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COMMUNICATION FROM THE OBSERVATORY AT LEIDEN

## Red magnitudes of 160 bright parallax stars, by *J. G. Ferwerda.*

*Program.* The great majority of the stars contained in this photometry have a large parallax. As the magnitudes have been determined visually and the red filter used absorbs rather much light the program had to be limited to the brighter stars. The limits of the program are as follows:

declination $> -20°$,

stars brighter than $6^m.4$ approximately,

trigonometric parallax $> ''.050$;

moreover stars with trigonometric parallax smaller than $''.050$ as far as the probable error is less than one tenth of the value of the trigonometric parallax have been included. For the stars of spectral types B and M the limit of the parallax (mainly spectroscopic) is $''.015$. Finally the bright members of the Ursa Major group were included in the program.

The stars were chosen from the card-system of parallaxes at the Observatory, which has been compiled by G. P. Kuiper, (the catalogue of F. Schlesinger had not yet appeared at that time) and further from the lists in *Mt. Wilson Contributions* **12**, 99, 1923 and **14**, 311, 1926.

As comparison stars 26 stars with Harvard spectrum A0 were selected (see Table 1; nos. 12 and 16 are omitted because they have not been used).

*Instrument.* The measurements have been performed in the years 1933–1935 with the aid of a photometer designed by K. Graff. The principle of the instrument is the same as that given in Graff's description [1]) except that there is no transversal eye-piece. For the purpose of photometry in the red the blue filter in front of the lamp has been removed and a red filter (RG1, thickness 2.0 mm, of Schott & Gen., Jena) was inserted between the mirror and the eye-piece. The photometer was attached to the 6-inch Merz refractor.

TABLE 1.

List of comparison stars

| No. | name | α (1900) | δ (1900) | $m_{vis}$ Potsdam |
|---|---|---|---|---|
| | | h m | ° ′ | m |
| 1 | BD + 63° 265 | 1 52.2 | + 64 08 | 5.59 |
| 2 | ξ² Cet | 2 22.8 | + 08 01 | 4.48 |
| 3 | ν Tau | 3 57.8 | + 05 43 | 4.20 |
| 4 | λ Per | 59.1 | + 50 05 | 4.51 |
| 5 | μ Lep | 5 08.3 | − 16 19 | 3.55* |
| 6 | 136 Tau | 47.0 | + 27 35 | 4.84 |
| 7 | 13 Mon | 6 27.5 | + 07 24 | 4.73 |
| 8 | γ Gem | 31.9 | + 16 29 | 2.34 |
| 9 | BD + 50° 1460 | 7 36.5 | + 50 40 | 5.58 |
| 10 | δ Hya | 8 32.3 | + 06 03 | 4.38 |
| 11 | 26 UMa | 9 28.0 | + 52 30 | 4.78 |
| 13 | 60 Leo | 10 57.0 | + 20 43 | 4.62 |
| 14 | η Vrg | 12 14.8 | − 00 07 | 4.25 |
| 15 | 21 CVn | 13 14.0 | + 50 12 | 5.40 |
| 17 | γ CrB | 15 38.5 | + 26 37 | 3.98 |
| 18 | λ Oph | 16 25.9 | + 02 12 | 3.98 |
| 19 | γ Oph | 17 42.9 | + 02 45 | 4.10 |
| 20 | δ UMi | 18 04.5 | + 86 37 | 4.68 |
| 21 | γ Lyr | 55.2 | + 32 33 | 3.55 |
| 22 | θ Aql | 20 06.1 | − 01 07 | 3.62* |
| 23 | σ Aqr | 22 25.4 | − 11 11 | 5.18* |
| 24 | ρ Peg | 50.2 | + 08 17 | 5.08 |
| 25 | κ And | 23 35.5 | + 43 47 | 4.44 |
| 26 | 2 Cet | 58.6 | − 17 54 | 4.91* |

*) HR magnitude, reduced to Potsdam system.

*The effective wavelength* of the measurements has been determined with the aid of the 10-inch refractor and a grating placed in front of the objective. The distance between the spectra of the fifth order of α Lyrae (A0) was measured with the micrometer. The resulting effective wavelength is 625 mμ. From the distance between the spectra of the third order it was found to be 629 mμ. Similar measures were made of the third order spectra of β Pegasi (M2). These gave the value 632 mμ. The weighted mean value 628 mμ (with weights 5, 3 and 3 respectively) was adopted as the effective wavelength of the photometry with neglection of the difference in effective wavelength for different spectral classes.

[1]) K. Graff, „Ein einfaches Universalphotometer für astrophysikalische Zwecke." *Ztschr. Instr.kunde* **35**, 1, 1915.

*The measurements.* Every star of the program has been measured on four different nights. During each night of observation the stars to be measured were taken together into groups. Each group was chosen in connection with one of the comparison stars and contains stars of the program in the neighbourhood of that special comparison star. The stars of one group were measured with time intervals as short as possible, but in such a way that the adjoined comparison star was measured immediately before each star of the group and also at the end of the group.

Every measurement consisted of four consecutive settings and readings of the wedge. During these settings the refractor had such a direction that the star and the artificial star could be seen on a horizontal line. Two settings were made with the artificial star at the right, two with the artificial star at the left.

It appeared that results of sufficient accuracy could only be obtained with a small magnification of the refractor (a magnification of about 20 was used). The eye proved namely to be extremely sensitive to small differences in shape between the images of the star and the artificial star, still more than in ordinary visual photometry. This might be explained by the fact that in the retina mainly the cones are sensitive to red light, thus obliging the observer to fix the images sharply.

It also appeared that the eye becomes tired very soon from observing the red light and that it looses within 20 seconds its power to distinguish small differences in brightness. This difficulty was removed by alternating rapidly the observations with the right and the left eye (changing about every 5 seconds) until the images were seen equally bright with both eyes.

In the case of a double star both components were measured, provided they were sufficiently separated and bright enough to be seen. For some stars the separation was too small to measure both components accurately. These stars have been omitted from the program. In all other cases one star image was seen and measured. For double stars with a separation less than 5″ the resulting red magnitude (marked with a colon in Table 2, column 8) may be considered as the total brightness, for separations more than 10″ as the magnitude of the brighter component. There is only one star in the program with a separation between 5″ and 10″ ($\alpha$ Gem) and in this case there is some uncertainty as to the meaning of the observed magnitude (marked with a double colon in Table 2, column 8) but it is considered best to assume that in this case the total brightness has been measured.

*The reduction.* The readings were reduced to provisional magnitudes with the aid of a calibration of the wedge made visually (without red filter) by G. P. KUIPER on a sequence of stars in the Pleiades. The calibration was repeated by the writer in red light by measurement of the intensities of the ordinary images of some stars as well as the central and spectral images obtained by placing a grating in front of the objective. It is in good agreement with KUIPER's calibration.

Because the comparison star was measured several times in each group it could be checked to some degree that no serious changes occurred in the instrument during the measurement of a group. In some cases the measurements of the comparison star showed a rather regular run. This run proved to be caused by a slowly appearing condensation of water vapour on the objective. A correction has been applied for this effect.

The corrections for extinction have been computed on the assumption of a transmission coefficient of ·830 for all observations. This value was taken from the tables of MÜLLER and KRON [1]) at a time when the effective wavelength had not yet been measured. The true value may be somewhat smaller but the errors in the corrections are negligible. The correction for differential extinction amounts to $^{m}$·20 or more in less than 5% of the material only.

From the corrected differences in magnitude between the stars and the adjoined comparison stars the definitive red magnitudes have been obtained on the assumption that the red magnitudes of the comparison stars are equal to the Potsdam visual magnitudes. For four comparison stars viz. nos. 5, 22, 23 and 26, not occurring in the Potsdam photometry on account of their low declination, the HR magnitudes have been taken after application of a correction [2]) to reduce them to the Potsdam system of magnitudes.

The results are given in Table 2. Columns 1 to 7 are self-explanatory. Column 8 gives the red magnitudes obtained in each of the four measurements. Column 9 gives the current numbers of the comparison stars used in these four measurements and column 10 gives the red magnitude definitively adopted, being the arithmetical mean of the values in column 8.

*Discussion of errors.* The internal mean error has been computed according to the formula

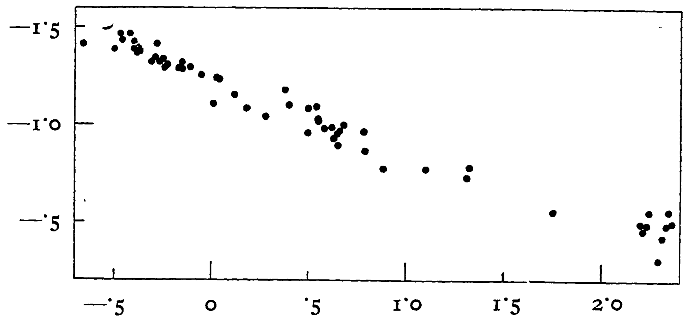
$$\text{m.e.} = \pm \sqrt{\frac{\Sigma \Delta^2}{3n}},$$

where $\Delta$ means the difference between each of the

[1]) G. MÜLLER, „Die Extinktion des Lichtes in der Erdatmosphäre usw.". *Publ. des Astroph. Obs. Potsdam,* Bd. **22,** Nr. 64, 1912.

[2]) *Publ. des Astroph. Obs. Potsdam,* Bd. **17**, p. XXXIV.

FIGURE 1.




abscissa: $m_{pg}$ (Leiden) minus $m_{red}$ (Leiden)
ordinate: HALL's colours 87

four single measurements obtained at different nights and their mean value, and where $n$ indicates the number of stars. The mean error has been computed separately for seven intervals of the red magnitudes. The values derived are:

| magnitude | $n$ | m.e. |
|---|---|---|
| 1 | 8 | ± ᵐ·16 |
| 1—2 | 5 | ± ·12 |
| 2—3 | 18 | ± ·12 |
| 3—4 | 35 | ± ·10 |
| 4—5 | 46 | ± ·11 |
| 5—6 | 44 | ± ·11 |
| >6 | 4 | ± ·12 |
| all | 160 | ± ·112 |

The internal mean error of a mean value as given in Table 2, column 10, is therefore ± ᵐ·056.

TABLE 2.

| HR | PGC | name | $m_{vis}$ Potsdam | π SCHLESINGER | M Potsdam system | Sp. Mt Wilson | measurements | | | | comp. stars | | | | $m_{red}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | 9 | | | | 10 |
| 8 | 6 | BD + 28°4704 | 6·39 | ″·078 | + 5·8 | G8 | 5·89 | 5·87 | 6·08 | 5·78 | 2 | 2 | 2 | 24 | 5·90 |
| 21 | 12 | β Cas | 2·56 | ·071 | + 1·8 | F2 | 2·48 | 2·35 | 2·41 | 2·46 | 1 | 1 | 1 | 1 | 2·42 |
| 33 | 22 | 6 Cet | | ·062 | (+ 4·2) | F5 | 4·89 | 4·95 | 4·92 | 5·08 | 26 | 26 | 26 | 26 | 4·96 |
| 166 | 133 | 54 Psc | 6·08 | ·104 | + 6·2 | K1 | 5·58 | 5·70 | 5·67 | 5·72 | 2 | 2 | 2 | 24 | 5·67 |
| 219 | 168 | η Cas | 3·72 | ·182 | + 5·0 | F9 | 3·32 | 3·48 | 3·40 | 3·38 | 1 | 1 | 1 | 1 | 3·40 |
| 222 | 171 | BD + 4°123 | 5·98 | ·148 | + 6·8 | K4 | 5·50 | 5·29 | 5·28 | 5·32 | 26 | 2 | 2 | 2 | 5·35 |
| 235 | 181 | 19 Cet | | ·063 | + 5·4 | F9 | 5·08 | 5·28 | 5·16 | 5·18 | 26 | 26 | 26 | 2 | 5·18 |
| 244 | 189 | BD + 60°124 | 5·06 | ·064 | (+ 4·1) | F8 | 4·83 | 4·77 | 4·94 | 4·74 | 1 | 1 | 1 | 1 | 4·82 |
| 321 | 244 | μ Cas | 5·32 | ·130 | + 5·9 | G4 | 5·09 | 5·27 | 5·01 | 5·09 | 1 | 1 | 1 | 1 | 5·12 |
| 337 | 259 | β And | 2·32 | ·044 | (+ ·5) | M0 | 1·70 | 1·67 | 1·99 | 1·75 | 1 | 2 | 2 | 2 | 1·78 |
| 458 | 350 | ν And | 4·28 | ·061 | + 3·2 | G0 | 4·12 | 3·98 | 4·08 | 4·09 | 1 | 2 | 2 | 2 | 4·07 |
| 483 | 372 | BD + 41°328 | 5·29 | ·087 | + 5·0 | G0 | 4·91 | 4·61 | 4·95 | 4·90 | 1 | 2 | 2 | 2 | 4·84 |
| 493 | 382 | 107 Psc | 5·56 | ·132 | + 6·2 | G9 | 5·10 | 4·75 | 4·92 | 5·00 | 2 | 2 | 2 | 2 | 4·94 |
| 509 | 391 | τ Cet | | ·301 | + 6·1 | G4 | 3·62 | 3·48 | 3·62 | 3·43 | 26 | 2 | 26 | 2 | 3·54 |
| 511 | 394 | BD + 63°238 | 5·82 | ·111 | + 6·0 | K0 | 5·60 | 5·65 | 5·51 | 5·51 | 1 | 1 | 1 | 1 | 5·57 |
| 542 | 419 | ε Cas | 3·64 | ·011 | (— 1·2) | B5 | 3·77 | 3·96 | 3·88 | 3·60 | 1 | 1 | 1 | 1 | 3·80 |
| 553 | 428 | β Ari | 3·02 | ·063 | + 2·0 | | 2·98 | 3·07 | 2·86 | 2·84 | 2 | 2 | 2 | 2 | 2·94 |
| 660 | 514 | δ Tri | 5·10 | ·098 | + 5·1 | G0 | 4·69 | 4·75 | 4·73 | 4·59 | 2 | 2 | 2 | 2 | 4·69 |
| 753 | 588 | BD + 6°398 | 6·16 | ·144 | + 7·0 | K4 | 5·50 | 5·41 | 5·59 | 5·41 | 2 | 2 | 3 | 2 | 5·48 |
| 799 | 617 | θ Per | 4·33 | ·078 | + 3·8 | F5 | 4·03 | 4·19 | 4·13 | 4·20 | 4 | 1 | 1 | 1 | 4·14 |
| 804 | 622 | γ Cet | 3·80 | ·040 | + 1·8 | A2 | 3·51 | 3·78 | 3·66 | 3·70 | 2 | 2 | 2 | 2 | 3·66 |
| 857 | | BD — 13°544 | | ·134 | + 6·8 | | 5·99 | 5·81 | 5·67 | 5·74 | 2 | 2 | 3 | 3 | 5·80 |
| 911 | 691 | α Cet | 2·89 | ·030 | (+ ·3) | M2 | 2·12 | 2·32 | 2·10 | 2·50 | 2 | 2 | 2 | 2 | 2·26 |
| 937 | 710 | ι Per | 4·22 | ·085 | + 3·9 | G1 | 3·99 | 4·08 | 4·07 | 4·03 | 2 | 4 | 1 | 1 | 4·04 |
| 962 | 722 | 94 Cet | | ·056 | + 4·0 | F8 | 4·89 | 5·09 | 4·97 | 4·79 | 2 | 2 | 2 | 2 | 4·94 |
| 996 | 752 | 96 Cet | 5·23 | ·106 | + 5·4 | G5 | 4·74 | 4·84 | 4·69 | 4·80 | 2 | 2 | 2 | 2 | 4·77 |
| 1084 | 814 | ε Eri | | ·305 | + 6·3 | K2 | 3·53 | 3·56 | 3·78 | 3·78 | 2 | 2 | 3 | 3 | 3·66 |
| 1101 | 825 | 10 Tau | | ·056 | + 3·2 | F9 | 4·19 | 4·16 | 4·31 | 4·17 | 2 | 2 | 3 | 2 | 4·21 |
| 1122 | 838 | δ Per | 3·31 | ·015 | (— ·8) | B5 | 3·42 | 3·48 | 3·34 | 3·37 | 4 | 1 | 1 | 1 | 3·40 |
| 1136 | 848 | δ Eri | | ·114 | + 4·0 | K0 | 3·16 | 3·26 | 3·42 | 3·33 | 2 | 2 | 3 | 3 | 3·29: |
| 1142 | 852 | 17 Tau | 4·01 | ·015 | (— ·1) | B7 | 3·98 | 4·09 | 4·17 | 4·13 | 6 | 3 | 3 | 4 | 4·09 |
| 1165 | 869 | η Tau | 3·09 | ·015 | (— 1·0) | B8 | 3·26 | 3·07 | 3·40 | 3·34 | 6 | 3 | 3 | 4 | 3·27 |
| 1178 | 877 | 27 Tau | 3·92 | ·015 | (— ·2) | B9 | 3·91 | 3·91 | 4·00 | 3·96 | 6 | 3 | 3 | 4 | 3·94 |
| 1231 | 915 | γ Eri | | ·022 | (— ·1) | M0 | 2·35 | 2·64 | 2·54 | 2·58 | 3 | 3 | 5 | 5 | 2·53 |
| 1262 | 939 | 39 Tau | 6·19 | ·080 | + 5·7 | G1 | 5·90 | 5·95 | 6·03 | 6·06 | 3 | 4 | 7 | 7 | 5·98 |
| 1325 | 984 | $o^2$ Eri | | ·202 | + 6·0 | K0 | 4·27 | 4·16 | 4·32 | 4·43 | 3 | 5 | 5 | 3 | 4·30 |
| 1457 | 1077 | α Tau | 1·15 | ·046 | — ·5 | K5 | ·50 | ·70 | ·76 | ·59 | 3 | 6 | 3 | 3 | ·64 |
| 1532 | 1132 | 58 Eri | | ·064 | (+ 4·8) | G1 | 5·50 | 5·19 | 5·39 | 5·17 | 3 | 3 | 5 | 5 | 5·31 |
| 1543 | 1140 | $\pi^3$ Ori | 3·50 | ·128 | + 4·0 | F5 | 3·54 | 3·43 | 3·37 | 3·44 | 6 | 3 | 3 | 3 | 3·44 |
| 1614 | | BD — 5°1123 | | ·105 | + 6·6 | K5 | 5·84 | 5·82 | 6·05 | 6·10 | 5 | 5 | 5 | 3 | 5·95 |
| 1708 | 1246 | α Aur | ·43 | ·071 | — ·3 | G1 | — ·04 | ·39 | ·14 | ·14 | 6 | 6 | 1 | 1 | ·16 |
| 1729 | 1259 | λ Aur | 4·83 | ·068 | + 4·0 | G0 | 4·65 | 4·68 | 4·59 | 4·50 | 6 | 6 | 1 | 1 | 4·60 |
| 1747 | | BD — 18°1051 | | ·061 | (+ 4·9) | | 6·01 | 6·02 | 5·74 | 5·83 | 5 | 3 | 5 | 5 | 5·90 |

TABLE 2 (continued).

| HR | PGC | name | $m_{vis}$ Potsdam | π SCHLESINGER | M Potsdam system | Sp. Mt Wilson | measurements | comp. stars | $m_{red}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1780 | 1294 | 111 Tau | 5·32 | ″·065 | + 4·4 | F8 | 4·97 5·02 5·08 4·96 | 6 6 7 7 | 5·01 |
| 1790 | 1303 | γ Ori | 2·06 | ·013 | (— 2·4) | B2 | 2·17 2·16 2·19 2·03 | 6 6 7 7 | 2·14 |
| 1791 | 1304 | β Tau | 2·01 | ·035 | (— ·3) | B9 | 2·11 2·17 2·04 2·05 | 6 6 7 7 | 2·09 |
| 1839 | 1331 | 32 Ori | 4·48 | ·011 | (— ·3) | B3 | 4·48 4·67 4·51 4·68 | 7 6 6 7 | 4·58 |
| 1910 | 1375 | ζ Tau | 3·29 | ·014 | (— 1·0) | B4 | 3·48 3·47 3·52 3·36 | 6 6 7 7 | 3·46 |
| 1925 | 1385 | BD + 53°934 | 6·42 | ·092 | + 6·2 | K1 | 6·13 5·97 5·94 6·09 | 6 6 1 1 | 6·03 |
| 2047 | 1461 | χ Ori | 4·65 | ·104 | + 4·7 | F9 | 4·42 4·33 4·44 4·45 | 9 7 6 6 | 4·41 |
| 2286 | 1604 | μ Gem | 3·06 | ·017 | (— ·8) | M3 | 2·53 2·72 2·51 2·62 | 9 8 7 6 | 2·60 |
| 2395 | 1666 | BD — 1°1274 | | ·008 | (— 5·1) | B3 | 5·43 5·35 5·20 5·61 | 7 6 6 7 | 5·40 |
| 2483 | 1724 | 56 Aur | 5·51 | ·065 | + 4·6 | F8 | 5·34 5·16 5·33 5·16 | 9 7 6 7 | 5·25 |
| 2491 | 1732 | α CMa | | ·375 | + 1·5 | A2 | —1·36 —1·12 —·77 —·88 | 8 8 8 8 | —1·03 |
| 2643 | 1809 | BD + 29°1441 | 6·16 | ·062 | + 5·1 | G2 | 5·94 6·10 5·86 5·87 | 9 8 7 6 | 5·94 |
| 2777 | 1898 | δ Gem | 3·69 | ·060 | + 2·6 | A8 | 3·66 3·73 3·67 3·63 | 9 8 7 6 | 3·67 |
| 2845 | 1944 | β CMi | 3·20 | ·025 | (+ ·2) | B9 | 3·35 3·13 3·24 3·10 | 7 10 7 6 | 3·20 |
| 2890 2891 | 1979 | α Gem | 1·94 | ·073 | + 1·3 | A2 | 1·71 1·80 2·07 1·88 | 8 8 8 8 | 1·86:: |
| 2905 | 1987 | ν Gem | 4·18 | ·016 | (+ ·2) | Mo | 3·59 3·68 3·75 3·64 | 9 7 7 6 | 3·66 |
| 2943 | 2008 | α CMi | ·72 | ·291 | + 3·0 | F3 | ·37 ·50 ·35 ·60 | 8 8 8 8 | ·46 |
| 2990 | 2031 | β Gem | 1·51 | ·100 | + 1·5 | G8 | ·81 1·01 ·91 1·05 | 8 8 8 8 | ·94 |
| 3064 | 2075 | 9 Pup | | ·060 | + 5·0 | G2 | 4·93 5·06 5·04 5·08 | 10 10 10 7 | 5·03: |
| 3259 | 2199 | BD — 12°2449 | | ·073 | + 5·4 | Ko | 5·71 5·91 5·75 5·88 | 10 10 10 7 | 5·81 |
| 3522 | 2380 | 55 Cnc | 6·19 | ·074 | + 5·5 | Ko | 5·85 5·81 5·96 5·74 | 11 10 10 13 | 5·84 |
| 3579 | 2413 | BD + 42°1956 | 4·12 | ·072 | + 3·4 | F2 | 4·33 4·30 3·68 4·05 | 11 11 10 13 | 4·09 |
| 3616 | 2441 | $\sigma^2$ UMa | 5·06 | ·053 | + 3·7 | F4 | 4·92 5·08 4·85 4·94 | 11 11 11 11 | 4·95: |
| 3648 | 2463 | 16 UMa | 5·40 | ·042 | + 3·5 | F9 | 5·30 5·11 5·23 5·05 | 11 11 11 11 | 5·17 |
| 3705 | 2507 | 40 Lyn | 3·38 | ·026 | (+ ·5) | Mo | 2·51 2·77 3·07 2·95 | 10 15 10 10 | 2·82 |
| 3759 | 2541 | $\tau^1$ Hya | | ·078 | + 4·4 / + 7·9 | F4 | 4·42 4·59 4·69 4·61 / 6·63 6·82 7·00 6·89 | 10 10 10 10 / 10 10 10 10 | 4·58 / 6·84 |
| 3815 | 2573 | 11 LMi | 5·66 | ·095 | + 5·6 | Ko | 5·41 5·15 5·32 5·27 | 10 13 13 10 | 5·29 |
| 3982 | 2698 | α Leo | 1·73 | ·041 | (— ·2) | B6 | 1·67 1·90 1·62 1·76 | 13 10 13 13 | 1·74 |
| 4039 | 2734 | 39 Leo | 6·02 | ·060 | + 4·9 | F3 | 5·74 5·52 5·57 5·74 | 13 10 13 13 | 5·64 |
| 4112 | 2785 | 36 UMa | 5·12 | ·082 | + 4·7 | F8 | 4·63 4·83 4·73 4·83 | 13 11 11 11 | 4·76 |
| 4141 | 2813 | 37 UMa | 5·36 | ·041 | + 3·4 | A9 | 5·08 5·23 5·16 5·21 | 15 15 15 15 | 5·17 |
| 4277 | 2920 | 47 UMa | 5·30 | ·073 | + 4·6 | Go | 4·84 4·90 4·93 4·90 | 13 13 13 13 | 4·89 |
| 4295 | 2930 | β UMa | 2·63 | ·043 | + ·8 | A2 | 2·72 2·81 2·52 2·54 | 15 15 15 15 | 2·65 |
| 4357 | 2972 | δ Leo | 2·92 | ·079 | + 2·4 | A2 | 2·65 2·82 2·60 2·89 | 13 13 13 13 | 2·74 |
| 4374 4375 | 2984 | ξ UMa | 3·92 | ·138 | + 4·6 | Go | 3·85 3·76 3·72 3·81 | 13 13 13 13 | 3·78: |
| 4496 | 3075 | 61 UMa | 5·58 | ·109 | + 5·8 | G6 | 5·20 5·07 5·23 5·15 | 13 13 13 11 | 5·16 |
| 4534 | 3101 | β Leo | 2·62 | ·076 | + 2·0 | A4 | 2·58 2·34 2·39 2·21 | 13 13 13 13 | 2·38 |
| 4540 | 3105 | β Vrg | 3·86 | ·101 | + 3·9 | F8 | 3·58 3·67 3·62 3·59 | 13 14 14 14 | 3·62 |
| 4554 | 3117 | γ UMa | 2·68 | ·039 | + ·6 | Ao | 2·73 2·79 2·63 2·73 | 15 15 15 15 | 2·72 |
| 4587 | 3137 | BD — 9°3413 | | ·074 | + 5·0 | G7 | 5·44 5·74 5·69 5·57 | 14 14 14 14 | 5·61 |
| 4660 | 3190 | δ UMa | 3·52 | ·041 | + 1·6 | Ao | 3·57 3·64 3·65 3·78 | 15 15 15 15 | 3·66 |
| 4785 | 3279 | β CVn | 4·46 | ·108 | + 4·6 | Go | 4·19 4·30 4·15 4·16 | 15 15 13 15 | 4·20 |
| 4845 | 3321 | 10 CVn | 6·25 | ·066 | + 5·4 | F9 | 5·91 5·99 5·86 5·94 | 15 15 13 15 | 5·92 |
| 4905 | 3363 | ε UMa | 2·16 | ·040 | + ·2 | | 2·02 1·95 2·14 2·11 | 15 15 15 15 | 2·06 |
| 4910 | 3367 | δ Vrg | 3·64 | ·022 | (+ ·4) | M3 | 2·92 3·21 3·01 3·14 | 15 14 14 14 | 3·07 |
| 4983 | 3424 | β Com | 4·45 | ·134 | + 5·1 | Go | 4·37 4·20 4·14 3·95 | 15 15 13 17 | 4·16 |
| 5011 | 3443 | 59 Vrg | 5·52 | ·074 | (+ 4·9) | F8 | 5·08 5·12 5·12 5·17 | 17 14 14 14 | 5·12 |
| 5019 | 3448 | 61 Vrg | | ·129 | + 5·4 | G6 | 4·99 4·68 4·71 4·62 | 14 14 14 14 | 4·75 |
| 5054 | 3474 | ζ UMa | | ·040 | + ·6 | A2 | 2·61 2·43 2·47 2·41 | 15 15 15 15 | 2·48 |
| 5055 | 3475 | | | | + 2·2 | A6 | 4·34 4·25 4·32 4·20 | 15 15 15 15 | 4·28 |
| 5056 | 3476 | α Vrg | | ·024 | (— 1·7) | B3 | 1·43 1·53 1·57 1·42 | 14 14 14 14 | 1·49 |
| 5062 | 3480 | g UMa | 4·18 | ·039 | + 2·1 | A1 | 4·22 4·19 4·03 4·32 | 15 15 15 15 | 4·19 |
| 5200 | 3572 | ν Boo | 4·07 | ·016 | (+ ·1) | Mo | 3·49 3·47 3·69 3·40 | 17 17 17 17 | 3·51 |
| 5340 | 3662 | α Boo | ·24 | ·085 | — ·3 | Ko | —·68 —·31 —·28 —·52 | 17 17 17 17 | —·45 |
| 5404 | 3704 | θ Boo | 4·38 | ·068 | + 3·5 | F6 | 4·03 3·88 4·06 4·00 | 17 15 15 17 | 3·99 |
| 5544 | 3798 | ξ Boo | 4·81 | ·147 | + 5·6 | G5 | 4·29 4·40 4·25 4·31 | 17 17 17 17 | 4·31: |
| 5553 | | BD + 19°2881 | 6·16 | ·084 | + 5·8 | K1 | 5·72 5·73 5·94 5·76 | 17 17 17 17 | 5·79 |
| 5618 | 3847 | 44 Boo | 4·95 | ·079 | + 4·4 | Go | 4·68 4·47 4·61 4·64 | 17 17 17 15 | 4·60: |
| 5634 | 3855 | 45 Boo | 5·24 | ·063 | + 4·2 | F4 | 4·58 4·74 4·78 4·91 | 17 17 17 17 | 4·75 |
| 5727 5728 | 3923 | η CrB | 5·24 | ·068 | + 4·4 | F9 | 4·68 4·74 4·70 4·87 | 17 17 17 17 | 4·75: |
| 5793 | 3961 | α CrB | 2·58 | ·038 | + ·5 | A1 | 2·45 2·38 2·37 2·46 | 17 17 17 17 | 2·42 |
| 5868 | 4010 | λ Ser | 4·62 | ·095 | + 4·5 | Go | 4·13 4·29 4·23 4·26 | 17 17 17 17 | 4·23 |

TABLE 2 (continued).

| HR | PGC | name | $m_{vis}$ Potsdam | π SCHLESINGER | M Potsdam system | Sp. Mt Wilson | measurements | comp. stars | $m_{red}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 5914 | 4042 | χ Her | 4·78 | ″·059 | + 3·6 | F7 | 4·33 4·38 4·47 4·44 | 17 17 17 17 | 4·40 |
| 5933 | 4055 | γ Ser | 4·07 | ·078 | + 3·5 | F5 | 3·69 3·81 3·71 3·71 | 17 17 17 17 | 3·73 |
| 6056 | 4134 | δ Oph | | ·031 | + ·5 | Mo | 2·09 2·23 2·18 2·32 | 18 18 18 18 | 2·20 |
| 6060 | 4137 | 18 Sco | | ·070 | + 4·9 | G1 | 5·60 5·44 5·45 5·46 | 18 18 18 18 | 5·49 |
| 6171 | 4222 | 12 Oph | | ·083 | + 5·5 | Ko | 5·57 5·54 5·53 5·48 | 18 18 18 18 | 5·53 |
| 6173 | | BD + 79°498 | 5·85 | ·067 | (+ 5·0) | | 5·56 5·79 5·72 5·83 | 20 20 20 20 | 5·72 |
| 6212 | 4246 | ζ Her | 3·16 | ·110 | + 3·4 | Go | 2·70 2·98 2·75 2·87 | 17 17 17 21 | 2·82: |
| 6281 | 4302 | ι Oph | 4·56 | ·014 | (+ 5·3) | | 4·56 4·38 4·59 4·55 | 18 17 21 21 | 4·52 |
| 6315 | 4322 | 19 Dra | 4·95 | ·065 | + 4·0 | F6 | 4·89 4·70 4·94 5·03 | 20 21 20 20 | 4·89 |
| 6458 | 4403 | 72 Her | 5·68 | ·076 | + 5·1 | G2 | 5·19 5·27 5·24 5·19 | 21 21 21 21 | 5·22 |
| 6516 | 4433 | BD — 0°3300 | | ·050 | + 3·9 | G6 | 5·49 5·13 5·15 5·19 | 19 19 19 19 | 5·24: |
| 6573 | 4470 | 26 Dra | 5·38 | ·066 | + 4·5 | G1 | 5·12 5·30 5·28 5·11 | 20 21 20 20 | 5·20 |
| 6623 | 4497 | μ Her | 3·62 | ·109 | + 3·8 | G4 | 3·29 3·23 3·43 3·32 | 21 21 21 21 | 3·32 |
| 6636 | 4504 | ψ Dra | 4·93 | ·048 | + 3·3 | F5 | 4·64 4·73 4·55 4·49 | 20 20 20 20 | 4·60 |
| 6637 | 4505 | | 6·02 | | + 4·4 | F6 | 5·92 5·96 6·05 5·85 | 20 20 20 20 | 5·94 |
| 6723 | 4552 | 68 Oph | 4·54 | ·029 | (+ 1·8) | B9 | 4·52 4·64 4·64 4·69 | 19 19 19 19 | 4·62 |
| 6752 | 4571 | 70 Oph | 4·12 | ·196 | + 5·6 | K1 | 3·98 3·93 3·84 3·97 | 19 19 19 19 | 3·93 |
| 6869 | 4638 | η Ser | | ·053 | + 2·1 | G8 | 3·30 3·12 3·34 3·21 | 19 19 19 19 | 3·24 |
| 6927 | 4672 | χ Dra | 3·75 | ·119 | + 4·1 | F5 | 3·66 3·59 3·76 3·66 | 20 20 20 20 | 3·67 |
| 7001 | 4722 | α Lyr | ·38 | ·121 | + ·8 | A1 | ·36 ·33 ·14 ·38 | 21 21 21 21 | ·30 |
| 7162 | 4815 | BD + 32°3267 | 5·36 | ·058 | + 4·2 | Go | 5·04 4·88 5·11 5·02 | 21 21 21 21 | 5·01: |
| 7260 | | BD + 16°3752 | 5·98 | ·059 | + 4·8 | G4 | 5·99 5·96 5·76 5·96 | 21 21 21 21 | 5·92 |
| 7373 | 4950 | 31 Aql | 5·32 | ·069 | + 4·5 | G7 | 5·03 4·99 4·79 5·00 | 21 21 21 21 | 4·95 |
| 7462 | 5009 | σ Dra | 4·87 | ·181 | + 6·2 | G8 | 4·50 4·62 4·60 4·63 | 20 20 20 20 | 4·59 |
| 7469 | 5014 | θ Cyg | 4·60 | ·067 | + 3·7 | F2 | 4·58 4·43 4·41 4·60 | 21 21 21 21 | 4·50 |
| 7534 | 5051 | 17 Cyg | 5·10 | ·045 | + 3·4 | F3 | 4·99 4·95 4·82 4·96 | 21 21 21 21 | 4·93 |
| 7557 | 5062 | α Aql | 1·12 | ·208 | + 2·7 | A1 | 1·05 ·98 ·88 ·86 | 22 21 21 21 | ·94 |
| 7602 | 5093 | β Aql | 3·82 | ·077 | + 3·2 | G8 | 3·70 3·63 3·68 3·68 | 22 21 21 21 | 3·67 |
| 7635 | 5118 | γ Sge | 3·83 | ·023 | (+ ·6) | Mo | 3·08 3·07 3·10 3·16 | 21 21 21 21 | 3·10 |
| 7672 | 5146 | 15 Sge | 5·72 | ·060 | + 4·6 | G1 | 5·88 5·62 5·74 5·92 | 21 21 21 21 | 5·79 |
| 7783 | 5219 | BD + 66°1281 | 6·18 | ·072 | + 5·5 | G1 | 6·03 5·97 6·06 5·95 | 20 20 20 20 | 6·00 |
| 7957 | 5346 | η Cep | 3·64 | ·069 | + 2·8 | G7 | 3·65 3·51 3·49 3·36 | 20 20 20 20 | 3·50 |
| 8028 | 5393 | ν Cyg | 4·10 | ·021 | (+ ·7) | B9 | 4·21 4·28 4·24 4·09 | 24 21 21 21 | 4·20 |
| 8085 | 5433 | 61 Cyg | 5·44 | ·299 | + 7·8 | K6 | 4·69 4·56 4·67 4·91 | 24 21 21 21 | 4·71 |
| 8086 | 5434 | | 6·09 | | + 8·5 | Mo | 5·44 5·48 5·55 5·46 | 24 21 21 21 | 5·48 |
| 8123 | 5455 | δ Equ | 4·68 | ·060 | + 3·6 | F3 | 4·58 4·36 4·68 4·29 | 22 21 21 21 | 4·48: |
| 8130 | 5460 | τ Cyg | 3·80 | ·050 | + 2·4 | Fo | 3·74 3·85 3·78 3·69 | 21 21 21 21 | 3·76: |
| 8162 | 5480 | α Cep | 2·78 | ·077 | + 2·2 | A3 | 2·77 2·73 2·87 2·56 | 20 20 20 20 | 2·73 |
| 8322 | 5600 | δ Cap | | ·065 | + 2·3 | A7 | 3·08 2·97 3·21 3·07 | 23 23 23 23 | 3·08 |
| 8430 | 5688 | ι Peg | 4·00 | ·077 | + 3·4 | F3 | 3·69 3·84 3·71 3·66 | 24 24 24 24 | 3·72 |
| 8518 | 5761 | γ Aqr | | ·047 | + 2·6 | | 3·94 4·12 4·20 4·22 | 23 23 23 23 | 4·12 |
| 8631 | | BD + 13°4971 | | ·032 | (+ 3·4) | G3 | 5·65 5·45 5·38 5·41 | 24 24 24 24 | 5·47: |
| 8698 | 5895 | λ Aqr | | ·017 | ( ·0) | M2 | 3·35 3·17 3·20 3·38 | 26 23 23 23 | 3·28 |
| 8729 | 5917 | 51 Peg | 5·48 | ·072 | + 4·8 | Go | 5·47 5·28 5·13 5·14 | 25 24 24 24 | 5·26 |
| 8762 | 5933 | ο And | 4·00 | ·012 | (— ·6) | B7 | 3·98 3·97 3·85 3·99 | 25 25 25 25 | 3·95 |
| 8775 | 5940 | β Peg | | ·025 | (— ·4) | M2 | 1·90 1·96 1·85 1·70 | 24 24 24 24 | 1·85 |
| 8795 | 5952 | 55 Peg | 4·62 | ·014 | (+ ·4) | M2 | 3·91 4·09 4·35 4·18 | 24 24 24 24 | 4·13 |
| 8832 | 5976 | BD + 56°2966 | 5·65 | ·146 | + 6·5) | K5 | 5·31 5·27 5·17 5·22 | 25 25 25 25 | 5·24 |
| 8834 | 5978 | φ Aqr | | ·018 | (+ ·7) | M2 | 3·81 3·62 3·72 4·13 | 26 23 23 23 | 3·82 |
| 8853 | 5989 | BD + 52°3410 | 5·74 | ·041 | + 3·8 | F7 | 5·77 5·58 5·40 5·57 | 25 25 25 25 | 5·58 |
| 8969 | 6077 | ι Psc | 4·28 | ·068 | + 3·4 | F5 | 4·16 4·10 4·18 4·15 | 24 24 24 24 | 4·15 |
| 8974 | 6078 | γ Cep | 3·43 | ·067 | + 2·6 | K1 | 3·21 3·24 3·27 3·21 | 25 25 20 20 | 3·23 |
| 9038 | 6129 | BD + 74°1047 | 6·48 | ·092 | + 6·3 | K5 | 6·01 6·15 6·35 6·01 | 25 25 20 20 | 6·13 |
| 9088 | 6172 | 85 Peg | 5·96 | ·086 | + 5·6 | G1 | 5·53 5·50 5·61 5·72 | 24 24 24 24 | 5·59 |

Absolute magnitudes in parentheses have a mean error exceeding ± $1^m\!\cdot\!0$.

Comparison of the present photometry (L) with the Potsdam visual photometry (P) yields:

$$m_P - m_L = - \cdot 006 \, (m_P + m_L - 7\cdot 27) + \cdot 222 \left(\frac{c_2}{T} - 2\cdot 61\right) + \cdot 229$$
$$\pm \cdot 005 \qquad \pm \cdot 015 \qquad \pm \cdot 014 \text{ (m.e.)}$$

(82 stars in common)

Comparison with BECKER's photometry in the red [1]) (B) gave:

$$m_L - m_B = - \cdot 010\,(m_L + m_B - 6{\cdot}95) + \cdot 196\left(\frac{c_2}{T} - 2{\cdot}64\right) + \cdot 417$$
$$\pm \cdot 030 \qquad\qquad \pm \cdot 039 \qquad\qquad \pm \cdot 029 \text{ (m.e.)}$$

(30 stars in common)

Finally a comparison of BECKER's photometry with the Potsdam photometry gave:

$$m_P - m_B = + \cdot 004\,(m_P + m_B - 7{\cdot}77) + \cdot 411\left(\frac{c_2}{T} - 2{\cdot}39\right) + \cdot 506$$
$$\pm \cdot 010 \qquad\qquad \pm \cdot 015 \qquad\qquad \pm \cdot 013 \text{ (m.e.)}$$

(141 stars in common)

The values of $\frac{c_2}{T}$ used are those given by E. HERTZSPRUNG [2]). There is no indication of any difference in scale between the three photometries.

From the residuals of the least squares solutions the following relations are found:

$$(\text{m.e. P})^2 + (\text{m.e. L})^2 = {}^{m^2}{\cdot}0150 \pm 23 \text{ (m.e.)}$$
$$(\text{m.e. L})^2 + (\text{m.e. B})^2 = \cdot 0278 \pm 73 \text{ (m.e.)}$$
$$(\text{m.e. B})^2 + (\text{m.e. P})^2 = \cdot 0235 \pm 28 \text{ (m.e.)}$$

Solving these three equations we get:

m.e. P $= \pm\, {}^{m}{\cdot}07$
m.e. L $= \pm\, \cdot 10$
m.e. B $= \pm\, \cdot 135$

These values are rather uncertain, their mean error may be estimated to be at least $\pm\, {}^{m}{\cdot}02$.

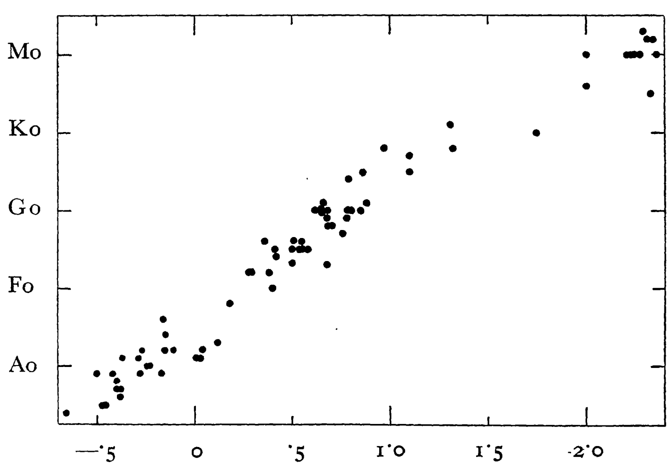
The red magnitudes have also been compared with J. S. HALL's [3]) photoelectric colour-indices. In Figure 1 the colours (87) given by HALL are plotted against the colour equivalents obtained by subtracting the Leiden red magnitudes from the Leiden photographic magnitudes determined by E. HERTZSPRUNG [4]). The relation is not strictly linear.

A comparison between the red magnitudes and the magnitudes obtained at the wavelength 629 mμ ($\frac{1}{\lambda} = 1{\cdot}589$) in the Göttingen spectral photometry [5]) (G) yielded:

$$m_L - m_G = + \cdot 023\,(m_L + m_G) - \cdot 034\,\frac{c_2}{T} + 2{\cdot}36$$
$$\pm \cdot 014 \qquad\qquad \pm \cdot 030 \quad \text{(m.e.)}$$

(15 stars in common)

FIGURE 2.




abscissa: $m_{pg}$ (Leiden) minus $m_{red}$ (Leiden)
ordinate: spectral class (Mount Wilson)

The colour equation as well as the difference in scale are negligible. From the least squares solution the value $\pm\, {}^{m}{\cdot}106$ was obtained for the mean error of a difference $m_L - m_G$. The mean error of a Leiden red magnitude cannot be much smaller than this, as the Göttingen magnitudes are very accurate.

Figure 2 shows the relation between spectrum (mainly Mt Wilson) and the colour equivalent Leiden photographic minus Leiden red.

1) *Ztschr. für Aph.* **9**, 79, 1934.
2) *B.A.N.* IX, 101, 1940.
3) *Ap. J.* **79**, 145, 1934.
4) *B.A.N.* I, 201, 1923.
5) H. KIENLE, H. STRASZL und J. WEMPE, *Ztschr. f. Aph.* **16**, 201, 1938.