MAGNITUDES AND COLOURS OF SOME MEMBERS OF THE PERSEUS CLUSTER

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Summary

Photoelectric colours and magnitudes have been determined for twenty-five stars considered to be members of the moving cluster in Perseus. A distance modulus of $6^{m}.83$, corresponding to a distance of 230 ps, has been derived. This value is nearly twice the value of 120 ps derived by Miss Roman and Morgan from the upsilon component of proper motion.

In a recent investigation, Miss Roman and Morgan (1) have examined the visual clustering around the F5 supergiant α Persei. They have shown that twenty-five stars of types B3 to A2 appear to share the space motion of the supergiant, and that a fair correlation exists between spectral type and apparent magnitude. The evidence provided by Roman and Morgan seems to favour the reality of this aggregate being a moving cluster.

Earlier, Smart and Ali (2) examined a list of 48 stars spread out over a large area of the sky and which had been ascribed to the moving cluster. They concluded " (*a*) that a considerable proportion of the stars in the so-called Perseus cluster cannot belong to a moving cluster, and (*b*) that a nucleus of stars remains which may possibly be regarded as a cluster formation ". Roman and Morgan comment that if α Persei, or some B stars of the visual clustering around the supergiant, had been considered as representatives of the group by Smart and Ali, the reality of this smaller group would have been easily noticed.

To settle the question of the existence of the Perseus moving cluster definitely, one would need reliable radial velocities and a homogeneous set of proper motions, which do not exist at present. Establishment of an accurate colour-magnitude array would decide whether the stars form part of a cluster. Whether they are members of a moving cluster can be determined only if a distance modulus (easily derivable from the colour-magnitude array) agrees, within the usual limits of tolerance, with that determined dynamically. In this paper a magnitude-spectral type diagram plotted from photoelectric data gives us a distance modulus for the cluster.

Twenty-five stars that were shown to be definite cluster members by Roman and Morgan have been included in this study. The photoelectric observations were made on three nights in 1952 September with the 12-inch refractor of Lick Observatory. The observational procedure and method of reduction are similar to those described in an earlier paper (3). Thirteen stars of this list have only one observation each. The consistency of the $P-V$ and V values derived for the remaining twelve stars indicates that there is no lack of observational accuracy in the colour and magnitude values derived from a single observation. One source

of error, however, may exist, and that is the recording of the sensitivity of the amplifier for the single observation. The Lick 12-inch photometer has gain-switch positions which change in steps of half a magnitude and, consequently, a mistake in recording will tend to alter the star's V value by $\pm 0^m{\cdot}5$, while $P-V$ value remains unchanged. The magnitudes obtained in this paper agree with those derived by Roman and Morgan without any serious discordances; thus such a source of error can scarcely exist. The tie-in with the (P, V) system was effected by nightly comparisons with C12, where the V values were those given by Eggen (4) and the $P-V$ values were revised values kindly supplied by Dr Kron in advance of publication. The probable errors for a final value of V and $P-V$ are the following:

$$P-V : \text{p.e.} = \pm 0^m{\cdot}008,$$
$$V : \text{p.e.} = \pm 0^m{\cdot}011.$$

Table I gives the magnitudes and colours of the cluster members investigated. The colour excesses have been computed by using the intrinsic $B-V$ colours of

TABLE I

Magnitudes and colours of members of the moving cluster in Perseus

Star	V	$P-V$	No. of obs.	Spectral type	E	V_{corr}	M
HD 20365	5·20	−0·20	2	B3 V	0·19	4·69	−2·1
HD 20418	5·08	−0·19	2	B5 V	0·16	4·63	−2·2
HD 20391	8·01	0·00	3	A1 V	0·14	7·62	+0·8
HR 1011	5·38	−0·20	2	B5 V	0·15	4·96	−1·8
HR 1029	6·13	−0·21	2	B6 V	0·12	5·79	−1·0
HR 1034	5·03	−0·22	3	B3 V	0·17	4·55	−2·2
HD 21375	7·55	−0·03	3	A1 V	0·11	7·24	+0·4
HD 21479	7·36	−0·05	2	A2 V	0·06	7·19	+0·4
34 Per	4·72	−0·24	2	B3 IV	0·15	4·30	−2·5
HR 1037	5·65	−0·19	2	B6 V	0·14	5·26	−1.5
HD 21481	7·70	−0·00	2	A0 V	0·17	7·22	+0·4
HR 1051	5·87	−0·17	2	B8 IV	0·10	5·59	−1·2
HD 20701	8·43	−0·03	1	A1 V	0·11	8·12	+1·3
HD 22401	7·50	−0·12	1	A0 V	0·05	7·36	+0·6
HD 20961	7·74	−0·03	1	A0 V	0·14	7·35	+0·6
HD 21091	7·60	−0·11	1	A0 V	0·06	7·43	+0·6
HD 21181	6·88	−0·13	1	B9 V	0·11	6·57	−0·2
HD 21398	7·44	−0·12	1	B9 V	0·12	7·10	+0·3
HR 1047	6·27	−0·01	1	B5 V	0·34	5·32	−1·5
HD 21641	6·77	−0·13	1	B9 V	0·11	6·46	−0·3
HD 21672	6·61	−0·16	1	B8 V	0·11	6·30	−0·5
HR 1063	5·53	−0·22	1	B8 III	0·05	5·39	−1·4
HD 21931	7·41	−0·11	1	B9 V	0·13	7·05	+0·3
ψ Per	4·27	−0·20	1	B5 e	0·15	3·85	−2·9
HD 22136	6·92	−0·15	1	B8 V	0·12	6·58	−0·2

Morgan, Harris and Johnson (5), converted to the $(P-V)$ scale. Fig. 1 is a plot of spectral type against observed colour. The absorption is non-uniform. In particular HR 1047 is highly reddened. But its membership in the cluster can scarcely be disputed, as will be seen from the colour-magnitude array in Fig. 2. Fig. 3 is a plot of spectral type against V, now corrected for absorption by subtracting $2{\cdot}8\times$ the colour excess (see col. 7 of Table I). The scatter among the stars in Fig. 3 is what we would expect for the main-sequence stars of early type. Most of the stars, therefore, do form a cluster.

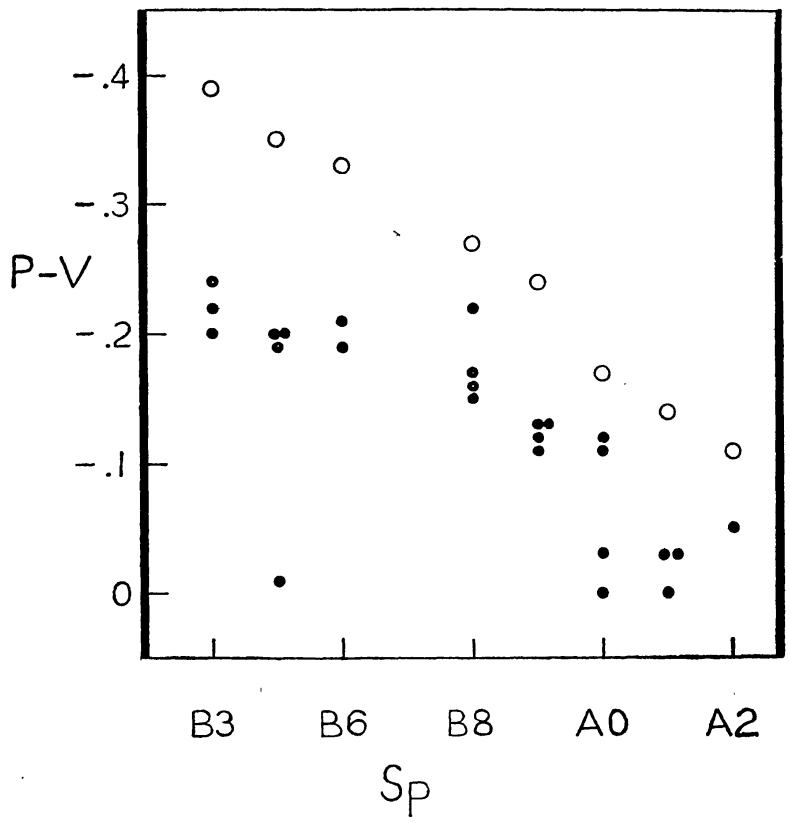

FIG. 1.—*Colour-spectral type diagram for members of the Perseus cluster. Open circles are intrinsic colours, while the observed colours are represented by filled circles.*

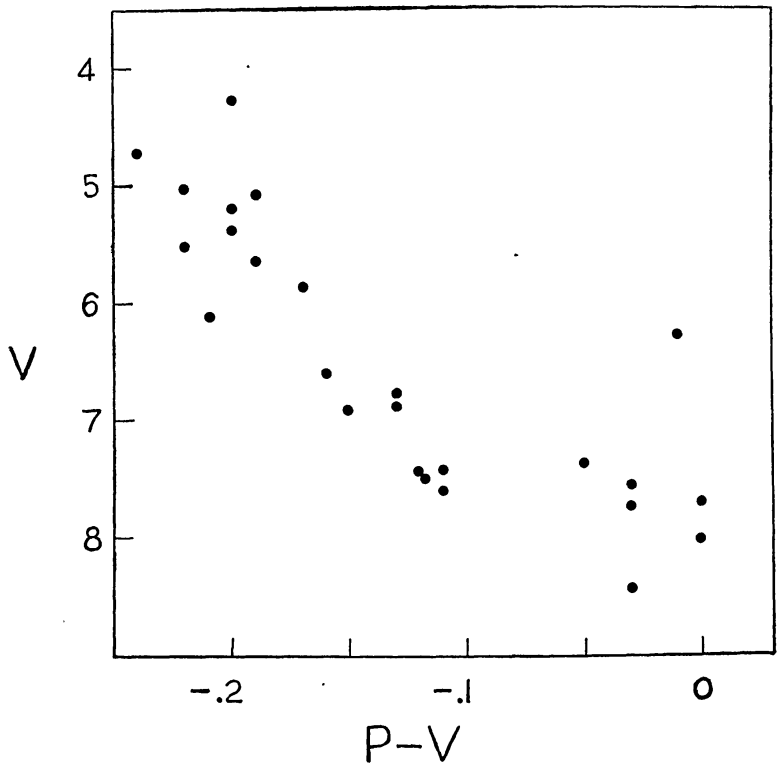

FIG. 2.—*Colour-magnitude array for members of the Perseus cluster.*

The distance moduli of the stars were next derived from the V magnitudes, corrected for absorption, and the absolute magnitudes of Keenan and Morgan (**6**). These absolute magnitudes have been corrected by $-0^m.1$ to bring them into accordance with the visual magnitudes used here. The mean distance modulus obtained from twenty stars of luminosity class V, with the exception of HD 20701, is $6^m.83$ (239 ps). HR 1063, which is classified as B8 III, has a distance modulus of $8^m.4$. If the classification of the star as a giant is correct, it cannot be considered a cluster member. The last column of Table I gives individual absolute magnitudes for the stars using the distance modulus $6^m.83$.

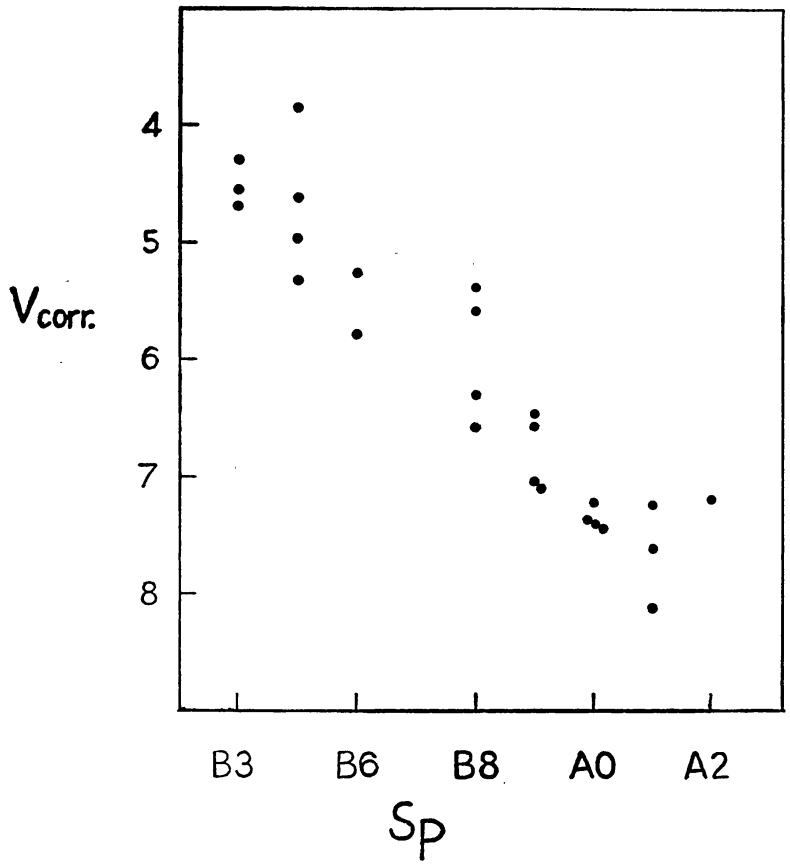

FIG. 3.—*Corrected visual magnitude-spectral type diagram for members of the Perseus cluster.*

The distance modulus obtained for the cluster by Roman and Morgan from dynamical considerations is $5^m.4$ (120 ps). The distance derived photometrically by me is thus nearly twice that derived from the proper motion data. It may be noted that Roman and Morgan derive the distance of 120 ps from the upsilon component of proper motion. The proximity of the convergent point to the solar antapex might very well introduce a large error in any distance derived by this means.

An interesting anomaly is the parallax of α Persei. The trigonometric parallax is $0''.029 \pm 0''.005$ (**7**) and using the corrected visual magnitude of Roman and Morgan, we get an absolute magnitude of -1.3, a value incompatible with its spectral characteristics. On the other hand, if we use the distance modulus as obtained in this study, the apparent magnitude, corrected for absorption, would have the low value of magnitude 2·2.

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