The VISTA survey of the Magellanic Clouds: unveiling their star formation history

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1. Abstract
The Magellanic Clouds (MC) have always been a rich laboratory for studies of stellar evolution, stellar populations, and the calibration of primary standard candles, thanks to the simultaneous presence of a wide variety of interesting objects - red clump giants, Cepheids, RR Lyrae, LPVs; C stars, PNe, the TRGB, dust-enshrouded giants, etc. These objects are however irredeemably mixed by a complex (and little known) history of star formation, and partially hidden by the presence of variable and patchy extinction across the MCs, which hinder the accurate calibration of their properties - luminosities, lifetimes, periods, etc. - as a function of age and metallicity. The VISTA Survey of the Magellanic System (VMC) is an ESO Public Survey which, in the next 5 years, critical near-infrared data to unveil the space-resolved star formation history (SFH) all over the MC system, hopefully opening the possibility of a more accurate calibration of stellar models and primary standard candles. We describe the preparatory work for the derivation of the SFH from VMC data, SFH-recovery performed over simulated VMC images allow us to access the random and systematic errors in the derivation of the SFH. We present the errors as a function of age, for the entire range of stellar densities met in the surveyed area. We investigate the sensitivity of our results to errors in the assumed reddening and distance.

2. Particularities of the near-infrared photometry
- VMC will be the first near-infrared survey to provide data suitable to the classical method of SFH-recovery for a nearby galaxy. Compared to the optical:
  - Less extinction
  - Good colour resolution, from the intermediate-age turn-offs to the reddest giants
  - More contamination from foreground Milky Way stars and background galaxies
  - Sky-dominated noise (especially in the LMC)
  - Higher chi-squares.

3. The SFH-recovery method
Following Dolphin (2002) and Harris & Zaritsky (2001), a given CMD is described as a sum of "partial CMDs" representing the bins of age and metallicity that make the composite galaxy.

The TRILEGAL simulator (Girardi et al. 2005) is used to build the set of partial CMDs, typically comprising 33 MC populations (11 bins in age and 3 in metallicity), plus a "primary standard candle" - a simple test case. The VMC will provide data suitable to the classical method of SFH-recovery for a nearby galaxy. The simulations so far confirm that VMC will reach the necessary sensitivity to access the random and systematic errors in the derivation of the SFH. We present the errors as a function of age, for the entire range of stellar densities met in the surveyed area. We investigate the sensitivity of our results to errors in the assumed reddening and distance.

4. SFH accuracy as a function of age and stellar density
The accuracy in recovering the SFH depends primarily on the number of stars (given by the area x density), and in the level of crowding (given by the density).

- For younger stars, the accuracy depends on both the selected area, and crowding.
- For older stars, the SFH is not known.

5. Reddening and distance errors
- When we assume the wrong LMC reddening and/or distance, the chi-square minimisation produces the wrong SFH and, obviously, higher chi-squares.
- The effect can be used to pin out the best-fitting (m-M), and E(B-V) values across the Magellanic System, with accuracies of the order of 0.02 mag in (m-M), and 0.01 mag in E(B-V).

6. Conclusions
- The simulations so far confirm that VMC will reach the goals of providing the space-resolved SFH all over the Magellanic System.
- For a spatial resolution of 0.15 arcmin, and age resolution of 0.2 Myr, the SFH will be below ~25%.
- In the case of the metallicity relation
- Errors are ~2 times larger if the metallicity relation is not known.
- As a bonus, the SFH-recovery will provide reddening maps and constraint to the 3D structure.
- Random errors are well understood, systematic errors are to be fully explored in the next few months.

References
- Emerson, J., 2006 private communication

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