THE log L/log T_e DIAGRAM FOR INTERMEDIATE MASS POP I RED GIANTS

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1. INTRODUCTION

The best empirical evolutionary tracks are provided by open cluster HR diagrams. The scarcity of giants in young clusters implies that diagrams of clusters having similar ages and metallicities have to be summed. Using UBV data, Mermilliod (1981a) has divided the nearby open clusters into 14 age groups, and has described the properties of the composite diagrams M_v/(B-V) and M_{bol}/log T_e. Several features complicate the structure of composite HRD, namely the presence of double stars which often mimic extended blue loops and the contamination by non-member stars difficult to identify as such in distant clusters. In order to refine the red giant observed evolutionary properties, cluster giants have been remeasured in the Geneva photometry and with the spectrovelocimeter CORAVEL.

2. THE PHOTOMETRY

For the present analysis 179 giants belonging to 29 clusters have been retained. The colour excesses are determined from Geneva colours of early-type star cluster members or from UBV data. [M/H] ratios are obtained for non-binary stars using Grenon's (1978, 1982) calibrations. This ratio is very sensitive to reddening errors and is used for checking the consistency of the adopted distance moduli and colour excesses. These latter parameters have been homogenized and Mermilliod's age grouping slightly modified. The cluster metal abundances appear, in the mean, solar to slightly metal-rich. The empirical isochrones may be compared with models built with Z = .02. The exceptions are the Hyades generation (without NGC 2539) with [M/H] +.15 or Z = .03, and NGC 752 and 7789 with Z = .01. The stellar T_{eff} are derived from Geneva colours using the 1982 calibration by Grenon. The luminosities are deduced from m_V, (m-M), E_{B-V} and a B.C. adapted from Bell et al.(1978) and Cohen et al.(1978).

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3. THE RADIAL VELOCITIES

All program stars have been measured with CORAVEL, in both hemispheres. Most stars have been monitored during several years in order to check the stability of RV or for the obtention of orbits. As σ_{VR} is less than 1 km/sec, the RV is now the best membership criterion. Only 5 program stars were rejected as non-members whereas 41 have been discovered or confirmed as binaries. The present rate of multiple systems among giants is at least 23 %.

4. THE STELLAR AGES AND MASSES

The cluster ages are obtained by fitting the observed upper main sequence HRD with Maeder and Mermilliod's (1981) isochrones. A mean age is deduced for each generation. The minimum mass of a red giant is derived from that of subgiants using the same models. The evaluation of the ratio of the number of red giants on that of MS stars in a two mag. interval below the evolutionary gap leads to an estimate of the maximum initial mass for the most evolved giants, assuming a Salpeter mass function.

5. THE log L/log T_e DIAGRAM

Empirical isochrones for single giants with age from 10^8 to $3.2 \cdot 10^9$ y. are now defined. Four generations are shown in Fig. 1. That of NGC 752, a = $1.4 \cdot 10^9$, shows the classical features of old clusters, i.e. an extended GB and a clump of core-He burning stars (logL 1.62, logT_e 3.673). The Hyades and NGC 3532 generations show an elongated concentration centered at logT_e 3.69 and logL 1.85 and 2.25 respectively with few stars on the AB. Their ages are $6.6 \cdot 10^8$ and $2.7 \cdot 10^8$y. The first blueward loop appears for the NGC 2516 generation, a = $1.1 \cdot 10^8$y. and seems more extended than predicted by Becker's (1981) models. The AB is very thin and well defined up to logL 3.9. Mermilliod's (1981b) relations between the mean M_{bol} and logT_e of giant concentration versus the age remain valid.

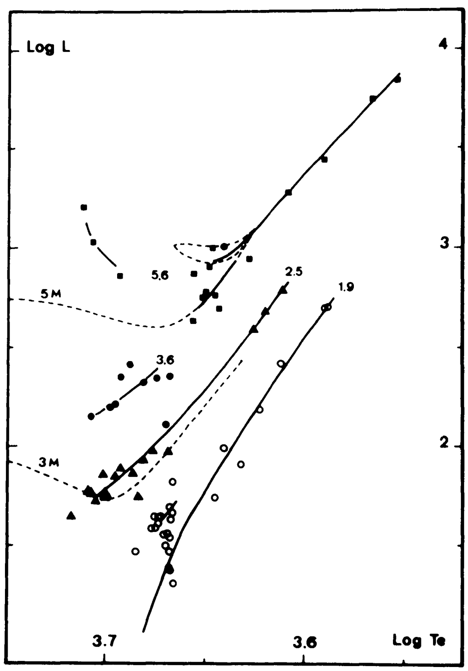

Fig. 1 HR diagram for single red giants of four age groups:

o : NGC 752 ▪ : NGC 2516+Pleiades
▲ : Hyades -- : Becker's models
• : NGC 3532

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DISCUSSION

Weidemann: In your HR diagram the brightest giant of the 5 $M_\odot$ turn-off mass group is located at about log $L/L_\odot$ = 3.9. Similarly NGC 1866 with the same turn-off mass (5 $M_\odot$) in the LMC shows the giant branch populated only up to log $L/L_\odot$ = 4.0, corresponding to core masses of only 0.7 $M_\odot$. Do you think that your ensemble is well enough populated to exclude red giant evolution to much higher luminosities (and thereby final masses)?

Mermilliod: Although we have plotted data from several clusters, the sample is too small to draw definitive conclusions concerning the evolution to higher luminosities. In addition, it would be worth to consider the difference in chemical composition between our Galaxy and the LMC.