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On the star formation history of galaxies in rich clusters ⋆

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Abstract. The analysis of the Colour Magnitude Relation (CMR) of cluster galaxies at different cosmological epochs is an effective tool to gain insight into the star formation history of galaxies in dense environments (Bower et al. 1992; Bower et al. 1998; Kodama & Bower 2001). By comparing the optical-NIR CMR $(R-K, K)$ and the colour-colour $(V-I, R-K)$ distribution of galaxies in the rich cluster AC 118 at $z = 0.31$, with the optical-NIR CMR $(V-K, K)$ of Coma ($z = 0.023$), we find that half of the stars in galaxies form at $z > 2$, while star formation still continues at intermediate redshifts: 20% of the stars are formed at $z < 1$.

Key words. galaxies: evolution – galaxies: fundamental parameters – galaxies: clusters: general

1. Data and models

The sample used for the present analysis consists of 252 galaxies in the cluster AC 118 at $z = 0.31$. The optical and infrared data are taken from Busarello et al. (2002) and from Andreon (2001) respectively. The sample is selected according to the following criteria: (1) galaxies are cluster members according to their photometric redshift (Busarello et al. 2002; Massarotti et al. 2001) and (2) the sample is complete in the $K-$band ($K = 18.25$). Since a complete sample of cluster galaxies in the NIR was not available at $z \sim 0$, we built a simulated sample based on the Coma cluster, from the data by de Propris et al. (1998) and Bower et al. (1992).

We introduce models of galaxy evolution based on the code of Bruzual & Charlot (1993). Each model is defined by three physical parameters: the metallicity Z, the time scale τ of the (exponential) Star Formation Rate (SFR), and the age T. In this way, any given value of (Z,T,τ) may be related to a point in the colour-magnitude spaces at $z \sim 0$ and $z \sim 0.3$, and vice versa.

First, we looked for the 'best' value of (Z,T,τ) that minimizes the distance between observed and predicted magnitudes for each galaxy of AC 118. As second step, we used the 'best' parameters to predict the distribution of AC 118 galaxies in the $V-K$ vs. K diagram at the redshift of Coma. The model distributions at $z \sim 0$ were compared with the distribution of the local sample and the best model was found

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by minimizing the differences of occurring frequencies in the $(V-K, K)$ plane.

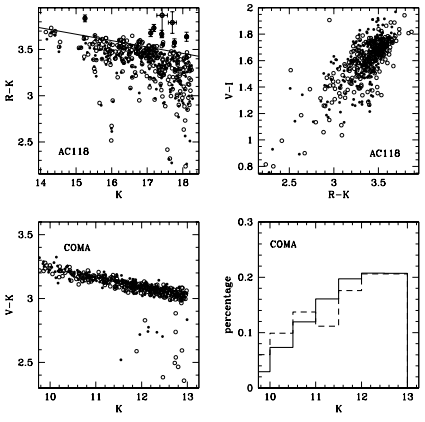

Fig. 1. Distribution in colour-magnitude space of the observed cluster galaxies (open circles and solid line) compared with the 'best fit' model (filled circles and dashed line).

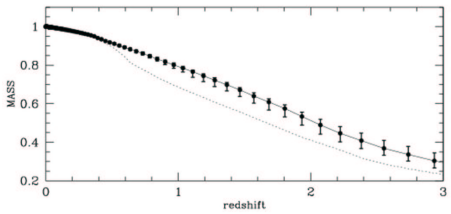

Fig. 2. Fraction of stellar mass already formed at a given redshift (solid line and dots).

2. Star formation history

The observed distributions and the best model are shown in Fig. 1. By using the values of (Z,T,τ) of the best model we obtain the star formation history shown in Fig. 2 (see Merluzzi et al. 2002). We conclude that half of the stars were born at high redshifts ($z > 2$), while star formation in cluster galaxies continues until intermediate redshifts: 20% of the stars are formed at $z < 1$.

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