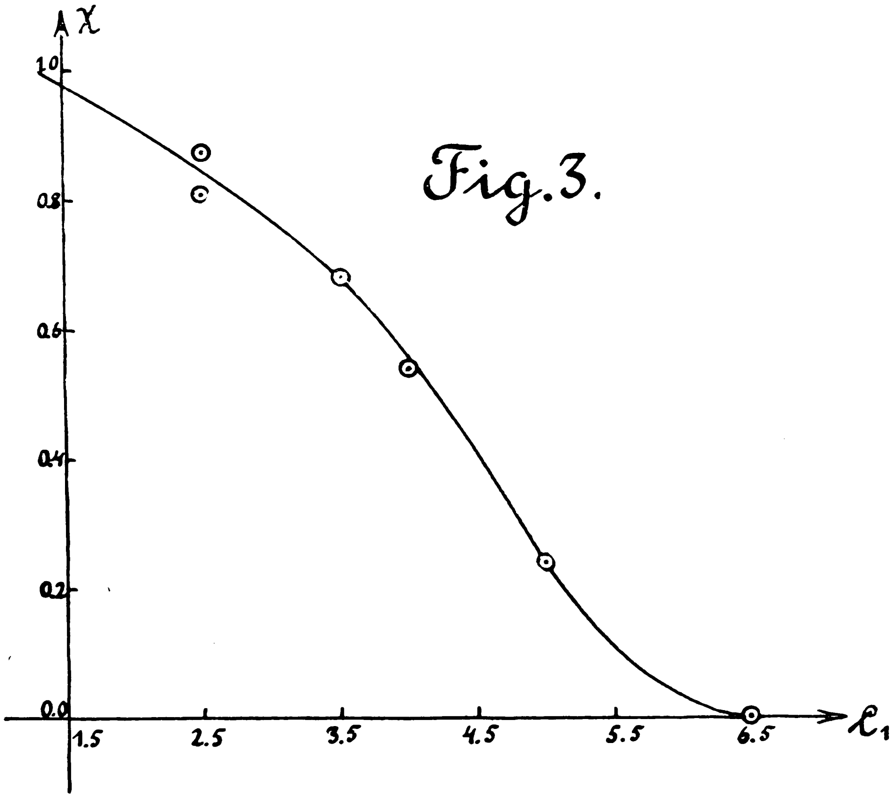


Fig.3.

is here made only with the purpose of obtaining a plausible formula of inter-or extrapolation for the computation of p.

With the values of π adopted the following values of $\chi(c_1)$ could be found according to formula (m):

	β_6		β_{9-26}		$\beta_{36,40}$		
c_1	4.0	5.0	2.5	3.5	1.5	2.5	6.5
$\chi(c_1)$	0.54	0.24	0.81	0.68	rej.	0.87	0.00

The first value for β_{36-40} ($c_1 = 1.5$) was rejected as based on 1 observed pair only; the last value for $c_1 = 6.5$ was assumed equal to zero because $c_1 = 6.5$ seems to be the limit reached by β_{36-40} (see table 13, section b).

The values of χ found here are plotted on fig. 3 with c_1 as abscissae; a smooth curve is drawn through the points; the smoothed values of $\chi(c_1)$ for β as read from the curve are given in table 15 together with the coefficients of perception, p, computed from formula (m), the values of π being those adopted above.

Table 15.

$m_A > 4.0$; $d \leqq 4''.9$.

c	1.5	2.5	3.5	4.5	5.5	6.0
	β_6: $c_1 = c + 2.5$; $\pi = 0.80$					
χ	0.56	0.24	(0.03)	0	0	0
p	0.45	0.19	(0.02)	0	0	0
	β_{9-26}: $c_1 = c + 1.0$; $\pi = 0.40$					
χ	0.84	0.68	0.41	0.11	(0.012)	0
p	0.34	0.27	0.16	0.04	(0.005)	0
	$\beta_{36,40}$: $c_1 = c$; $\pi = 0.15$					
χ	0.95	0.84	0.68	0. 41	0. 11	(0. 03)
p	0.14	0.13	0.10	0.061	0.016	(0.004)

From a comparison of the relative frequency of discoveries for different limits of c in table 13, section b) it appears that the discoveries of Hough and of the combined recent observers — Aitken, Hussey, See, Innes — have the same general character as β_{9-26}, i. e. resemble the observations of Burnham with an effective aperture of 18 inches; therefore the function χ for these observers was assumed equal to the χ for β_{9-26} (table 15); with the χ given and p taken from table 14 (for $c = 1.1 \ldots 2.0$ and $2.1 \ldots 3.0$) π could be determined; thus we found for

Ho . . . $\pi = 0.11$

Combined A, Hu, See, Innes . . . $\pi = 0.57$.

The two values of π furnished by the data of table 14 for each observer are joined here into one *weighted* mean.

Finally the values of the coefficient of perception for each group of observers given in table 16 were adopted; stars brighter than $m_A = 4.0$ were not taken into account in the construction of this table; the values of p for Ho and the recent observers are computed according to formula (m) with the values of π and χ adopted above; the values for $\Sigma + \mathrm{H}$, $\mathrm{O}\Sigma$ and the miscellaneous observers and for $c \leqq 3.0$ are those given in table 14; for $c > 3.0$ the coefficients of perception of these observers were estimated by comparing the numbers of pairs found by them with the number of the β discoveries.

Table 16.

Adopted Coefficients of Perception.

$m_A > 4.0$.

Observer	Σ+H	OΣ	Misc.	β_6	β_{9-26}	$\beta_{36,40}$	Ho	A, Hu, Es, See, Innes $d < 5''.0$	A, Hu, Es, See, Innes $d = 5''.0 \ldots 7''.9$	All Observ. $d < 5''.0$	All Observ. $d = 5''.0 \ldots 7''.9$	$d < 8''.0$
c	Coefficient of Perception											
1.1...2.0	0.25	0.34	0. 10	0.45	0. 34	0. 14	0. 09	0. 48	0. 24	0.942	0.914	**0.938**
2.1...3.0	0.06	0.13	0. 12	0.19	0. 27	0. 13	0.075	0. 39	0. 20	0.798	0·726	**0.789**
3.1...4.0	0	0.03	0. 03	0.02	0. 16	0. 10	0.045	0. 23	0. 12	0.488	0.415	**0.480**
4.1...5.0	0	0	0.006	0	0. 04	0. 06	0.012	0. 06	0. 03	0.168	0.141	**0.164**
5.1...6.0	0	0	(0.001)	0	(0.005)	0.016	(0.001)	(0.009)	(0.004)	0.032	0.027	**0.031**

The above considerations dealed only with pairs having $d < 5''.0$; for $d = 5''.0 \ldots 7''.9$ the same coefficients of perception were assumed for all observers except for the "recent" group; in the latter it seems probable that through the adoption by some observers of the upper limit of distance at 5″ many pairs which might be observed remained unrecorded; therefore in the recent group the coefficient of perception for $d = 5''.0 \ldots 7''.9$ was roughly estimated as $\frac{1}{2}$ of the coefficient for $d < 5''.0$.

The resulting coefficient of perception corresponding to the combined activity of all observing groups was computed according to formula (d) and is given in the 11th and 12th column of table 16; these are the values given also in the last column of table 13. Since the values for $d < 5''$ and $> 5''$ show little difference, they were finally joined into mean values given in the last column of table 16; in computing the mean the weight was adopted equal to the number of pairs observed within each distance group.

The bright stars, having $m_A < 4.0$, were treated separately. By analogy with the wide pairs it might be expected that the companions to these stars are represented in our list more completely than the companions to fainter stars. An inspection of section a) of table 13 confirms this surmise: up to $c = 4.0$ there is only one addition to the preceding discoveries made by β and up to $c > 6.0$ not a single made by the subsequent observers; it appears therefore that for $c < 4.0$ the list for the bright stars may be regarded as complete, whereas for the fainter stars within the same limit of c it is far from being so. Owing to the small number of pairs, some uncertainty exists as to the real degree of completeness; e. g. for $c = 3.1 \ldots 4.0$ the coefficient of perception might be 0.9, leaving a probable number of only 1 pair undiscovered.

The greater completeness attained for the bright stars may be explained by a more frequent and repeated examination of these stars by different observers; if the bright stars are examined n-times more frequently than the faint ones, and if p_b and p_f are the coefficients of perception for the bright and faint stars respectively, we may assume that

$$p_b = 1 - (1 - p_f)^n \ldots (n).$$

For $c = 3.1 \ldots 4.0$ we have $p_f = 0.48$; $p_b =$ from 0.9 to 1.0; a value of $n = 4$ seems to answer these figures; assuming this we have

$c =$	2.1 ... 3.0	3.1 ... 4.0	4.1 ... 5.0	5.1 ... 6.0
$p_f =$	0.79	0.48	0.164	0.031
$p_b =$	1.00	0.93	0. 51	0. 12.

These values may however be underestimated since values of n greater than 4 will little alter in p_b for $c < 4.0$.

Another way of estimating p for the bright stars may be found in the consideration of the optical companions; the opticals were discussed above using as arguments the apparent magnitude and distance; below are given the coefficients of perception of optical companions classified according to the value of $c = \Delta m - 4 \log d$; the coefficients were computed as the mean of the *reciprocals* of p, the individual values of p being taken from table 11; the reciprocals were used because they represent the probable true number of pairs corresponding to one observed pair.

Estimated p_b. Mean values from optical companions.

The number of pairs used is given in parentheses.

c	$\leqq 3.0$	3.1 ... 4.0	4.1 ... 5.0	5.1 ... 6.0	> 6.0
d	p_b				
8.″0 ... 15.″9	—	1. 0 (1)	—	—	—
16. 0 ... 31. 9	0. 8 (4)	—	0. 4 (2)	0.10 (2)	
32. 0 ... 63. 9	0.70 (22)	0.25 (7)	0.21 (2)	0.13 (1)	—

These values must be regarded also as underestimated since the *choice* of the observers tended to reject many wide pairs which could be observed.

The values finally adopted for p_b are given in the last column of section a), table 13; the uncertainty of these values for $c > 5$ is great, but they probably indicate the right order of magnitude. By the way, in the general statistical treatment this uncertainty will have little influence because the bright stars form only a small percentage of all stars.

If the *observed* number of pairs of a certain class is n, and the mean coefficient of perception is p, the probable *true number* N will be given by

$$N = \frac{n}{p} = nz, \text{ where } z = \frac{1}{p} \ldots (0);$$

the quantity z may be called the *extrapolation factor*; tables 17 and 18 give the values of z finally adopted according to the data of tables 10, 11, 13 and 16. Since table 10 comprises *all* stars whereas here the data for stars fainter than $m_A = 3.9$ are needed separately, the p of table 10 were altered a little, so that the weighted mean of the new values of p and those of table 11 should give the values of table 10; the new values of p differed very little, indeed, from those given in table 10, since the weights of tables 10 and 11, being assumed equal to the total number of stars in the sky within the magnitude limits of these tables, are in the ratio 25:1. The 5th column of table 1 contains for each companion used in the counts the values of z taken from tables 17 and 18, but rounded off to the first decimal. For companions classified as? and f? if used in the count the corresponding z was multiplied by the probability of the companion being physically related to the primary.

For *Procyon* z was assumed equal to 1 notwithstanding the abnormally high value of $c = 9.3$; the reason was that the variable proper motion, known previously, made the visual detection of the companion certain. In triple (or multiple) systems, where the secondary component is itself a close pair (BC), z was assumed equal for both components, and was computed from the *combined* magnitude of BC; in other cases independent values of z for each component were assumed.

The values of z here adopted may be systematically influ-

Table 17.

Values of z for $m_A < 4.0$ *(Bright Stars).*

a) $d < 8''.0$

$c = \Delta m - 4 \log d$	< 4.1	4.1 ... 5.0	5.1 ... 6.0	6.1 ... 7.0
z	1.00	1.4	2.5	10.

b) $d \geqq 8''.0$

m_B	$\leqq 8.0$	8.1 ... 9.0	9.1 ... 10.0	10.1 ... 11.0	11.1 ... 12.0	12.1 ... 13.0	13.1 ... 14.0
d				z			
8.″0 ... 15.″9	1.00	1.0	1.0	1.0	1.0	(3.7)	(25.)
16. 0 ... 31. 9	1.00	1.0	1.0	1.0	1.0(?=0.7)	2.0(?=1.4)	3.3(f?,?=1.6)
32. 0 ... 63. 9	1.00	1.0	1.0	1.0	1.0(? rej.)	1.4	rej.
64. 0 ... 127.	1.00	1.0	1.0(? = 0.5)	rej.	rej.	rej.	rej.

Table 18.

Values of z for $m_A \geqq 4.0$.

a) $d < 8''.0$

$c = \Delta m - 4 \log d$	<1.1	1.1 ... 2.0	2.1 ... 3.0	3.1 ... 4.0	4.1 ... 5.0	5.1 ... 6.0
z	1.00	1.07	1.27	2.08	6.1	32.

b) $d \geqq 8''.0$

m_B	$\leqq 7.0$	7.1 ... 8.0	8.1 ... 9.0	9.1 ... 10.0	10.1 ... 11.0	11.1 ... 12.0	12.1 ... 13.0	13.1 ... 14.0
8.″0 ... 15.″9	1.0	1.0	1.0	1.0	1.0(?=0.7)	1.2(?= 0.7)	3.7(?=2.2)	25.
16. 0 ... 31. 9	1.0	1.0	1.0	1.0(?=0.7)	1.0(?=0.6)	2.0(?=1.2)	8.0	25.
32. 0 ... 63. 9	1.0	1.0	1.1	1.5	4.0	6.7	rej.	rej.
64. 0 ... 127.	1.3	1.3(f?,?=0.7)	3.3(? = 1.6)	6.7	rej.	rej.	rej.	rej.

enced by many factors; in the discussion of the optical companions a possible systematic error in the *magnitude scale* might have entered; such an error seems probable from the somewhat high number of observed opticals frequently surpassing the theoretical number. For $d < 8''.0$ the uncertainty in z increases with the increasing c or z.

In a limited region for $m \geqq 4.0$, $d = 4''.0 \ldots 7''.9$ our two methods of determining the coefficient of perception could be applied simultaneously; for comparison the results of both methods are given here:

	m_B = 12.1...13.0	13.1...14.0
reciprocal mean p from consideration of the relative difficulty and completeness of discoveries	0.32	0.07
p from consideration of optical companions	0.40	0.1
number of opticals used	16	7

In both cases the agreement of the independently determined values of p is as good as might be expected from the uncertainty of the data; taking into account that the p here compared belong to those the most uncertainly determined, the agreement may be regarded as an indication that even the most uncertain great values of z occurring in table 18 are of the right order of magnitude.

6. Frequency-Function of Distances and Magnitudes.

The knowledge of the absolute magnitudes of stars of different spectral type is of first importance for the following statistical discussion. The progress attained by the cooperation of many observatories of the world in the investigation of trigonometric, spectroscopic and statistical parallaxes makes it now possible to assign to each spectral subdivision a mean luminosity about which the luminosities of individual stars crowd with a relatively small dispersion. The absolute magnitudes here adopted are based chiefly on a summary given by K. Lundmark[1]). Table 19 gives the limits of spectral class used in our counts, the mean absolute magnitude adopted and the angular separation of a pair for a projected distance = 220 astron. units and the apparent magnitude = 4.9 in the Harvard scale. The absolute and apparent magnitudes here adopted refer to the *primary*, not to the combined light. The projected distance here adopted may correspond with a period of revolution of about 2—3 thousand years or more, just sufficient for the detection of relative motion during an interval of, say, 80—100 years; this distance seems also to coincide approximately with a critical limit in the distribution of luminosities and distances of the components.

Below 220 a. u. the pairs are generally classified as "moving", above this limit — as "fixed" or as having "common proper motion".

1) *Publ. of the Astronomical Society of the Pacific* № **199** (1922).

Table 19.

	a) Dwarfs					b) Giants			c) Supergiants and O stars
Class	B	A	F	G	K	G	K	M	
Limits of Spectrum	B_0—B_7	B_8—A_4	A_5—F_6	F_7—G_4	G_5—K_5	F—G_4	G_5—K_4	K_5—Mb	
H. D.	B_0—B_5	B_8—A_3	A_5—F_5	F_8, G_0	G_5—K_5	F—G_0	G_5—K_2	K_5—Mb	
Mean Absol. Magn.	—5.8	—3.8	—2.3	—0.8	+0.7	—6.	—4.2	—4.6	—8.
Ang. Separation for pr. dist. 220 a. u. and $m_A = 4.9$	1″.6	4″.0	8″.0	16″.	32″.	1″.6	3″.3	2″.8	0″.6

The limits of spectrum in table 19 were chosen so that the mean absolute magnitude for the consecutive classes should differ by 1.5 magnitudes which corresponds to a ratio of distances equal to 2; such a ratio presents many advantages in the statistical treatment. For the giants and the B stars this ratio could of course not be maintained. The class of K-dwarfs contains chiefly members of subdivisions G_5 and K_0, the K_5 dwarfs being very scarce among the naked-eye stars.

According to the apparent magnitude of the primary the data were also subdivided into classes differing by 1.5 magnitudes; the adopted limits of apparent magnitude were:

m_A						
limits:	< 0.9;	1.0 ... 2.4;	2.5 ... 3.9;	4.0 ... 5.4;	$\geqslant 5.5$	(5.5 ... 7.4)
mean:	(0.4);	(1.9);	(3.4);	4.9;		6.3.

The mean magnitude for $m_A \geqslant 4.0$ was directly computed from "gauges" made in table 1; for the brighter magnitudes the mean was simply estimated and is given in parentheses.

Tables 20, 21, 22 and 23 contain the result of the counts made in table 1 together with other data needed for the derivation of the distribution of relative magnitudes and distances of physical companions. In all 1216 companions were used in the construction of these tables; the few *Md* and *N* stars were not included.

Table 20 gives the distribution of Δm for the *close* companions, *table 21* — the same distribution for the *distant* companions.

The intention was to place the limit between the close and distant companions as near as possible to the above mentioned

Table 20.

Distribution of Relative Magnitudes. Close Companions.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
					1) Dwarfs G_5–K_5.							
					$m_A \leqslant 3.9$; $N_0 = 6$							
n	0	0	0	0	0	0	1	2	0	0	0	—
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	1.00	1.00	(3.)	(5.)	(10.)	—
lim d″	0.2—63.9	=	=	0.3—63.9	0.5—63.9	=	1.0—63.9	2.0 · 63.9	=	4.0—63.9	=	—
F	1.00	=	=	=	=	=	=	=	=	1.23	1.23	—
W	6.	6.	6.	6.	6	6.	6.	6.	2.0	1.0	0.5	—
					$m_A = 4.0 \ldots 5.4$; $N_0 = 9$							
n	1	2	2	0	0	0	0	0				
$\bar{z}$	1.00	1.05	1.00	(1.2)	(1.3)	(3.)	(4.)	(15.)				
lim d″	0.2—31.9	0.3—31.9	=	0.5—31.9	1.0—31.9	=	2.0—31.9	=				
F	1.00	=	=	=	=	=	1.23	=				
W	9	9	9	8	7	3	2	0.5				
					$m_A \geqslant 5.5$; $N_0 = 97$							
n	6	0	4	1	2	3	2	1				
$\bar{z}$	1.02	(1.0)	1.20	1.00	1.85	5.20	3.95	7.00				
lim d″	0.2—15.9	0.3—15.9	0.5—15.9	=	=	1.0—15.9	2.0—15.9	4.0—15.9				
F	1 00	=	=	=	=	1.23	2.07	3.77				
W	95	97	81	97	52	15	12	3.7				
					2) Dwarfs F_7–G_4.							
					$m_A \leqslant 3.9$; $N_0 = 4$							
n	0	0	0	2	0	0	0	0	0	1	0	0
$\bar{z}$	(1.0)	(1.0)	(1.0)	1.00	(1.0)	(1.2)	(1.5)	(1.2)	(3.)	10.0	(10.)	(10.)
lim d″	0.2—31.9	=	=	0.3—31.9	0.5—31.9	=	1.0—31.9	2.0—31.9	=	4.0—31.9	=	=
F	1.00	=	=	=	=	=	1.35	1.94	=	4.32	=	=
W	4	4	4	4	4	3.	2.	2.	0.7	0.1	0.1	0.1

Table 20. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	2) Dwarfs F_7-G_4. Continued.											
	$m_A = 4.0 \ldots 5.4$; $N_0 = 37$											
n	2	0	0	4	2	2	0	2	0			
$\bar{z}$	1.00	(1.0)	(1.2)	1.70	1.80	1.15	(3.)	19.0	(19.)			
lim d″	0.2—15.9	0.3—15.9	=	0.5—15.9	1.0—15.9	=	2.0—15.9	=	4.0—15.9			
F	1.00	1.07	=	1.35	1.94	=	4.32	=	6.73			
W	37	34	30	16	11	17	3	0.5	0.3			
	$m_A \geqslant 5.5$; $N_0 = 227$											
n	17	4	1	1	4	1	1	0	—			
$\bar{z}$	1.05	1.48	1.00	1.40	3.78	64.0	2.80	(7.0)	—			
lim d″	0.2—7.9	=	0.5—7.9	=	=	=	2.0—7.9	4.0—7.9	—			
F	1.21	=	1.94	=	=	=	6.73	17.0	—			
W	179.	127.	117.	83.	31.	2.	12.	2.	—			
	3) Dwarfs A_5—F_6.											
	$m_A \leqslant 3.9$; $N_0 = 30$											
n	1	0	0	1	1	0	0	2	1	0	0	1
$\bar{z}$	1.00	(1.0)	(1.1)	1.00	1.00	(1.6)	(1.5)	1.00	1.00	(5.)	(5.)	6.00
lim d″	0.2—15.9	=	=	0.5—15.9	=	=	1.0—15.9	2.0—15.9	=	4.0—15.9	=	=
F	0.95	—	=	1.00	=	=	1.24	1.45	=	1.88	=	=
W	32	32	30	30	30	19	16	21	21	3	3	3
	$m_A = 4.0 \ldots 5.4$; $N_0 = 160$											
n	8	3	6	3	1	3	4	1	—			
$\bar{z}$	1.09	1.07	1.05	1.17	1.20	3.20	8.00	32.	—			
lim d″	0.2—7.9	0.3—7.9	=	0.5—7.9	1.0—7.9	=	2.0—7.9	=	—			
F	0.98	1.05	=	1.24	1.45	=	1.88	=	—			
W	150	143	145	110	92	34	11	3	—			

Table 20. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	3) Dwarfs A_5—F_6. Continued.											
	$m_A \geqslant 5.5$; $N_0 = 665$											
n	40	19	8	13	5	3	1	—	—			
$\bar{z}$	1.08	1.17	1.14	1.38	1.92	12.6	5.10	—	—			
lim d″	0.2—3.9	=	0.5—3.9	=	=	1.0—3.9	=	—	—			
F	1.10	=	1.45	=	=	1.88	=	—	—			
W	559	516	400	332	239	28.	69.	—	—			
	4) Dwarfs B_8—A_4.											
	$m_A \leqslant 3.9$; $N_0 = 62$											
n	3	1	2	1	1	0	0	0	1	1	1	0
$\bar{z}$	1.00	1.00	1.20	1.00	1.00	(1.2)	(1.5)	(1.2)	2.40	2.00	6.00	(10.)
lim d″	0.2—7.9	=	0.3—7.9	=	0.5—7.9	=	1.0—7.9	2.0—7.9	=	4.0—7.9	=	=
F	0.79	=	0.83	=	1.00	=	1.40	2.07	=	4.8	=	=
W	78	78	62	75	62	52	30	25	12.5	6.5	2.1	1.3
	$m_A = 4.0 \ldots 5.4$; $N_0 = 360$											
n	10	6	6	4	3	3	0	0	—			
$\bar{z}$	1.14	1.30	1.63	1.32	2.10	8.4	(10.)	(36.)	—			
lim d″	0.2—3.9	0.3—3.9	=	0.5—3.9	1.0—3.9	=	2.0—3.9	=	—			
F	0.92	1.08	=	1.40	2.07	=	4.8	=	—			
W	342	257	201	194	83	21	8.	2.0	—			
	$m_A \geqslant 5.5$; $N_0 = 1500$											
n	58	24	5	9	6	2	1	—	—			
$\bar{z}$	1.08	1.48	1.48	1.93	3.20	12.6	48.	—	—			
lim d″	0.2—1.9	=	0.5—1.9	=	=	1.0—1.9	=	—	—			
F	1.24	=	2.07	=	=	4.8	=	—	—			
W	1120	816	490	375	227	25	7	—	—			

Table 20. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
						5) Dwarfs B_0-B_7.						
						$m_A \leqslant 3.9$; $N_0 = 36$						
n	0	0	0	0	0	0	0	1	0	—	—	—
$\bar{z}$	(1.0)	(1.0)	(1.2)	(1.1)	(1.1)	(2.0)	(2.0)	2.5	(11.)	—	—	—
lim d″	0.2–3.9	=	=	0.3—3.9	0.5—3.9	=	1.0—3.9	2.0—3.9	=	—	—	—
F	0.74	=	=	0.79	1.00	=	1.45	4.1	=	—	—	—
W	49	49	36	41	33	18	13	4	0.8	—	—	—
						$m_A = 4.0 \ldots 5.4$; $N_0 = 241$						
n	2	3	1	3	2	0	—	—	—			
$\bar{z}$	1.40	1.13	1.10	2.73	17.2	(10.)	—	—	—			
lim d″	0.2—1.9	=	0.3—1.9	0.5—1.9	=	1.0—1.9	—	—	—			
F	0.90	=	1.09	1.45	=	4.1	—	—	—			
W	190	236	201	61	10	6	—	—	—			
						$m_A \geqslant 5.5$; $N_0 = 318$						
n	2	2	1	1	0	0	—	—	—			
$\bar{z}$	1.20	1.45	1.70	3.10	(6.)	(64.)	—	—	—			
lim d″	0.2—0.9	=	0.5—0.9	=	=	=	—	—	—			
F	1.27	=	4.1	=	=	=	—	—	—			
W	209	173	45	25	13	1.	—	—	—			
						6) Giants $F-G_4$.						
						$m_A \leqslant 3.9$; $N_0 = 13$						
n	0	1	0	1	0	0	1	0	1	—	—	—
$\bar{z}$	(1.0)	1.00	(1.1)	1.0	(1.1)	(2.0)	1.40	(2.5)	11.0	—	—	—
lim d″	0.2—3.9	=	=	0.3—3.9	0.5—3.9	=	1.0—3.9	2.0—3.9	=	—	—	—
F	0.57	=	=	0.65	1.00	=	1.37	1.59	=	—	—	—
W	23	23	21	20	12	6	7	3	0.8	—	—	—

Table 20. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	6) Giants F—G_4. Continued.											
	$m_A = 4.0 ... 5.4$; $N_0 = 40$											
n	0	1	0	0	0	0	—	—	—			
$\bar{z}$	(1.1)	1.20	(1.5)	(2.4)	(2.6)	(10.)	—	—	—			
lim d″	0.2—1.9	0.3—1.9	=	0.5—1.9	1.0—1.9	=	—	—	—			
F	0.83	1.07	=	1.37	1.59	=	—	—	—			
W	44	31	25	12	10	3	—	—	—			
	$m_A \geqslant 5.5$; $N_0 = 124$											
n	4	3	0	0	0	0	—	—	—			
$\bar{z}$	1.05	1.13	(1.7)	(3.1)	(6.1)	(64.)	—	—	—			
lim d″	0.2—0.9	=	0.5—0.9	=	=	=	—	—	—			
F	1.22	=	1.59	=	=	=	—	—	—			
W	97	90	46	25	13	1	—	—	—			
	7) Giants G_5—K_4.											
	$m_A \leqslant 3.9$; $N_0 = 68$											
n	0	1	1	1	0	4	1	2	0	0	0	0
$\bar{z}$	(1.0)	1.00	1.00	1.00	(1.1)	1.38	18.0	1.00	(3.)	(5)	(7.)	(10.)
lim d″	0.2—7.9	=	=	0.3—7.9	0.5—7.9	=	=	2.0—7.9	=	4.0—7.9	—	=
F	1.00	=	=	1.00	1.00	=	=	2.54	=	4.8	=	=
W	68	68	68	68	62	49	4.	27.	9.	3.	2.	1.
	$m_A = 4.0 ... 5.4$; $N_0 = 380$											
n	0	1	9	4	4	3	2	2	—			
$\bar{z}$	(1.1)	1.70	1.51	1.25	1.55	10.5	9.8	36.	—			
lim d″	0.2—3.9	0.3—3.9	=	0.5—3.9	1.0—3.9	=	2.0—3.9	=	—			
F	1.00	1.14	=	1.68	2.54	=	4.8	=	—			
W	345	196	221	181	96	14	8	2	—			

Table 20. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	7) Giants G_5—K_4. Continued.											
	$m_A \geqslant 5.5$; $N_0 = 1356$											
n	8	5	2	5	3	2	0	—	—			
$\bar{z}$	1.06	1.26	1.35	2.04	2.63	12.6	(48.)	—	—			
lim d″	0.2—1.9	=	0.5—1.9	=	=	1.0—1.9	=	—	—			
F	1.40	=	2.54	=	=	4.8	=	—	—			
W	916	771	395	262	203	22	6	—	—			
	8) Giants K_5—Mb.											
	$m_A \leqslant 3.9$; $N_0 = 20$											
n	0	0	1	0	1	0	0	0	0	0	0	0
$\bar{z}$	(1.0)	(1.0)	1.00	(1.1)	1.40	(1.2)	(1.4)	(1.2)	(3.)	(5.)	(7.)	(10.)
lim d″	0.2 7.9	=	=	0.3—7.9	0.5—7.9	=	1.0—7.9	2.0—7.9	=	4.0—7.9	=	=
F	1.00	=	=	=	=	=	2.43	=	=	3.6	=	=
W	20	20	20	18	14	17	6	7	3	1	0.8	0.6
	$m_A = 4.0 \ldots 5.4$; $N_0 = 118$											
n	0	0	0	1	2	1	0	0	—			
$\bar{z}$	(1.1)	(1.1)	(1.3)	1.10	1.20	4.10	(10.)	(36.)	—			
lim d″	0.2—3.9	0.3—3.9	=	0·5—3.9	1.0—3.9	=	2.0—3.9	=	—			
F	1.00	1.28	=	2.43	=	=	3.6	=	—			
W	107	84	69	44	40	12	3	1	—			
	$m_A \geqslant 5.5$; $N_0 = 356$											
n	0	1	0	2	0	0	0	—	—			
$\bar{z}$	(1.1)	1.00	(1.3)	2.20	(4.)	(12.)	(48.)	—	—			
lim d″	0.2—1.9	=	0.5—1.9	=	=	1.0—1.9	=	—	—			
F	2.1	=	2.43	=	=	3.6	=	—	—			
W	155	170	111	66	37	8	2	—	—			

Table 21.

Distribution of Relative Magnitudes. Distant Companions.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
1) Dwarfs G_5—K_5.												
$m_A = 4.0 \dots 5.5$; $N_0 = 9$												
n	0	0	0	0	0	2	0	0	—			
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.7)	(3.0)	12.0	(6.0)	(17.0)				
lim d″	32.—127.	=	=	=	=	=	32.—63.9	=	—			
F	1.00	=	=	=	=	=	1.72	=	—			
W	9	9	9	5	3	0.8	0.9	0.3	—			
$m_A \geqslant 5.5$; $N_0 = 97$												
n	1	2	2	1	0	1	0	0	—			
$\bar{z}$	1.00	1.00	2.55	5.40	(2.6)	1.70	(8.8)	(18.)	—			
lim d″	16.—127.	=	=	=	16.—63.9	=	16.—31.9	=	—			
F	0.33	=	=	=	1.00	=	1.72	=	—			
W	290	290	114	54	37	57	6.5	(3.1)	—			
2) Dwarfs F_7—G_4.												
$m_A \leqslant 3.9$; $N_0 = 4$												
n	0	0	1	0	0	0	0	0	0	0	0	0
$\bar{z}$	(1.0)	(1.0)	1.00	(1.0)	(1.0)	(1.0)	(1.2)	(3.5)	(1.0)	(1.0)	(1.0)	(1.5)
lim d″	32.—127.	=	=	=	=	=	=	=	32.—63.9	=	=	=
F	1.33	=	=	=	=	=	=	=	2.96	=	=	=
W	3.	3.	3.	3.	3.	3.	3.	1.	1.	1.	1.	1.
$m_A = 4.0 \dots 5.4$; $N_0 = 37$												
n	0	0	0	0	1	0	0	0	—			
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.6)	4.70	(7.)	(4.)	(10.)	—			
lim d″	16.—127.	=	=	=	=	=	16.—63.9	=	—			
F	1.00	=	=	=	=		1.33	=	—			
W	37	37	37	23	8	5	7	3	—			

Table 21. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	2) Dwarfs F_7—G_4. Continued.											
	$m_A \geqslant 5.5$; $N_0 = 227$											
n	5	3	2	0	1	1	0	0	—			
$\bar{z}$	1.00	1.00	1.00	(2.)	1.30	1.70	(5.8)	(19.)	—			
lim d″	8.0—127.	=	=	=	8.0—63.9	=	8.0—31.9	=	—			
F	1.00	=	=	=	=	=	1.33	=	—			
W	227	227	227	114	175	133	29	9	—			
	3) Dwarfs A_5—F_6.											
	$m_A \leqslant 3.9$; $N_0 = 30$											
n	0	0	0	0	0	1	0	0	0	0	0	0
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	1.00	(1.2)	(2.)	(2.)	(2.)	(2.)	(2.5)
lim d″	16.—127.	=	=	=	=	=	=	=	16.—63.9	=	=	=
F	1.43	=	=	=	=	=	=	=	2.27	=	=	=
W	21	21	21	21	21	21	17	10	7	7	7	5
	$m_A = 4.0 \ldots 5.4$; $N_0 = 160$											
n	2	2	6	5	5	1	4	1	0			
$\bar{z}$	1.00	1.00	1.02	1.80	3.30	1.80	3.90	2.20	(19.)			
lim d″	8.0—127.	=	=	=	=	=	8.0—63.9	=	8.0—15.9			
F	1.00		=	=	=	=	1.43	=	4.00			
W	160	160	157	89	48	89	29	51	2			
	$m_A \geqslant 5.5$; $N_0 = 665$											
n	18	10	11	15	9	5	3	1	—			
$\bar{z}$	1.01	1.00	1.29	1.39	1.46	1.28	2.80	20.0	—			
lim d″	4.0—127.	=	=	=	4.0—63.9	=	4.0—31.9	=	—			
F	0.84	=	=	=	1.00	=	2.27	=	—			
W	792	792	616	568	455	520	105	15	—			

Table 21. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
4) Dwarfs B_8—A_4.												
$m_A \leqslant 3.9$; $N_0 = 62$												
n	0	0	1	0	0	1	3	1	1	1	0	1
$\bar{z}$	(1.0)	(1.0)	1.00	(1.0)	(1.0)	1.00	1.17	6.00	1.00	2.00	(3.)	9.6
lim d″	8.0—127.	=	=	=	=	=	=	=	8.0—63.9	=	=	=
F	1.30	=	=	=	=	=	=	=	1.84	=	=	=
W	48	48	48	48	48	48	41	8	34	17	11	3
$m_A = 4.0 \ldots 5.4$; $N_0 = 360$												
n	6	3	7	7	3	11	3	2	3			
$\bar{z}$	1.00	1.00	1.01	1.37	1.20	5.6	1.80	2.55	18.7			
lim d″	4.0—127.	=	=	=	=	=	4.0—63.9	=	8.0—15.9			
F	1.00	=	=	=	=	=	1.30	=	5.8			
W	360	360	354	263	300	64	154	108	3.			
$m_A \geqslant 5.5$; $N_0 = 1500$												
n	42	32	33	38	36	22	9	4	—			
$\bar{z}$	1.01	1.14	1.10	1.50	1.31	1.83	4.13	9.8	—			
lim d″	2.0—127.	=	=	=	2.0—63.9	=	2.0—31.9	4.0—31.9	—			
F	0.81	=	=	=	1.00	=	1.30	1.52	—			
W	1830	1620	1690	1240	1145	820	279	101	—			
5) Dwarfs B_0—B_7.												
$m_A \leqslant 3.9$; $N_0 = 36$												
n	0	0	0	0	1	2	2	2	1	0	0	0
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.0)	1.00	1.00	1.00	1.00	2.20	(2.)	(3.)	(6.)
lim d″	4.0—127.	=	=	=	=	=	=	=	4.0—63.9	=	=	=
F	1.51	=	=	=	=	=	=	=	2.29	=	=	=
W	24	24	24	24	24	24	24	24	7.	8	5	3

Table 21. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	5) Dwarfs B_0—B_7. Continued.											
	$m_A = 4.0 \dots 5.4$; $N_0 = 241$											
n	4	3	7	4	10	6	4	4	0			
$\bar{z}$	1.00	1.00	1.01	1.68	1.84	3.10	5.04	2.90	(19.)			
lim d″	2.0–127.	=	=	=	=	=	2.0—63.9	=	8.0—15.9			
F	1.00	=	=	=	=	=	1.51	=	12.4			
W	241	241	239	144	131	78	32	55	1			
	$m_A \geqslant 5.5$; $N_0 = 318$											
n	6	10	6	12	7	6	3	1	—			
$\bar{z}$	1.00	1.00	1.55	1.26	1.63	1.52	2.80	18.0	—			
lim d″	1.0—127.	=	=	=	1.0—63.9	=	2.0—31.9	4.0—31.9	—			
F	0.90	=	=	=	1.00	=	1.85	2.09	—			
W	353	353	227	281	195	209	61	8	—			
	6) Giants F — G_4.											
	$m_A \leqslant 3.9$; $N_0 = 13$											
n	0	0	0	0	0	0	0	1	1	0	1	0
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.1)	0.90	1.80	(5.)	14.0	(10.)
lim d″	4.0–127.	=	=	=	=	=	=	=	4.0—63.9	=	=	=
F	1.42	=	=	=	=	=	=	=	2.36	=	=	=
W	9	9	9	9	9	9	8	10	3	1	0.4	0.6
	$m_A = 4.0 \dots 5.4$; $N_0 = 40$											
n	0	1	1	1	2	2	0	3	0			
$\bar{z}$	(1.0)	1.00	1.10	2.30	4.70	1.20	(5.)	12.0	(19.)			
lim d″	2.0—127.	=	=	=	=	=	2.0—63.9	=	8.0—15.9			
F	1.00	=	=	=	=	=	1.42	=	6.4			
W	40	40	36	17	9	33	6	2	0.3			

Table 21. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
6) Giants F—G_4. Continued.												
$m_A \geqslant 5.5$; $N_0 = 124$												
n	2	6	2	1	4	0	2	1	—			
$\bar{z}$	1.00	1.00	1.00	0.90	1.55	(5.)	5.8	7.0	—			
lim d″	1.0—127.	=	=	=	1.0—63.9	=	1.0—31.9	4.0—31.9	—			
F	1.00	=	=	=	=	=	1.42	2.11	—			
W	124	124	124	138	80	25	15	8	—			
7) Giants G_5—K_4.												
$m_A \leqslant 3.9$; $N_0 = 68$												
n	0	0	1	0	2	0	1	0	1	2	0	1
$\bar{z}$	(1.0)	(1.0)	1.00	(1.0)	1.00	(1.0)	1.50	(1.5)	1.80	2.00	(4.)	12.0
lim d″	8.0—127.	=	=	=	=	=	=	=	8.0—63.9	=	=	=
F	1.22	=	=	=	=	=	=	=	1.85	=	=	=
W	56	56	56	56	56	56	37	37	20	18	9	3
$m_A = 4.0 ... 5.4$; $N_0 = 380$												
n	0	4	3	2	6	7	4	4	1			
$\bar{z}$	(1.0)	1.00	1.03	1.65	1.15	1.40	1.88	5.58	19.0			
lim d″	4.0—127.	=	=	=	=	=	4.0—63.9	=	8.0—15.9			
F	1.00	=	=	=	=	=	1.22	=	6.3			
W	380	380	369	230	330	271	166	54	3			
$m_A \geqslant 5.5$; $N_0 = 1356$												
n	3	10	12	26	26	17	8	3	—			
$\bar{z}$	1.07	1.18	1.34	1.86	1.23	2.09	5.34	11.3	—			
lim d″	2.0—127.	=	=	=	2.0—63.9	=	2.0—31.9	4.0—31.9	—			
F	0.65	=	=	=	1.00	=	1.22	2.14	—			
W	1940	1760	1560	1120	1100	649	208	56	—			

Table 21. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
8) Giants K_5—Mb.												
$m_A \leqslant 3.9$; $N_0 = 20$												
n	0	0	0	0	0	0	0	0	0	0	1	2
$\bar{z}$	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.3)	(2.)	(3.)	4.0	12.0
lim d″	8.0—127.	=	=	=	=	=	=	=	8.0—63.9	=	=	=
F	1.23	=	=	=	=	=	=	=	1.33	=	=	=
W	16	16	16	16	16	16	16	12	8	5	4	1.2
$m_A = 4.0 \ldots 5.4$; $N_0 = 118$												
n	0	2	0	0	1	2	4	1	0			
$\bar{z}$	(1.0)	1.00	(1.0)	(1.2)	1.00	1.40	2.20	2.90	(19.)			
lim d″	4.0—127.	=	=	=	=	=	4.0—63.9	=	8.0—15.9			
F	1.00	=	=	=	=	=	1.23	=	5.4			
W	118	118	118	100	118	84	44	33	1			
$m_A \geqslant 5.5$; $N_0 = 356$												
n	0	1	1	9	3	5	2	1	—			
$\bar{z}$	(1.0)	1.90	1.00	2.03	1.73	2.84	3.95	7.00	—			
lim d″	2.0—127.	=	=	=	2.0—63.9	=	2.0—31.9	4.0—31.9	—			
F	0.44	=	=	=	1.00	=	1.23	2.16	—			
W	810	424	810	400	206	125	73	24	—			
9) Supergiants + 0 stars.												
$m_A \leqslant 3.9$; $N_0 = 25$												
n	0	2	3	1	3	3	2	5	5	0	1	1
$\bar{z}$	(1.0)	1.00	1.00	1.00	1.00	1.50	1.00	1.00	1.72	(3.)	4.0	8.4
lim d″	0.2—127.	=	=	0.3—127.	0.5—127.	=	1.0—127.	2.0—127.	2.0—63.9	4.0—63.9	=	=
F	1.04	=	=	=	=	=	1.29	1.51	1.77	2.17	=	=
W	24	24	24	24	24	16	19	17	8	4	3	1.4

Table 21. Continued.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5
	9) Supergiants + 0 stars. Continued.								
	$m_A = 4.0 \dots 5.4$; $N_0 = 37$								
n	0	3	2	1	4	4	1	2	0
$\bar{z}$	(1.0)	1.07	1.05	1.10	1.20	1.40	2.10	2.55	(19.)
lim. d″	0.2—127.	0.3—127.	=	0.5—127.	1.0—127.	=	2.0—63.9	=	8.0—15.9
F	1.00	1.04	=	1.22	1.43	=	1.79	=	7.1
W	37	33	34	28	22	18	10	8	0.3
	$m_A \geqslant 5.5$; $N_0 = 40$								
n	1	2	2	0	1	1	2	0	—
$\bar{z}$	1.20	1.00	2.85	(1.5)	1.40	1.70	25.4	(15.)	—
lim. d″	0.2—127	=	0.5—127.	=	0.5—63.9	1.0—63.9	1.0—31.9	4.0—31.9	—
F	0.68	=	0.88	=	1.43	1.67	1.79	2.68	—
W	49	59	16	30	20	14	0.8	1.0	—

Table 22.

Distribution of Distances.

d″	0.10—0.19	0.20—0.29	0.30—0.49	0.50—0.99	1.0—1.9	2.0—3.9	4.0—7.9	8.0—15.9	16.0—31.9	32.0—63.9	64.0—127.
	1) Dwarfs G_5—K_5.										
	$m_A \leqslant 3.9$; $N_0 = 6$										
n	—	0	0	0	0	0	0	0	1	0	0
$\bar{z}$	—	(1.3)	(1.2)	(1.3)	(1.5)	(1.1)	(1.0)	(1.0)	1.00	(1.0)	(1.1)
lim. Δm	—	2.9	3.9	5.9	6.9	=	=	=	=	=	6.9
F_1	—	3.32	2.55	1.15	1.00	=	=	=	=	=	1.00
W	—	1.5	2.0	4.	4.	5.	6.	6.	6.	6.	5.
	$m_A = 4.0 \dots 5.4$; $N_0 = 9$										
n	—	0	0	0	1	1	2	1	0	0	1
$\bar{z}$	—	(2.2)	(2.3)	(1.8)	1.00	1.00	1.00	1.00	(1.2)	(1.8)	13.2
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	=	7.9	=	6.9	5.9
F_1	—	4.25	3.32	2.55	1.15	1.00	=	0.60	=	1.00	1.10
W	—	1.0	1.2	2.0	8.	9.	9.	15.	12.5	5.	0.7
	$m_A \geqslant 5.5$; $N_0 = 97$										
n	0	0	0	4	3	3	4	4	4	1	2
$\bar{z}$	(2.5)	(2.0)	(1.4)	1.20	1.60	2.67	2.58	1.45	1.18	1.10	4.7
lim. Δm	0.9	1.9	=	4.9	=	6.9	7.9	6.9	6.9	4.9	3.9
F_1	5.50	4.25	=	1.73	=	1.00	0.60	1.00	1.00	1.38	1.65
W	7.	10.	18.	46	35.	36	62.	67.	83	64	13

Table 22. Continued.

d″	0.10—0.19	0.20—0.29	0.30—0.49	0.50—0.99	1.0—1.9	2.0—3.9	4.0—7.9	8.0—15.9	16.0—31.9	32.0—63.9	64.0—127.
2) Dwarfs F_7—G_4.											
$m_A \leqslant 3.9$; $N_0 = 4$											
n	—	0	0	1	0	0	0	0	0	0	1
$\bar{z}$	—	(1.3)	(1.2)	1.00	(1.5)	(1.1)	(1.0)	(1.0)	(1.0)	(1.0)	1.00
lim. Δm	—	2.9	3.9	5.9	6.9	=	=	=	=	6.9	=
F_1	—	3.32	2.55	1.15	1.00	=	=	=	=	1.00	=
W	—	1.0	1.3	3.4	2.7	3.6	4.	4.	4.	4.	4.
$m_A = 4.0 ... 5.4$; $N_0 = 37$											
n	—	0	0	1	3	1	3	3	0	0	1
$\bar{z}$	—	(2.2)	(2.3)	3.40	1.63	1.00	1.13	1.40	(1.2)	(1.8)	4.7
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	=	7.9	7.9	6.9	5.9
F_1	—	4.25	3.32	2.55	1.15	1.00	=	0.60	1.00	=	=
W	—	4.	5.	4.	20.	37.	33	44	30	20	8
$m_A \geqslant 5.5$; $N_0 = 227$											
n	1	2	3	5	7	6	5	6	5	2	0
$\bar{z}$	2.60	2.10	1.10	3.06	1.06	1.15	1.36	1.00	1.20	1.00	(3.0)
lim. Δm	0.9	1.9	=	4.9	=	6.9	7.9	6.9	=	4.9	3.9
F_1	5.50	4.25	=	1.73	=	1.00	0.60	1.00	=	1.38	1.65
W	16	26	49	42	124.	197.	278.	227.	190.	164.	46
3) Dwarfs A_5—F_6.											
$m_A \leqslant 3.9$; $N_0 = 30$											
n	—	0	0	0	1	1	1	1	1	0	0
$\bar{z}$	—	(1.3)	(1.2)	(1.3)	1.00	1.00	1.00	1.00	1.00	(1.0)	(1.1)
lim. Δm	—	2.9	3.9	5.9	6.9	=	=	=	6.9	=	=
F_1	—	2.69	2.05	1.24	1.00	=	=	=	1.00	=	=
W	—	9	12	19	30	30	30	30	30	30	27
$m_A = 4.0 ... 5.4$; $N_0 = 160$											
n	—	1	2	2	4	10	9	5	4	9	7
$\bar{z}$	—	1.40	1.35	1.10	1.15	4.26	1.20	1.02	1.27	2.31	3.16
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	=	6.9	=	=	5.9
F_1	—	3.40	2.69	2.05	1.24	1.00	=	1.00	=	=	1.25
W	—	34	44	71	112	38	133	157	126	69	41
$m_A \geqslant 5.5$; $N_0 = 665$											
n	4	7	5	20	32	22	22	18	20	8	3
$\bar{z}$	2.55	1.56	1.12	1.22	1.19	1.29	1.20	1.11	1.04	1.71	3.53
lim. Δm	0.9	1.9	=	4.9	=	6.9	6.9	=	=	4.9	3.9
F_1	5.16	3.40	=	1.83	=	1.00	1.00	=	=	1.37	1.78
W	51	125	175	296	305	516	554	599	640	285	106
4) Dwarfs B_8—A_4.											
$m_A \leqslant 3.9$; $N_0 = 62$											
n	—	0	2	1	1	3	1	4	3	1	1
$\bar{z}$	—	(1.3)	1.20	1.00	1.00	1.00	1.00	1.00	1.00	6.0	1.50
lim. Δm	—	2.9	3.9	5.9	6.9	=	=	8.9	=	=	7.9
F_1	—	2.39	1.85	1.11	1.00	=	=	0.64	=	=	0.81
W	—	20	28	56	62	62	62	97	97	16	51

Table 22. Continued.

d″	0.10—0.19	0.20—0.29	0.30—0.49	0.50—0.99	1.0—1.9	2.0—3.9	4.0—7.9	8.0—15.9	16.0—31.9	32.0—63.9	64.0—127.
	4) Dwarfs B_8—A_4. Continued.										
	$m_A = 4.0 \ldots 5.4$; $N_0 = 360$										
n	—	3	4	5	10	10	15	11	6	3	7
$\bar{z}$	—	1.40	2.18	1.20	3.33	1.35	1.14	1.10	1.52	1.40	8.5
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	7.9	=	=	6.9	5.9
F_1	—	3.06	2.39	1.85	1.11	1.00	0.81	=	=	1.00	1.22
W	—	84	69	162	97	267	391	404	293	256	35.
	$m_A \geqslant 5.5$; $N_0 = 1500$										
n	8	10	18	41	34	37	42	52	53	18	11
$\bar{z}$	2.55	1.80	1.31	1.39	1.31	1.15	1.50	1.22	1.43	1.69	2.92
lim. Δm	0.9	1.9	=	4.9	=	6.9	7.9	6.9	=	4.9	3.9
F_1	4.92	3.06	=	1.47	=	1.00	0.81	1.00	=	1.63	2.12
W	120	272	374	735	780	1304	1240	1230	1050	545	242
	5) Dwarfs B_0—B_7.										
	$m_A \leqslant 3.9$; $N_0 = 36$										
n	—	0	0	0	0	0	0	3	1	3	0
$\bar{z}$	—	(1.3)	(1.2)	(1.3)	(1.5)	(1.5)	(1.0)	1.00	1.00	1.00	(1.5)
lim. Δm	—	2.9	3.9	5.9	6.9	=	7.9	=	=	=	=
F_1	—	3.16	1.50	1.00	=	=	0.73	=	=	=	=
W	—	9	20	28	24	24	49	49	49	49	33
	$m_A = 4.0 \ldots 5.4$; $N_0 = 241$										
n	—	2	0	4	4	10	4	6	11	6	5
$\bar{z}$	—	1.40	(2.3)	2.30	1.52	1.96	1.12	1.00	1.90	1.93	5.2
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	7.9	=	=	6.9	5.9
F_1	—	4.50	3.16	1.50	1.00	1.00	0.73	=	=	1.00	1.31
W	—	38	33	70	159	122	294	330	174	125	35
	$m_A \geqslant 5.5$; $N_0 = 318$										
n	1	1	1	4	3	4	9	6	20	7	1
$\bar{z}$	2.60	1.30	1.70	1.75	1.07	1.00	1.27	1.60	1.18	1.96	4.0
lim. Δm	0.9	1.9	=	4.9	4.9	6.9	7.9	6.9	=	4.9	3.9
F_1	10.	4.50	=	1.00	1.60	1.00	0.73	1.00	=	1.68	2.53
W	12	54	41	182	177	318	342	199	270	96	32
	6) Giants F—G_4										
	$m_A \leqslant 3.9$; $N_0 = 13$										
n	—	1	0	0	0	2	0	0	1	0	0
$\bar{z}$	—	1.00	(1.2)	(1.3)	(1.5)	1.20	(1.0)	(1.0)	0.90	(1.0)	(1.5)
lim. Δm	—	2.9	3.9	5.9	6.9	7.9	7.9	=	=	=	=
F_1	—	6.3	4.3	=	1.00	=	0.51	=	=	=	=
W	—	2.1	2.6	2.4	9	11	26	26	29	26	17
	$m_A = 4.0 \ldots 5.4$; $N_0 = 40$										
n	—	0	0	1	0	1	1	1	1	0	4
$\bar{z}$	—	(2.2)	(2.3)	1.20	(2.5)	1.00	1.40	1.10	1.00	(1.8)	3.20
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	7.9	=	=	6.9	5.9
F_1	—	6.3	=	4.3	=	1.00	0.51	=	=	1.00	1.37
W	—	3	3	8	4	40	56	71	78	22	9

Table 22. Continued.

d″	0.10—0.19	0.20—0.29	0.30—0.49	0.50—0.99	1.0—1.9	2.0—3.9	4.0—7.9	8.0—15.9	16.0—31.9	32.0—63.9	64.0—127.
	6) Giants F—G_4. Continued.										
	$m_A \geqslant 5.5$; $N_0 = 124$										
n	1	0	0	7	3	4	3	1	5	1	0
$\bar{z}$	2.60	(2.0)	(1.4)	1.09	1.53	1.00	3.63	1.00	2.64	1.00	(3.0)
lim. Δm	0.9	1.9	=	4.9	5.9	6.9	7.9	6.9	=	4.9	3.9
F_1	15.	6.3	=	4.3	1.37	1.00	0.51	1.00	=	1.69	3.00
W	3	10	14	27	60	124	68	124	48	74	14
	7) Giants G_5—K_4.										
	$m_A \leqslant 3.9$; $N_0 = 68$										
n	—	0	0	1	1	2	6	0	1	1	2
$\bar{z}$	—	(1.3)	(1.2)	18.	2.50	1.00	1.00	(1.0)	1.00	1.00	1.25
lim. Δm	—	2.9	3.9	6.9	=	7.9	=	7.9	=	=	=
F_1	—	9.6	5.38	1.00	=	0.75	=	0.74	=	=	=
W	—	5	11	4	27	91	91	92	92	92	74
	$m_A = 4.0 \ldots 5.4$; $N_0 = 380$										
n	—	0	2	2	9	10	11	6	7	4	2
$\bar{z}$	—	(2.2)	2.90	1.55	4.47	2.84	2.75	1.20	1.31	1.70	1.70
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	7.9	=	=	6.9	5.9
F_1	—	20.	9.6	5.38	1.59	1.00	0.74	=	=	1.00	1.35
W	—	9	14	46	53	135	186	426	392	224	166
	$m_A \geqslant 5.5$; $N_0 = 1356$										
n	2	0	4	10	11	28	23	11	23	10	8
$\bar{z}$	2.55	(2.0)	1.25	1.49	3.68	1.45	1.66	1.49	2.33	1.85	3.64
lim. Δm	0.9	1.9	=	4.9	5.9	6.9	7.9	6.9	=	4.9	3.9
F_1	46.	20.	20.	3.66	1.59	1.00	0.74	1.00	=	1.88	3.09
W	12	34	54	248	232	935	1102	910	582	391	121
	8) Giants K_5—Mb.										
	$m_A \leqslant 3.9$; $N_0 = 20$										
n	—	0	0	1	0	0	1	0	0	0	0
$\bar{z}$	—	(1.3)	(1.2)	1.40	(1.5)	(1.2)	1.00	(1.0)	(1.0)	(1.0)	(1.5)
lim. Δm	—	2.9	3.9	5.9	6.9	7.9	=	7.9	=	=	=
F_1	—	9.6	5.38	1.59	1.00	0.75	=	0.84	=	=	=
W	—	1.6	3	9	13	22	27	24	24	24	16
	$m_A = 4.0 \ldots 5.4$; $N_0 = 118$										
n	—	0	0	0	0	4	4	1	4	1	0
$\bar{z}$	—	(2.2)	(2.3)	(1.8)	(2.5)	1.90	1.92	1.00	1.75	1.80	(4.0)
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	7.9	=	=	6.9	5.9
F_1	—	20.	9.6	5.38	1.59	1.00	0.84	=	=	1.00	1.56
W	—	3	5	12	29	62	73	140	80	65	20
	$m_A \geqslant 5.5$; $N_0 = 356$										
n	0	0	0	1	2	6	5	5	1	1	3
$\bar{z}$	(2.5)	(2.0)	(1.4)	3.10	1.20	1.77	2.60	1.12	1.30	4.0	4.2
lim. Δm	0.9	1.9	=	4.9	5.9	6.9	7.9	6.9	=	4.9	3.9
F_1	46.	20.	20.	3.66	1.59	1.00	0.84	1.00	=	2.55	3.42
W	3	8	13	32	186	201	163	318	274	35	24

Table 22. Continued.

d″	0.10—0.19	0.20—0.29	0.30—0.49	0.50—0.99	1.0—1.9	2.0—3.9	4.0—7.9	8.0—15.9	16.0—31.9	32.0—63.9	64.0—127.
	9) Supergiants + O-Stars.										
	$m_A \leqslant 3.9$; $N_0 = 25$										
n	—	0	0	2	2	3	3	3	4	6	1
$\bar{z}$	—	(1.3)	(1.2)	1.75	1.00	1.00	1.93	1.00	1.18	1.00	1.00
lim. Δm	—	2.9	3.9	5.9	6.9	7.9	8.9	=	=	=	7.9
F_1	—	3.84	3.40	1.33	1.00	0.73	0.50	=	=	=	0.73
W	—	5	6	11	25	34	26	50	43	50	34
	$m_A = 4.0 \ldots 5.4$; $N_0 = 37$										
n	—	0	0	1	0	3	0	5	4	3	1
$\bar{z}$	—	(2.2)	(2.3)	1.20	(2.5)	1.17	(2.5)	1.24	1.75	1.67	1.10
lim. Δm	—	1.9	2.9	3.9	5.9	6.9	7.9	=	=	6.9	5.9
F_1	—	8.8	3.84	3.40	1.33	1.00	0.73	=	=	1.00	1.33
W	—	2	4	9	11	32	20	40	29	22	26
	$m_A \geqslant 5.5$; $N_0 = 40$										
n	0	0	0	1	0	1	1	1	2	0	2
$\bar{z}$	(2.5)	(2.0)	(1.4)	1.70	(3.0)	1.40	2.80	1.00	1.15	(1.8)	2.60
lim. Δm	0.9	1.9	=	4.9	5.9	6.9	7.9	6.9	=	4.9	3.9
F_1	63.	8.8	=	2.09	1.33	1.00	0.73	1.00	=	2.09	3.40
W	0.4	2	3.3	11	10	29.	20.	40	35	10	4.5

Table 23.

Distribution of Distances and Relative Magnitudes.

All Spectra together (Md and N excluded).

Δm / d″	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	$\geqslant$ 11.0	0.0 ... 12.2
	1) $m_A \leqslant 3.9$												
0.20— n	0	1	0	—	—	—	—	—	—	—	—	—	1
—0.29 $\bar{z}$	1.0	1.0	2.0										—
0.30— n	1	0	1	0	0	—	—	—	—	—	—	—	2
—0.49 $\bar{z}$	1.0	1.0	1.4	2.0	10.								—
0.50— n	1	1	0	1	1	1	1[1])	—	—	—	—	—	6
—0.99 $\bar{z}$	1.0	1.0	1.0	1.0	1.4	2.5	18.						—
1.0— n	0	0	0	1	1	1	0	—	—	—	—	—	3
—1.9 $\bar{z}$	1.0	1.0	1.0	1.0	1.0	2.5	2.5						—
2.0— n	1	1	3	2	0	1	1	1	1	—	—	—	11
—3.9 $\bar{z}$	1.0	1.0	1.0	1.0	1.0	1.0	1.4	2.5	11.				—
4.0— n	1	1	1	0	1	3	1	2	4	1	1	1[2])	17
—7.9 $\bar{z}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.4	7.0	14.	6.	—
8.0— n	0	1	1	2	2	1	2	5	2	1	1	0	18
—15.9 $\bar{z}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	—	—

1) α Ursae Majoris; $\Delta m = 7.2$, but counted with $\Delta m = 6.5$.

2) Procyon; $\Delta m = 12.0$, counted with 11.5.

Table 23. Continued.

Δm		0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	$\geqslant$ 11.0	0.0 ... 12.2
d″		1) $m_A \leqslant 3.9$. Continued.												
16.0—31.9	n	0	0	1	0	2	3	3	3	3	3	2	4[1]	24
	z	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.8	2.1	4.2	12.6	—
32.0—63.9	n	0	0	2	1	1	0	1	4	2	0	0	1[1]	12
	z	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	(2.)	(3.)	8.4	—
64.0—127.	n	0	0	1	0	1	1	2	1	—	—	—	—	6
	z	1.0	1.0	1.0	1.0	1.0	1.0	1.5	6.0					—
													Total	100
		2) $m_A = 4.0 \ldots 5.4$									0.0...8.9			
0.20—0.29	n	6	0	0	—	—	—	—	—	—	6			
	z	1.40	(3.)	(20.)							—			
0.30—0.49	n	3	3	2	0	—	—	—	—	—	8			
	z	1.13	1.73	4.10	(30.)						—			
0.50—0.99	n	3	7	3	3	1	—	—	—	—	17			
	z	1.03	1.19	1.53	3.43	32.					—			
1.0—1.9	n	4	2	7	8	5	5	—	—	—	31			
	z	1.00	1.05	1.13	1.38	2.56	10.5				—			
2.0—3.9	n	7	5	9	9	10	4	6	3	1[3]	54			
	z	1.00	1.00	1.01	1.13	1.20	4.10	9.75	36.	36.	—			
4.0—7.9	n	6	6	8	7	6	7	6	2	1[4]	49			
	z	1.00	1.00	1.00	1.00	1.17	1.36	2.23	6.7	6.7	—			
8.0—15.9	n	2	6	7	1	6	9	3	6	4	44			
	z	1.00	1.00	1.00	1.00	1.00	0.97	1.07	2.20	18.8	—			
16.0—31.9	n	2	3	3	2	5	7	8	6	1[3]	37			
	z	1.00	1.00	1.00	1.00	1.00	1.05	2.09	2.9	2.9	—			
32.0—63.9	n	2	2	5	1	5	8	3	1	1[4]	28			
	z	1.00	1.00	1.02	1.10	1.42	1.81	6.2	16.8	16.8	—			
64.0—127.	n	0	0	6	8	8	6	1[2]	—	—	29			
	z	1.0	1.0	1.07	2.30	4.7	12.1	∞			—			
										Total	303			
		3) $m_A \geqslant 5.5$								0.0...7.9				
0.10—0.19	n	17	1	—	—	—	—	—	—	18				
	z	2.55	32.							—				
0.20—0.29	n	15	5	0	—	—	—	—	—	20				
	z	1.33	2.88	(20.)						—				
0.30—0.49	n	23	8	0	0	—	—	—	—	31				
	z	1.11	1.71	5.	(30.)					—				
0.50—0.99	n	51	24	7	8	3	1[5]	—	—	94				
	z	1.04	1.15	1.70	3.09	6.10	64.			—				

1) Δm exceeding 11.9 counted with $\Delta m = 11.5$.
2) Dwarf G_5; counted with $\Delta m = 5.5$.
3) $\Delta m = 8.2$; counted with $\Delta m = 7.5$.
4) $\Delta m = 8.0$; counted with $\Delta m = 7.5$.
5) Dwarf F_8; $\Delta m > 5.9$, but counted with $\Delta m = 5.5$.

Table 23. Continued.

Δm		0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	0.0 ... 7.9
		3) $m_A \geqslant 5.5$. Continued.								
1.0—1.9	n	37	18	9	17	12	8	2	—	103
	$\bar{z}$	1.00	1.03	1.13	1.35	2.62	12.6	48		—
2.0—3.9	n	15	21	17	26	21	7	4	—	111
	$\bar{z}$	1.00	1.00	1.01	1.13	1.45	1.84	5.1		—
4.0—7.9	n	21	7	12	21	24	12	9	8	114
	$\bar{z}$	1.00	1.00	1.00	1.01	1.09	1.17	2.81	7.0	—
8.0—15.9	n	19	17	14	12	17	12	13	2	106
	$\bar{z}$	1.00	1.00	1.00	1.00	0.96	1.21	2.78	20.	—
16.0—31.9	n	19	16	18	23	25	26	6	2	135
	$\bar{z}$	1.00	1.00	1.00	0.87	1.26	1.69	8.83	18.	—
32.0—63.9	n	8	10	8	17	5	3	—	—	51
	$\bar{z}$	1.00	1.00	1.14	2.19	4.0	9.4			—
64.0—127.	n	5	8	7	10	—	—	—	—	30
	$\bar{z}$	1.18	1.91	3.97	5.4					—
									Total	813

critical projected distance, 220 astr. units; but, strictly, this could not be attained, and for the sake of convenience the following distances separating the *close* and *distant* companions were adopted:

Table 24. *Maximum distance of close companions.*

m_A	Dwarfs K	Dwarfs G	Dwarfs F	Dwarfs A	Dwarfs B	Giants G	Giants K	Giants M	Supergiants
$\geqslant 5.5$	15.″9	7.″9	3.″9	1.″9	0.″99	0.″99	1.″9	1.″9	All distant
4.0 ... 5.4	31. 9	15. 9	7. 9	3. 9	1. 9	1. 9	3. 9	3. 9	
2.5 ... 3.9	63. 9	31. 9	15. 9	7. 9	3. 9	3. 9	7. 9	7. 9	
1.0 ... 2.4	127.	63. 9	31. 9	15. 9	7. 9	7. 9	15. 9	15. 9	
$\leqslant 0.9$	127.	127.	63. 9	31. 9	15. 9	15. 9	31. 9	31. 9	

In *tables 20* and *21* the different data mean:

m_A — the magnitude of the primary; Δm — the difference of magnitude (the intervals 0.0 ... 0.9, 1.0 ... 1.9 of Δm are denoted symbolically by 0.5, 1.5 etc.); N_0 — the assumed *total* number of stars of the given spectrum, absolute magnitude and magnitude limits, contained in the *H. R.* north of declination — 31°; n — the *observed* number of companions; $\bar{z}$ — the average *extrapolation factor*, i. e. the factor by which the observed number must be multiplied to obtain the probable *true* number; lim. d'' — the limits of angular separation within which the companions were counted; F — a factor by which the observed numbers must be multiplied to reduce them to certain *standard limits* of distance; W — the *effective number* of exhaustively examined stars of the given spectral type, computed from $W = \frac{N_0}{\bar{z}.F} \ldots$ (a); the ratio $1000\,n:W$ gives the number of companions within given limits of Δm per 1000 stars of the *H. R.*

In *table 22* m_A, Δm, N_0, n, $\bar{z}$ and W have the same meaning as in table 20; *lim.* Δm denotes the upper limit of Δm to which the companions were counted; F_1 is a factor by which the observed numbers must be multiplied to reduce them to the *standard limits* of $\Delta m = 0.0 \ldots 6.9$.

The data for each spectral type in tables 20—22 are subdivided into sections according to the magnitude of the primary, m_A; the first section, relating to the *bright* stars with $m_A \leqslant 3.9$, contains actually three classes of m_A: 2.5—3.9, 1.0—2.4 and $\leqslant 0.9$; in our tables these classes are for brevity's sake joined together, the *limits of distance* given in the tables relating to the interval of $m_A = 2.5 \ldots 3.9$; for the brighter classes other limits of distance were assumed in accordance with table 24; e. g. a 1.2 magnitude star having a component 3.″0 distant is in table 22 recorded under the limits of distance = 1.″0 ... 1.″9 etc.; in this manner the data for the brighter stars were reduced to the same average *absolute separation*.

Table 23 gives the distribution of companions to stars of all spectra within different limits of Δm and d; n and z have the same meaning as in table 20. As to the bright stars ($m_A \leqslant 3.9$), in table 23 the *measured distances* were directly counted without allowing for the absolute separation.

The data of tables 20—22 were derived from tables like table 23 constructed for each spectral type separately; to save costs of printing these individual tables are not reproduced here; it may be remarked that the values of $\bar{z}$ in these tables were always adopted the same as in table 23.

Certain data occurring in the tables mentioned above need some explanation.

N_0 or the total number of stars of a given spectral type contained in the *H. R.* north of declination — 31° was not derived from direct counts[1]) but was estimated in the following way.

1) Direct counts in the *H. R.* would be of little use owing to the rough spectral classification there used.

The total number of stars of each spectral type up to the effective limit of the *H. R.*, which may be assumed at 6.55 in the Harvard Scale, was derived from *Harvard Circular* **226**, where Dr. Shapley and Miss Cannon give results of preliminary counts made in the Henry Draper Catalogue; the obtained figures were multiplied by a constant factor to make the total sum equal to the number of stars in the *H. R.* north of $\delta = -31^0$; this latter number was determined from direct counts as 6563, but allowing for the *double entries* (companions of double stars) was diminished by $3^0/_0$ and the finally adopted figure was 6360; the sum of the N_0 for the spectral types included in the counts is 6329, leaving 31 for the spectral types not counted (Md, P, R, N etc).

The number of stars up to $m_A \leqslant 3.9$ (m combined eff. $\leqslant 3.85$) and $\delta \geqslant -31^0$ was counted in *Harvard Annals* **71** № 1; the numbers for the magnitude intervals, $m_A = 4.0 \ldots 5.4$ and $m_A \geqslant 5.5$ were assumed for B_0—B_7 (B_5) according to the data of *Harvard Circular* **239**; for the other spectral types the distribution of the numbers within these limits of apparent magnitude was made with the aid of some tables of *Groningen Publications* **30**, which furnished the *ratio* of the numbers for $m_A = 4.0 \ldots 5.4$ and $m_A \geqslant 5.5$; in using the data of *Groningen Publications* **30** some allowance was made for the different limits and character of the spectral classification adopted there and in the present investigation.

Greater difficulties were met with in estimating the relative number of giant and dwarf stars in certain spectral subdivisions. The number of G (F_7—G_4) and K (G_5—K_5) dwarfs was estimated in the following way. The total number up to the limiting magnitude 6.55 was assumed equal to the number of stars of *absolute magnitude* ($\pi = 1''$) from -0.2 to -1.4 for the G-dwarfs, and from -0.1 to $+2.9$ for the K-dwarfs and was computed on the basis of the Luminosity-Curve given by Kapteyn and Van Rhijn[1]; the details of the computation are not given here, the result was as follows: north of declination -31^0 there are probably 268 G-dwarfs and 112 K-dwarfs which are brighter than magnitude 6.55 in the Harvard Scale. These numbers were checked by considering directly the distribution of proper motions as given in *Groningen Publications* **30** for the

1) *Mount Wilson Contributions* **188**.

corresponding limits of apparent magnitude, and the agreement was found to be satisfactory. For $m_A \leqslant 5.4$ the number of G and K dwarfs was counted directly from *Mt Wilson Contributions* **199**; the number for $m_A \geqslant 5.5$ was assumed equal to the difference between the total number and the number for $m_A \leqslant 5.4$. The number of O-stars was directly counted from a table in *Groningen Publications* **30**; as to the probable number of *supergiants*, chiefly represented by the *c* and *ac* stars of Miss Maury's classification, this number cannot be very accurate; for the brighter stars it is based on the data of *Harvard Annals* **28** p. I, whereas for $m \geqslant 5.0$ it is based on a rough estimate; it may be noted that a few of the double stars classified as supergiants from their hypothetical parallaxes and proper motions had no remark in the *H. D.* indicating a narrowness of the spectral lines; it seems therefore probable that the adopted N_0 for the supergiants is somewhat underestimated as based solely on remarks relating to the spectral characteristics.

After subtracting the number of supergiants from the total number of the B, A and F stars the number of *dwarfs* of these types was obtained; the number of G and K *giants* was obtained by subtracting from the total number the adopted number of dwarfs and supergiants; the M-stars are practically all giants.

As to the number of the F—G_4 giants, it appeared probable that a part of the fainter F-stars must also belong to this category; at least among the giant double stars of this class with $m_A \geqslant 5.5$ about one-half had the *H. D.* spectrum classified as F_0, F_2 or F_5, whereas the brighter giants were almost exclusively of spectrum F_8 or later; thus it appeared that for $m_A \geqslant 5.5$ the number of G-giants obtained according to the method described above should be doubled on the expense of the F-stars; accordingly for $m_A \geqslant 5.5$ the originally obtained numbers of F-dwarfs $=$ $= 727$ and G-giants $= 62$ were changed as follows: F-dwarfs $=$ $= 665$; G-giants $= 124$. It must be remarked, however, that the estimated number of the G-giants cannot be regarded as accurate.

The *extrapolation factor* $\bar{z}$ in table 23 represents the average of the $\bar{z}$ for the individual stars; in constructing tables 20—22 the $\bar{z}$ for the observed stars were taken from table 23 and were assumed equal for all stars within the same limits of Δm and d″.

At the extremities of table 23 the adopted values of $\bar{z}$ are not always simply averages of the individual values of table 1, but were multiplied by certain factors to allow for the impossibility of observing or for the rejection of a certain number of pairs within the given limits of Δm and d''. The following examples will give an idea of the method of deriving $\bar{z}$ in table 23.

1) $m_A \geqslant 5.5$; $\Delta m = 3.5 = 3.0 - 3.9$; $d'' = 0.50 - 0.99$;

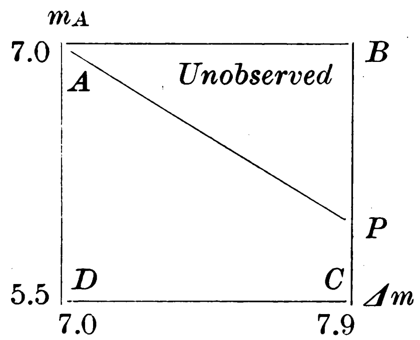
individual $\bar{z}$: 2.08 (2.1 in table 1) $\times$ 6; 6.1 $\times$ 2;

$$\text{mean } \bar{z} = \frac{2.08 \times 6 + 6.1 \times 2}{8} = 3.09;$$

observations possible within entire range of d'' and Δm.

2) $m_A \geqslant 5.5$; $\Delta m = 7.5 = 7.0 - 7.9$; $d'' = 4.0 - 7.9$;

individual values of $\bar{z}$: 6.1$\times$5; 4.9$\times$1; 3.0$\times$1; 2.1$\times$1; mean$=$5.06; limiting magnitude assumed$=$14.0; thus pairs having $\Delta m \leqslant 14.0 - m_A$ only were counted; the range of m_A being practically from 5.5 to 7.0, evidently not all stars within the assumed limits of Δm could be included in the count; taking Δm as abscissae, m_A as ordinates, the category of stars here considered may be regarded as a rectangle *ABCD*.



The straight line *AP*, represented by the equation $\Delta m = 14.0 - m_A$, divides the area into two parts: the *unobserved* part *ABP*, and the observed part *APCD*; the area of the latter is about 0.7 of the area of the rectangle; thus our mean $\bar{z}$ found above must be multiplied by $1:0.7 = 1.4$ and finally we obtain: $\bar{z} = 5.06 \times 1.4 = 7.0$ (assumed round value).

When no observed stars were found within given limits of d'' and Δm in tables 20—22, the probable value of $\bar{z}$ was roughly estimated from table 23 and is included in this case in parentheses.

The factors F and F_1 in tables 20—22 were found by successive approximations in the course of deriving the frequency-functions which form the purpose of the present investigation. The *standard limits of distance* to which the factor F reduces the data of tables 20 and 21 were:

for the *close* companions, from 0.″50 to *limit of close*, for $m_A \leqslant 3.9$;
„ „ „ „ „ 0.″25 „ „ „ „ „ $m_A = 4.0 ... 5.4$;
„ „ „ „ „ 0.″125 „ „ „ „ „ $m_A \geqslant 5.5$;

for the distant companions, from the *limit of close* to 256″,
for $m_A \leqslant 3.9$;
„ „ „ „ „ „ „ *of close* to 127″,
for $m_A = 4.0 \ldots 5.4$;
„ „ „ „ „ „ „ *of close* to 63.″9,
for $m_A \geqslant 5.5$.

These limits are thought to correspond approximately with constant limits of the *absolute projected distance* for stars of the same absolute magnitude.

The order of the successive approximations was:

1) a first approximation to the frequency-function of Δm was obtained by estimating F from the directly given numbers in tables similar to table 23;

2) from the 1st approximation of the distribution of Δm the F_1 of table 22 were derived; no better approximation of F_1 could be obtained, and thus the final *distribution of distances* was derived from the data of table 22;

3) the *distribution of distances* being given, the 2nd and final approximation of F could be obtained; this approximation is given in tables 20—21; the second approximation of the *distribution of* Δm showed no essential divergences from the first approximation; thus a third approximation appeared unnecessary.

It may be added that in these approximations the companions of each spectral type were treated separately; an exception was made in the following cases: 1) the *distant* companions to the K and G dwarfs were joined together; 2) the *close* companions to the K and M giants were also joined in the first approximation.

From the data of tables 20—22 the frequency-functions of Δm and d were found in the following way.

1) *Distribution of relative magnitudes.*

The probable true number of companions of a given Δm reduced to the *standard limits of distance* is $n.\bar{z}.F$; the *number per 1000 stars* of the same spectral class is

$$\varphi(\Delta m) = \frac{1000\, n\, \bar{z}\, F}{N_0} \ldots \text{(b)};$$

the weight of (b) may be assumed equal to the *effective number of completely examined stars*, i. e. to

$$W = \frac{N_0}{\bar{z} F} \ldots \text{(a)};$$

thus if several equations of the form (b) relating to the same Δm are available, the mean value of φ is given by

$$\overline{\varphi(\Delta m)} = \frac{\Sigma \varphi W}{\Sigma W} = \frac{1000\, \Sigma n}{\Sigma W} \dots \text{(c)};$$

the different equations (b) are afforded by the different classes of apparent magnitude; in fact tables 20 or 21 will always give three or less such equations for each Δm.

2) *Distribution of distances.*

No essential difference in deriving this distribution and the distribution of relative magnitudes exists; thus we have

$$\psi(d) = \frac{1000\, n\, \bar{z}\, F_1}{N_0} \dots \text{(b')},$$

$$W = \frac{N_0}{\bar{z}.F_1} \dots \text{(a') and}$$

$$\overline{\psi(d)} = \frac{1000\, \Sigma n}{\Sigma W} \dots \text{(c')};$$

since the distribution of *absolute distances* must be determined, the apparent distances which correspond to the same ψ (d) and which are to be joined together in equation *(c')* are in the ratio as

1 : 2 : 4 for the limits of apparent magnitude
$\geqslant$ 5.5; 4.0—5.4; $\leqslant$ 3.9 respectively.

The value of $\overline{\psi(d)}$ so obtained gives the number of companions having Δm from 0.0 to 6.9 magn., per 1000 stars of the given spectral class.

The ratio of the successive limits of distance was adopted equal to 1 : 2; an exception present the distances below 0.″5 where the subdivision in the tables 20—23 is more detailed; in deriving $\overline{\psi(d)}$, the stars within these limits of distance were distributed as follows:

limits 0.″10 . . . 0.″19 counted all with 0.″12 ... 0.″24;
„ 0.″20 . . . 0.″29 „ 40 % with 0.″12 . . . 0.″24 and 60 % with 0.″25 . . . 0.″49;
limits 0.″30 . . . 0.″49 counted all with 0.″25 . . . 0.″49.

Corresponding *mean* values of W for these limits of distance were also adopted.

Table 25. *Frequency-Function of Δm for Close Companions.*

$\varphi(\Delta m)$ = number of companions per 1000 stars of the *H. R.*

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
	1) Dwarfs G_5—K_5; limits of distance: from 1.7 to 220 astron. units											
Σn	7	2	6	1	2	3	3	3	0	0	0	—
ΣW	110	112	96	111	65	24	20	10	2	1	0.5	—
$\varphi(\Delta m)$	**64**	**18**	**62**	**9**	**31**	**125**	**150**	**300**	(<500)	(<1000)	...	—
	2) Dwarfs F_7—G_4; limits of distance: from 3.5 to 220 astron. units											
Σn	19	4	1	7	6	3	1	2	0	1	0	0
ΣW	220	165	151	103	46	22	17	5	1	0.1	0.1	0.1
$\varphi(\Delta m)$	**86**	**24**	**7**	**68**	**130**	**136**	**60**	**400**	(<1000)	(10 000)	(<10000)	(<10000)
	3) Dwarfs A_5—F_6; limits of distance: from 7 to 220 astron. units											
Σn	49	22	14	17	7	6	5	3	1	0	0	1
ΣW	741	691	575	472	361	81	96	24	21	3	3	3
$\varphi(\Delta m)$	**66**	**32**	**24**	**36**	**19**	**74**	**52**	**125**	**48**	(<300)	(<300)	(330)
	4) Dwarfs B_8—A_4; limits of distance: from 14 to 220 astron. units											
Σn	71	31	13	14	10	5	1	0	1	1	1	0
ΣW	1540	1151	753	644	372	98	45	27	12.5	6.5	2.1	1.3
$\varphi(\Delta m)$	**46**	**27**	**17**	**19**	**27**	**49**	**22**	**0**	**80**	(150)	(500)	(<800)
	5) Dwarfs B_0—B_7; limits of distance: from 35 to 280 astron. units											
Σn	4	5	2	4	2	0	0	1	0	—	—	—
ΣW	448	458	282	127	56	25	13	4	1	—	—	—
$\varphi(\Delta m)$	**9**	**11**	**7**	**31**	**36**	(<40)	(<80)	(250)	(<1000)	—	—	—
	6) Giants F—G_4; limits of distance: from 35 to 280 astron. units											
Σn	4	5	0	1	0	0	1	0	1	—	—	—
ΣW	164	144	92	57	35	10	7	3	0.8	—	—	—
$\varphi(\Delta m)$	**24**	**34**	**0**	**18**	(<30)	(<100)	(140)	(<300)	(1200)	—	—	—
	7) Giants G_5—K_4; limits of distance: from 18 to 280 astron. units											
Σn	8	7	12	10	7	9	3	4	0	0	0	0
ΣW	1329	1035	684	511	361	85	18	29	9	3	2	1
$\varphi(\Delta m)$	**6**	**7**	**18**	**20**	**19**	**106**	**167**	**138**	(<110)	(<300)	(<500)	(<1000)
	8) Giants K_5—Mb; limits of distance: from 19 to 310 astron. units											
Σn	0	1	1	3	3	1	0	0	0	0	0	0
ΣW	282	274	200	128	91	37	11	8	3	1	1	1
$\varphi(\Delta m)$	**0.**	**4**	**5**	**23**	**33**	**27**	(<110)	(<120)	(<300)	(<1000)	(<1000)	(<1000)

Tables 25, 26 and 27 represent the frequency-functions, derived according to the method described above from the data of tables 20, 21 and 22; it may be noted that the $\varphi(\Delta m)$ for different spectral types in tables 25 and 26 are not directly comparable on account of the different limits of distance to

Table 26. *Frequency-Function of Δm for Distant Companions.*

$\varphi(\Delta m)$ = number of companions per 1000 stars of the *H. R.*

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
1) Dwarfs G_5—K_5; limits of distance: from 220 to 880 astron. units												
Σn	1	2	2	1	0	3	0	0	—	—	—	—
ΣW	299	299	123	59	40	58	7	3	—	—	—	—
$\varphi(\Delta m)$	**3**	**7**	**16**	**17**	**0**	**52**	(<140)	(<300)	—	—	—	—
2) Dwarfs F_7—G_4; limits of distance: from 220 to 1760 astron. units												
Σn	5	3	3	0	2	1	0	0	0	0	0	0
ΣW	267	267	267	140	186	141	39	13	1	1	1	1
$\varphi(\Delta m)$	**19**	**11**	**11**	**0**	**11**	**7**	**0**	(<80)	(<1000)	(<1000)	(<1000)	(<1000)
3) Dwarfs A_5—F_6; limits of distance: from 220 to 3500 astron. units												
Σn	20	12	17	20	14	7	7	2	0	0	0	0
ΣW	973	973	794	678	524	630	151	76	9	7	7	5
$\varphi(\Delta m)$	**21**	**12**	**21**	**29**	**27**	**11**	**46**	**26**	(<110)	(<140)	(<140)	(<200)
4) Dwarfs B_8—A_4; limits of distance: from 220 to 7000 astron. units												
Σn	48	35	41	45	39	34	15	7	4	1	0	1
ΣW	2238	2028	2092	1551	1493	932	474	217	37	17	11	3
$\varphi(\Delta m)$	**21.4**	**17.2**	**19.6**	**29.0**	**26.2**	**36.**	**32.**	**32.**	**110.**	**60.**	(0.)	(330.)
5) Dwarfs B_0—B_7; limits of distance: from 280 to 18000 astron. units												
Σn	10	13	13	16	18	14	9	7	1	0	0	0
ΣW	618	618	490	449	350	311	117	87	8	8	5	3
$\varphi(\Delta m)$	**16**	**21**	**27**	**36**	**50**	**45**	**77**	**80**	(125)	(<125)	(<200)	(<300)
6) Giants F—G_4; limits of distance: from 280 to 18 000 astron. units												
Σn	2	7	3	2	6	2	2	5	1	0	1	0
ΣW	173	173	169	164	98	67	29	20	3	1	0.4	0.6
$\varphi(\Delta m)$	**12**	**40**	**18**	**12**	**61**	**30**	**69**	**250**	(330)	(<1000)	(2500)	(<1700)
7) Giants G_5—K_4; limits of distance: from 280 to 9000 astron. units												
Σn	3	14	16	28	34	24	13	7	2	2	0	1
ΣW	2376	2196	1985	1406	1486	976	411	147	23	18	9	3
$\varphi(\Delta m)$	**1.3**	**6.4**	**8.1**	**20.0**	**23.0**	**25.**	**32.**	**48.**	**87.**	(110)	(<110)	(330)
8) Giants K_5—Mb; limits of distance: from 310 to 10000 astron. units												
Σn	0	3	1	9	4	7	6	2	0	0	1	2
ΣW	944	558	944	516	340	225	133	69	9	5	4	1.2
$\varphi(\Delta m)$	**0**	**5**	**1**	**17**	**12**	**31**	**45**	**29**	(<110)	(<200)	(250)	(1700)
9) Supergiants +0 stars; limits of distance: from 90 to 46 000 astron. units												
Σn	1	7	7	2	8	8	5	7	5	0	1	1
ΣW	110	116	74	82	66	48	30	26	8	4	3	1.4
$\varphi(\Delta m)$	**9**	**60**	**95**	**24**	**121**	**167**	**167**	**270**	**625**	(<250)	(330)	(700)

which the data are reduced; on the contrary, the absolute values of $\psi(D)$ in table 27 may be directly compared since they are all reduced to the same interval of Δm, from 0.0 to 6.9 magnitudes. The meaning of the data contained in the tables may be illustrated by some examples.

Table 27. *Frequency-Function of Distances.*

$\psi(D)$ = number of companions with $\Delta m \leqslant$ **6.9** per 1000 stars of the *H. R.*;
D = projected distance expressed in *astronomical units.*

1) Dwarfs G_5—K_5

lim. D	0.8—1.7	1.7—3.5	3.5—7.0	7—14	14—28	28—55	55—110	110—220	220—440	440—880	880—1760
Σn	0	0	0	5	4	5	6	4	4	2	2
ΣW	2	14	22	59	50	51	83	85	93	65	13
$\psi(D)$	(<500)	(<70)	(<50)	**85**	**80**	**98**	**72**	**47**	**43**	**31**	(150)

2) Dwarfs F_7—G_4

lim. D	1.7—3.5	3.5—7.0	7—14	14—28	28—55	55—110	110—220	220—440	440—880	880—1760	1760—3500
Σn	0	3	5	8	8	9	8	6	6	3	0
ΣW	3	27	53	66	165	234	326	261	214	172	46
$\psi(D)$	(<300)	**111**	**94**	**121**	**48**	**38**	**25**	**23**	**28**	**17**	(<20)

3) Dwarfs A_5—F_6

lim. D	3.5—7.0	7—14	14—28	28—55	55—110	110—220	220—440	440—880	880—1760	1760—3500	3500—7000
Σn	0.5	10.0	11.5	25.	43	32	28	22	29	15	3
ΣW	25	142	266	438	373	679	741	755	736	326	106
$\psi(D)$	(20.)	**70**	**43**	**57**	**115**	**47**	**38**	**29**	**39**	**46**	**28**

4) Dwarfs B_8—A_4

lim. D	7—14	14—28	28—55	55—110	110—220	220—440	440—880	880—1760	1760—3500	3500—7000	7000—14000
Σn	3.5	19.5	29	54	45	56	56	59	57	25	11
ΣW	59	308	578	894	1109	1792	1741	1539	1357	580	242
$\psi(D)$	**59**	**63**	**50**	**60**	**40**	**31**	**32**	**38**	**42**	**43**	**45**

5) Dwarfs B_0—B_7

lim. D	18—35	35—70	70—140	140—280	280—560	560—1120	1120—2240	2240—4500	4500—9000	9000—18000	18000—36000
Σn	1	2.5	5.5	8	13	11	16	20	26	12	1
ΣW	32	90	138	365	348	661	721	422	428	131	32
$\psi(D)$	(31)	**28**	**40**	**22**	**37**	**17**	**22**	**47**	**61**	**92**	(31)

Table 27. Continued.

6) Giants F—G_4

lim. D	18—35	35—70	70—140	140—280	280—560	560—1120	1120—2240	2240—4500	4500—9000	9000—18000	18000—36000
Σn	1	1	1	9	4	5	5	2	5	5	0
ΣW	4	11	30	42	126	206	160	228	87	83	14
$\psi(D)$	(250)	(91)	**33**	**210**	**23**	**24**	**30**	**9**	**57**	**60**	(<70)

7) Giants G_5—K_4

lim. D	9—18	18—35	35—70	70—140	140—280	280—560	560—1120	1120—2240	2240—4500	4500—9000	9000—18000
Σn	0	5	7	21	27	39	30	19	29	12	8
ΣW	13	43	123	392	458	1213	1620	1394	880	557	12:
$\psi(D)$	(<80)	**116**	**57**	**54**	**59**	**32**	**19**	**14**	**33**	**22**	**66**

8) Giants K_5—M_b

lim. D	10—19	19—38	38—77	77—155	155—310	310—620	620—1240	1240—2500	2500—5000	5000—10000	10000—20000
Σn	0	1	0	1	7	10	6	9	2	1	3
ΣW	4	19	37	83	275	298	327	422	355	55	24
$\psi(D)$	(<250)	(53)	(<30)	**12**	**25**	**34**	**18**	**21**	**6**	**18**	**125**

9) Supergiants + 0 stars

lim. D	45—90	90—180	180—360	360—720	720—1450	1450—2900	2900—5800	5800—11500	11500—23000	23000—46000	46000—92000
Σn	0	2	3	4	6	4	10	11	6	1	2
ΣW	7	16	37	56	68	99	103	119	91	36	5
$\psi(D)$	(<140)	**125**	**81**	**71**	**88**	**40**	**97**	**93**	**66**	**28**	(400)

a) From table 25 we learn that among 1000 dwarf stars of class A_5—F_6 chosen at random in the *Harvard Revised Photometry* [1]) 36 are likely to have companions within the limits of $\Delta m = 3.0$—3.9 and within the limits of the projected distance $D = 7$—220 astronomical units; the observed number is 17, the *effective number* of stars *completely* examined within the limits of Δm and D mentioned above is 472.

b) Table 27 teaches us that among 1000 giants of class G_5—K_4 chosen as explained above there are probably 19 which have a companion at a projected distance from 560 to 1120 astronomical units and differing from the primary by less than 7.0 magnitudes.

Tables 25—27, however, cannot be regarded as representing the final form of our frequency-functions; these tables relate to an aggregate of stars chosen on the celestial sphere according to the *combined apparent magnitude*, whereas the true frequency-functions must relate to stars chosen at random *in space*. Were the *combined absolute magnitude* of a pair on the average equal to the absolute magnitude of a single star of the same spectral type as the primary of the pair, both methods of selection would give the same result; but such a presumption appears highly improbable. Much more probable seems to be the assumption that a primary of a binary system and a single star of the same spectral type are on the average of equal luminosity; this assumption appears to be supported by certain considerations of the physical properties of the stars, although direct evidence is scarce. On our assumption the combined luminosity of a double star must be on the average greater than the luminosity of a single star of the same spectral type; in a list of stars selected by their combined *apparent magnitude* the binaries will thus be counted within a greater volume of space than the single stars and will appear more numerous than they actually are; the excess of binaries in such a list will be the greater the smaller the difference of magnitude is; the values of $\varphi(\Delta m)$ must thus be influenced by the said selection in a degree depending on the difference Δm itself.

It is interesting that the sort of selection here described

1) The number 1000 is conventional; of course the *H. R.* may contain a smaller number of stars of the given spectral type.

seems, at least partly, to account for the *greater galactic condensation* of double stars as compared with the stars as a whole — a phenomenon discovered by R. G. Aitken and by R. Jonkheere independently; it is a well known fact that the galactic phenomenon is chiefly a function of the *distance* of the objects, the condensation increasing with the distance; the binaries of small Δm, being more distant, will thus show a greater galactic condensation than stars of the same apparent magnitude on the average; on the other hand, among faint and close double stars values of $\Delta m < 1.0$ are the most frequent.

Thus we are led to the conclusion that our numbers of double stars for different Δm refer to different volumes of space; the *reduction to equal volumes of space* may be made by changing the *limiting magnitude* and the corresponding total number of stars, N_0; the effective limit of the *combined* magnitude m_c of stars in the *H. R.* is 6.55; the limit of m_A for double stars having a certain Δm is

$$6.55 + (m_A - m_c),$$

$m_A - m_c$ depending on Δm; if the average value of $m_A - m_c$ for all stars in the *H. R.* is Δ, and $N(m)$ denotes the number of stars (of a given spectral type) from the brightest to the apparent magnitude m, the factor f by which the $\varphi(\Delta m)$ of tables 25 and 26 must be multiplied will be given by

$$f = \frac{N(6.55 + \Delta)}{N(6.55 + m_A - m_c)};$$

owing to the logarithmic character of the function $N(m)$ this formula may by substituted by the following:

$$f = \frac{N(6.55)}{N(6.55 + m_A - m_c - \Delta)} \quad \ldots\ldots \text{(d)}.$$

In this way the values of f given in table 28 were computed; the logarithmic increase of the stellar number $N(m)$ near $m = 6.5$ for separate spectra was derived from the data of *Harvard Circular* 226, table 1, except the G and K dwarfs, for which simply a uniform distribution in space was adopted. From the preliminary frequency-function of Δm the value of

$\Delta = \frac{\Sigma(m_A - m_c)\,\varphi(\Delta m)}{1000}$ was found approximately as

$+0.05$ for dwarfs B_8—K_5 and
0.00 „ „ B_0—B_7, the giants and the supergiants.

Table 28.

Factors of reduction of $\varphi(\Delta m)$ to equal volumes of space.

Δm	0.0—0.9	1.0—1.9	2.0—2.9	3.0—3.9	4.0—4.9	$\geqslant 5.0$
$m_A - m_C$	+0.55	0.25	0.10	0.04	0.02	0.00
Sp.	*f*					
Dwarfs *B*	0.73	0.86	0.94	0.98	0.99	1.00
„ *A*	0.585	0.807	0.948	1.01	1.03	1.05
„ *F*	0.550	0.787	0.942	1.01	1.04	1.06
„ *G*, „ *K*	0.500	0.759	0.933	1.01	1.04	1.07
Giants *G*	0.60	0.79	0.90	0.96	0.98	1.00
„ *K*	0.53	0.76	0.89	0.95	0.98	1.00
„ *M*	0.58	0.78	0.90	0.96	0.98	1.00
Supergiants +0	(0.86)	(0.93)	(0.97)	(0.99)	(1.00)	(1.00)

By these factors the $\varphi(\Delta m)$ of tables 25 and 26 were multiplied; the $\psi(D)$ of table 27 need also a correction in the form of a constant factor equal to

$$f_1 = \frac{\Sigma f . \varphi(\Delta m)}{\Sigma \varphi(\Delta m)},$$ the sum being taken from

$\Delta m = 0.0$ to $\Delta m = 6.9$; the factor f_1 was separately computed for the close and distant companions and was found as follows:

Table 29.

Factors of reduction of $\psi(D)$ to equal volumes of space.

Spectrum	Dwarfs *K*	Dwarfs *G*	Dwarfs *F*	Dwarfs *A*	Dwarfs *B*	Giants *G*	Giants *K*	Giants *M*	Super-giants +0
	f_1								
Close	0.95	0.94	0.90	0.90	0.95	0.92	0.98	0.97	0.99
Distant	1.00	0.78	0.95	0.96	0.96	0.94	0.97	0.98	

Table 30 gives the final result for the distribution of distances; the figures of this table were obtained by multiplying the $\psi(D)$ of table 27 by the factors given in table 29. Tables 31 and 32 contain the final result for the distribution of Δm; after multiplying the values of tables 25 and 26 by the factor f (table 28) a reduction to *uniform intervals of the projected distance* was also made; the data for this reduction were based on table 30 and the method of reduction will be explained in the following section.

The limits of the projected distance for the *B*-dwarfs, the giants and supergiants did not exactly correspond with the limits given at the head of table 30; nevertheless the data for these stars were placed under the nearest corresponding limits of the table, the change needed in the adopted limits of distance being indicated in the remarks.

Table 30.

$\psi(D)$ = Frequency-Function of Distances, Final Result.

Number of companions with $\Delta m \leqslant 6.9$ per 1000 stars of each class of spectrum chosen at random *in space*.

The *observed* number is given in parentheses.

Projected Distance astron. un.	—3.5	—7	—14	—28	—55	—110	—220	—440	—880	—1760	—3500	—7000	—14000	—28000	—56000 —112000	Total Observed	Abs. Magn. adopted
Dwarfs *K*	... (0)	83 (5)	76 (4)	93 (5)	68 (6)	45 (4)	43 (4)	31 (2)	150 (2)	— —	— —	— —	— —	— —	— —	— (32)	+0.7
Dwarfs *G*	104 (3)	88 (5)	115 (8)	44 (8)	36 (9)	24 (8)	18 (6)	22 (6)	14 (3)	... (0)	— —	— —	— —	— —	— —	— (56)	−0.8
Dwarfs *F*	18 (0.5)	63 (10.0)	39 (11.5)	52 (25)	104 (43)	42 (32)	36 (28)	28 (22)	37 (29)	44 (15)	27 (3)	— —	— —	— —	— —	— (219)	−2.3
Dwarfs *A*	— —	53 (3.5)	57 (19.5)	45 (29)	54 (54)	36 (45)	30 (56)	31 (56)	36 (59)	40 (57)	41 (25)	43 (11)	— —	— —	— —	— (415)	−3.8
Dwarfs *B* 1)	— —	— —	29 (1)	27 (2.5)	38 (5.5)	21 (8)	36 (13)	16 (11)	21 (16)	45 (20)	59 (26)	88 (12)	30 (1)	— —	— —	— (116)	−5.8
Giants *G* 1) 2)	— —	— —	230 (1)	84 (1)	30 (1	193 (9)	22 (4)	23 (5)	28 (5)	8 (2)	54 (5)	56 (5)	... (0)	— —	— —	— (38)	−6.
Giants *K* 1)	— —	... (0)	114 (5)	56 (7)	53 (21)	58 (27)	31 (39)	18 (30)	14 (19)	32 (29)	21 (12)	64 (8)	— —	— —	— —	— (197)	−4.2
Giants *M* 3)	— —	... (0)	51 (1)	0 (0)	12 (1)	24 (7)	33 (10)	18 (6)	21 (9)	6 (2)	18 (1)	123 (3)	— —	— —	— —	— (40)	−4.6
Supergiants 4) + 0-stars	— —	— —	— —	— —	... (0)	124 (2)	80 (3)	70 (4)	87 (6)	40 (4)	96 (10)	92 (11)	65 (6)	28 (1)	400 (2)	— (49)	−8.
															Total	(1162)	

1) With the absolute magnitude here adopted the limits of projected distance should be *multiplied by 1.25*.

2) From the distribution of distances an absolute magnitude of the *G*-giants equal to the abs. magn. of the *A*-dwarfs seems more probable; in this case the limits of the distance should be *divided by 2*.

3) With the absolute magnitude here adopted the limits of distance should be *multiplied by 1.44*

4) The limits of distance of this table would correspond to an absolute magnitude = — 8.4.

Table 31.

φ(Δm) = Frequency-Function of Δm for Close Companions, Final Result.

Number of companions within the limits of projected distance from 3.5 to 220 astronomical units per 1000 stars of each class of spectrum chosen at random *in space.*

For the *B*-dwarfs and the giants the limits of projected distance must be changed in the same proportion as indicated in the remarks to table 30.

The *observed* number is given in parentheses.

The limits of *Δm* are for brevity denoted : 0.0—0.9 by 0.5 ; 1.0—1.9 by 1.5 etc.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	Total observed
Dwarfs *K*	23 (7)	10 (2)	41 (6)	6 (1)	23 (2)	96 (3)	110 (3)	230 (3)	— —	— —	— —	— —	— (27)
Dwarfs *G*	29 (19)	12 (4)	5 (1)	46 (7)	90 (6)	97 (3)	43 (1)	290 (2)	0 (0)	6700 (1)	0 (0)	0 (0)	— (44)
Dwarfs *F*	47 (49)	33 (22)	30 (14)	47 (17)	26 (7)	103 (6)	72 (5)	175 (3)	67 (1)	0 (0)	0 (0)	460 (1)	— (125)
Dwarfs *A*	45 (71)	37 (31)	27 (13)	32 (14)	47 (10)	85 (5)	38 (1)	0 (0)	140 (1)	270 (1)	800 (1)	0 (0)	— (148)
Dwarfs *B*	20 (4)	26 (5)	20 (2)	87 (4)	104 (2)	0 (0)	0 (0)	700 (1)	0 (0)	— —	— —	— —	— (18)
Giants *G*	29 (4)	57 (5)	0 (0)	36 (1)	0 (0)	0 (0)	290 (1)	0 (0)	2500 (1)	— —	— —	— —	— (12)
Giants *K*	3 (8)	5 (7)	16 (12)	19 (10)	19 (7)	105 (9)	165 (3)	137 (4)	0 (0)	0 (0)	0 (0)	0 (0)	— (60)
Giants *M*	0 (0)	5 (1)	8 (1)	37 (3)	54 (3)	46 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	— (9)
												Total	443

7. Discussion of Results.

a) *Distribution of distances.* In examining the figures of table 30 it will be noted that the variation of the frequency of companions with the distance is generally very slow; for the best respresented class — the *A*-dwarfs — the ratio of maximum (57) to minimum (30) frequency is less than 2, whereas the extreme distances are in a ratio as 1000 to 1; for the other classes of spectrum the variation of the frequency with distance is generally greater, although many extreme values of the frequency are apparently due to accidental errors produced by the scarcity of the observational data. The limits of distance here adopted form a geometrical progression, they are actually *loga-*

Table 32.

$\varphi(\Delta m)$ = *Frequency-Function of Δm for Distant Companions, Final Result.*

Number of companions within the limits of projected distance from 220 to 28 000 astronomical units per 1000 stars of each class of spectrum chosen at random *in space.*

For the *B*-dwarfs and the giants the limits of projected distance must be changed in the same proportion as indicated in the remarks to table 30.

The *observed* number is given in parentheses.

The limits of Δm are for brevity denoted: 0.0—0.9 by 0.5; 1.0—1.9 by 1.5 etc.

Δm	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	Total observed
Dwarfs *K*	4 (1)	12 (2)	37 (2)	42 (1)	0 (0)	140 (3)	0 (0)	0 (0)	— —	— —	— —	— —	— —
Dwarfs *G*	54 (5)	43 (3)	54 (3)	0 (0)	59 (2)	38 (1)	0 (0)	0 (0)	— —	— —	— —	— —	— —
Dwarfs *K*+*G* joined	17 (6)	21 (5)	45 (5)	20 (1)	40 (2)	85 (4)	(<100) (0)	... (0)	— —	— —	— —	— —	— (23)
Dwarfs *F*	20 (20)	16 (12)	35 (17)	50 (20)	48 (14)	20 (7)	85 (7)	48 (2)	0 (0)	0 (0)	0 (0)	0 (0)	— (99)
Dwarfs *A*	17.2 (48)	19.0 (35)	25.5 (41)	40.1 (45)	37 (39)	52 (34)	47 (15)	47 (7)	158 (4)	86 (1)	0 (0)	480 (1)	— (270)
Dwarfs *B*	9 (10)	14 (13)	19 (13)	26 (16)	38 (18)	34 (14)	58 (9)	60 (7)	95 (1)	0 (0)	0 (0)	0 (0)	— (101)
Giants *G*	10 (2)	46 (7)	23 (3)	17 (2)	87 (6)	44 (2)	100 (2)	360 (5)	480 (1)	0 (0)	3600 (1)	0 (0)	— (31)
Giants *K*	2 (3)	11 (14)	17 (16)	43 (28)	52 (34)	57 (24)	73 (13)	109 (7)	198 (2)	250 (2)	0 (0)	760 (1)	— (144)
Giants *M*	0 (0)	4 (3)	1 (1)	17 (9)	13 (4)	33 (7)	48 (6)	31 (2)	0 (0)	0 (0)	270 (1)	1800 (2)	— (35)
Supergiants + *O*-Stars	5 (1)	37 (7)	61 (7)	16 (2)	80 (8)	110 (8)	110 (5)	180 (7)	410 (5)	0 (0)	220 (1)	460 (1)	— (52)
												Total	755

rithmic limits; hence the approximate constancy of the frequency revealed by table 30 leads to the following formula for the total number of companions between certain limits of distance, D_1 and D_2:

$$N(D_1, D_2) = F(D_1, D_2)(\log D_2 - \log D_1) \ldots \text{ (a)},$$

where the function $F(D_1, D_2)$ changes but slowly, remaining of the same order of magnitude within the entire range of D covered by the observations; as a rough approximation we may put $F(D_1, D_2) = const.$; formula (a) becomes then

$$N(D_1, D_2) = C(\log D_2 - \log D_1) \ldots \text{ (a}^1\text{)};$$

if the difference $D_2 - D_1 = \Delta D$ is small, the number within the limits of projected distance D and $D + \Delta D$ will be given by

$$\frac{C \Delta D}{D} \dots (b);$$

on the other hand, the projected area of a ring limited by the radii D and $D + \Delta D$ will be

$$2\pi D \Delta D \dots (c);$$

dividing (*b*) by (*c*) we obtain the *density of companions per unit of the projected area* as

$$\varrho(D) = \frac{C^1}{D^2} \dots (d).$$

This is a rough approximation; in the actual case C^1 must be regarded as variable and may be assumed proportional to $\psi(D)$ of table (30); hence

$$\varrho(D) = \frac{\psi(D)}{D^2} \times \text{const.} \dots (d^1).$$

As a first approximation the projected density of the companions may be assumed to vary as the *inverse square of the projected distance;* how nearly this is generally fulfilled may be judged from the following data for the *F*-dwarfs:

	proj. distance =	10	20	40	80	160	320	640	1280	2560 a. u.
ϱ	computed $\frac{100}{D^2}$	1	0.25	0.06	0.016	0.004	0.0010	0.00025	0.00006	0.000016
	observed	1	0.15	0.05	0.027	0.003	0.0006	0.00011	0.00004	0.000011

the agreement with the inverse-square law appears from these data to be excellent, as for ϱ varying within the ratio 60 000 : 1 the density computed according to this law diverges from the observed density less than in the ratio 2 : 1.

According to a well known theorem frequently applied by different authors to the study of stellar distribution in globular clusters, the *spacial density* $\delta(r)$ in a system with spherical symmetry may be determined from the projected density $\varrho(D)$ with the aid of the following equation:

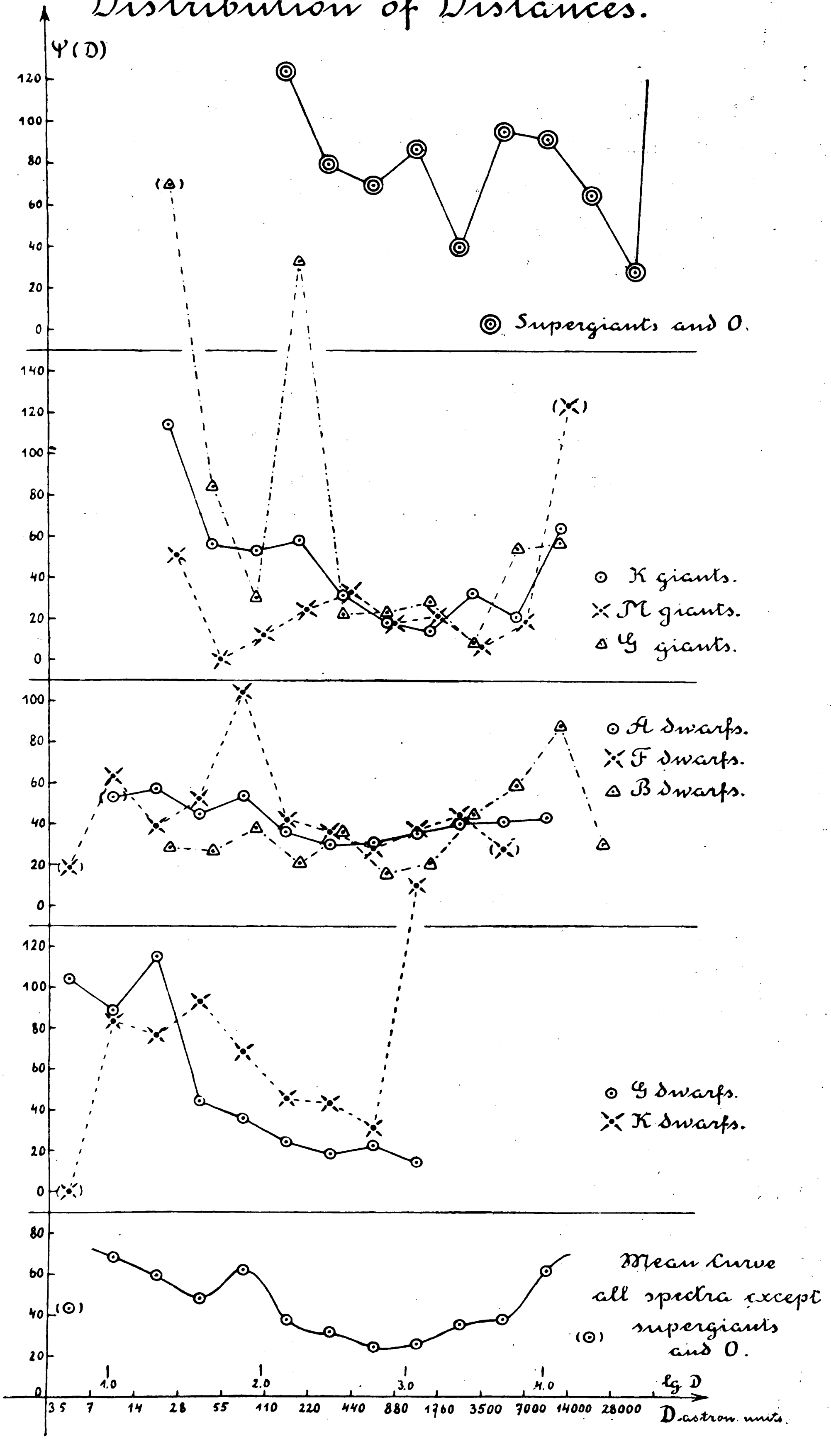
$$\delta(r) = -\frac{1}{\pi} \int_0^\infty \frac{dx}{\sqrt{r^2 + x^2}} \; \frac{\partial \varrho(\sqrt{r^2 + x^2})}{\partial \sqrt{r^2 + x^2}} \dots (e).$$

For $\varrho(D) = \frac{1}{D^2}$, $\delta(r)$ becomes $\frac{1}{r^3}$; thus the spacial density of companions of double stars must vary roughly as the *inverse of the cube of distance.* Such a distribution would lead to an infinite total number of companions; but it must be pointed out that there exists without doubt an upper limit of distance where external forces put a boundary to the *sphere of action* of a single star; this maximum distance may be estimated at about 1 parsec = 200 000 astron. units; it may be expected that, as this boundary is approached, $\psi(D)$ will rapidly diminish; in the present investigation this limit is not reached by far; an inferior limit of the possible distance exists also — this is the *average diameter* of a star. Within these two extreme limits of distance the number of companions will be quite finite with a law of density like $\frac{1}{r^3}$.

The deviations of the projected density, ϱ, from the inverse-square law, although small, seem to be real as almost all classes of spectrum show the same character of the deviation — a minimum density between $D = 400$—2000 astron. units and an increase both on the side of small and great distances. To make the comparison more easy the data of table 30 are plotted on fig. 4; as abscissae are chosen the *log D*, in accordance with the construction of table 30.

A comparison of the curves of fig. 4 leads to the conclusion that they are all much alike; although certain peculiarities of distribution for the individual spectra may be real, e. g. the pronounced maximum for the F-dwarfs between $D = 55$ and 110 *a. u*, — other deviations may be of an accidental character, due to the small number of companions observed; in their general features the curves may be assumed to represent parts of a curve common to all spectra; on this assumption the mean distribution of distances, $\psi(D)$, given in table 33 was computed; this mean distribution comprises all spectra except the super-giants and O-stars; using the data of table 30 the computation was made according to formula (c^1) of section **6**; the effective number W was put equal to $\frac{1000\,n}{\psi(D)}$, n and $\psi(D)$ being given by table 30. For the sake of simplicity the limits of distance for the B-stars and the K- and M-giants were assumed unchanged

Fig. 4.
Distribution of Distances.



as they are given at the head of table 30; as to the *G*-giants, their absolute magnitude as assumed above seems to be over-estimated; by reducing the distance limits of this class in the ratio 1:2 a better agreement with other curves on fig. 4 may be obtained; this would correspond to a mean absolute magnitude of the *G*-giants $= -3.8$, and on this assumption they were included in the derivation of the mean frequency-function of distances. By the way, the *G*-giants are not numerous and have, therefore, very little influence on the result.

Table 33.

Mean Frequency-Function of Distances. All Spectra except Supergiants and O-Stars.

For explanation consult table 30.

	Projected Distance (astron. units)													
	3.5–7	7–14	14–28	28–55	55–110	110–220	220–440	440–880	880–1760	1760–3500	3500–7000	7000–14000	14000–28000	Total
$\overline{\psi(D)}$	43	68	59	47.4	61.3	36.5	30.8	23.5	25.1	34.9	37.6	61.	29.	557.
n obs.	(3.5)	(24.5)	(51)	(77.5)	(148.5)	(135)	(161	(138)	(139)	(128)	(72)	(34)	(1)	(1113)

The values of $\overline{\psi(D)}$ of table 33 are plotted at the bottom of fig. 4; this curve representing the mean distribution of distances turns out to be very smooth but for the secondary maximum between $D = 55$ and 110 *a. u.*; the first and last values of table 33 are of low weight, being based on too small a number observed; therefore the corresponding points were not taken into account in drawing the curve; much weight cannot be laid on the apparent decrease at the ends of the curve indicated by these points.

A source of systematic error which might have influenced the frequency-function of distances may be mentioned here: the non-simultaneousness of the measures of distance for the stars in table 1; the distance adopted there refers to the *time of discovery*; it is natural to expect that very close pairs are more frequently detected when their separation is greater than the average separation; during a century of double-star observations the chances of discovering a rapidly moving pair are greater than the chances for a fixed pair of the same average angular separation, since the former may be caught at the moment of greatest elongation even if at an average distance it is invisible; the effect of this systematic error will reveal itself in an apparent increase of the number of companions as both the absolute and angular separation diminish; for two groups of stars having *the same angular separation* the effect will be greater for the *nearer* i. e. the more rapidly moving binaries; for two groups having the same *absolute separation* the effect will be more pronounced for the *distant* i. e. the more difficult pairs; within the same limits of D we thus should expect relatively greater values of $\psi(D)$ for the more luminous stars than for the absolutely faint ones; an inspection of fig. 4 shows an effect more in the opposite direction. We may conclude therefore that if such an effect exists, its influence on our statistical material must be small i. e. our *coefficients of perception* have already made account of it; the increase of $\psi(D)$ as D diminishes must also be regarded as real.

The distribution of distances may throw some light on the question of evolution of stellar masses. The problem may be formulated as follows: if stars of different spectral types form a continuous chain of evolution, i. e. if we assume that, say, an *average* G-dwarf has evolved from an *average* A-star, an assumption of a change, e. g. of a decrease of the mass, with the increasing age becomes necessary; for it seems to be a well established fact that the average masses of stars of different spectral classes differ considerably; in a system with a secular change in the mass the dimensions of the orbit must change inversely to the mass, the eccentricity remaining invariable[1]); we have therefore

$$D \backsim \frac{1}{\mu} \quad . \; . \; . \; . \quad \text{(f)},$$

D being the average distance and μ — the mass; the curves $\psi(D)$, representing the distribution of distances, will thus be shifted along the x-axis ($x = log D$) by the amount $log \frac{\mu_0}{\mu}$, the shape of the curves remaining unchanged. In the order of decreasing masses the spectral classes may be arranged in the following sequence: B; A; giants (?); F; G; K. In passing the curves on fig. 4 in the same order we should expect a progressive displacement of their characteristic maxima and minima from left to right, in the direction of increasing D; a relative displace-

1) H. Poincaré, *Leçons sur les Hypothèses Cosmogoniques* pp. 79—80.

ment of the curves may indeed be perceived, but in the *opposite* direction. Copies of the *individual curves* made on transparent paper were superposed on the *mean curve* and displaced until the agreement of the general features of both curves seemed the best; on account of peculiarities of the distribution for the individual spectra an exact agreement could never be attained, especially in what concerns the *absolute frequency*; in the comparison attention was paid only to the *relative* rise and fall of both curves. The result of the comparison is given in table 34.

Table 34.

Spectrum	Displacement in $log D$	Ratio $D:D_0$	Mass 1)	Theoretical Ratio $D:D_0 = 5.4:\mu$	$0.9\sqrt{\frac{\mu}{6}}$	$0.9\sqrt[3]{\frac{\mu}{6}}$
Dwarfs *K*	—0.33	0.5	0.7	8.	0.3	0.4
„ *G*	—0.60	0.25	1.0	5.	0.4	0.5
„ *F*	—0.09	0.8	2.5	2.2	0.6	0.7
„ *A*	—0.06	0.9	6.	0.9	0.9	0.9
„ *B*	+0.03	1.1	9.	0.6	1.1	1.0
Giants *G*	+0.39	2.5	...	...	...	...
„ *K*	+0.21	1.6	...	...	...	...
„ *M*	+0.60	4.0	...	...	...	...

In this table the 3[d] column gives the ratio $D:D_0$ or the proportion in which the distances of the *mean curve*, D_0, must be changed to make this curve as similar as possible to the curve for the given class of spectrum. The theoretical ratio in the 5[th] column was computed according to (f), the constant being chosen so as to make the observed and theoretical values agree for the *A*-dwarfs. A glance at the figures in the 3[d] and 5[th] columns of table 34 gives a decisive answer to the question put above: it appears almost certain that during a period of time comparable with the age of the companions of double stars no evolution in the sense suggested above could take place; the idea of a continuous series of evolution in the order *B-A-F-G-K* or in any other order, where it is supposed that a given spectral class changes in the course of time into another class with all its characteristics, must be entirely abandoned; a group of *G*

1) The masses are adopted according to Fr. H. Seares, *Mt Wilson Contributions* 226, table IV.

dwarfs could never have possessed the statistical characteristics of the A-stars as we know them now, and a group of A-stars will, in the course of evolution, never appoach the conditions now revealed by F, G or K dwarfs. If any evolution exists, it must be only partial, represented by oscillations within a relatively limited range of spectrum; the existing series of spectral classes must be regarded chiefly as a classification according to some *invariable initial conditions*, like the mass, with only a slight superposed effect of evolution (age).

Instead of a change of the manner expected, the ratios $D:D_0$ appear to change in the same direction as the masses, although less rapidly than the latter; in the two last columns the representation of $D:D_0$ by certain tentative formulae is given; both, $\mu^{1/2}$ and $\mu^{1/3}$, seem to represent satisfactorily the observed ratio, the latter, maybe, a little better. A formula like $\frac{D}{D_0} = C\mu^{1/3}$ would mean that the frequency of companions at a given distance D from the primary is a function solely of the average density of a spherical body with a radius $= D$ and a mass equal to the mass of the star. Physical grounds for such a formula may be evidently found in the theory of the origin of companions of double stars during the process of contraction of a vast gaseous body having originally a mass equal to the mass of the binary system.

If it is permissible to extend the empirical formulae over the giant stars, a very rough estimate of their masses may be obtained; so we find

from $\mu^{1/2}$ ... masses of giants: $G = 40\odot$; $K = 18\odot$; $M = 120\odot$
" $\mu^{1/3}$ ... " " " : $G = 130\odot$; $K = 35\odot$; $M = 500\odot$;

no weight can, however, be laid on these estimates as e. g. for the G-giants the displacement of the curve $\psi(D)$ may be accounted for by a change of the absolute magnitude, and for the M-giants the curve is too peculiar to be put aside with the distribution for the other classes.

Our general conclusion is that although the distribution of distances in double stars of different spectral types shows remarkable similarity, it is far from being identical; the similarity is in no way due to a community of origin but appears to be the result of action of a general physical or statistical law by which the frequency of companions originating at different distances from the primary is regulated.

b) *Relative number of companions in different classes of spectrum.* On the assumption of the similarity of $\psi(D)$ for different classes of spectrum, i. e. in attributing the individual differences to chance errors, the relative frequency of companions to stars of different classes may be determined by comparing the $\psi(D)$ within the same limits of D.

If Σ and Σ_1 are the sums of $\psi(D)$ within the same limits of distance for two classes of spectrum, the ratio of the number of companions may be assumed equal to $\Sigma : \Sigma_1$. The relative numbers were determined in two different ways.

1) By comparing directly only two classes being the nearest to one another with regard to absolute magnitude; the data of table 30 [1]) gave for the ratio of the number of companions:

dwarfs $K : G = 439 : 451 = 0.97$; $G : F = 361 : 401 = 0.90$;
$F : A = 382 : 329 = 1.16$; $B : A = 263 : 313 = 0.84$;
giants G[2])$: A = 498 : 370 = 1.35$; $K : A = 397 : 370 = 1.07$;
$M : A = 183 : 370 = 0.49$;
Supergiants $+ O : B = 465 : 265 = 1.76$.

In deriving these ratios the extreme categories of distance were not used as being of low weight; no distinction was made between the "close" and "distant" companions.

Taking the number for the A-dwarfs as unity, from the above given ratios the following values of the relative frequency of companions may be obtained:

Table 35.

	Dwarfs					Giants			
Sp. class	K	G	F	A	B	G	K	M	Supergiants + 0
Rel. Frequency ($\Delta m \leqslant 6.9$)	1.01	1.04	1.16	1.00	0.84	1.35	1.07	0.49	1.48

2) By comparing the data of table 30 [1]) for each spectral class with the mean curve, table 33; of course, only those parts of the mean curve are fit for a comparison which were derived

1) The factors of distance mentioned in the remarks to the table being neglected; the slow variation of $\psi(D)$ with distance makes these factors unimportant for purposes of comparison.

2) Absolute magn. of giants G assumed $= -3.8$.

from *all* spectra; the limits of projected distance within which the comparison could thus be made were: from $D = 14$ to $D = 1760$ astron. units. The extremities of the mean curve, being based on few of the spectral groups, are likely to be unequally influenced by their individual properties and cannot be used for comparison. As in the preceding method, the *extremities* of the individual curves were also rejected. In this way the following relative numbers were obtained, the number for the A-dwarfs being taken as unity:

Table 36.

	Dwarfs					Giants			Supergiants
Sp. class	K	G	F	A	B	G	K	M	+0
Limits of D	14—880	14—1760	=	=	28—1760	(28—3900)= =14—1760	14—1760	=	(220—14000)
Rel. frequency ($\Delta m \leqslant 6.9$)	1.34	0.94	1.17	1.00	0.70	1.34	1.19	0.55	(2.17 ±)

The agreement with the above found values is generally good, except for the K-dwarfs where, however, the observed number is small. From these data it appears that the F—K dwarfs and the G—K giants show an excess, the M-giants and B-dwarfs a deficiency of companions differing from the primary by less than 7.0 magnitudes *visually*. The supergiants appear also to be richer in companions than other stars. It must be pointed out that the relative frequency found for the G-giants and the supergiants is somewhat uncertain an account of the inaccurately known *total number* of stars of these classes.

It is remarkable that the relative frequency of companions among stars of widely differing spectra and absolute magnitudes shows such a small range of variation as revealed by the above given tables; excluding the doubtful values, there is only one class — the M-giants — which has a relative number certainly differing from the mean by more than 20 per cent.

The difference between the data of tables 35 and 36 is partly accidental, partly due to the difference in the methods; in table 36 the accidental errors must be less than in the other table since the comparison was made with the *mean curve* based on a great number of observations; however, from the standpoint of *systematical errors* table 35 must be preferred, since the comparison was made there between groups of stars little differing in absolute magnitude and, consequently, in angular separation; therefore, in the following the figures of table 35 were adopted.

With weights equal to the actually *observed* number the weighted mean of the relative frequency in table 35 becomes 1.02 for all spectra except the supergiants and 0 stars; if the similarity of $\psi(D)$ for different spectra is adopted, the *absolute number* of companions within certain limits of distance is given by

$$\nu = \nu_0 \cdot \frac{r}{1.02} \ldots \text{(g)},$$

where ν_0 is the absolute number for the *mean curve* within the same limits of distance, and r — the relative frequency from table 35; from table 33 we find:

for the limits of distance from $D = 3.5$ to $D = 220$, $\nu_0 = 315$... (*close companions)*;

for the limits of distance from $D = 220$ to $D = 2800$, $\nu_0 = 242$... (*distant companions*).

With these values the absolute number of companions for each spectral type was computed according to formula (g); the result is given in table 37.

Table 37.

Probable Number of Companions with $\Delta m \leqslant 6.9$ vis. among 1000 Stars of a given Spectral Class chosen at random in space.

Class	Dwarfs *K*	Dwarfs *G*	Dwarfs *F*	Dwarfs *A*	Dwarfs *B*	Giants *G*	Giants *K*	Giants *M*	Supergiants +0
	Close companions, $D = 3.5$—220 astron. units								
	312	321	359	309	258	416	331	151	...
	Distant companions, $D = 220$—28 000 astron. units								
	240	247	276	237	198	327	254	116	358

The original numbers representing the *frequency-function of Δm, $\varphi(\Delta m)$*, being computed in a manner described in the preceding section, were finally all multiplied by certain factors to make the sum of the numbers from $\Delta m = 0.0$ to $\Delta m = 6.9$ equal to the numbers in table 37; thus the numbers contained in tables 31 and 32 were obtained; the use of round values made the sums in these tables sometimes differ by a few units from the exact figures of table 37.

c) *Distribution of relative magnitudes.* The first conclusion from a comparison of tables 31 and 32 is that the frequency-function of Δm, $\varphi(\Delta m)$, is doubtlessly different, for the *close* and the *distant* companions; among the close companions small Δm are relatively more frequent than among the distant ones. It is possible that $\varphi(\Delta m)$ shows a progressive change with the distance, but the scarcity of material does not allow to investigate the change in details; we have contented ourselves with the rough subdivision into "close" and "distant" companions and shall treat separately only these two groups; by the way, certain characteristic features are revealed by each of these groups in such a well developed manner that practical homogeneity may be assumed for each of them separately.

In dealing with the distribution of distances we found a certain similarity revealed by the different spectra, a similarity although not of the character of organic relationship within a continuous series of evolution, but more likely produced by some unknown common law. It is natural to expect that the distribution of Δm will show also some similarity; from this standpoint the *argument* on which $\varphi(\Delta m)$ depends, becomes a matter of first importance; an argument must be chosen which makes the distribution for different spectra the most similar to one another. There are only two arguments which may be taken into consideration: M, the absolute magnitude of the companion, and the difference of magnitude $\Delta m = M - M_0$, M_0 being the absolute magnitude of the primary. Our frequency-function may be written $\varphi(\Delta m)$ or $\varphi(M - M_0)$, generally $\varphi(M, M_0)$; two extreme cases may be imagined: a) when M and M_0 enter only in the form of their difference, Δm; b) when in $\varphi(M, M_0)$ M_0 disappears so that φ becomes a function of the absolute magnitude of the companion only[1]).

To answer the question as to the argument of φ the data of tables 30 and 31 were plotted using as abscissae Δm and M alternately; as will be explained later on, instead of the visual Δm the *bolometric* difference of magnitude was used, because it appears natural that if only the *ratio* of luminosities determines

1) Particulars as to the theory may be found in *T. P.* 25_5, pp. 4—5.

their frequency, the ratio which more nearly corresponds with the relative physical importance of both components is the ratio of their total radiation; after all, the use of the bolometric difference of magnitude introduced no substantial alteration in the curves, whereas the agreement of curves which appeared similar in the visual magnitudes was apparently improved. The absolute magnitudes used were, on the contrary, *visual*, as the reduction to bolometric magnitude, depending on the absolute magnitude only, would change nothing in the relative character of curves having as argument the absolute magnitude itself.

Of the curves obtained in this way are reproduced here only those which have as abscissae the argument leading to the best agreement of the different spectra; from an examination of *all* curves the following conclusions were drawn:

1) the *giants* show a distribution of Δm which is distinctly different from the distribution among the dwarfs; the difference is equally revealed by the close and the distant companions; the spectra may thus be divided into two principal groups: the dwarfs from B to K and the giants; as to the supergiants and O-stars, they stand apart and are omitted from the subsequent discussion;

2) the curves for the *close companions* plotted with Δm bolometric as abscissae show high similarity for all spectra of the dwarf branch, from B to K; the same curves plotted with the absolute magnitudes as abscissae show no trace of agreement;

3) on the contrary, the curves for the *distant companions* to dwarfs from B to K show very bad agreement with Δm, and remarkably good agreement with the absolute magnitude as abscissae; the agreement is good not only in the relative rise and fall of the curves, but also in the *absolute frequency;* an exception present only the joined $G+K$ dwarfs which show systematically a frequency 40—50 % less than the other types, but the total observed number for this category is very small — only 23, and the reduction to absolute numbers (cf. tables 37, 36, 35) somewhat uncertain.

In the case of the giants the question as to the most convenient argument of the luminosity-curve cannot be answered independently, as the range in the average absolute magnitude is small there, and of the three groups only the K-giants are sufficiently numerous for individual treatment; moreover, the distribution for each of the three groups seems to be peculiar; by analogy with the dwarf series we may assume, however, that the frequency of *close* companions depends on the *difference* of magnitude, and the frequency of the *distant* ones — on their absolute magnitude.

The reduction to bolometric magnitude was executed in the following way. Let within the limits of visual magnitude from $\Delta m = x_1$ to $\Delta m = x_2$ be found ν companions, and let the corrections for bolometric magnitude be b_1 and b_2 respectively; the limits of bolometric magnitude will be x_1+b_1 and x_2+b_2 respectively; the frequency per unit of magnitude interval will then be

$$\varphi(\Delta m_{\text{bol.}}) = \frac{\nu}{(x_2+b_2)-(x_1+b_1)} \quad . \quad . \quad . \quad \text{(h)},$$

corresponding to a mean

$$\Delta m_{\text{bol.}} = \frac{x_1+b_1+x_2+b_2}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(i)}.$$

The corrections b, which are applied to Δm, represent the *differential* correction for bolometric magnitude in the sense: companion *minus* primary.

The difference of bolometric and visual magnitude, $m_b - m_v$, may be computed with an accuracy sufficient for our purposes if the spectral type is given; on the other hand, for the dwarf branch the spectrum may be assumed to be a continuous function of the absolute magnitude: exceptional stars of early type and low luminosity like $o_2 B$ Eridani are apparently too rare to influence sensibly the statistical relation between $m_b - m_v$ and the absolute magnitude. For the difference $m_b - m_v$ were therefore used the data of table 1, *T.P.* 25_2 (1922) p. 11 and fig. 1 on p. 23, ibidem. As to the companions to giant stars, within $\Delta m = 0.0 - 0.9$ it was assumed that $\frac{1}{2}$ of them belonged to giants of class K and $\frac{1}{2}$ — to the normal dwarf series; such appears to be approximately the proportion of giants to $B+A$ dwarfs in space, according to H. Shapley (*Harvard Bulletin* **792**).

In this way the data of table 31 were reduced to the bolometric difference of magnitude; the result is given in table 38.

At the bottom of the table are given the *mean* frequency-functions of $\Delta m_{\text{bol.}}$, for the dwarfs and the giants separately. There Σn denotes the total observed number, ΣW — the *effective*

Fig. 5.

Frequency-Function of Δm bolometric.

Dwarfs, Close Companions.

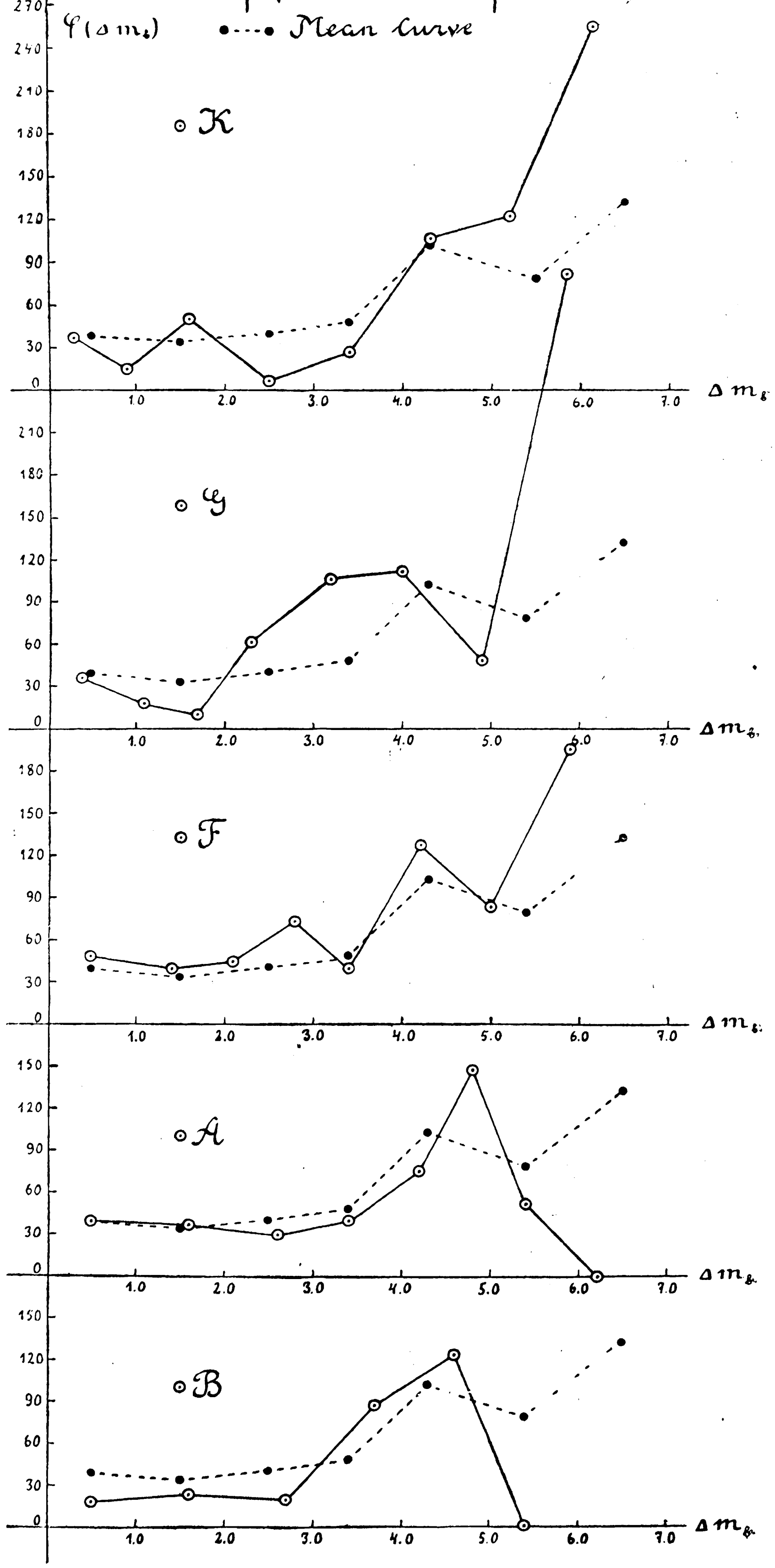


Table 38.

Frequency-Function of the Difference of Bolometric Magnitude.

Close Companions.

		$\Delta m_{vis.}$	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
1) Dwarfs														
K		$\Delta \bar{m}_b$	0.3	0.9	1.6	2.5	3.4	4.3	5.2	6.1	—	—	—	—
		$\varphi(\Delta \bar{m}_b)$	37	15	50	7	26	107	122	255	—	—	—	—
		n	(7)	(2)	(6)	(1)	(2)	(3)	(3)	(3)	—	—	—	—
G		$\Delta \bar{\ }_b$	0.4	1.1	1.7	2.3	3.2	4.0	4.9	5.8	6.7	7.6	8.5	9.5
		$\varphi(\Delta \bar{m}_b)$	36	19	9	61	104	111	48	320	0	7000	0	0
		n	(19)	(4)	(1)	(7)	(6)	(3)	(1)	(2)	(0)	(1)	(0)	(0)
F		$\Delta \bar{m}_b$	0.5	1.4	2.1	2.8	3.4	4.2	5.0	5.9	6.8	7.7	8.6	9.5
		$\varphi(\Delta \bar{m}_b)$	47	39	44	73	40	126	83	196	74	0	0	490
		n	(49)	(22)	(14)	(17)	(7)	(6)	(5)	(3)	(1)	(0)	(0)	(1)
A		Δm_b	0.5	1.6	2.6	3.4	4.2	4.8	5.4	6.2	7.1	8.0	8.9	9.8
		$\varphi(\Delta \bar{m}_b)$	40	36	29	40	76	146	50	0	160	300	900	0
		n	(71)	(31)	(13)	(14)	(10)	(5)	(1)	(0)	(1)	(1)	(1)	(0)
B		Δm_b	0.5	1.6	2.7	3.7	4.6	5.4	6.0	6.7	7.4	—	—	—
		$\varphi(\Delta \bar{m}_b)$	19	23	19	87	124	0	0	1000	0	—	—	—
		n	(4)	(5)	(2)	(4)	(2)	(0)	(0)	(1)	(0)	—	—	—
2) Giants														
G		$\Delta \bar{m}_b$	0.4	1.4	2.5	3.3	4.1	4.7	5.3	6.1	7.0	—	—	—
		$\varphi(\Delta \bar{m}_b)$	28	53	0	45	0	0	380	0	2800	—	—	—
		n	(4)	(5)	(0)	(1)	(0)	(0)	(1)	(0)	(1)	—	—	—
K		$\Delta \bar{m}_b$	0.8	1.9	3.0	3.8	4.6	5.2	5.8	6.6	7.5	8.4	9.3	10.2
		$\varphi(\Delta \bar{m}_b)$	3.	5.	16	24	29	194	218	163	0	0	0	0
		n	(8)	(7)	(12)	(10)	(7)	(9)	(3)	(4)	(0)	(0)	(0)	(0)
M		$\Delta \bar{m}_b$	1.5	2.9	4.0	4.9	5.7	6.4	7.0	7.7	8.6	9.4	10.3	11.2
		$\varphi(\Delta \bar{m}_b)$	0.	5.	8.	41.	69.	90.	0.	0.	0.	0.	0.	0.
		n	(0)	(1)	(1)	(3)	(3)	(1)	(0)	(0)	(0)	(0)	(0)	(0)

3) All dwarfs, mean

$\Delta m_{bol.}$ limits / mean	0.0—0.9 **0.5**	1.0—1.9 **1.5**	2.0—2.9 **2.5**	3.0—3.9 **3.4**	4.0—4.9 **4.3**	5.0—5.9 **5.4**	6.0—6.9 **6.5**	7.0—7.9 **7.6**	8.0—8.9 **8.7**	9.0—9.9 **9.6**
Σn	152	69	54	33	29	13	8	2	1	1
ΣW	3879	2084	1362	706	285	166	60	6.6	3.6	3.1
$\varphi(\Delta m_{bol.})$	**39.2**	**33.2**	**39.7**	**47.**	**102.**	**78.**	**133.**	**300.**	**280.**	**320.**

4) All giants, mean

$\Delta m_{bol.}$ limits / mean	0.0—0.9 **0.8**	1.0—1.9 **1.8**	2.0—3.4 **3.0**	3.5—4.4 **3.9**	4.5—4.9 **4.7**	5.0—5.9 **5.6**	6.0—6.9 **6.5**	7.0—7.9 **7.4**
Σn	12	12	14	11	10	16	5	1
ΣW	2643	1774	1022	559	319	106	38	20
$\varphi(\Delta m_{bol.})$	**4.6**	**6.8**	**14.**	**20.**	**31.**	**151.**	**132.**	**50.**

number of stars completely examined; $\overline{\varphi(\Delta m_b)} = \frac{1000\,\Sigma n}{\Sigma W}$. From the table we learn e. g. that within the limits of $\Delta m_b = 5.0$—5.9 there are known 13 companions to dwarfs of the *H.R.*; the combined efforts of all observers in searching double stars of the given Δm_b among the dwarfs of the *H.R.* is equivalent to an exhaustive examination of 166 dwarfs within the limits of projected distance from 3.5 to 220 astronomical units.

In deriving the mean distribution of close companions for the dwarfs the Δm_b of the individual curves were not taken as given in table 38, but the following corrections were applied to the Δm_b beginning from $\Delta m_b \geqslant 2.0$: to K, $+0.3$; to G, $+0.2$; to F, 0.0; to A, -0.2; to B, -0.2; these small corrections are only a matter of convenience and have no practical influence on the result; they represent a first approximation of the *relative displacement* of the individual curves, the displacement being smoothed out with respect to spectral type.

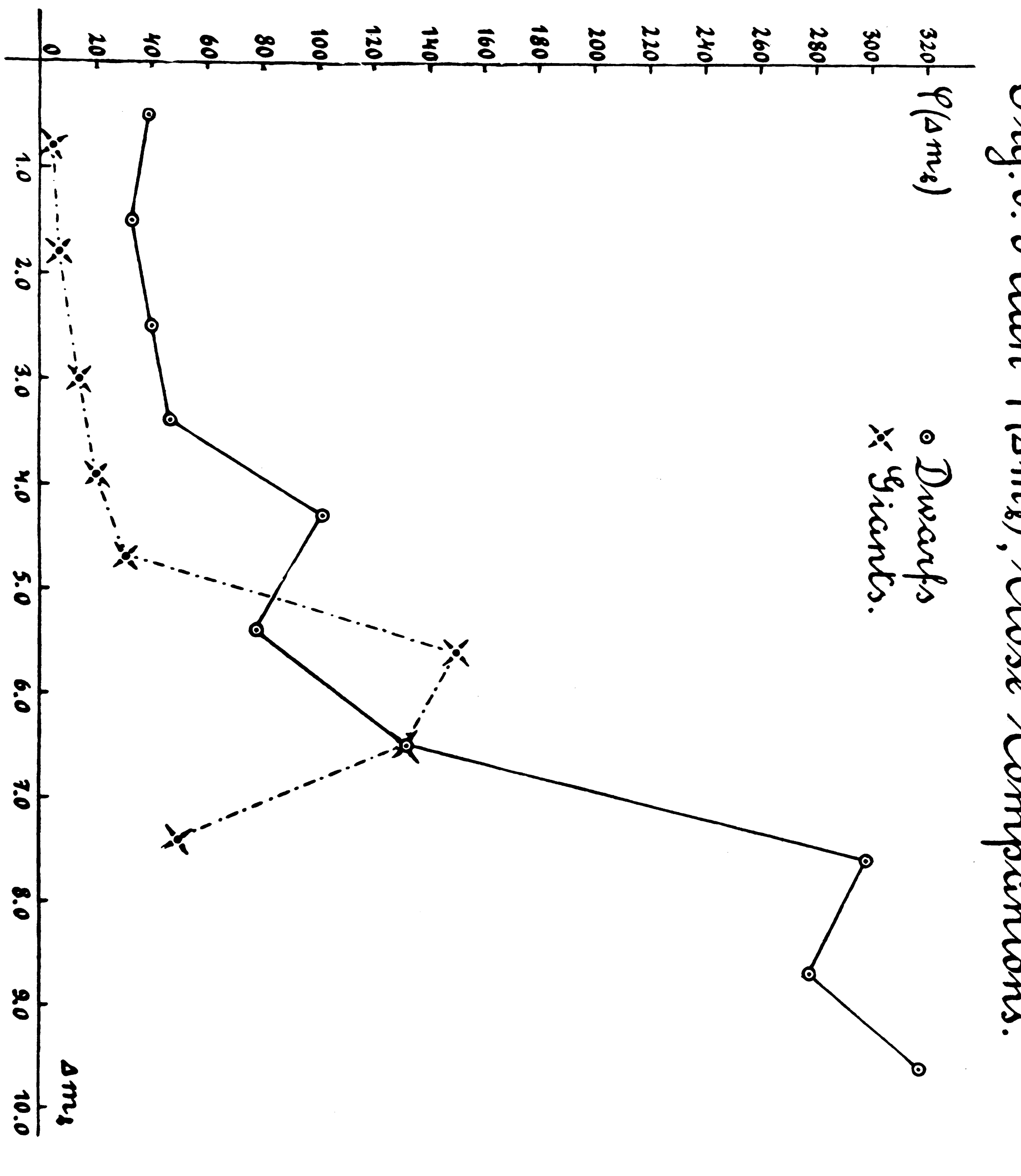
The $\varphi(\Delta m_{bol})$ for the dwarfs, contained in table 38, are plotted on fig. 5 with the bolometric difference of magnitude as abscissae; for comparison the *mean curve* derived from all dwarfs, given at the bottom of table 38, is also reproduced. In fig. 6 are compared the mean frequency-functions of Δm_b of close companions for dwarfs and giants.

As to the distant companions, no alteration was introduced into the data of table 32; table 39 represents the mean distribution of absolute magnitudes of the distant companions, for the dwarfs and the giants separately.

The data of this table are arranged in the same manner as for the mean curves of the close companions and require no separate explanation.

On fig. 7 the distribution of the absolute magnitudes of distant companions to dwarfs is given as compared with the corresponding mean curve; fig 8 gives a comparison of the mean luminosity-curves of the distant companions as found here for the dwarfs and the giants, with the luminosity-curve of stars as a whole — according to Kapteyn and Van Rhijn — and with the preliminary curve, dwarfs and giants joined, derived in *T.P.* 25_5, p. 24.

It may be hoped to obtain new knowledge of the laws of stellar evolution chiefly from the luminosity-curve of close



companions; the distribution of luminosities of the distant companions, being independent of the luminosity of the primary, only indicates that the physical properties of these companions were formed without any influence on the part of the central mass, the latter being only a *"primus inter pares"*. On the contrary, the distribution of the close companions depends on

Table 39. ***Mean Frequency-Function of Visual Absolute Magnitudes of Distant Companions.***

The curve is supposed to begin abruptly at the absolute magnitude of the primary.

1) Dwarfs *B, A, F, G, K* joined.

M_{abs} (π=1″) lim.	−4.9...−4.0	−3.9...−3.0	−2.9...−2.0	−1.9...−1.0	−0.9...0.0	+0.1...1.0	1.1...2.0	2.1...3.0	3.1...4.0	4.1...5.0	5.1...6.0	6.1...7.0	7.1...8.0
mean	**−4.8**	**−3.4**	**−2.4**	**−1.6**	**−0.5**	**+0.5**	**+1.4**	**+2.4**	**+3.4**	**+4.4**	**+5.3**	**+6.3**	**+7.3**
Σn	10	61	48	77	80	73	67	38	19	13	3	3	1
ΣW	1110	3719	2524	3225	2437	2022	1515	920	598	167	84	39	9
$\varphi(M_{abs.})$	**9.**	**16.4**	**19.0**	**23.9**	**32.8**	**36.1**	**44.1**	**41.**	**32.**	**78.**	**36.**	**77.**	**111.**
$\log \varphi$	0.95	1.21	1.28	1.38	1.52	1.56	1.64	1.61	1.51	1.89	1.56	1.89	2.05

2) Giants *G, K, M* joined.

$M_{abs.}$ (π=1″) lim.	−4.5...−3.6	−3.5...−2.6	−2.5...−1.6	−1.5...−0.6	−0.5...+0.4	+0.5...+1.4	1.5...2.4	2.5...3.4	3.5...4.4	4.5...5.4	5.5...6.4	6.5...7.4
mean	**−4.0**	**−3.0**	**−2.0**	**−1.0**	**0.0**	**+1.0**	**+2.0**	**+3.0**	**+4.0**	**+5.0**	**+6.0**	**+7.0**
Σn	5	24	20	39	44	33	21	14	3	2	2	3
ΣW	3580	2172	2071	1299	1033	678	323	143	21	14	8	3.
$\varphi(M_{abs})$	**1.4**	**11.1**	**9.7**	**30.0**	**43.**	**49.**	**65.**	**98.**	**143.**	**143.**	**250.**	**1000.**
$\log \varphi$	0.15	1.04	0.99	1.48	1.63	1.69	1.81	1.99	2.16	2.16	2.40	3.00

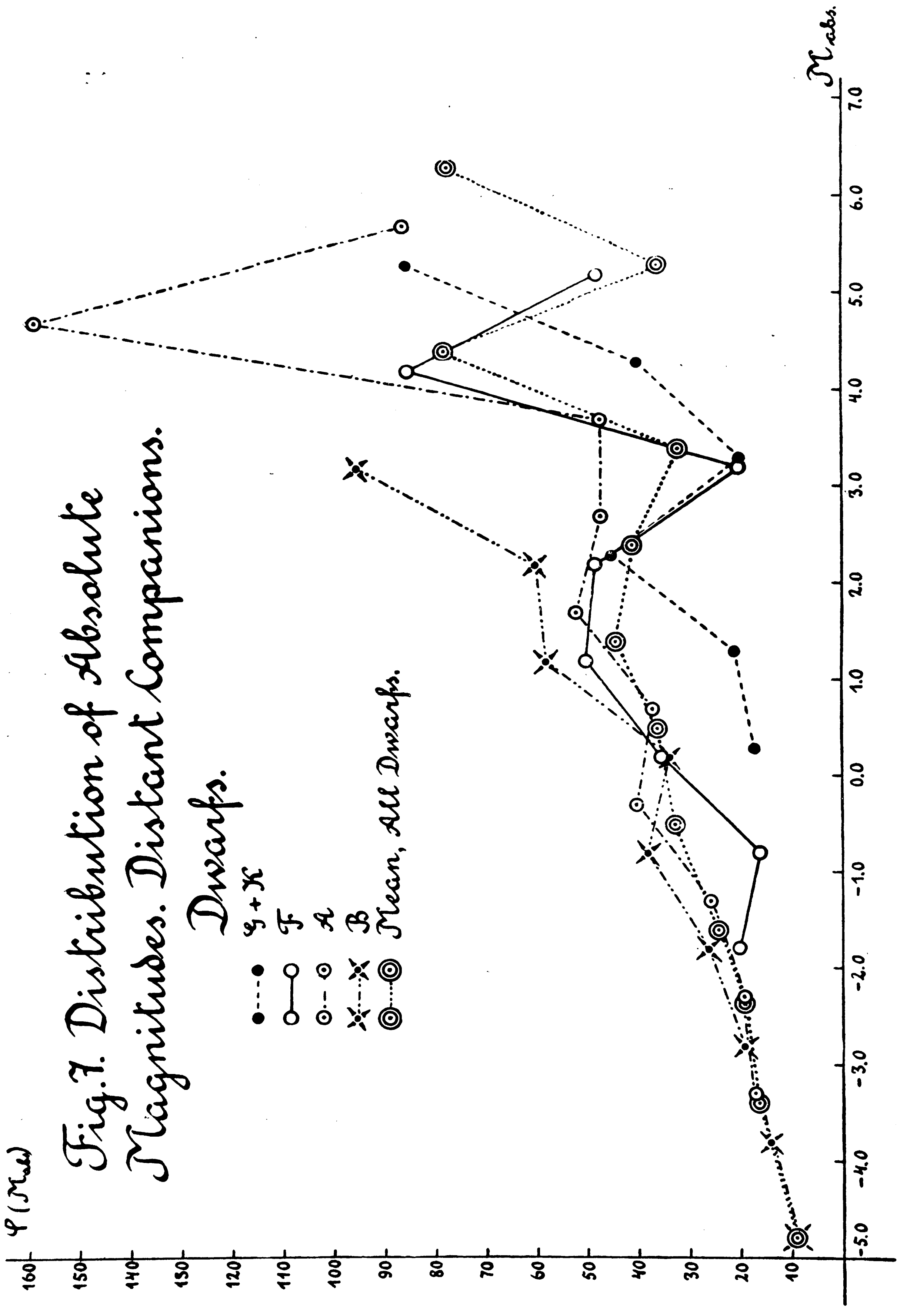
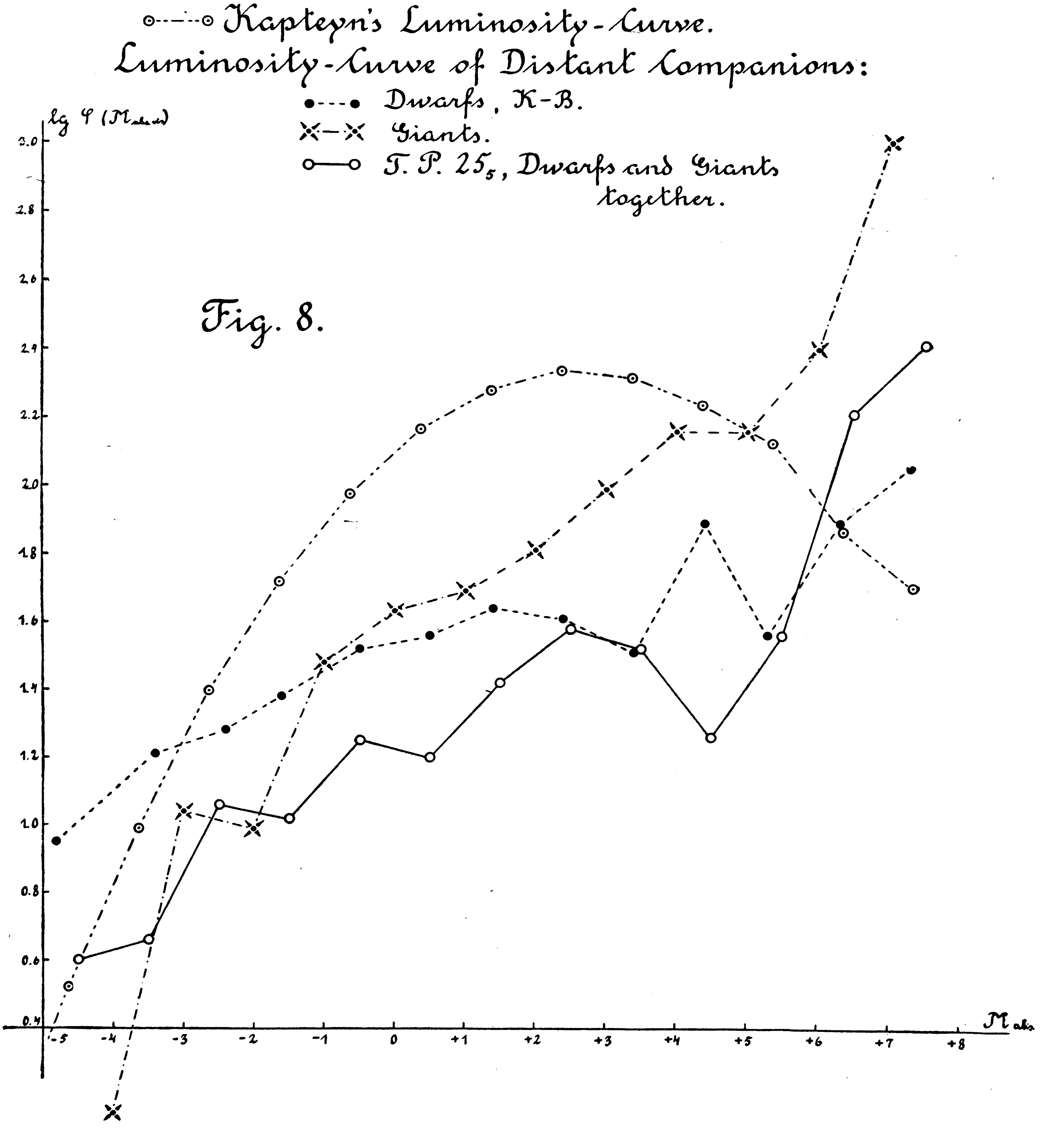


Fig. 7. Distribution of Absolute Magnitudes. Distant Companions. Dwarfs.


Kapteyn's Luminosity-Curve.
Luminosity-Curve of Distant Companions:
Dwarfs, K-B.
Giants.
T. P. 25₅, Dwarfs and Giants together.
Fig. 8.
lg φ (M abs)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
-5
-4
-3
-2
-1
0
+1
+2
+3
+4
+5
+6
+7
+8
M abs

the *ratio* of luminosities of the companion and the primary, so that an organical relation between them must exist.

d) *Close companions and stellar evolution.* A comparison of the curves on fig. 5 leads to the following conclusions. The curves for the dwarfs are very similar both with respect to the shape and to the absolute number; perhaps the frequency for the *B*-stars between $\Delta m_b = 0.0 - 3.0$ is about 50% below the average, but it must be taken into account that the observed number of close companions in this class is very small, so the difference is not certain. We are thus very near the conclusion of the identity of all curves for the dwarfs. Nevertheless certain relative displacements of the curves along the Δm_b-axis seem probable; practically the displacements can be determined with some certainty only by using the wave of the *mean* curve between $\Delta m_b = 3.5 - 5.5$, as for smaller Δm_b the curve presents no conspicuous markings, and for greater Δm_b the observations for the individual curves are either too scarce, or entirely lacking. The following shifts of the curves relative to the *mean* curve were found:

Table 40.

Displacements of Individual Luminosity-Curves of Close Companions relative to the Mean Curve for Dwarfs.

Effective $\Delta m_b = 4.3$. The *weight* of the estimated displacement is given in parentheses.

Spectrum		*K*	*G*	*F*	*A*	*B*	Giants, mean
Displacement (st. magn.)	ascending branch	+0.2(3)	−1.1(3)	0.0(5)	+0.4(8)	−0.2(2)	+1.2(14)
	descending	...	−0.6(2)	−0.1(4)	+0.2(2)	+0.1(1)	...
	mean	+0.20(3)	−0.90(5)	−0.04(9)	+0.36(10)	−0.10(3)	+1.2(14)

A positive displacement indicates that Δm_b of the given spectrum appears *increased* as compared with Δm_b of similar points on the mean curve. The weights are assumed equal to the number of observed companions on which the corresponding point of the individual curve depends. The last column of the table represents the result of comparison of the mean curve for the giants with the mean for the dwarfs. Although the weights are very low, some conclusions from the data of table 40 may be drawn. We shall consider here a few typical working hypotheses on stellar evolution with the purpose of comparing them with the few observational facts found. Certain theories proposed by the author cannot be explained here in details; for particulars concerning these theories *T. P.* **25**$_2$ and **25**$_5$ may be consulted.

The hypotheses may be divided into two chief groups: I) hypotheses supposing a one-sided uninterrupted course of evolution, e. g. a continuous decrease of luminosity since the "origin" of the star; II) those supposing a *reiteration* of the consecutive stages of evolution, e. g. a gradual decrease of luminosity, interrupted by „catastrophes" after which the star regains its *initial luminosity* and begins anew its evolutionary course. With respect to the supposed source of stellar energy and the *rate of cooling* [1]) two extreme cases will be considered, the theory of *gravitational contraction* [2]) and the so-called theory of "*radio-active cooling*" where the decrease of luminosity follows the logarithmic law known to hold for radioactive substances. Finally the II-nd group of hypotheses presents two alternatives: 1) the "catastrophes" may occur simultaneously for both components of a double star; 2) the components may be independent from one another with respect to the catastrophes. The different combinations of these alternatives give together 6 cases which must be examined.

I. *One-sided evolution.* The origin of both components may be assumed to be simultaneous, and their „age", measured in units of time, to be equal. 1) *Gravitational contraction;* the ratio of the *rate of cooling* for the components A and B of a binary was determined in *T. P.* **25**$_5$, p. 17 by

$$\log \frac{v_A}{v_B} = -0.15\,(M_A - M_B) \quad . \; . \; . \; . \; . ;$$

this formula was deduced on the assumption that the mean masses of the components are related to their luminosities in the same way as the masses of single stars [3]), i. e. that approximately $J_1 : J_2 = (\mu_1 : \mu_2)^3$ . . . . [4]); however, in the same publi-

1) *T. P.* **25**$_2$, p. 5 and further.

2) For compressed dwarfs the conditions of thermal cooling are approached in this case.

3) More correctly — as the masses of the primaries to one another.

4) Formula (14), p. 19 in *T. P.* **25**$_5$.

cation it has been shown that the relative masses of two components of a double star are, on the average, represented satisfactorily by another formula:

$$J_A : J_B = (\mu_A : \mu_B)^{10} \quad . \quad . \quad . \quad . \quad .^{1)},$$

J_A and J_B being the luminosities, μ_A and μ_B — the masses; by using this formula together with table 9 in *T. P.* **25**$_2$ it was found that the ratio of the *rates of cooling* for gravitational contraction could be well represented by the following formula:

$$\log (v_A : v_B) = -0.28\,(M_A - M_B) \quad . \quad . \quad . \quad . \quad (k);$$

this formula may be applied practically to all classes of the dwarf series. The magnitudes M_A and M_B are supposed to be *bolometric*.

For $M_A - M_B = -\Delta m_b = -4.3$ we have

$$\boldsymbol{v_A : v_B = 16.}$$

The decrease of magnitude of the bright companion is thus 16 times more rapid than the corresponding decrease of the faint companion, and the difference of magnitude will decrease almost as rapidly as the brightness of A diminishes. Taking into account that $v_A : v_B = \Delta M_A : \Delta M_B$, we may obtain from formula (k) the following relation:

$$10^{0.28\,x_B} = 10^{0.28\,(x_A - \Delta m_0)} + 1 - 10^{-0.28\,\Delta m_0} \quad . \quad . \quad . \quad . \quad (l);$$

here x_A and x_B denote the decrease of brightness (in stellar magnitudes) during the process of contraction of the components A and B respectively, Δm_0 — the *initial* difference of magnitude; the final difference of magnitude is given by

$$\Delta m = \Delta m_0 + x_B - x_A \quad . \quad . \quad . \quad . \quad . \quad (m).$$

With $\Delta m_0 = 4.3$ we have:

Table 41.

x_A	=	0.0	+2.0	+4.0	+6.0
x_B	=	0.0	+0.2	+0.9	+2.1
Δm	=	4.3	2.5	1.2	0.4
displacement	=	0.0	−1.8	−3.1	−3.9

1) Formula (12), p. 18 in *T. P.* **25**$_5$.

Comparing these values with the displacements of table 40 we conclude that between the dwarfs from B to K x_A does, certainly, not exceed 1.0 magn.: the maximum range of "cooling" corresponds to an advance in the evolution by less than one spectral class[1]; with the gravitational source of stellar energy the age of the stars should, on an average, be less than 1 million years, which seems quite improbable. Even if the gravitational theory with such a small space of time is nevertheless adopted, the spectral types of the dwarf branch cannot be regarded as a homogeneous and continuous series of evolution, since the *maximum* admissible range of cooling is only about $\frac{1}{7}$th of the range of absolute magnitude from B to K; this conclusion is quite analogous to the conclusion arrived at in discussing the distribution of distances.

The inclusion of giants into the comparison (table 40, last column) somewhat increases the possible range of x_A, for the sequence giants, *F*-dwarfs, *G*-dwarfs, *K*-dwarfs up to about 2 magnitudes *maximum*; but this represents also only about 0.4 of the range in absolute magnitude, the conclusions remaining thus practically unaltered; moreover, the legitimacy of comparing in this way the giants with dwarfs is questionable, as the luminosity-curve of giants differs sensibly from the luminosity-curve of dwarfs.

2) *"Radioactive cooling"*, defined by $v = \frac{\partial M}{\partial \tau} = \text{const.}$, v representing the rate of fading of the absolute magnitude per unit of time. As a working hypothesis v may be assumed to be constant not only for the same star during different stages of evolution, but also for different stars. On this assumption the range of decrease in the magnitude will be equal for the bright and the faint companion of a binary, and the difference of magnitude will remain unchanged; thus the displacement in the luminosity-curve will be zero, whatever the decrease in the absolute magnitude be. The displacements in table 40 may, in this case, be regarded as accidental errors — or as the result of a small deviation of v from constancy for stars of different absolute magnitudes. The continuity of the series of evolution cannot be tested from the standpoint of this hypothesis. However,

1) The average change of absolute magnitude per spectral class may be assumed equal to 1.5 magnitudes between B—K.

assuming the conclusions to which the discussion of the *distance-distribution* led, we are forced to admit that the actual range of decrease in the absolute magnitude since the "origin" of the stars must be small in comparison with the range of the absolute magnitudes themselves; such a form of the hypothesis differs little from the assumption of a *stationary state* of the stars, which is equivalent to a negation of any evolution, since a slow simultaneous change of the absolute magnitudes of all stars cannot be revealed by the available data.

II. *Periodical evolution.* We shall adopt here the numerical results at which we arrived in a preceding publication [1]); in this publication it was found that the *general luminosity-curve* of stars may be explained on the assumption of periodical evolution, and for the two hypotheses as to the source of stellar energy certain constants seemed to give the best representation of the observational data [2]); the hypothesis of "radioactive cooling" led to satisfactory agreement, whereas the theory of gravitational contraction showed some agreement for the ascending branch of the luminosity-curve, failing utterly for the descending branch; for luminosities exceeding absolute magnitude $+2$ (bolometric, $\pi = 1''$) the consequences of the theory of gravitational contraction do not differ too much from the observational data, so it is permissible to apply both theories to the double stars here considered, since the absolute luminosities of the primary components fall not below the above given limit.

Let us call the *age of cooling* of a star the decrease of luminosity reckoned from the last maximum of brightness; the *age of cooling* expressed in stellar magnitudes is

$$a = M - M_0 \quad . \quad . \quad . \quad . \quad \text{(n)},$$

M being the absolute magnitude at present, M_0 — the *initial magnitude* [3]), both *bolometric.* Using the denotations of *T. P.* 25_2, according to formula (11) there given, we obtain

$$a = M - \frac{\int\limits_{M_0=-\infty}^{M_0=M} M_0 \psi(M, M_0) X(M_0) dM_0 + [M_0 \,.\, n_1 X(M_0)]_{M_0=M}}{\varphi(M)} \quad . \quad . \quad . \quad \text{(p)}.$$

---

1) *T.P.* 25_2. 2) *Ibidem*, p. 22—24 and 30—31. 3) *Ibidem*, p. 6 and further.

According to the theory exposed on pp. 20—24 and 30—31 of the said publication and using the constants there given, values of a given below in table 42 were computed. These values thus represent the probable decrease of the absolute bolometric magnitude since the "origin" — or the first preceding maximum of luminosity —, as derived from the general luminosity-curve of the stars; the a are *average* values for a given class of the absolute magnitude.

Table 42.

Average Age of Cooling, a (stellar magnitudes).

$M_{\text{abs. bolom.}}$	+4	+3	+2	+1	0	—1	—2	—3	—4	—5	—6
a Gravit Contr.	...	...	3.6	3.3	2.7	2.0	1.3	0.8	0.5	0.3	(0.3)
a Radioact. Cooling	2.7	2.0	1.5	1.1	0.8	0.6	0.4	0.2	0.0	0.0	0.0

For the separate spectra the following values of a were assumed according to table 42:

Table 43.

Average Age of Cooling for different Spectra.

Spectrum	Dwarfs *K*	Dwarfs *G*	Dwarfs *F*	Dwarfs *A*	Dwarfs *B*	Giants, mean
($\pi = 1''$) $M_{\text{vis.}}$	+0.7	—0.8	—2.3	—3.8	—5.8	—4.4
($\pi = 1''$) $M_{\text{bolom.}}$	+0.3	—0.8	—2.3	—4.0	—6.0	—4.9
a Gravit.	2.9	2.1	1.1	0.5	0.3	0.3
a Radioact.	0.9	0.6	0.3	0.0	0.0	0.0

Now we may proceed to the discussion of the particular cases.

1) *Gravitational contraction.* A) *Simultaneous "catastrophes" for both companions;* this case resembles hypotheses I, as after the "catastrophe" the difference of magnitude diminishes with a speed equal to $v_A — v_B$; in table 41 we put $x_A = a$, the latter being determined by table 43; from tables 41 and 40 we obtain the following data.

Displacement of the luminosity-curve at $\Delta m_b = 4.3$

Sp., dwarfs	*K*	*G*	*F*	*A*	*B*
d_c (computed displ., gravit. cooling)	—2.4	—1.9	—1.1	—0.5	—0.3
d_0 (observed, table 40)	+0.20	—0.90	—0.04	+0.36	—0.10

A glance at these figures is sufficient to show that the adopted hypothesis is feebly supported by observational evidence; assuming

$$d_0 = kd_c + c \quad . \; . \; . \; (r),$$

from a least-square solution we obtain:

$$k = +0.45 \pm 0.08$$
$$c = +0.45;$$

The correlation factor k indicates that the observed displacements are less than $\frac{1}{2}$ of the size expected according to the theory. The smallness of the probable error makes a value of $k = 1$ quite improbable.

B) *Independent "catastrophes" for both companions.* In this case the mean distribution of *faint* companions may be assumed invariable, and the dispcementⁱa beginning from a certain Δm_b will be constant and equal to a taken with the opposite sign. For small Δm_b, of the order of a, the displacement will gradually increase from zero to a because the primary and secondary components may sometimes change their parts.

Therefore the displacements to be expected in this case are those given under "*a Gravit.*" in table 43, taken with the sign "—"; they differ but little from the displacements required by the preceding hypothesis, being somewhat greater and giving thus even a smaller factor of correlation, k.

In conclusion it may be stated that cases A) and B) differ too little from one another to allow of an independent test of both separately; but the smallness of the factor of correlation, k, makes the general hypothesis of *gravitational cooling* to appear improbable also in the case of *periodical evolution.*

2) ***Radioactive cooling.*** A) *Simultaneous catastrophes*; the rate of cooling being constant, no displacement will occur. In this case the displacements in table 40 must be regarded as accidental. This hypothesis resembles exactly the hypothesis I, 2).

B) *Independent catastrophes.* As explained above, the displacement must be equal to $-a$. Assuming a correlation of the form (r), where d_0 is given by table 40, and d_c = "*a Radioact.*" of table 43, from a least-square solution we found:

$$k = +0.67 \pm 0.30; \quad c = +0.15.$$

The theoretical value of k in this case is 1, whereas for A) it should be 0. The value found differs from 1 within the limits of the probable error.

The conclusions arrived at in the above discussion may be summarized as follows.

The theory of *periodical evolution* with the *radioactive law of cooling* and catastrophes occurring *independently* for both components of a binary gives the best account of the observed displacements in the luminosity-curve of close companions.

Simultaneous catastrophes in periodical evolution, as well as the *absence of any evolution* appear less probable, though not altogether impossible; there is very little probability in favour of the theory of *gravitational cooling*, even in the form of periodical evolution, where gravitation may supply energy only during the "quiet" state of regular decrease of luminosity, whereas the energy of catastrophes may be imagined to come from another source, gravitation playing thus only the part of an *accumulator;* if other facts like those dealed with in *T. P.* 25_2, or the time-scale of the universe are taken into consideration, the tests against gravitation playing a conspicuous part in supplying energy and governing the rate of stellar evolution, become almost overwhelming. By the way, the usefulness of the theory of gravitational contraction as a working hypothesis may be acknowledged only as far as the stars are believed, during their life-time, to run through a wide range of absolute magnitude and spectrum; as soon as the view of all spectral classes forming an uninterrupted chain of evolution is rejected, and the average range within which the absolute magnitude can vary being proved to be far less than the range existing among the absolute magnitudes themselves, the application of the theory in explaining facts of stellar evolution becomes very limited: gravitation may be regarded henceforth only as the force which holds together the mass of the star, whereas the supply of energy on which the evolution depends, must be attributed to other forces.

Some remarks may be added on the method of deriving the relative displacements of the luminosity-curves. The method adopted above appears to the writer to be the most reliable: a comparison of the position of the most pronounced maxima and minima, or of the relative rise and fall of the curves seems to lead to the most confident results, whereas the *absolute number* for the different spectral types is liable to be influenced by many sources of systematic error. Nevertheless a comparison of the absolute numbers will also be given below. Let ν denote the *probable* number of companions within certain limits of Δm, and let $\Sigma^x \nu$ denote the *total* number from $\Delta m = 0$ to $\Delta m = x$; if for two curves $\Sigma^x \nu = \Sigma^{x_1} \nu_1$, the relative displacement is given by $d = x - x_1$. In this way the displacements given in table 44 were found. The displacements in this table are reckoned relative to the *mean curve* for all dwarfs, and are expressed in stellar magnitudes (bolometric); lim. $\Delta m_b = x$.

Table 44.

Relative Displacement of Luminosity-Curves for Close Companions as derived from the absolute numbers.

	All dwarfs, mean							
lim. Δm_b	0.95	1.95	2.95	3.85	4.85	5.95	7.05	8.15
$\Sigma\nu$	39	72	112	159	261	339	472	772
	Individual Curves							
lim. Δm_{vis}	0.95	1.95	2.95	3.95	4.95	5.95	6.95	7.95
	1) *K*-dwarfs							
lim. Δm_b	0.59	1.24	2.06	2.93	3.83	4.72	5.63	6.52
$\Sigma\nu$	23	33	74	80	103	199	309	539
displacement	+0.02	+0.51	+0.06	+0.78	+1.10	+0.47	+0.16	−0.77
	2) *G*-dwarfs							
lim. Δm_b	0.76	1.38	1.96	2.72	3.58	4.46	5.35	6.25
$\Sigma\nu$	29	41	46	92	182	279	322	612
displ.	+0.05	+0.38	+0.84	+0.27	−0.50	−0.65	−0.36	−1.31
	3) *F*-dwarfs							
lim. Δm_b	0.95	1.79	2.48	3.12	3.77	4.59	5.46	6.36
$\Sigma\nu$	47	80	110	157	183	286	358	533
displ.	−0.14	−0.36	−0.42	−0.69	−0.32	−0.62	−0.65	−0.91
	4) *A*-dwarfs							
lim. Δm_b	1.07	2.11	3.05	3.85	4.47	5.05	5.81	—
$\Sigma\nu$	45	82	109	141	188	273	311	—
displ.	−0.15	−0.09	+0.18	+0.34	+0.34	+0.05	+0.22	—
	5) *B*-dwarfs							
lim. Δm_b	0.99	2.12	3.20	4.20	5.04	—	—	—
$\Sigma\nu$	20	46	66	153	257	—	—	—
displ.	+0.51	+0.96	+1.43	+0.46	+0.23	—	—	—
	Giants, mean							
lim. Δm_b	1.30	2.40	3.45	4.30	5.15	6.05	6.95	7.85
$\Sigma\nu$	5	11	25	45	76	227	359	409
displ.	+1.14	+2.16	+2.83	+3.17	+3.10	+1.53	+0.83	+1.33

These displacements generally confirm those of table 40; the range within which the displacement for the same class varies remains generally within the limits of the accidental error, except for the giants where the enormous and variable displacements indicate that the nature of the curve is in this case altogether different from the curve of the dwarfs. From the table it appears that beginning from $\Delta m_b \geqslant 3.0$ the displacements for the dwarfs are practically *constant*, the variation being of an accidental character; this is exactly what would be required by the theory of *periodic evolution* with independent catastrophes, the hypothesis being thus supported by independent evidence also from this part.

e) *Distant companions.* Their luminosity-curve being apparently independent of the luminosity of the primary, the independency of their origin may be also suggested; whereas the close companions seem to have originated by some process of fission, the distant ones may be regarded as originated from independent nuclei in the primordial nebula; these views are in accord with certain conclusions of H. N. Russel, derived from altogether different observational facts. A capture-theory of the distant companions appears, however, improbable; were these bodies captured, their luminosity-curve should resemble the distribution of luminosities among the "free" stars of our universe; after the researches of J. C. Kapteyn the latter distribution may be assumed to be fairly well known; a direct comparison of the curves may be made on fig. 8, whence it appears that the curves are altogether different. The continuous logarithmic increase of the frequency of distant companions with decreasing absolute magnitude, the curve running almost in a straight line, bears much likeness to the luminosity-curves as known for stellar clusters. The rise of the curve is more steep for the giants than for the dwarfs, the former possessing thus a relatively greater number of absolutely faint companions.

f) *The total number of companions.* According to the mean curve for dwarfs as given in table 38, among 1000 average dwarfs there must be found 472 close companions within the limits of $\Delta m_b = 0.0 - 6.9$ and within the projected distance $D = 3.5 - 220$ astron. units; within $\Delta m_b = 7.0 - 9.9$ and the same limits of distance the corresponding number is 900; although the latter is based on 4 observed companions only, the number must be of the right order of magnitude, its probable error being estimated at ± 42 per cent; thus the probable number of close companions to an average dwarf star within $\Delta m_b = 0.0 - 9.9$ and within the limits of distance given above may be estimated at

1400 per 1000; if the distribution of distances for $D < 3.5$ retains the same character as found for greater distances, an estimate of the number of closer companions may be made according to formula (a′) of this section; assuming the average diameter of a dwarf star to be $= 2\odot$ or 0.02 astron. units, we have for the ratio of the numbers between $D = 0.02 - 3.5$ and $D = 3.5 - 220$ the value

$$\frac{N_{0.02-3.5}}{N_{3.5-220}} = \frac{\log 3.5 - \log 0.02}{\log 220 - \log 3.5} = 1.2,$$

or it may be assumed that the number of companions below $D = 3.5$ a. u. roughly equals the number between $D = 3.5$—220 a. u. This is rather an underestimate, as the factor C in formula (a′) shows a tendency to increase with the decreasing distance. We arrive at the conclusion that one dwarf star must, on an average, have about 3.1 companions of a bolometric luminosity $= \frac{1}{10\,000}$ or more of the primary, at a projected distance less than 220 astronomical units.

Assuming for the average diameter of a giant 0.2 a. u., we find in a similar way

$$\frac{N_{0.2-3.5}}{N_{3.5-220}} = 0.7\,;$$

for $N_{3.5-220}$ table 38 gives 409 per 1000 within $\Delta m_b \leqslant 8.0$; thus a giant will possess, on an average, 0.7 companions of a bolometric luminosity $\geqslant \frac{1}{1600}$ of the primary at a projected distance less than 220 astron. units. As the dwarfs within $\Delta m_b < 8.0$ would give about 1.6 for the corresponding number, it appears that the dwarfs have about twice as many companions as the giants.

From the data of table 39 we find that within the limits of $D = 220$—28 000 a. u. an average (F-type) dwarf will possess about 0.5 companions brighter than absolute magnitude $+8.0$ (visual, $\pi = 1''$), and an average giant — about 1.8 companions brighter than absolute magnitude $+7.5$; estimating the effective sphere of action of a star at about 200 000 astron. units, we find, according to formula (a′), that about 40 % must be added to the above given numbers to obtain the probable number between $D = 28\,000 - 200\,000$ a. u. Finally we may estimate the average number of distant companions brighter than absolute magnitude $+8.0$ at 0.7 for one dwarf, and at 2.5 for one giant. Thus, whereas the dwarfs are richer in close companions, the giants show an abundancy of distant ones.

The total number of physical companions brighter than, say, absolute magnitude $+8$ may be estimated, on an average, at 4 for one dwarf and 3 — for one giant. Thus *multiple* stars seem to represent the general rule, whereas single stars like our sun, or even *double* stars must be regarded as rather exceptional. The known double stars figuring in our lists thus represent a small fraction of the total number, the majority escaping from being observed on account of an unfavourable combination of angular separation, relative magnitudes and apparent magnitude. A part of the closest pairs inaccessible for direct observation reveals itself in the form of spectroscopic and eclipsing binaries, and the relatively high percentage of variable radial velocity among stars examined for this purpose [1]) seems to support our conclusions as to the total number of companions.

An average star may thus be regarded as analogous to a small cluster of 3—5 self-luminous members; the unit which is ordinarily counted in stellar statistics is such a cluster, not a single star; of course, in the majority of cases the companions are much less luminous — and, probably, also less massive — than the primary, so that the latter practically determines the physical properties (magnitude, spectrum, etc.) of the system.

g) *Comparison with T. P.* 25_5. The conclusions arrived at in our former paper from considering the luminosity-curve of a selected list of pairs are in their general features confirmed here. The conclusions were changed only in two points: 1) the *B*-dwarfs apparently show a distribution of relative magnitudes similar to the other dwarfs; 2) the giants show a distribution decidedly different from the distribution for the dwarfs. The chief cause of the mistake in *T. P.* 25_5 must be sought in the neglection of angular separation and difference of magnitude as a factor of selection; for the luminous *B*-stars and giants this neglection should be of especially conspicuous consequences, as the angular separation in the moving *B*-type pairs is the smallest for the same apparent magnitude among all spectra, and a consi-

---

1) The Victoria observers find that 25 % of stars examined are spectroscopic binaries, the percentage for the B-stars approaching 50. *Publications of the Dominion Astrophysical Observatory.* Vol. I № 26.

derable percentage of giant pairs possess, according to the present investigation, great Δm, whence an underestimate of the corresponding coefficients of selection must have resulted.

8. Summary of Results and Conclusions.

1. In table 1 a list of double and multiple stars containing about 1850 entries is given. The magnitudes of the components are reduced to the photometric scale with the aid of systematic corrections applied to the estimated difference of magnitude.

2. Tables 4, 5 and 6 furnish a means for converting estimates of the difference of magnitude made by different observers into photometric magnitudes; these tables are derived only from pairs where the primary is a naked-eye star, but as a first approximation they may be used for fainter pairs also.

3. The *selection* of the list is discussed and probable numerical values for the *completeness* of the data are determined.

4. From 1216 physical or probably physical companions the distribution of the relative distances and magnitudes is derived and discussed, different spectral classes being treated separately. The final results for the distribution are contained in tables 30, 31, 32, 33, 38, 39.

5. The projected density of companions around the primary varies nearly as the inverse *square* of the projected distance; the true (spacial) density must vary inversely to the *cube* of the distance.

6. The deviations from the inverse-square law in the distribution of distances are of a similar character for all classes of spectrum and absolute magnitude [1]), which implies the existence of a general statistical law governing the origin of companions. The character of the distribution is such that similar maxima correspond to greater distances for stars of greater mass. This is quite contrary to what should be expected if the spectra presented a continuous series of evolution, the "later" types originating directly from the "earlier" ones with a corresponding *change in the average mass.*

7. The distribution of the *relative luminosities* of close companions (proj. distance $<$220 astr. units), or of the *absolute*

1) Supergiants excluded.

luminosities of distant companions (proj. distance $>$ 220 astron. units) shows remarkable similarity for stars of the dwarf series from *B* to *K*, whence the similarity of origin may also be concluded. The close companions are likely to be originated by *fission*, whereas the distant companions represent apparently independent nuclei in the cosmic cloud from which the system is believed to have developed. A capture theory of the distant companions appears highly improbable, of the close companions — impossible.

8. From the discussion of the distribution of relative magnitudes and distances the following conclusions regarding stellar evolution may be drawn:

a) *if evolution exists,* the change in the absolute magnitude for a star, at present brighter than absolute magnitude $+1$ (visual, $\pi = 1''$), cannot exceed 1 stellar magnitude since its "origin", i. e. since the moment when the companions of double stars were formed; the observed range in the absolute magnitude being much greater, it follows that almost the same variety in the absolute magnitudes and spectra as observed at present must have existed since the origin of the stars and that this variety must chiefly be attributed to the initial conditions, e. g. to the difference in the mass, evolution accounting for only a small fraction of the observed difference in luminosity and spectral characteristics;

b) nevertheless a slight increase of the *age* with the advancing spectral type among the dwarfs is indicated by the relative displacement of the luminosity-curves of close companions; the best agreement with the observational data is obtained for the hypothesis of *periodical evolution*[1]) with the *radioactive law of cooling* and catastrophes occurring *independently* for the companions of a binary[2]);

c) a *stationary state* of the stars, without any evolution, appears less probable but not altogether impossible;

d) gravitational contraction as a source of stellar energy, or as a factor determining the character of stellar evolution may

1) Compare *T. P.* 25_2.

2) i. e. when the principal star undergoes a catastrophe like the phenomenon of a *Nova*, a companion at a distance from 3.5 to 220 astron. units will be influenced only superficially, its heat-radiation regaining after the catastrophe the value which it possessed before the catastrophe.

be entirely neglected; no facts in favour of this theory can be found.

9. *Multiple* stars seem to represent the general rule in our stellar universe, the probable number of companions brighter than absolute magnitude $+8\,(\pi = 1'')$ being from 3 to 4 for one average star. The majority of them cannot, however, be observed visually.

10. The luminosity-curve of companions to giant stars differs decidedly from the corresponding luminosity-curve of dwarfs, the giants having a very small number of bright companions and a relatively high number of faint ones.