COMPOSITE COLOUR-MAGNITUDE AND COLOUR-COLOUR DIAGRAMS FOR Be STARS IN OPEN CLUSTERS

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By the end of 1980, the total number of Be stars discovered in the field of open clusters amounted to 180 stars distributed in 60 clusters. Among these, 110 Be stars belong to 32 clusters included in the sample I studied, which contains 75 open clusters younger than the Hyades. But only 88 stars with complete *UBV* photoelectric photometry have been taken into consideration here. The concept of age groups, defined elsewhere (Mermilliod 1981a), is used throughout the present analysis, as well as the new estimate of the colour excesses and distance moduli I obtained for these 32 clusters. Under the assumption of uniform reddening across the clusters, absolute magnitudes and dereddened colour indices have been calculated for the 88 Be stars.

Fig. 1 shows a composite M_V vs $(U-B)_o$ diagram. The lower sequence is the ZAMS (Mermilliod 1981b) and the upper dashed one is the theoretical TAMS from models with overshooting in the core (Maeder and Mermilliod 1981). The four curves represent the empirical time-lines I determined for the so-called NGC 884, 457, 3766 and Pleiades age groups. Close examination of my individual and composite diagrams shows that the Be stars do not occur at random on the main sequence. Several classes and sub-classes have been distinguished according firstly to the ages of the parent clusters and secondly to the location in the colour-magnitude diagram. They are represented by various symbols in fig. 1:

a) B8.5-A2 stars: mostly shell stars ("+")

b) B3-B8e stars: they occur at three different places:

   1) on the main sequence, at M_V=-0.5 $\pm$ 0.5, and spectral type B8 ("o"),
   2) near the termination of the main sequence ("x"),
   3) in the position of blue stragglers.

c) B1-B2e stars: three sub-classes are distinguished:

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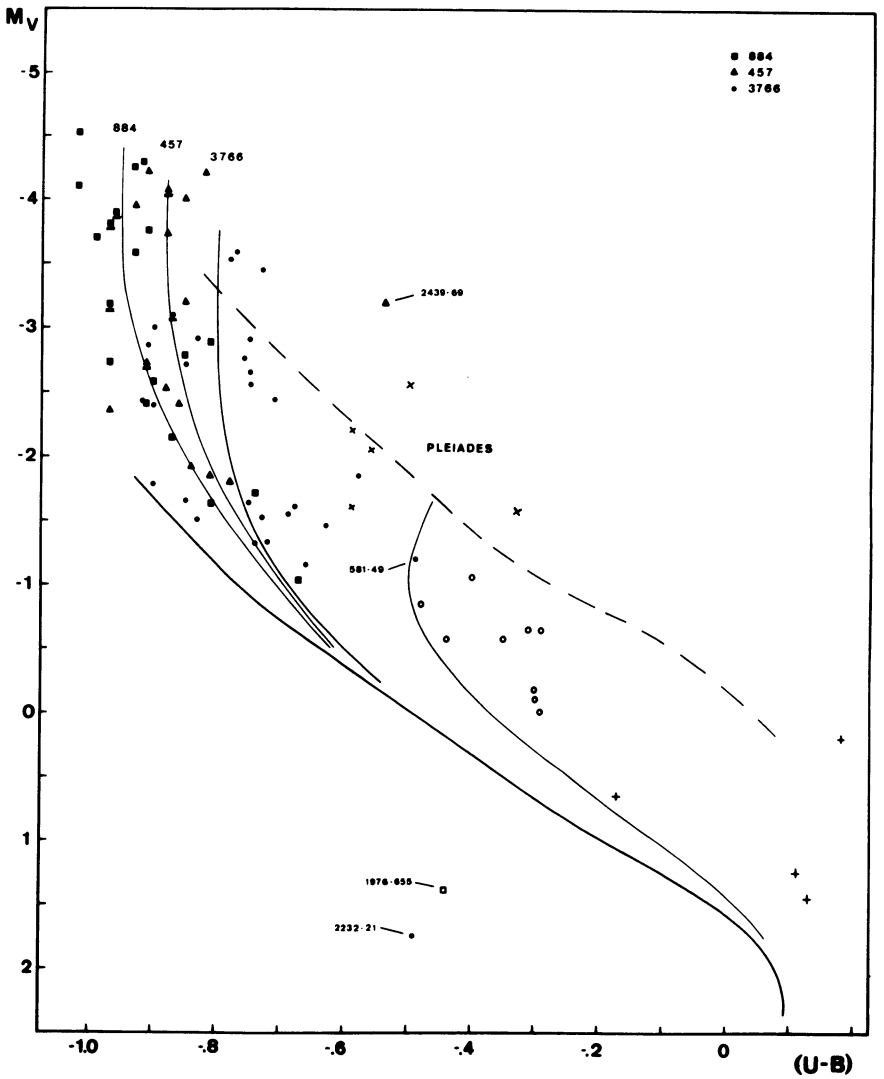

Fig. 1 Composite colour-magnitude diagram for Be stars in open clusters. Curves and symbols are explained in the text.

1) the nearly unevolved stars: $M_V > -2$,
2) the semi-evolved stars: $-3.25 < M_V < -2.25$,
3) the stars near the TAMS: $M_V < -3.5$.

The B1-B2e stars present a strong frequency maximum, which reaches 34% in NGC 663 (Sanduleak 1979). The earlier O-BOe stars are much less frequent.

These classes are closely related to the spectroscopic groups

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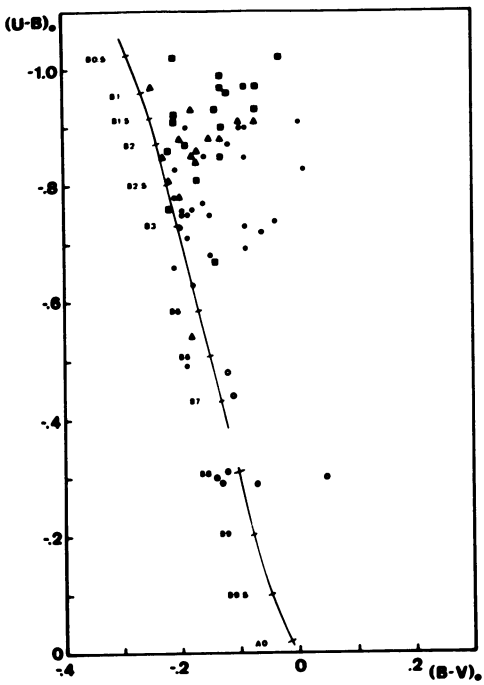

Fig. 2 Colour-colour diagram for Be stars in open clusters. The interstellar reddening has been subtracted.

formed by Jaschek et al. (1980). This results in establishing a connection between the location of the Be stars in the HR diagram and their spectroscopic properties.

Fig. 2 shows the distribution of the Be stars "intrinsic" colours (interstellar reddening subtracted) in the *UBV* plane. It is similar to the figure obtained by Feinstein and Marraco (1979) for bright field Be stars. The analysis of this diagram confirms that the colours of the B1-B2e stars are different from those of the normal stars of similar spectral type: *B-V* is redder while *U-B* is bluer. Although the hypothesis that the pseudo-reddening depends on both the stars' orientation and the envelope density appears as a tempting one, an application of the models of Poeckert and Marlborough (1978) is not straightforward.

Much more data on *V*sin*i*, emission-line strength and photometry for stars in open clusters are badly needed to refine and extend the present picture.

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DISCUSSION

Houziaux: How do you determine intrinsic colours of the Be stars?

Mermilliod: Intrinsic colours have been determined by using the B-V colour excesses estimated for the parent clusters. The assumption of uniform reddening seems to be justified in most cases.

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