PROPERTIES OF TWO STAR CLUSTERS OF THE LMC: NGC 2164, NGC 1850

A. VALLENARI [1 2] C. CHIOSI [1], G. BERTELLI [1], G. MEYLAN [3], S. ORTOLANI [4]
[1] *Department of Astronomy, Padova, Vicolo Osservatorio, 5, Italy*
[2] *Sternwarte, auf dem Hugel 71, Bonn, West Germany*
[3] *Space Science Institute, Baltimore, USA*
[4] *Astronomical Observatory, Padova, Vicolo Osservatorio, 5, Italy*

ABSTRACT. We present the photometry of two clusters NGC 2164 and NGC 1850 located in the Large Magellanic Cloud (LMC). The ages are determined taking into account the presence either of convective overshoot or of semiconvection in the stellar models. The experimental luminosity functions are compared with the theoretical models.

1. The age determination

We analyse the Colour-Magnitude Diagrams (C-M) and the integrated luminosity functions (ILF) of two young clusters of the Large Magellanic Clouds, NGC 2164 and NGC 1850, to discriminate among different treatments of convection in the stellar cores. The C-M diagrams and ILF of the clusters are compared with synthetic ones generated by a Monte-Carlo simulation obtained at varying chemical composition, initial mass function, age, star formation law and stellar evolution input. The photometric errors are also taken into account. The details of the method are described by Chiosi *et al.* (1989) and Vallenari *et al.* (1990). Two sets of stellar sequences are considered: the first incorporates a non local treatment of the convective overshoot (Bertelli *et al.* 1990) whereas the second takes into account semiconvective mixing during the core He-burning phase (Lattanzio *et al.* 1990). An interstellar reddening of $E_{B-V} = 0.09$ is suitable for NGC 2164, whereas a value of $E_{B-V} = 0.2$ seems appropriate for NGC 1850. The distance modulus of the LMC is assumed to be $(m-M)_0 = 18.6$. For both clusters, the comparison with the theoretical isochrones suggests the metallicity Z = 0.004. The C-M diagram of NGC 2164 (Fig. 1) shows a well-defined main sequence with a turnoff at about V = 16.0 mag. The comparison with the C-M diagram of the field stars suggests that all the stars brighter than V = 16 mag are cluster members; the red giant branch extends from V = 16 to 14.8 mag and from (B-V) = 0 to 1.5. On the basis of models with convective overshoot we determine for NGC 2164 an age of 2×10^8 yr, whereas for those with semiconvection we get an age of 7×10^7 yr. Figure 2 shows the C-M diagram simulated using models with overshoot.

The C-M diagram of NGC 1850 (Fig. 3) shows the main sequence extending up to V = 16 mag, even if a residual population can be seen toward brighter magnitudes. The blue giants crowd a distinct zone ranging from V = 16 to 14.5 mag and from (B-V) = 1.1 to 1.8. A very narrow and scarcely populated structure extends from V = 16 to 13.5. For this cluster, an age of 1.6×10^8yr is predicted by the overshoot models whereas an age of 7×10^7yr is indicated by the semiconvection models. To reproduce the distribution of the evolved stars on the C-M diagram the star formation in this cluster should have continued over about 7×10^7yr. This age spread is reduced to 2×10^7yr if semiconvection models are used. The residual brightest population seems

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to be marginally in agreement with an age of 1 x 10^7yr. However, any other conclusion is difficult because of the paucity of stars. Figure 4 presents the simulation of C-M diagram of NGC 1850 obtained with the overshoot models.

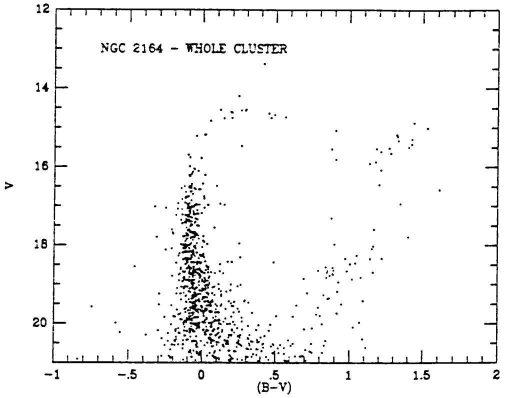

Figure 1. Experimental C-M of NGC 2164.

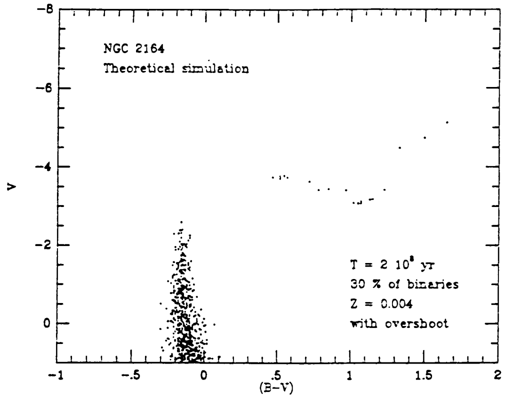

Figure 2. Theoretical simulation of NGC 2164 for the described choice of the parameters.

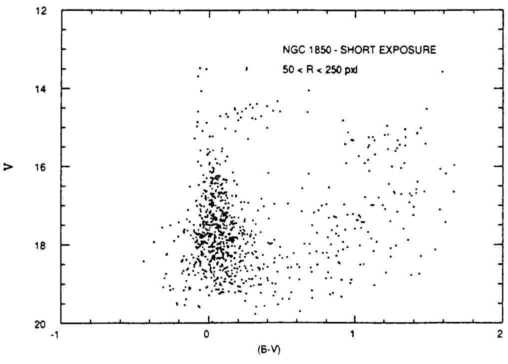

Figure 3. Experimental C-M of NGC 1850.

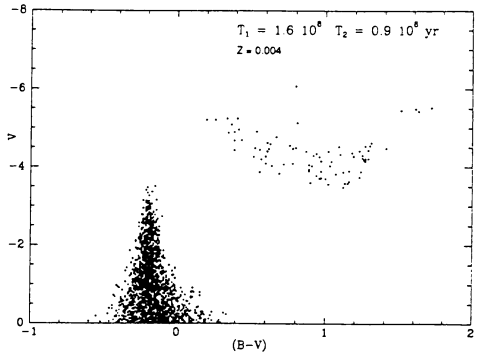

Figure 4. Theoretical simulation of the C-M of NGC 1850 with the described choice of the parameters.

Even if a detailed discussion is beyond the scope of this work, a few points can be singled out:

a) both models with overshoot and with semiconvection reproduce the basic features of the experimental C-M diagrams (turnoff magnitude, main sequence location, mean magnitude of the He-burning loop).

b) The ILFs of the main sequence normalized to the number of evolved stars in both clusters are in agreement with the expectation from models with convective overshoot, while the ILF from semi-convection models runs much flatter than the observational ILF for any reasonable choice of the initial mass function slope. Figures 5 and 6 compare the observational and the theoretical ILF of NGC 2164 and NGC 1850 respectively.

c) the presence of a certain amount of binary stars seems to be required by the observations in order to reproduce both the location of the turn off and the luminosity of the giants loop.

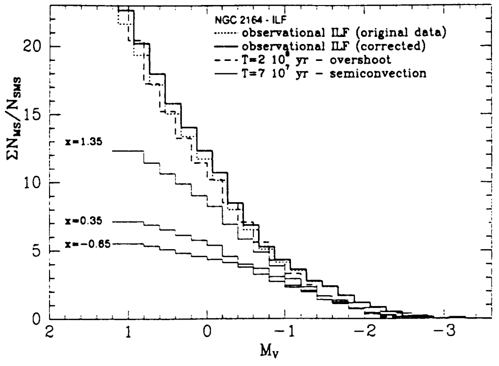

Figure 5. Experimental ILF of NGC 2164 is compared with the theoretical ILFs determined with and without overshoot, for various values of the slope x of the IMF.

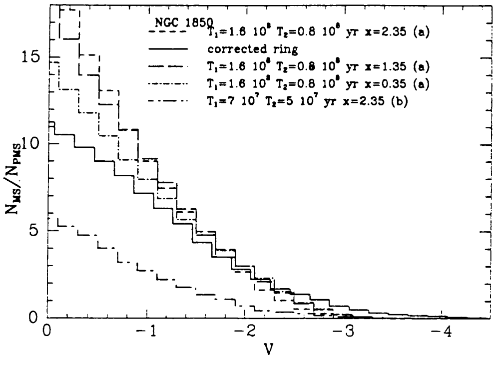

Figure 6. Experimental and theoretical ILFs of NGC 1850 are compared for various values of the slope x of the IMF. (a) indicates the models with overshoot; (b) models with semi-convection.

2. References

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