

PHOTOMETRY OF THE LOWER MAIN SEQUENCES OF NEARBY CLUSTERS

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Photoelectric photometry in *BVRI* colors has been obtained at the Kitt Peak National Observatory of many stars in the regions of the Hyades, Praesepe and Coma star clusters which had no previous photometry. The stars were limited mostly to the lower main sequence. Their range is approximately 0.6 to 1.5 (and to 1.7 in the Hyades) in *B-V* and 0.25 to 0.85 (and to 1.3 in the Hyades) in *R-I*. Their ranges correspond from mid G through early M in spectral class. The purpose of this project is to detect and examine the main sequences of the nearest open clusters. It continues the results reported earlier in this program for the Hyades cluster [Upgren (1974), Upgren and Weis (1977)] and extends them to include Praesepe and Coma as well, by means of the new sensitive gallium-arsenide photocells which permit fainter stars to be observed with moderate sized telescopes, especially in the *R* and *I* bands.

Unlike most earlier photoelectric observations of nearby clusters, this program concentrates on the lower main sequence, since only for the lower main sequence are parallaxes of field stars of sufficient number and precision for systematic effects to be evaluated and eliminated such that their main sequences can be compared to those of clusters. The linear main sequence in the *V, R-I* diagram is particularly useful in comparing the sequences of cluster and field stars [a full discussion will be found in Upgren (1978)].

In Coma, 90 stars were observed; their positions in the *V, B-V* and *V, R-I* diagrams indicate that perhaps four of them are members. The coverage of sky extends well beyond that of Argue and Kenworthy (1969) but confirms their conclusion that Coma has no distinct main sequence later than about spectral type G5. In Praesepe, 55 stars were observed which appear to be members on the basis of their proper motions, and only four are rejected as members on the

the basis of their proper motions, and only four are rejected as members on the basis of the photometry. The main sequence which the members define, shows a slope parallel to that of the Hyades and displaced by 3.0 mag indicating a distance modulus of 6.2 for Praesepe. No previous R, I photometry exists for this cluster. Two earlier photoelectric determinations of the modulus are those in UBV of Johnson (1957) and in $uvby\beta$ of Crawford and Barnes (1969). They found moduli of 6.0 and 6.1 mag, respectively, but they used the former value of 3.0 mag for the modulus of the Hyades. A correction of +0.2 mag is necessary since the Hyades modulus has been shown to be at least 3.2 mag by many studies and the main sequence of the nearby field stars requires a similar sized correction as found by Lutz and Kelker (1973). The correction brings the earlier modulus estimates into closer agreement with ours and indicates that the distance to Praesepe must be increased from about 160 pc to 180 pc. It is likely that the 0.2 mag correction has yet to be applied to other more distant clusters as well. The Praesepe observations are given by Upgren, Weis and DeLuca (1979).

The new photometry of the Hyades increases to 92 the number of members in the linear portion of the $V, R-I$ main sequence. More significantly, it shows that a recent study of the structure of the Hyades and its total mass (Pels, Oort, and Pels-Kluyver, 1975) is in need of revision, since a number of stars located on the Hyades main sequence were missed in the proper motion survey on which that study is based. Photoelectric observations are being extended to cover stars considered to be members in other proper motion surveys in order to obtain a more complete and definitive list of members than is now available.

REFERENCES

- Argue, A.N., and Kenworthy, C.M.: 1969, *Mon. Not. Roy. Astron. Soc.* 146, 479.
- Crawford, D.L., and Barnes, J.V.: 1969, *Astron. J.* 74, 818.
- Johnson, H.L.: 1957, *Astrophys. J.* 126, 121.
- Lutz, T.E., and Kelker, D.H.: 1973, *Pub. Astron. Soc. Pacific* 85, 573.
- Pels, G., Oort, J.H., and Pels-Kluyver, H.A.: 1975, *Astron. Astrophys.* 43, 423.
- Upgren, A.R.: 1974, *Astrophys. J.* 193, 359.
- Upgren, A.R.: 1978, in A.G.D. Philip and D.S. Hayes (eds.), *IAU Symp. 80: The H-R Diagram*, Reidel, Dordrecht, p. 39.
- Upgren, A.R., and Weis, E.W.: 1977, *Astron. J.* 82, 978.
- Upgren, A.R., Weis, E.W., and DeLuca, E.E.: 1979, *Astron. J.* (in press).

DISCUSSION

MERMILLIOD: Did you select the stars in Praesepe from the Klein-Wassink list?

UPGREN: Yes, almost entirely.

MERMILLIOD: And did you observe all faint stars in that list?

UPGREN: We used the gallium-arsenide tube with the 0.9-m telescope at Kitt Peak, which gave us a faint limit of about 15.2 in the visual. So the observing was mostly complete. I'm not saying we're totally complete. Certainly close to it, for the stars brighter than that magnitude in the visual.

KING: Just a quick comment. I feel very much chastened by your remarks; and I note that even in the very much higher accuracy work of Mcnamara and Saunders on M 11 they comment that a certain number of their high probability stars must be non-members statistically. So even, apparently, with high probabilities, you still get some non-members.

UPGREN: That's right.