ABSOLUTE MAGNITUDES AND INTRINSIC COLOURS OF NON-SUPERGIANT Be STARS*

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ABSTRACT. 101 normal Be stars, probable members of 56 galactic clusters and OB-associations, and more than 2o extreme Be stars in the Large Magellanic Cloud were used to derive intrinsic colours of O9-B9(III-V)e stars. Furthermore, the correlation between the intrinsic colour $(U-B)_o$ and the absolute magnitude of non-supergiant Be stars was confirmed to be

$M_V = 4.55 \cdot (U-B)_o + o^m.81$ for $< (U-B)_o < -o^m.53$

and $M_V = 1.18 \cdot (U-B)_o - o^m.98$ for $(U-B)_o > -o^m.53$.

The aim of the present investigation is to enlarge the basis for the determination of intrinsic colours and absolute magnitudes by providing a large sample from the southern sky.

The program stars were taken out of the catalogues of Wackerling (197o) and Jaschek et. al. (1971). Probable cluster membership was found by cross-checking with the Alter and Ruprecht catalogue of star clusters and associations (197o). Stars lying within two cluster radii of the center were regarded as possible candidates for membership. Additionally we have used all Be stars, which were regarded by other authors as members of clusters and associations. Some of these have been measured once more during this research. The objects of the northern hemisphere, which have been investigated in previous papers e.g. by Schmidt-Kaler (1964a,b,c), Schild (1966), Schild and Romanishin (1976) have also been included.

This research also included Be-supergiants of luminosity classes I-II, but these are not presented here. To obtain a sufficient sample I have observed Hα -emission-line stars in the Large Magellanic Cloud (LMC) compiled in a catalogue by Bohannan and Epps (1974). Besides the supergiants this catalogue may contain a bigger sample of dwarf B(III-V)e (dBe) stars earlier than B1, if we consider its limiting magnitude. The colour-colour diagram (figure 1) for the measured stars fainter than $V = 13^m$ makes visible a group of stars having an (U-B)-excess. Using the normal dereddening procedure we would obtain intrinsic colours above the values for O5 stars. These stars are according to their photometric appearance equivalent to the extreme Be stars as defined spectroscopically

M. Jaschek and H.-G. Groth (eds.), Be Stars, 33–36.

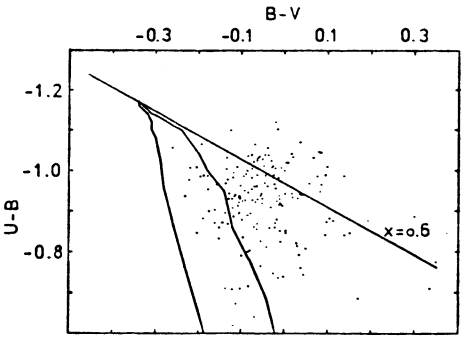

Figure 1. Two colour diagram for LMC emission-line stars with visual magnitudes V = 13^m - 15^m. The line of reddening for E_{U-B}/E_{B-V}= o.6o is plotted.

by Schild (1966). Taking into account the excesses given by Schild and Romanishin (1976) it is possible to deredden these stars which yields reasonable E_{B-V} values for the LMC. Moreover the assumption that these stars are extreme Be is consistent with the absolute magnitudes we derive after correcting the basic visual magnitudes for the distance modulus of the LMC $m_o - M_V = 18^m.6$ (Crampton, 1979). Looking at the brighter LMC stars which were measured, the percentage of these objects substantially reduces and disappears for stars with $M_V < -6^m$ completely. This is another hint that we deal partly with extreme dBe stars and that these objects are very well suited to investigate the intrinsic colours of the early Be stars.

The program stars in the galactic clusters and OB-associations have been measured during three observing runs in 1979 and 198o in the UBV system. For the analysis of the data I have taken mean reddenings $\overline{E}_{B-V}$ and distance moduli as given by Becker and Fenkart (1971) and Fenkart and Binggeli (1979). The values for the clusters not listed there were taken from the latest papers. Dereddening the stars with the corresponding E_{B-V} gives the colour-colour relation (figure 2) for the intrinsic colours of the dBe stars. It can easily be seen that most of the stars are lying above the main sequence. After calculating floating means we obtain relation 1 between $(B-V)_o$ and $(U-B)_o$ shown in this diagram. Relation 2 is derived from stars for which cluster membership seemed quite sure. Both graphs are very much alike and for further analysis we will use line 2. Both diagrams show the same behaviour for stars earlier than Bo as the main sequence, but this is defined mostly by stars in associations for which the mean reddening is not that reliable.

To get better accuracy for this part of the sequence we reduce the LMC stars, which have been characterized as extreme Be, with a mean $\overline{E}_{B-V} = o^m.o7$ given by Isserstedt (1975). For the bluest stars we obtain positions that lie somewhat above the turn-off point. After applying the excess values for extreme Be stars, they all lie on the main sequence with reasonable E_{B-V}'s. The adopted intrinsic colours for dBe stars in this part of the diagram are therefore to be modified for the extreme Be stars, which results in line 3. The higher dispersion for the data in this region is caused by a mixture of extreme and normal Be stars. But the upper end is completely dominated by extreme Be stars.

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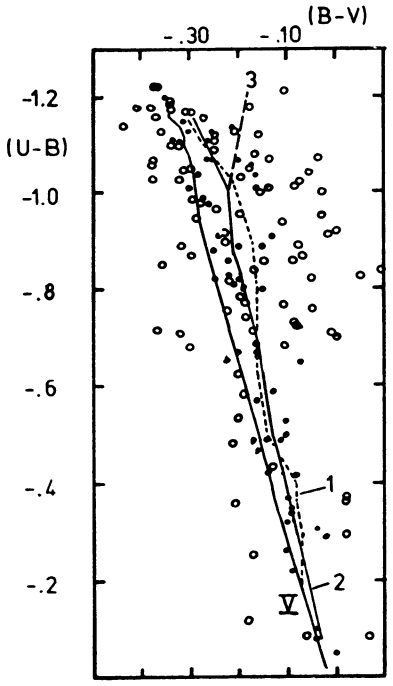

Figure 2. Two colour diagram for dereddened non-supergiant Be stars, probable members of galactic clusters and OB-associations. (Dots: the cluster membership for the Be star is quite sure; open circle: the cluster membership is uncertain.)

The last part of the paper concerns the correlation between the absolute magnitude M_V and the intrinsic colour $(U-B)_o$. For this purpose we take first the values dereddened by $\overline{E}_{B-V}$ and correct for the distance modules, and second we use the relation 2 to deredden each star individually and then correct for its distance (figure 3) and then compare both values of absolute magnitude, which do not differ substantially.

$$M_V = 4.55 \cdot (U-B)_o + 0^m.81 \qquad \text{for} \qquad (U-B)_o < -0^m.53$$

and $$M_V = 1.18 \cdot (U-B)_o - 0^m.98 \qquad \text{for} \qquad (U-B)_o > -0^m.53 \ .$$

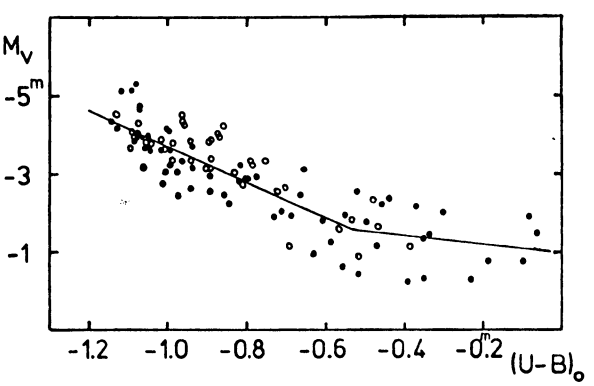

Figure 3. The absolute magnitude M_V is plotted as a function of the intrinsic colour $(U-B)_o$ for non-supergiant normal Be stars, probable members of galactic clusters and OB-associations. (Dots: own measurements; open circles: data given by other authors.)

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For early type stars the mean deviation is about $\pm$ $0^{m}.80$. The later type Be's show worse correlation, but we should not forget that this is also because we have less data for this part of the relation. Uncertain distances of clusters contribute essentially to the presented dispersion.

The analysis for the Be stars of luminosity class I-II in the LMC is under way. Additional measurements in both Magellanic Clouds and a comparison to the few galactic Be supergiants, which have been discovered in clusters,is intended. As Iam limited by time, it is not possible to give a full presentation of all data here.

*Based on observations obtained partly at the European Southern Observatory, La Silla.

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