Assessing the stability of the Magellanic spiral arms: The SMASH view

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The off-centered bar and its single spiral arm are the most defining morphological features of the Large Magellanic Cloud (LMC), prototype of the Magellanic Spirals. Fortunately, its proximity and the quality of the colour-magnitude diagrams from SMASH allow an unprecedented characterisation of its stellar populations covering its whole extension. Such characterisation shows compelling evidence supporting the long-term stability of the LMC spiral arm, dating its origin to at least 2 Gyr ago, linked with the close LMC-SMC encounter that produced the gaseous Magellanic Stream and its Leading Arm.

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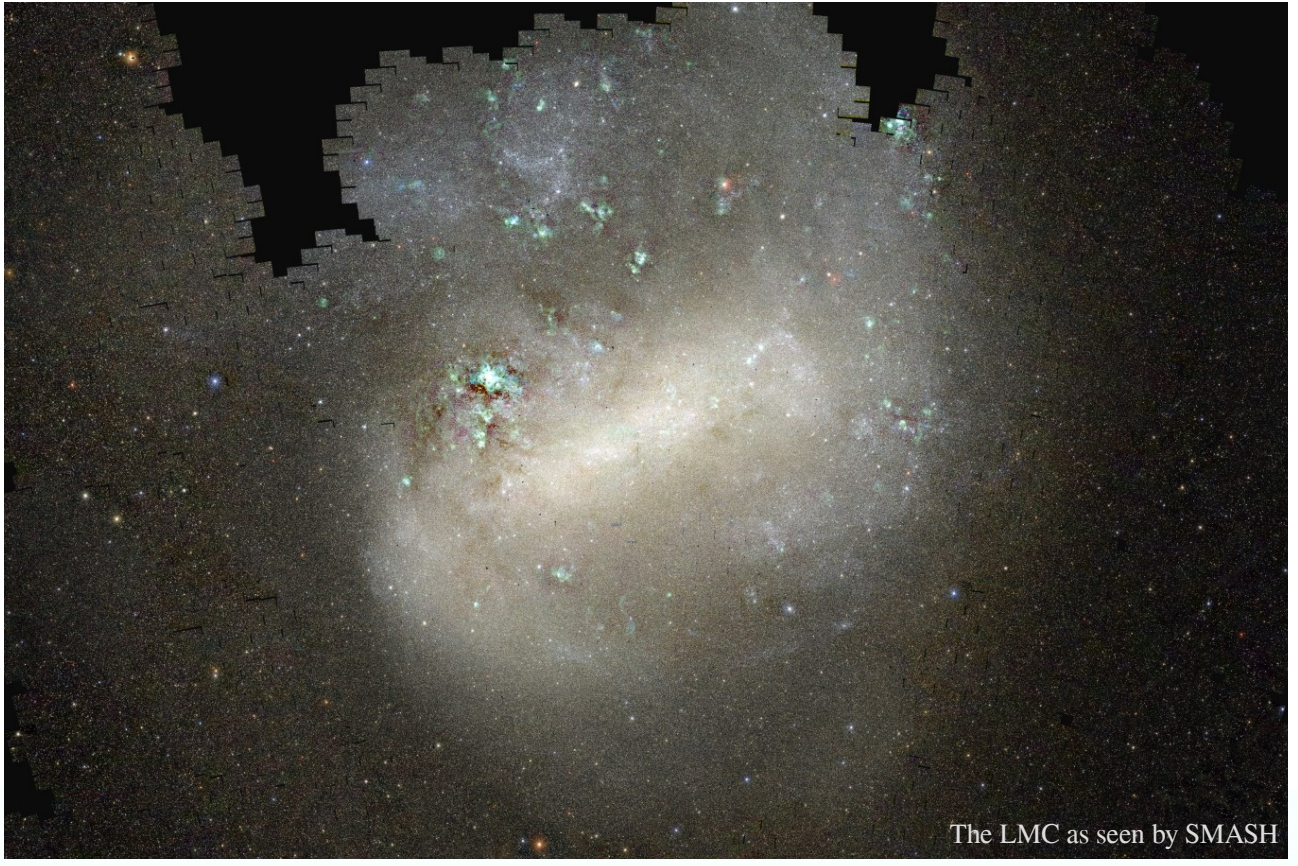


The LMC as seen by SMASH

Context

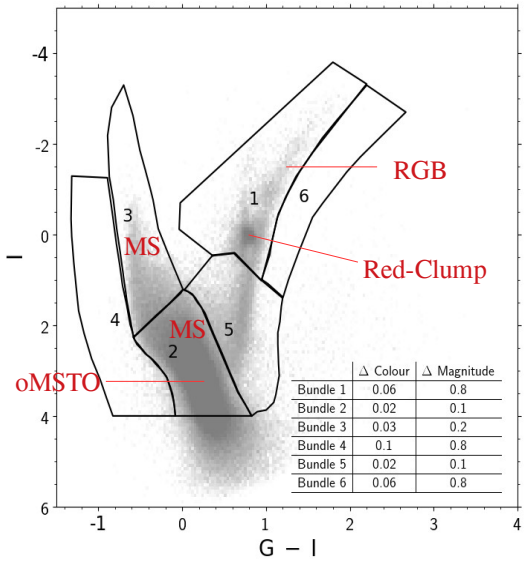

Credit: V. Belokurov, D. Erkal, A. Mellinger

- Magellanic spirals (off-centred bar, single spiral arm) are ubiquitous in the Universe
  de Vaucouleurs&Freeman 1972
- Tidal interactions have long been invoked to explain asymmetries in galaxies
  Odewahn 1994
- Evidence exists supporting a LMC-SMC common evolution for several billion years
  Mathewson+1974
- Leading arm and Magellanic Stream observationally linked to interactions between the clouds ~2Gyr ago
  Nidever+2008, Fox+2018
- Pericentric passages between the Clouds ~2.7 and 1.1 Gyr ago as well as a direct collision ~100-300 Myr ago derived by orbit integration using accurate 3D motions and positions
  Besla+2012

Method: CMD Fitting Techniques

Observations + Stellar Evolution Models + ASTs + TheStorm = Star Formation History

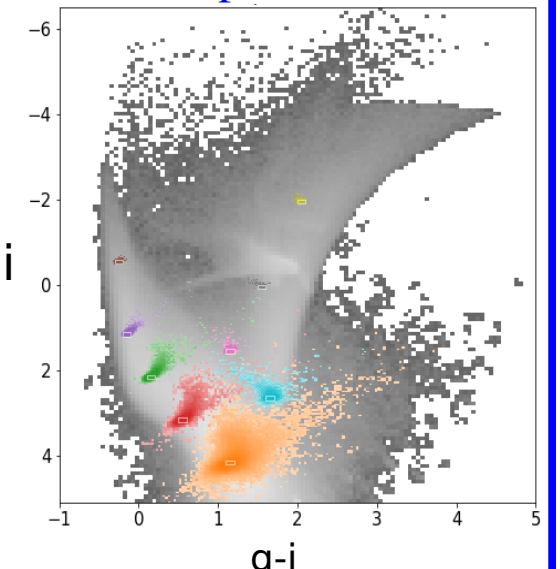
Observed CMD - SMASH



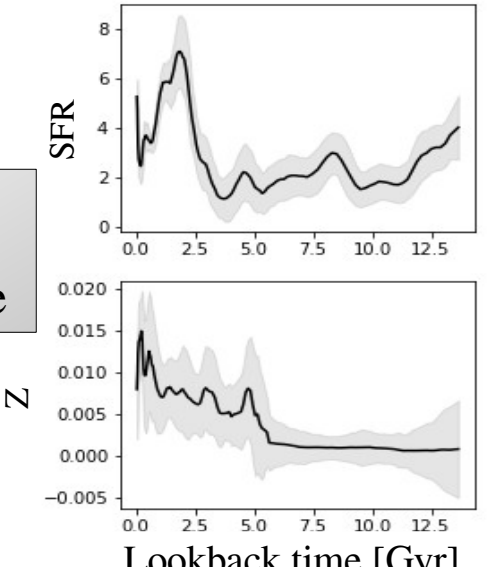
	Δ Colour	Δ Magnitude
Bundle 1	0.06	0.8
Bundle 2	0.02	0.1
Bundle 3	0.03	0.2
Bundle 4	0.1	0.8
Bundle 5	0.02	0.1
Bundle 6	0.06	0.8

+

Dispersed CMD



~ 7000 hours of CPU time



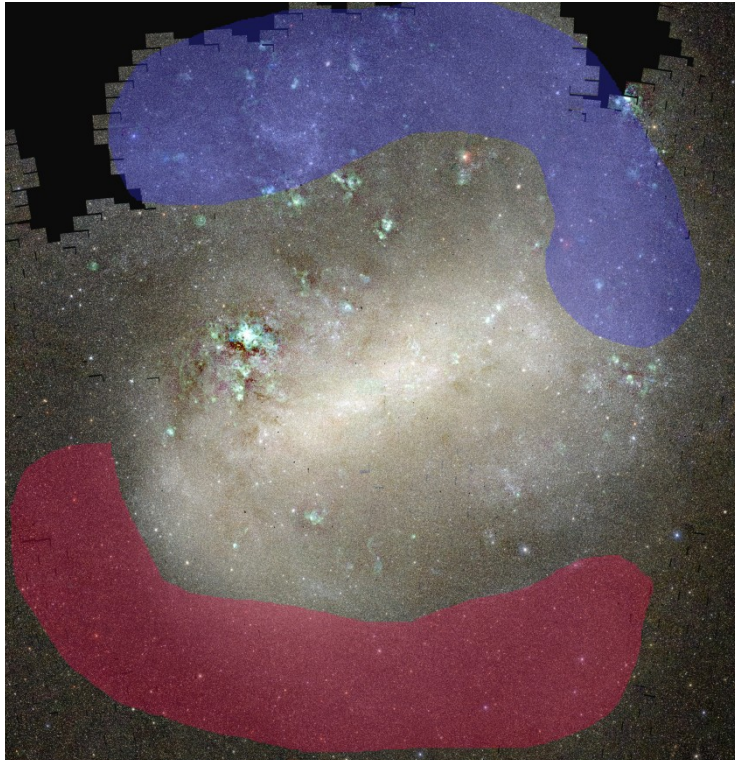
The distribution of stars in the observed CMD (reaching the oMSTO) is compared to that of a number of SSPs from a model CMD with observational errors simulated

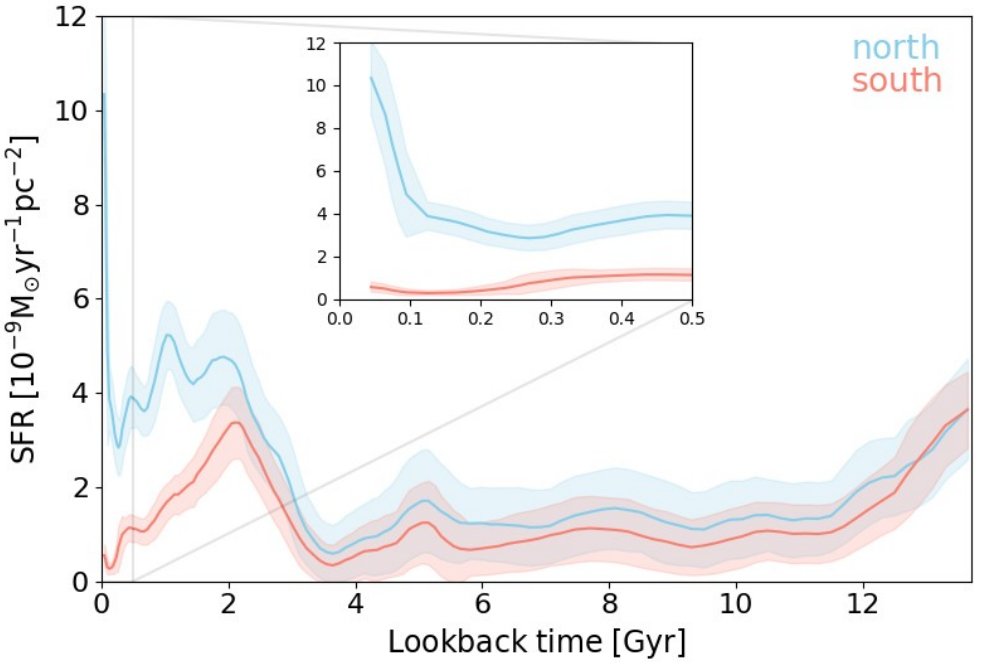
Model CMD computed using BaSTI models Pietrinferni et al. 2004

Age: 0.03 Gyr to 14.0 Gyr
Metallicity: 0.0001 to 0.025

No prior knowledge of the AMR is adopted

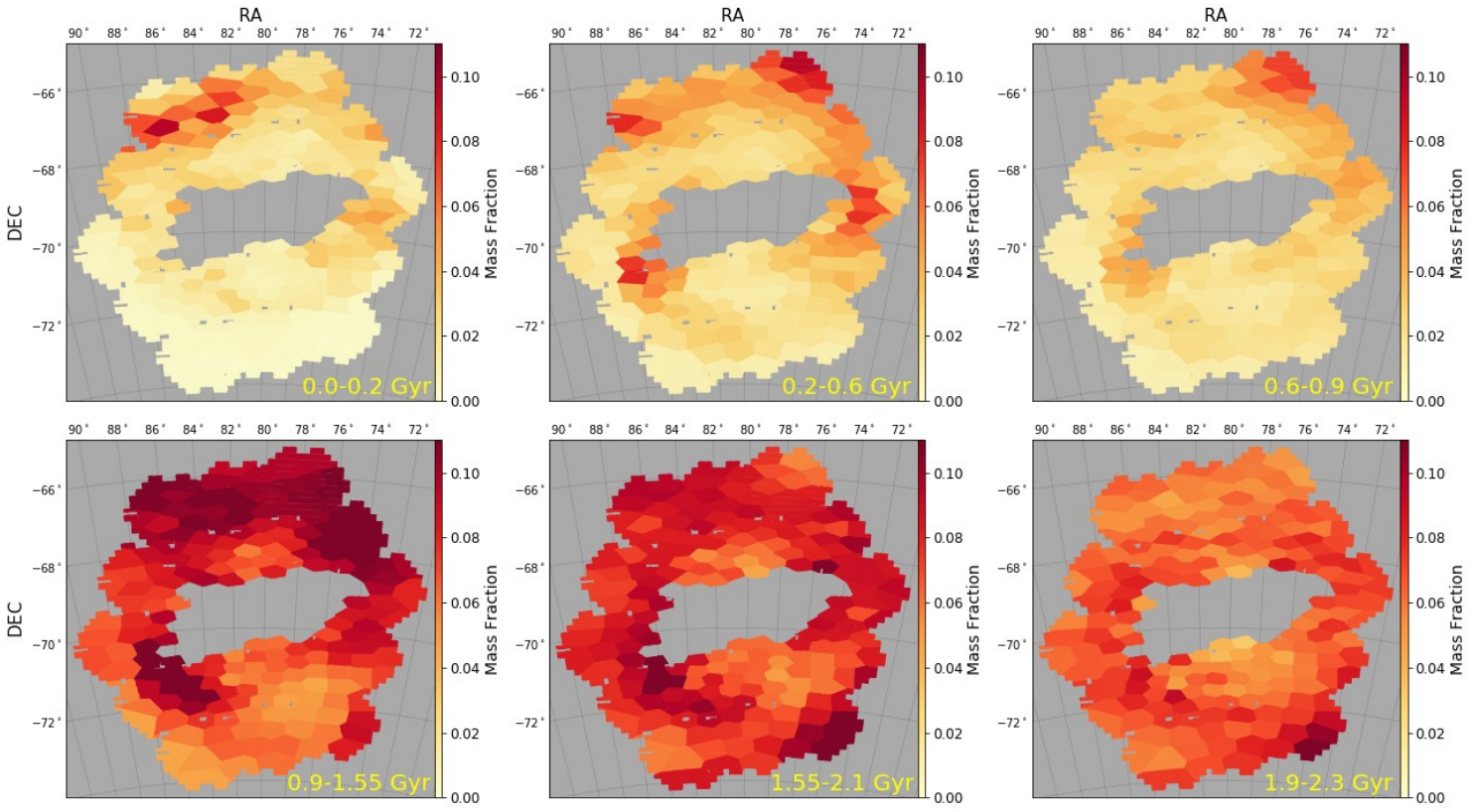
Results I





Differences in the SFH of the LMC arm and southern region appear drastically ~2 Gyr ago. Otherwise both regions share the same evolution

Results II



- Stars younger than ~2 Gyr show a clear spatial coherence around the arm region
- This spatial coherence provides indisputable evidence that this structure has been in place for at least ~2 Gyr, surviving dynamical arguments such as differential rotation

Conclusions

- We have developed a robust methodology based on **CMD fitting techniques** to massively obtain SFHs from SMASH 2D photometric catalogues (~ 200000 hours of CPU time)
  - Unprecedented coverage of both clouds with deep CMDs, reaching the oMSTO
  - Unparalleled age resolution at intermediate-to-old ages
- We have found a clear dichotomy in the young stellar content (younger than 2Gyr) of the LMC arm region compared to that of an opposite region towards the south
- Stars younger than 2 Gyr pile up in the arm region
- We conclude that the LMC spiral arm is a stable structure whose formation is linked to the close LMC-SMC interaction ~2 Gyr ago that triggered the formation of the Magellanic Stream and its Leading Arm
- Analysis just started, full characterisation of the SFH of the LMC and SMC in 2D coming soon… **the best is still to come!**