STRÖMGREN PHOTOMETRY OF F-TYPE STARS IN M67 AND NGC3680

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Photoelectric uvby photometry has been obtained for about 30 F-type stars in each of the open clusters M67 and NGC3680. For some of the stars the H-beta index was also observed. The photometry was carried out with the Danish 1.5 m telescope at La Silla by the aid of a four-channel uvby photometer and a two channel H-beta photometer.

The stars were selected to cover the upper main sequence, the turn-off region, and the lower sub-giant branch. The corresponding range in magnitude is V = 14.5 to 12.0. The majority of the stars were observed on 3 different nights. The errors of the Strömgren photometric indices, b-y, m_1, c_1, and β are of the order of 0.01 magnitudes. The error of the V magnitude is 0.03.

By comparing the observed β,(b-y) values with the standard β,$(b-y)_0$ relation for nearby F-type stars (Crawford, 1975) an interstellar reddening of E(b-y) = 0.02 is found for M67 and E(b-y) = 0.03 for NGC3680. The corresponding reddening in B-V is E(B-V) = 0.03 for M67 and E(B-V) = 0.04 for NGC3680. The value for M67 is significantly lower than the value of E(B-V) = 0.06 found by Eggen and Sandage (1964) from the two-colour (U-B),(B-V) relation.

The metal abundance of the clusters are derived from the dereddened $(b-y)_0$ - m_0 diagram, using the calibration of this diagram in terms of [Me/H] by Nissen (1981). Both clusters are found to have a metal abundance very close to that of the Sun. The rms dispersion in [Me/H] is 0.10 only.

Having determined accurate values of the interstellar reddening and metal abundance for the clusters it is possible to make a detailed comparison of the colour-magnitude diagrams with theoretical isochrones. For M67 a very good fit is obtained to the shape of the isochrones of Hejlesen (1980) for Z = 0.02, including the position of the gab between the upper turn-off and the lower sub-giant branch. The age of M67 is found to be between 3 and $4 \cdot 10^9$ y, depending on the choice of the values of the mixing-length parameter, the helium abundance, and the zero-point

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for the calibration of (b-y) in terms of T_{eff}.

The stars in NGC3680 show a much larger dispersion in the $(b-y)_0 - V_0$ diagram than the stars in M67. The distribution tends to be bimodal with one sequence of stars around the isochrone corresponding to an age of $1.5 \cdot 10^9$ y and the other sequence around an isochrone corresponding to $2.5 \cdot 10^9$ y. The $c_0-(b-y)_0$ diagram of NGC3680 shows that this bimodal distribution cannot be explained in terms of binaries alone. Apparently other parameters - most likely rotation - have rather dramatic effects on the position of early F-type stars in the colour-magnitude diagram. A similar conclusion has recently been reached by Twarog (1983) from uvby-β photometry of the open cluster NGC752.

References

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DISCUSSION

R. Cayrel: Do you consider that the results you have reported settle for ever the question of the alledged supermetallicity of M67?

Nissen: The Strömgren $m_o-(b-y)_o$ diagram for M67 clearly indicates a solar metal abundance. Thus, at least in the case of the elements affecting m_1 (e.g. the iron-peak elements) M67 is not supermetal-rich.

Mermilliod: The peculiar aspect of the main sequence of NGC 3680 is probably related to the temperature of the cluster turn-up, which corresponds to the one of the F0-F5 gap described by Böhm-Vitense and Canterna, appearing at the onset of the convection in the atmosphere.

Janes: I will be reporting tomorrow on more M67 observations which are in excellent agreement with most of the results of this paper. In particular, I find a metallicity very close to that of the Sun.

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