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THE MAGELLANIC CLOUDS FIELD POPULATION CHEMICAL ENRICHMENT HISTORY

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RESUMEN

Presentamos los resultados de nuestro proyecto dedicado al estudio de la historia del enriquecimiento químico de las poblaciones de campo de las Nubes de Magallanes usando espectroscopía del triplete de Ca II.

ABSTRACT

We report the results of our project devoted to study the chemical enrichment history of the field population in the Magellanic Clouds using Ca II triplet spectroscopy.

Key Words: galaxies: abundances — galaxies: individual (LMC, SMC)

1. INTRODUCTION

The most accurate way to obtain stellar abundances and overall metallicities is through high resolution spectroscopy. However, a lot of telescope time is necessary to measure a suitable number of stars with this technique. The alternative is low-resolution spectroscopy, which allows us to observe a large number of stars in a reasonable time using modern multi-object spectrographs. At low resolution, the metallicity is obtained from a spectroscopic line strength index (i.e. Mg_2, Ca II H & K lines, Fe lines, etc.). In the case of external galaxies, only the brightest stars can be observed spectroscopically from the ground. In most cases these objects are those near the tip of the RGB. The best spectroscopic index to obtain metallicities for these stars is the infrared Ca II triplet (CaT), whose lines are the strongest features in their infrared spectra. Carrera et al. (2007) have demonstrated that this index can be used to derive stellar metallicities in systems with large ranges of age and/or metallicities.

Because of their proximity, and the fact that they present a wide range of ages and metallicities, the Magellanic Clouds are attractive objects to study their chemical enrichment histories.

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2. LARGE MAGELLANIC CLOUD

The evolution of the abundance of metals with time in the LMC has been investigated from its cluster population (e.g., Dirsch et al. 2000) which suffers a lack of objects with ages between 10 and 4 Gyr, from its planetary nebula (Dopita et al. 1997), and from RGB stars in the bar (Cole et al. 2005). In all cases, the chemical evolution shows a first important chemical enrichment at the beginning of the galaxy life. After this, it was paused until about 4 Gyr ago, when again the metallicity increased significantly. The last period of chemical enrichment is not observed in the bar red giant field population.

But, what about the chemical enrichment history of the disk RGB population? To address this question, we have observed about 500 stars in four $36' \times 36'$ fields situated at 3°, 5°, 6° and 8° at the North of the Bar. These stars were selected in the upper part of the RGB, and their metallicities were obtained from the infrared CaT lines following the procedure described by Carrera et al. (2007).

Figure 1 shows the age-metallicity relationships (AMR) observed in our four fields. The age of each star has been estimated from its position in the color-magnitude diagram (CMD), taken into account the metallicity obtained from the CaT. The metallicity evolution with time in the four fields can be described as follows: an initial epoch of prompt chemical enrichment was followed by a plateau at intermediate ages (10–5 Gyr ago) and by a final gradual increase of the metallicity of almost 1 dex during the last 5 Gyr. This behaviour is similar to the one observed in the clusters. Inset panels show the age distribution of each field. The outermost field is a factor of two more metal-poor than the other fields

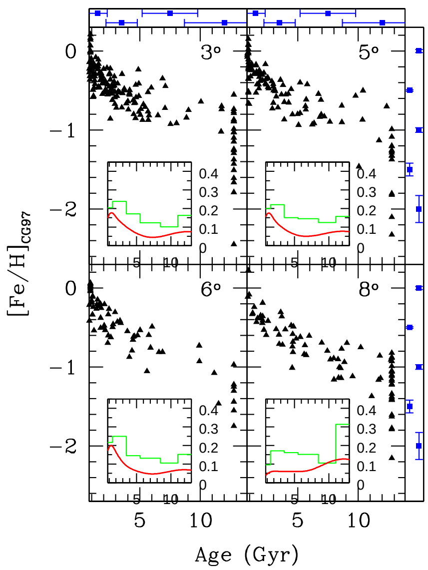

Fig. 1. AMR for the four LMC fields in our sample. Inset panels show the age distribution computed taking into account the age determination uncertainties (dark line) and without taking them into account (histogram). Top and left panels show the age and metallicity errors in each bin, respectively.

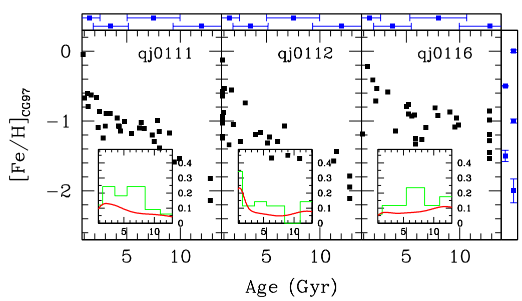

Fig. 2. The same as Figure 1 for the eastern fields of the SMC.

due to the lack of the youngest stars, which are also the most metal-rich. The AMRs observed in the disk differ from the one observed in the bar (Cole et al. 2005) where the metallicity has not increased in the last few Gyr.

3. SMALL MAGELLANIC CLOUD

There are considerable less studies of the SMC as compared with the LMC. Its chemical enrichment has been mainly determined from studies of its cluster system. The cluster AMR has been obtained by some authors (e.g., Piatti et al. 2005), mainly from photometric indicators. A fast initial chemical enrichment has been found, followed by a period of relatively slow increase in the metal abundance. Clusters more metal-rich than [Fe/H]≥ -1 are younger than 5 Gyr. Since then, the metallicity has again increased until now. A similar result has been found by Idiart et al. (2007) from chemical abundances in SMC planetary nebula. On average, the SMC is more metal-poor than the LMC.

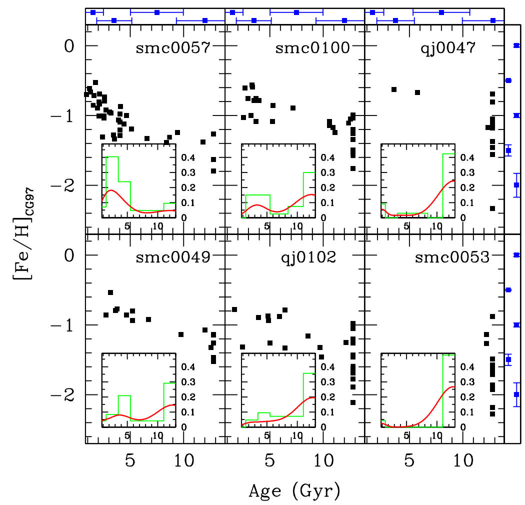

Fig. 3. The same as Figure 1 for the southern fields of the SMC.

Following the same procedure as in the LMC, we have obtained the AMR in 13 $8.'85\times8.'85$ fields on the SMC body. The CMDs of these fields have been presented by Noël et al. (2007). Figures 2 and 3 show the AMR for the eastern (in the wing facing the LMC) and southern fields, respectively.

In spite of the irregular appearance of this galaxy, and in particular the differences between the young populations at the East, facing the LMC, and at the West, in the opposite direction, both groups of fields show a similar AMR. In the case of southern fields, we have found a population gradient in the sense that the younger stars, which are also more metal-rich, are concentrated in the central regions of the SMC. The small number of stars in the most southern fields makes difficult to trace the behaviour of the AMR. However, in the most populated fields, we can notice a behaviour relatively similar to the LMC fields, though running at lower metallicity.

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