The associations LH 95 and LH 91-I of LMC 4 NE

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Abstract

We have invesitaged associations at the edge of LMC 4 to derive ages and to study their dynamic stabilty. The associations are young ($\simeq$ 10 Myr), contain Be stars, while the field is clearly older $>$ 50 Myr). Mass function slopes are in the range $-1 < \Gamma < -2$. An investigation of the total mass and mass distribution shows that LH 95 is probably in the process of dissipation and LH 91-I is a bound system.

1 Results of photometry

We have obtained BVR photometry in the region of the association LH 95 situated in the north-east side of the super-giant shell LMC 4. This region of the LMC is of interest because it is easily accessible near the outskirts of the LMC while suffering in general little from extinction.

We have investigated the stellar content of three stellar associations (LH 91, LH 91-I & LH 95) and their surrounding fields (see Kontizas et al. 1994 for details of the associations). Our goal is to find the age of the associations in order to study their stability.

Our observations in an area of $20\farcm5 \times 20\farcm5$ were taken in BVR and in Hα. The Hα image is shown in Fig. 1a. Within that field we isolated areas for detailed scrutiny (see Fig. 1b).

We estimated the reddening and the age of the systems based on isochrone fitting. The reddening was found to vary between $E(B-V) \simeq 0.15$ and 0.20 mag.

All systems were found to be younger than 10 Myr (see Fig. 2), while the background field is older than $\sim$ 50 Myr.

Using the $R-$Hα colour index (see e.g. Grebel et al. 1991) we have identified the Be star population of the region. Be stars exist in all the investigated associations. Within LH 95 we find a central group of four Be stars appears to be associated with the H II emissivity in this area.

2 Luminosity and mass functions

We present the luminosity and mass functions of the systems, as well as that of the field. It was found that the luminosity function (LF) slope s of the field is steeper than that of the systems, which were found to be $s \simeq 0.12 - 0.32$.

The statistics of the stars over mass intervals was derived by directly counting stars between evolutionary tracks. We then fitted an exponential function using the minimum chi-square method to arrive at the mass functions four each of the associations and for the field. We verify that the

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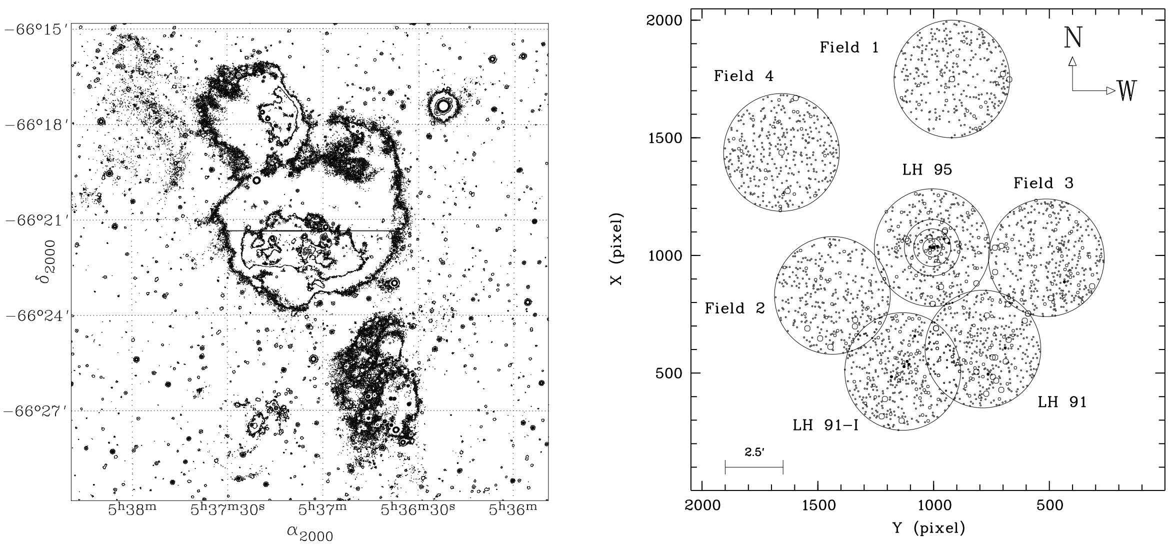

Figure 1: **a) left**: The region observed in the NE corner of the LMC at the outer edge of LMC 4 is shown in Hα. **b) right**: The fields selecetd for detailed study are indicated. Three annuli are centered on the associations LH 95 and LH 91-I (LH 91 turned out *not* to be an association) while there are four background star fields (1-4).

MF slopes of the systems are rather shallower than the ones of the field. The MF slopes of the systems lie in the range $-1.0 < \Gamma < -2.0$, while those of various fields are significantly steeper, around $\Gamma \simeq -4.0$.

Given that the photometry of the associations LH 95 and LH 91-I does contain field stars as well, we have corrected the MF derived for the contribution of the background field. In particular for LH 95 the final MF slope becomes shallower, with $\Gamma = -.2 \pm 0.3$.

3 Dynamical status of the systems

In order to investigate the dynamical behavior of the systems and check for any differences between them we estimated some of their basic dynamical parameters under various assumptions. We estimated the Spitzer (1987) radius of each system as the square mean distance of the stars from its centre:

$$r_{\rm sp} = \sqrt{\frac{\Sigma_i^N {r_i}^2}{N}} \tag{1}$$

where r_i is the radial distance of the $i^{\rm th}$ star and N the total number of observed stars. Then we found the distance where half of the observed mass is lying (half-mass radius) $r_{\rm h}$. In both estimations we counted stars within specified limits of the systems. For LH 95 we performed these estimations for the systems' limits (up to radial distance of 1.′2) and for a larger area around its center covering their surrounding field (up to radial distance of 2.′5).

In order to estimate the stellar density of the systems (in M$_\odot$ pc^{-3}) we calculated their masses for three cases: First by converting the observed brightness of each star into mass using the Geneva isochrone grids for 6 to 10 Myr, and then by extrapolating the constructed MFs down to ~ 1 M$_\odot$ as well as down to ~ 0.1 M$_\odot$.

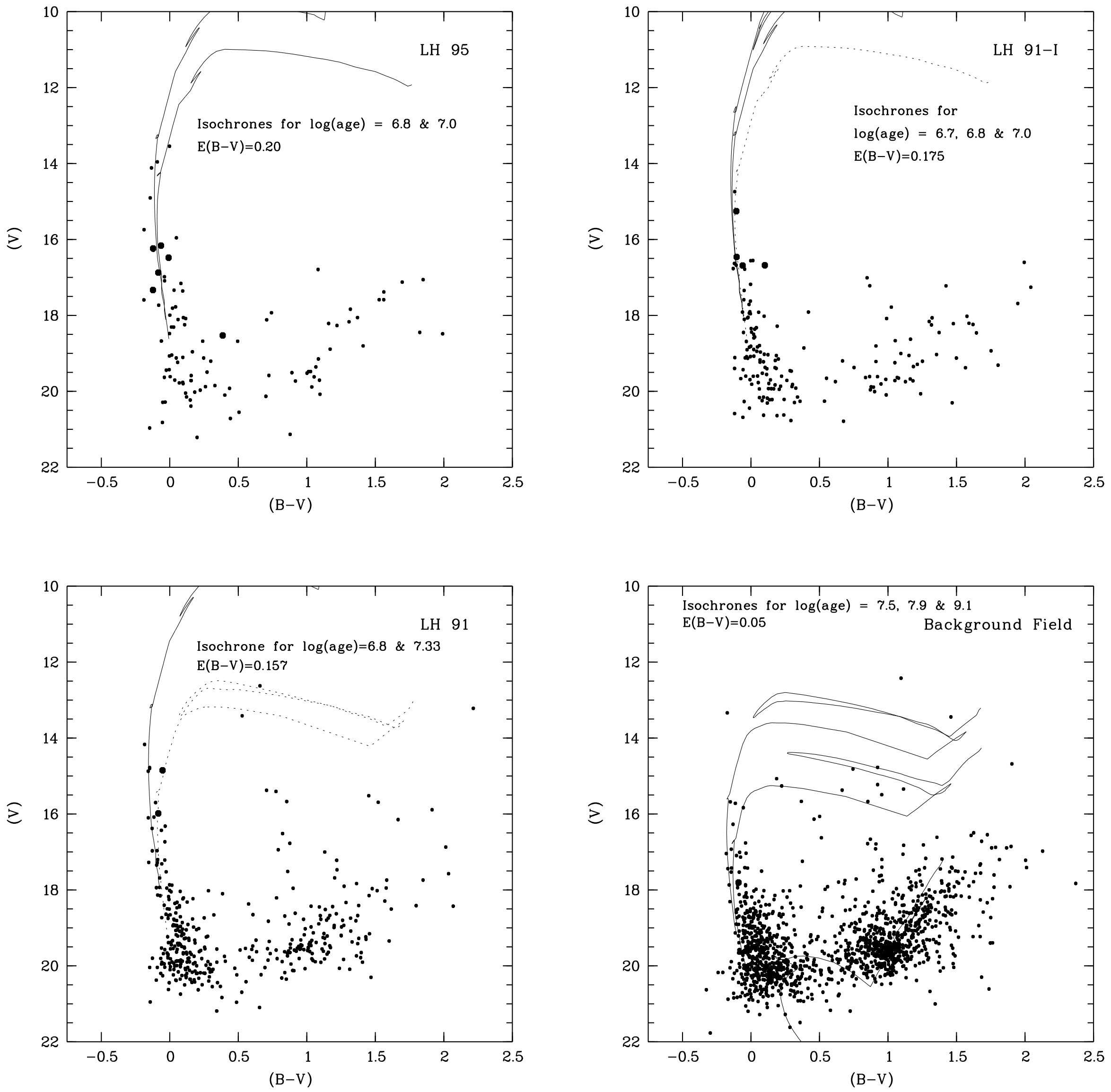

Figure 2: *Top panels*: CMDs for LH 95 and for LH 91-I (for stars with radial distances $\leq 1\farcm2$ from the centre in both systems). *Bottom panels*: CMDs for LH 91 (for stars with radial distances $\leq 2\farcm5$ from the centre) and for the background field (sum of fields 1-4 of Fig. 1b). In all cases thick circles represent the Be stars. The corresponding isochrones have been overplotted.

3.1 Is LH 95 evaporating?

The flatness of the MF of LH 95 can be explained in two ways: either the system is 'mass segregated' or the system is evaporating (see e.g. Kontizas et al. 2001). Given the age of LH 95, mass segregation is very unlikely at this point.

From these calculations detailed above we estimate that LH 95 is seen to be a loose system with stellar density in the half mass radius not exceeding the value of 0.2 $M_\odot$ pc^{-3} and with disruption time of the order of few tens Myr.

3.2 LH 91 and LH 91-I

For LH 91 and LH 91-I similar analyses as those for LH 95 have been performed. LH 91-I can be considered as a bound stellar system with stellar density $\varrho \simeq 6$ $M_\odot$ pc^{-3} if it contains stars as small as 0.1 $M_\odot$ within $1\farcm2$ and a corresponding disruption time of the order of a Gyr.

LH 91 is seen from its estimated parameters to be an unbound system with stellar density not larger than ~ 0.3 $M_\odot$ pc^{-3} and a disruption time varying from less than 5 Myr up to few tens of Myr.

4 Hα emission, radiation field, and gas density

We have investigated the ionizing flux from the systems to compare that with the Hα emission. Taking the extent of the H II region and combining that with the age of LH 95 as well as with the UV flux detected, we find gas densities of the order of $n_e = 20$ to 30 cm^{-3}. Similar values are found for the region of LH 91-I.

5 Conclusions

We conclude that while LH 91 appears to be a loose system, rather disrupted. LH 91-I shows a set of structural parameters varying extremely with the assumptions used for their calculation. If we assume that no stars with masses smaller than about 1 $M_\odot$ belong to LH 91-I, then the system behaves like an unbound system very close to disruption. On the other hand if stellar masses down to 0.1 $M_\odot$ are members of LH 91-I, then the system seems to be a bound young cluster.

LH 95 was shown to be a loose system very close to, or undergoing disruption. LH 95 is evaporating, in the sense that the system feeds the general background field with less massive stars, which are escaping into the surrounding field, resulting a shallower MF slope for this field than the one of the more distant field regions.

Further details can be found in the full paper on the subject (Gouliermis et al. 2001).

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