The Magellanic System: Stars, Gas, and Galaxies
Proceedings IAU Symposium No. 256, 2008
Jacco Th. van Loon & Joana M. Oliveira, eds.

DOI: 00.0000/X000000000000000X

LMC: Stellar Populations and their gradients

I. Meschin[1], C. Gallart[1], A. Aparicio[1],[2], R. Carrera[3], M. Monelli[1], S. Hidalgo[4] and P.B. Stetson[5]

[1]Instituto de Astrofsica de Canarias, C/Via Láctea s/n, E38200 La Laguna, Tenerife, Spain
email: imeschin@iac.es

[2]Departamento de Astrofsica, Universidad de La Laguna, Tenerife, Spain

[3]INAF-Osservatorio Astronomico di Bologna, Italy

[4]Department of Astronomy, University of Minnesota, USA

[5]Dominion Astrophysical Observatory, Herzberg Institute of Astrophysics, National Research Council, Victoria, Canada

Abstract. In the context of a major project aimed at obtaining detailed Star Formation Histories (SFHs) across the Large Magellanic Cloud (LMC) disk, we present here the first results for four fields in the Northern direction between 2 and 6 kpc from the LMC center. A gradual change with galactocentric distance in the composition of the LMC disk population is observed, with the intermediate-age and old population being more prominent at increasing galactocentric radius. We report the presence of a substantial intermediate-age (>4 Gyr old and some ~ 1.0 Gyr old stars) and old stellar population in the outermost fields.

Keywords. Magellanic Clouds, galaxies: individual (LMC), galaxies: stellar content, galaxies: evolution

1. The Project

We are undertaking a major project aimed at obtaining detailed Star Formation Histories (SFHs) across the Large Magellanic Cloud (LMC) disk, in order to characterize its stellar population gradients and to delimit the total extent of its stellar population. To this end, we have imaged 12 fields, 6 toward approximately the north of the bar at 2.3, 4, 5.5, 7.1, 8.5 and 9.5 degrees from the LMC center ($\sim$ 2, 3, 4, 6, 7 and 8 kpc), and 6 fields in the east-west directions at $\sim$ 5, 6.5 and 8 kpc on both sides of the bar (see Fig. 1). This will allow us to find its actual outer edge and to fully characterize the differences in the SFH at each side of the bar. For all these fields we have obtained Color-Magnitude Diagrams (CMDs) reaching the oldest MS turnoffs.

2. Observations and Photometry

B , V and I images from several LMC fields were taken in 3 campaigns, the first two (1999 December and 2001 January) using the Mosaic II CCD Imager on the CTIO Blanco 4 m telescope (Cerro Tololo, Chile) and the third (2005 January) using the WFI camera at the 2.2 m ESO/MPI telescope at La Silla Observatory (Chile). These wide field imagers provide a total field of approximately 0.5 x 0.5 degrees. Several Landolt standards were also observed in photometric nights for calibrations purposes.

The mosaic frames were pre-reduced in a standard way, using the MSCRED package within IRAF. Photometry was obtained using DAOPHOT/ ALLFRAME suite of programs (Stetson 1987 and Stetson 1994).

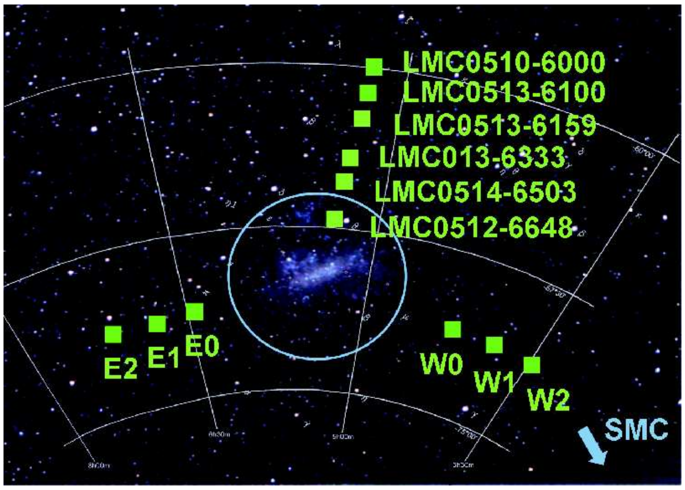

Figure 1. Positions of the LMC fields.

3. The Color Magnitude Diagrams

In Fig 2 we show the CMDs of the North-fields with BaSTI isochrones (Pietrinferni et al. 2004) superimposed. Each of these CMDs show the details of the age structure of the stellar population in the corresponding area of the LMC. Fields LMC0512−6648 to LMC0513−6159 were studied and presented in Gallart et al. (2004) and Gallart et al. (2008). They showed that, while the oldest population is coeval in all fields, the age of the youngest component of the dominant stellar population gradually increases with galactocentric distance, from currently active star formation in field LMC0512−6648 to 1.5 Gyr old in field LMC0513−6159. In field LMC0513−6159, the presence of a substantial intermediate-age stellar population up to about 2 Gyr old can be noted. Fields LMC0513−6100 and LMC0510−6000 seem to still contain an intermediate-age (4−5 Gyr old) population. However the large errors at the old turnoff magnitude advise to consider this conclusion as a preliminary one. The faintest stars in the subgiant branch are well matched by the 13.5 Gyr isochrone, but no blue extended horizontal branch can be seen in these CMDs.

4. The Star Formation History

The SFH has been obtained using the IAC-star (Aparicio & Gallart 2004) and IAC-pop (Aparicio & Hidalgo 2008) codes†, and the MINNIAC package. IAC-pop is a code designed to solve the SFH of a complex stellar system, like a galaxy, from star counts on the CMDs. It uses a genetic algorithm to minimize a χ^2 merit function comparing the stellar distribution in observed and model CMDs. For this purpose, IAC-star is used to compute a single synthetic CMD (model) from which the simple populations and their corresponding CMD stellar distributions are extracted. The MINNIAC package analyzes the observed and synthetic CMDs, counting the number of stars in different age intervals and CMD areas, to produce the input to IAC-pop.

In the analysis presented here, we used as IAC-star inputs parameters the BaSTI stellar evolution library (Pietrinferni et al. 2004) and the Castelli & Kurucz (2003) bolometric

† IAC-pop and IAC-pop are free software available at http://iac-star.iac.es/iac-star and http://iac-star.iac.es/iac-pop

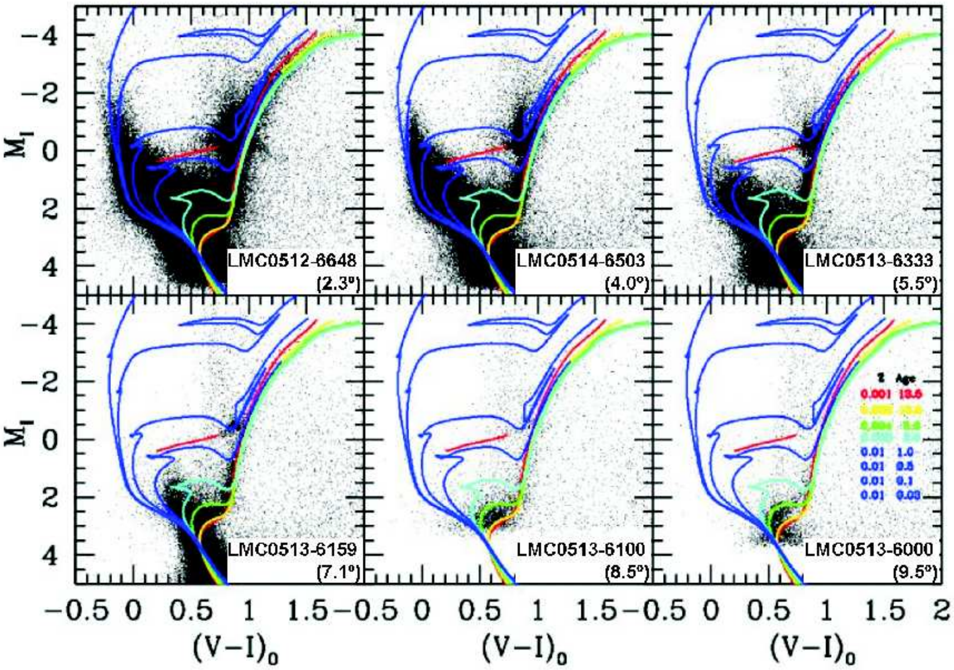

Figure 2. Color Magnitude Diagrams with BaSTI isochrones superimposed for the Northern fields.

corrections. The number of stars in the synthetic CMD were 8×10^6 and the population was computed with constant SFR from 13 Gyr ago to present, metallicities from 0.0001 to 0.02, Initial Mass Function (IMF) from Kroupa (2001) and 50% of binary stars.

The obtention of SFHs is ongoing and for this reason the results that we presented here are preliminary. Fig. 3 shows the SFHs for inner fields in the Northern direction. The horizontal plane represents the age and metallicity intervals used. The volume of each bar over this plane gives the mass in stars that has been ever formed within each age-metallicity interval. In the vertical axis, two projections of the SFH $\Psi(t, z)$ are represented: the SFH as function of time only $\Psi(t)$ and metallicity only $\Psi(z)$ are shown in red and blue color respectively. A gradual change with galactocentric distance in the composition of the LMC disk population is observed, with the intermediate-age and old population being more prominent at increasing galactocentric radius. A depressed star formation around ~ 5 Gyr ago, with respect to earlier and later epochs, is observed in all fields. In the innermost field N0, we infer that the amount of old population is very small while star formation is currently very active. Field LMC0514−6503 shows also currently active star formation, even though the star formation rate has been decreasing since 0.3 Gyr ago. In fields LMC0513−6333 and LMC0513−6159 the star formation stopped 0.5 and 1.5 Gyr ago respectively.

5. Ongoing Work

Next step will be to calculate the star formation histories of the two North outermost fields (LMC0513−6100 and LMC0510−6000). We plan to finish with the photometry of 6 fields (3 to East and 3 to West) at ~ 5, 6.5 and 8 kpc from the LMC center in B and I bands in order to determine detailed SFH at different galactocentric distances. Also we

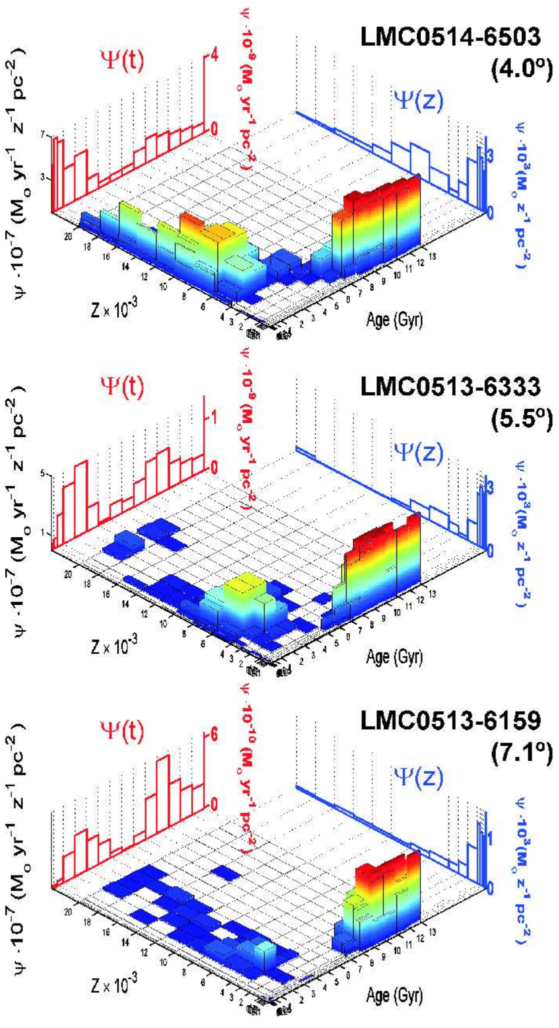

Figure 3. Star Formation History for inner fields in the Northern direction between 4 and 7 degrees from the LMC center.

are interested in detecting the signature of possible interactions LMC-SMC in the fields towards the East, that may be reflected in the star formation histories of these regions

References

Aparicio, A., & Gallart, C. 2004, *AJ*, 128, 1465

Aparicio, A., & Hidalgo, S. 2008, *AJ*, submitted

Castelli, F., & Kurucz, R.L. 2003, in N. Piskunov, W.W. Weiss, & D.F. Gray (eds.), *Modeling of Stellar Atmospheres*, IAU Symp 210 (San Francisco: ASP), p. A20

Gallart, C., Stetson, P.B., Hardy, E., Pont, F., & Zinn, R. 2004, *ApJ*, 614, L109

Gallart, C., Stetson, P.B., Meschin, I.P., Pont, F., & Hardy, E. 2008, *ApJ*, 682, L89

Kroupa, P. 2001, *MNRAS*, 322, 231

Pietrinferni, A., Cassisi, S., Salaris, M., & Castelli, F. 2004, *ApJ*, 612, 168

Stetson, P.B. 1987, *PASP*, 99, 191

Stetson, P.B. 1994, *PASP*, 106, 250