UNIVERSITAT DE BARCELONA

ICCUB Institut de Ciències del Cosmos

IEEC Institut d'Estudis Espacials de Catalunya

Gaia DPAC Data Processing & Analysis Consortium

Dynamical characterization of the Magellanic Clouds using Gaia data

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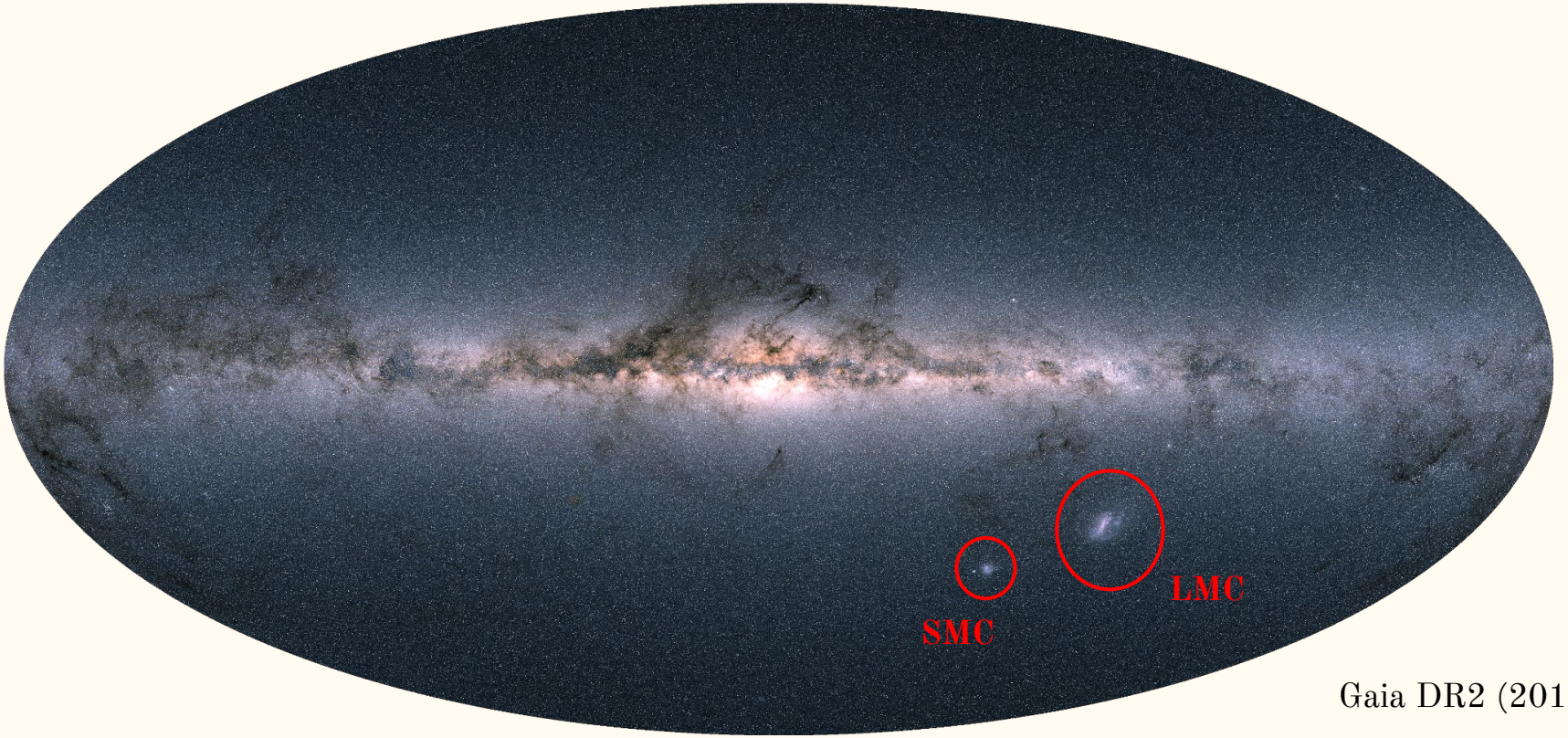
08/02/22

What are the Magellanic Clouds?



Gaia DR2 (2018)

Characterising the Magellanic Clouds

Surveys that study the Magellanic Clouds:

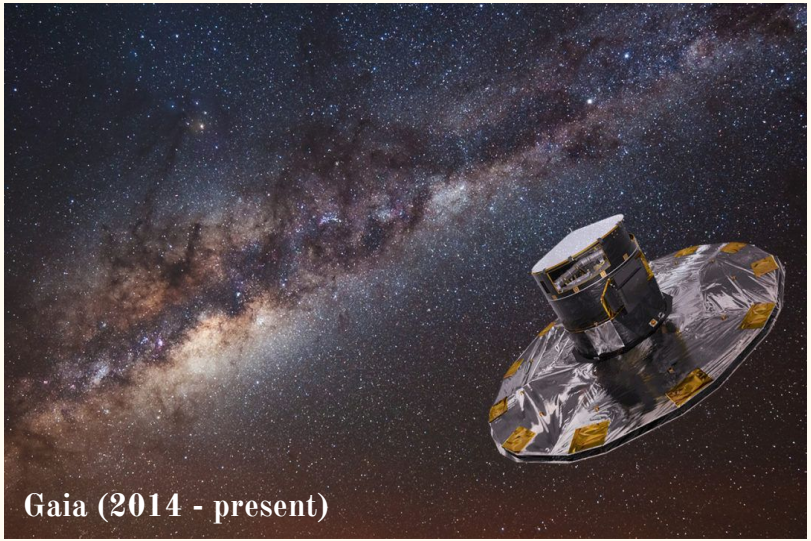
- VMC (Cioni+11)
- SMASH (Nidever+17)
- SMSS (Wolf+18)
- 2MASS (Skrutskie+06)
- MCELS (Pellegrini+12)
- ...

Photometric Surveys

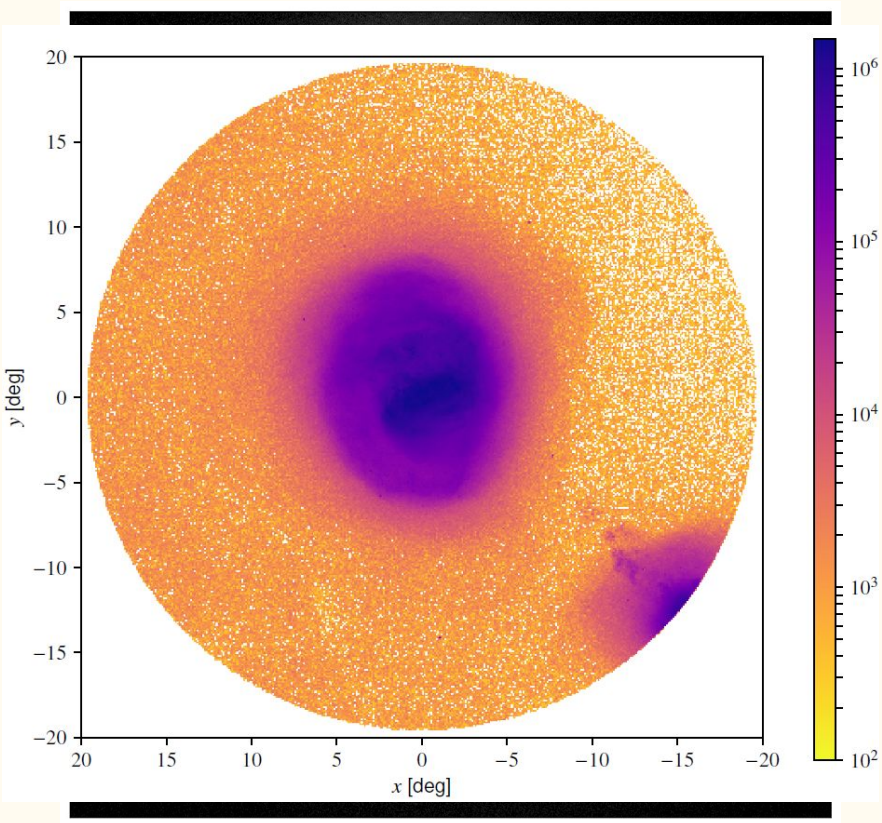
Spectroscopic Surveys

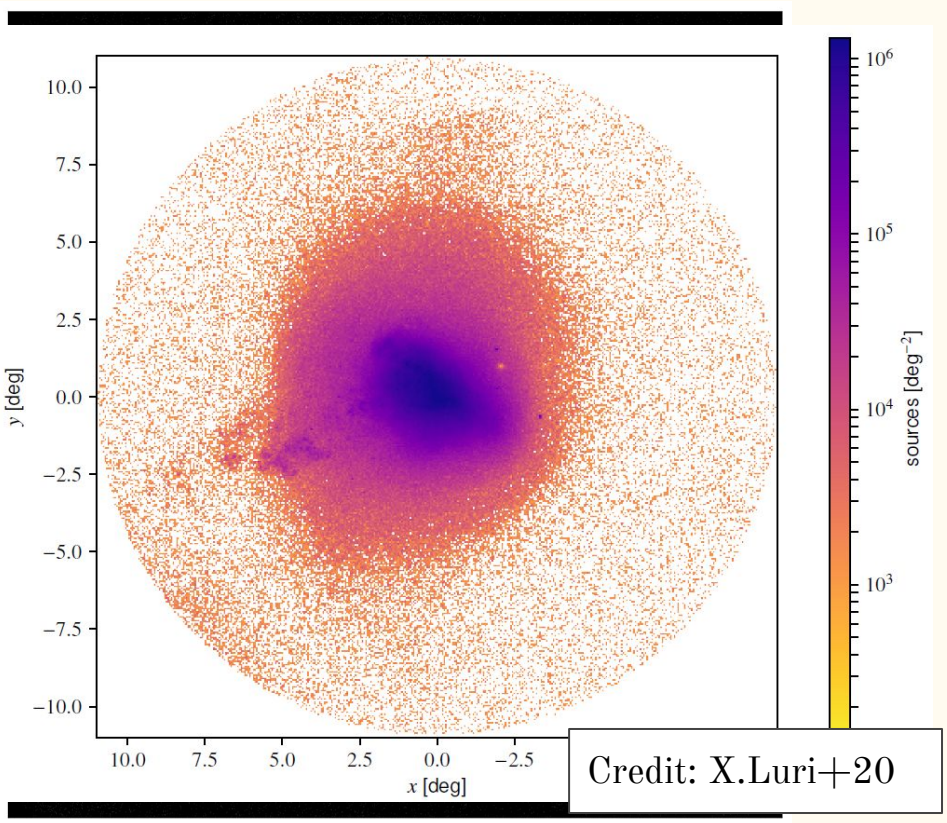
- Gaia mission

Astrometric Mission (+ Photometry)



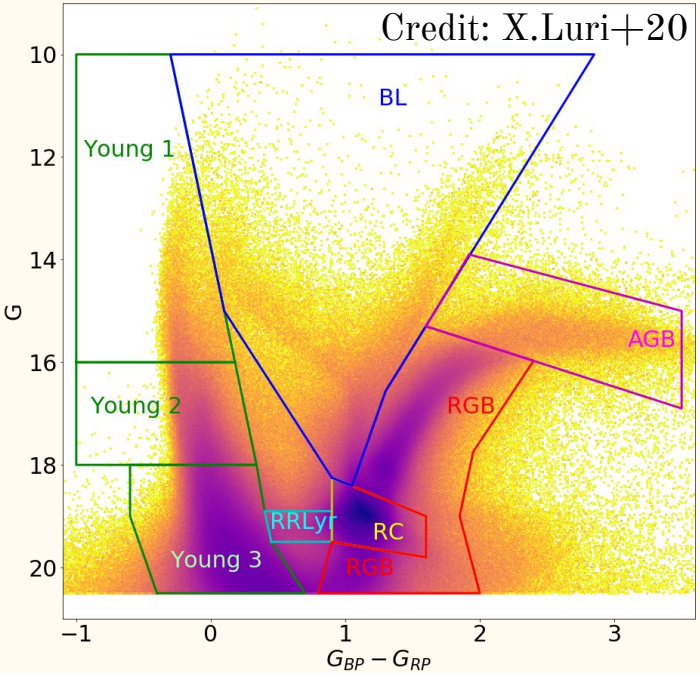
Characterising the Magellanic Clouds using Gaia data



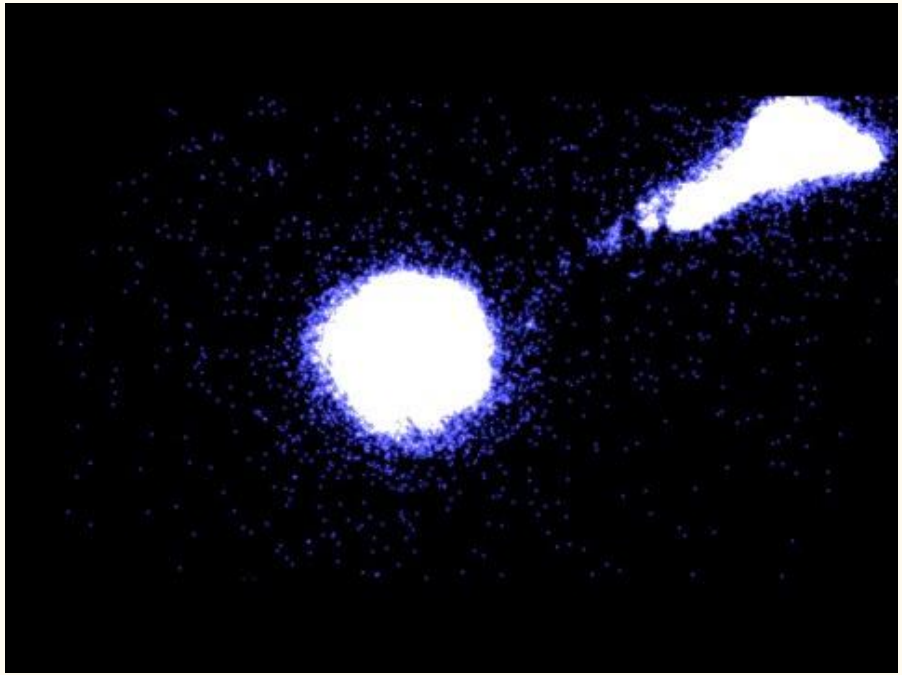


Credit: X.Luri+20

Characterising the Magellanic Clouds using Gaia data

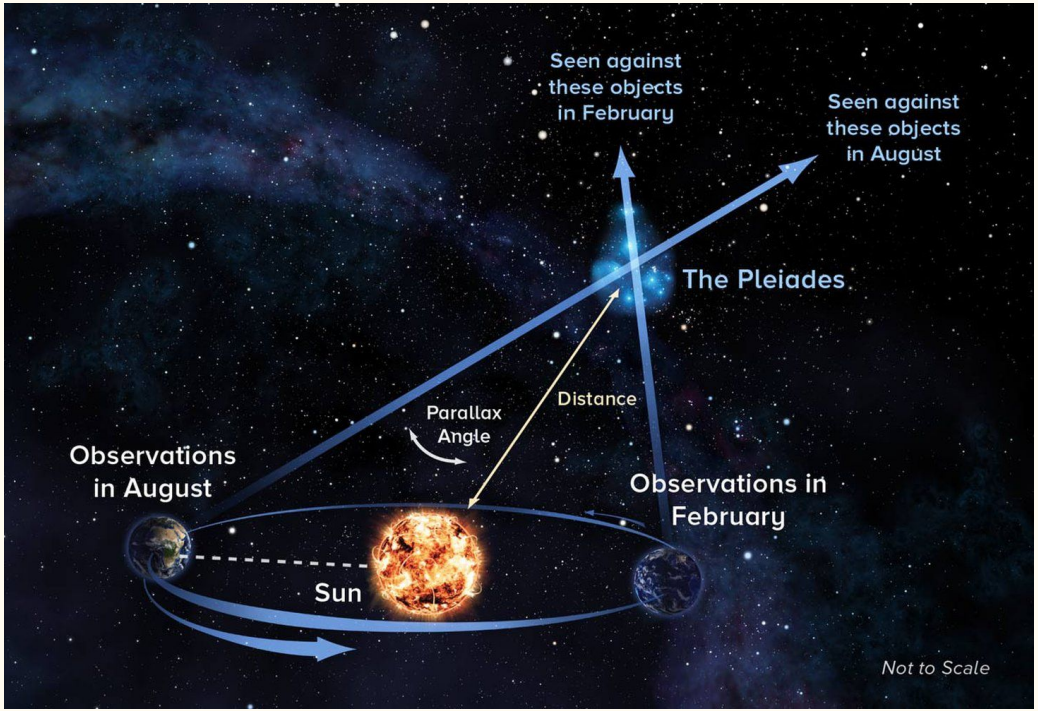


Color-magnitude diagram (CMD) for the Gaia eDR3 LMC clean sample.

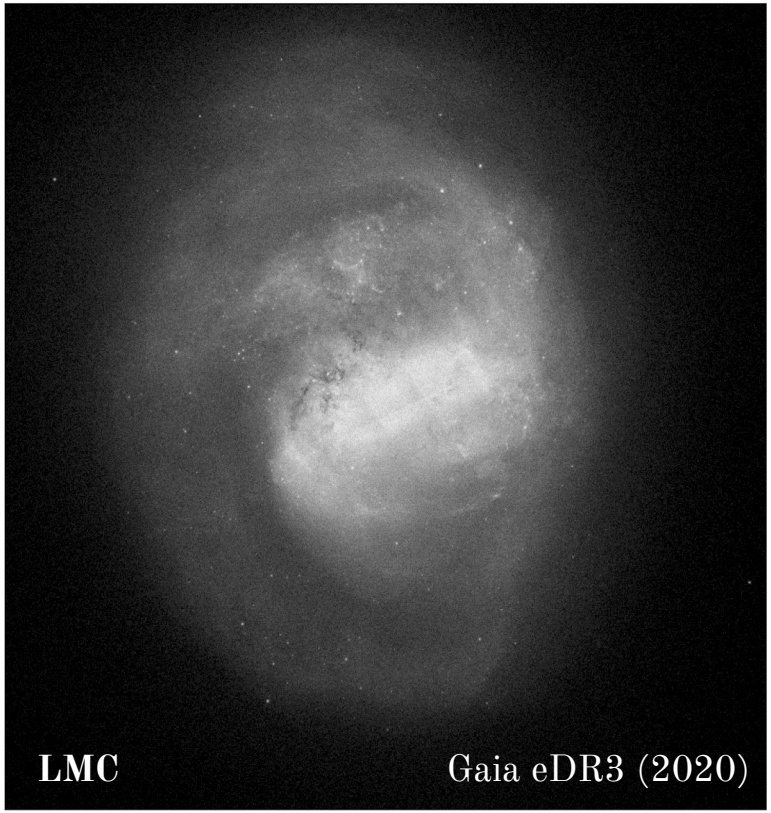


Youtube: “Gaia Early Data Release 3 - structure and properties of the Magellanic Clouds” (0:35 - 1:16)

However...
Gaia does not measure distances, but parallaxes



1) LMC 3D structure

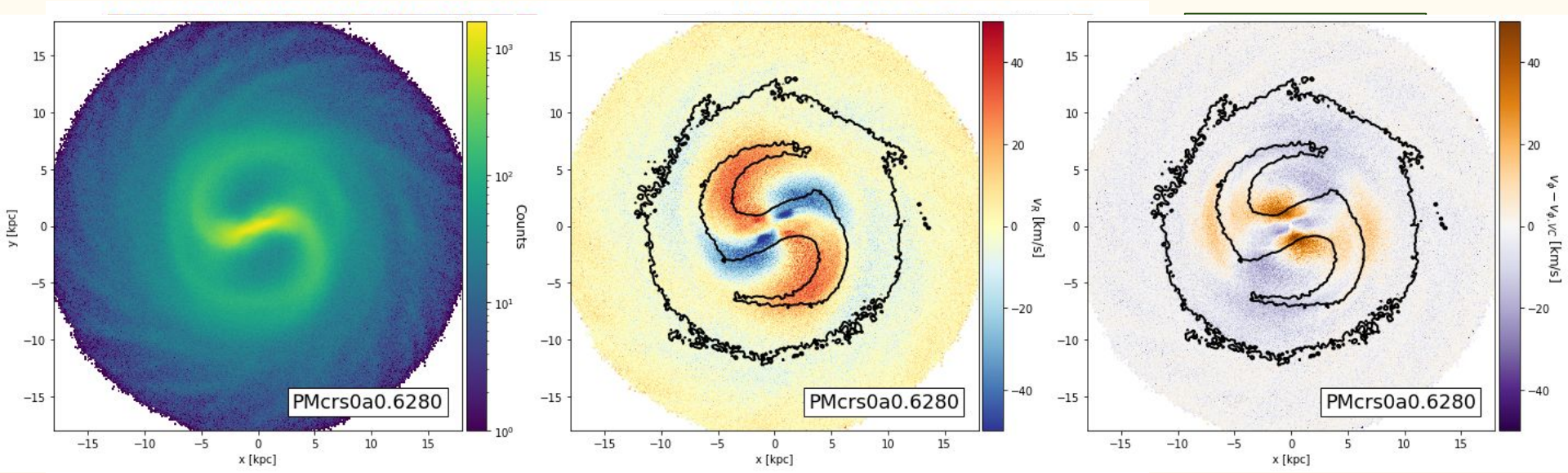


1) LMC 3D structure

To tackle this problem, we are trying the following methods:

- Approximation Bayesian Computation (ABC)
- Markov Chain Monte Carlo (MCMC)
- Using variable stars as tracers

2) LMC spiral arms nature

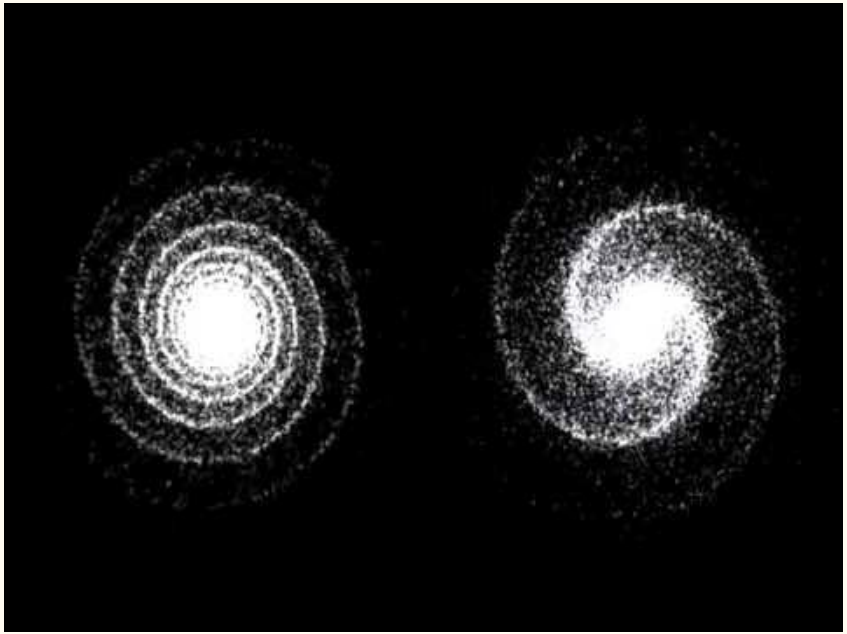


Now, thanks to Gaia, we are in position of comparing observables with different models to see which is the nature of the LMC spiral arms.

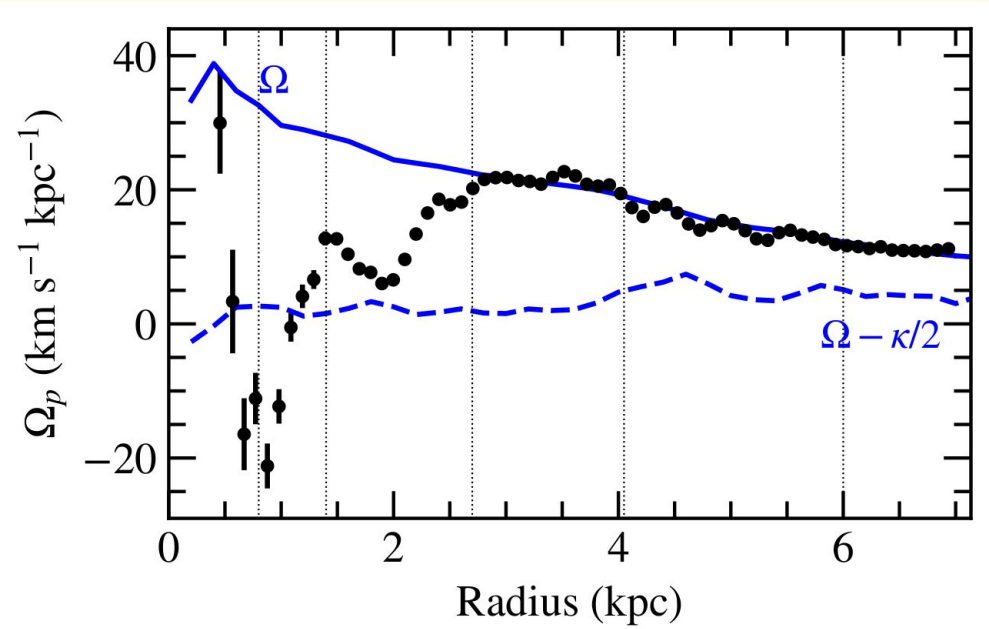
N-body simulation
Credit: S. Roca-Fàbrega

3) LMC spirals pattern speed

Ó. Jiménez-Arranz et al. (in prep.)

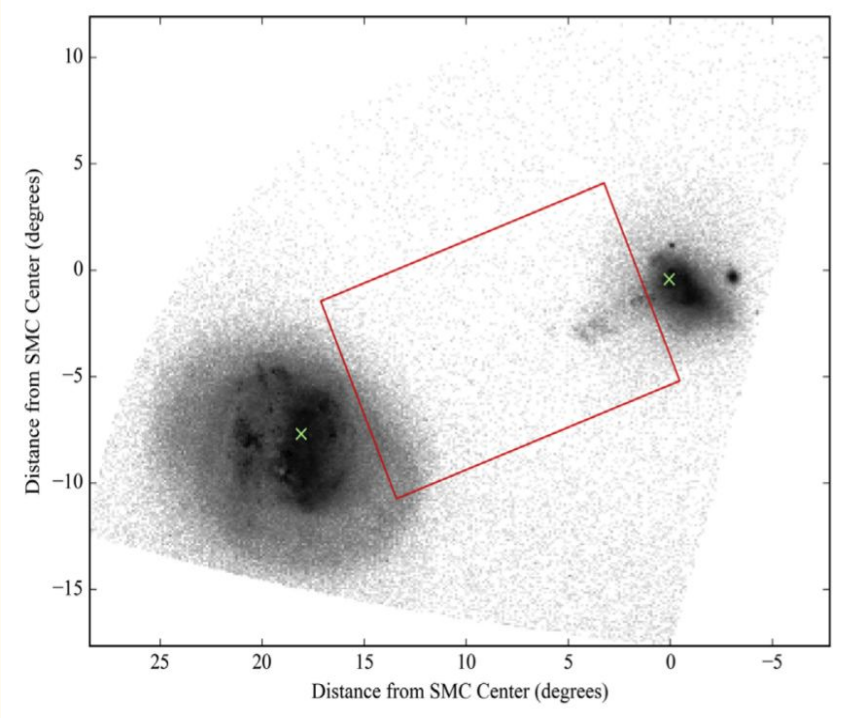


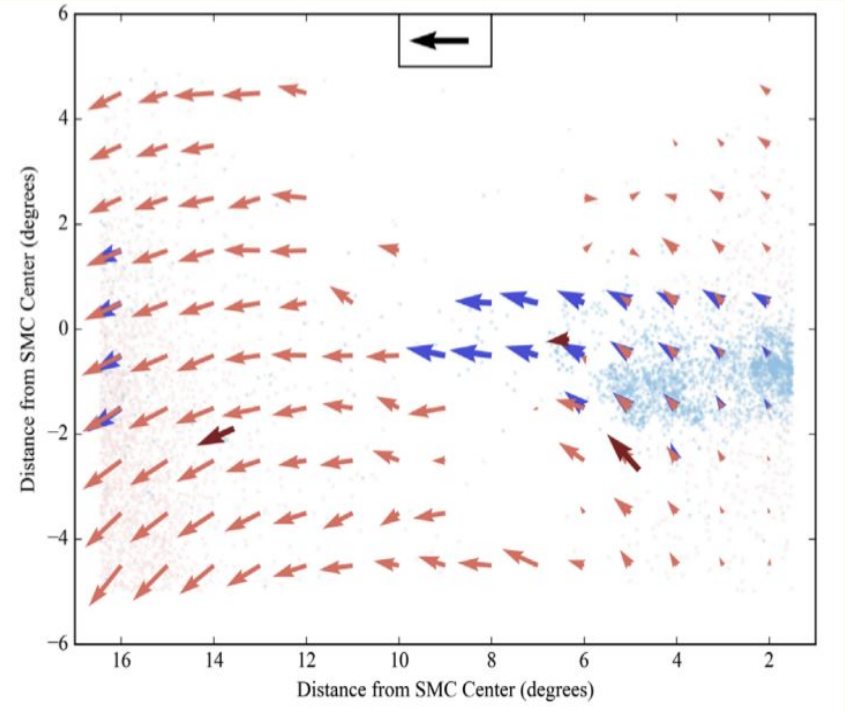
Youtube: “Density Wave Theory Animation”



Angular speed of rotation Ω_p of the bar and spiral patterns in the Large Magellanic Cloud (filled symbols). Obtained solving the Tremaine and Weinberg equation.

4) The Magellanic Bridge

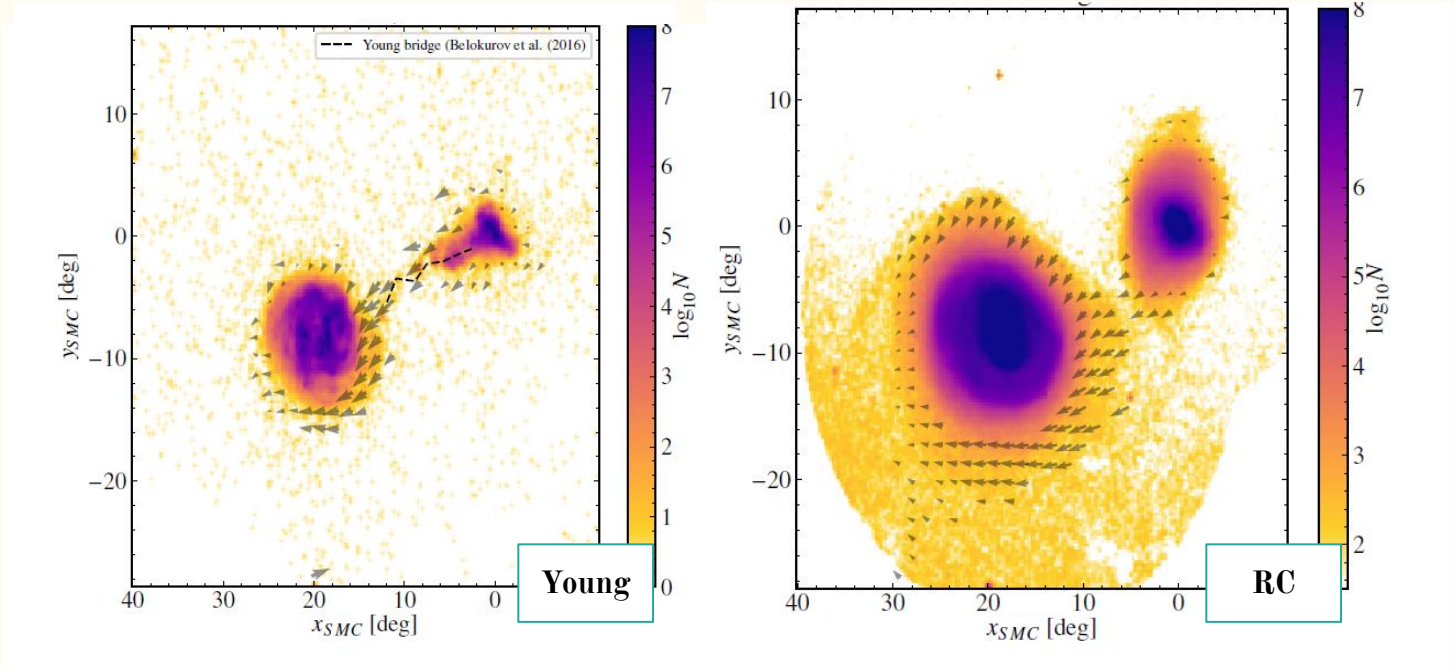




Credit: P. Zivick+19

4) The Magellanic Bridge

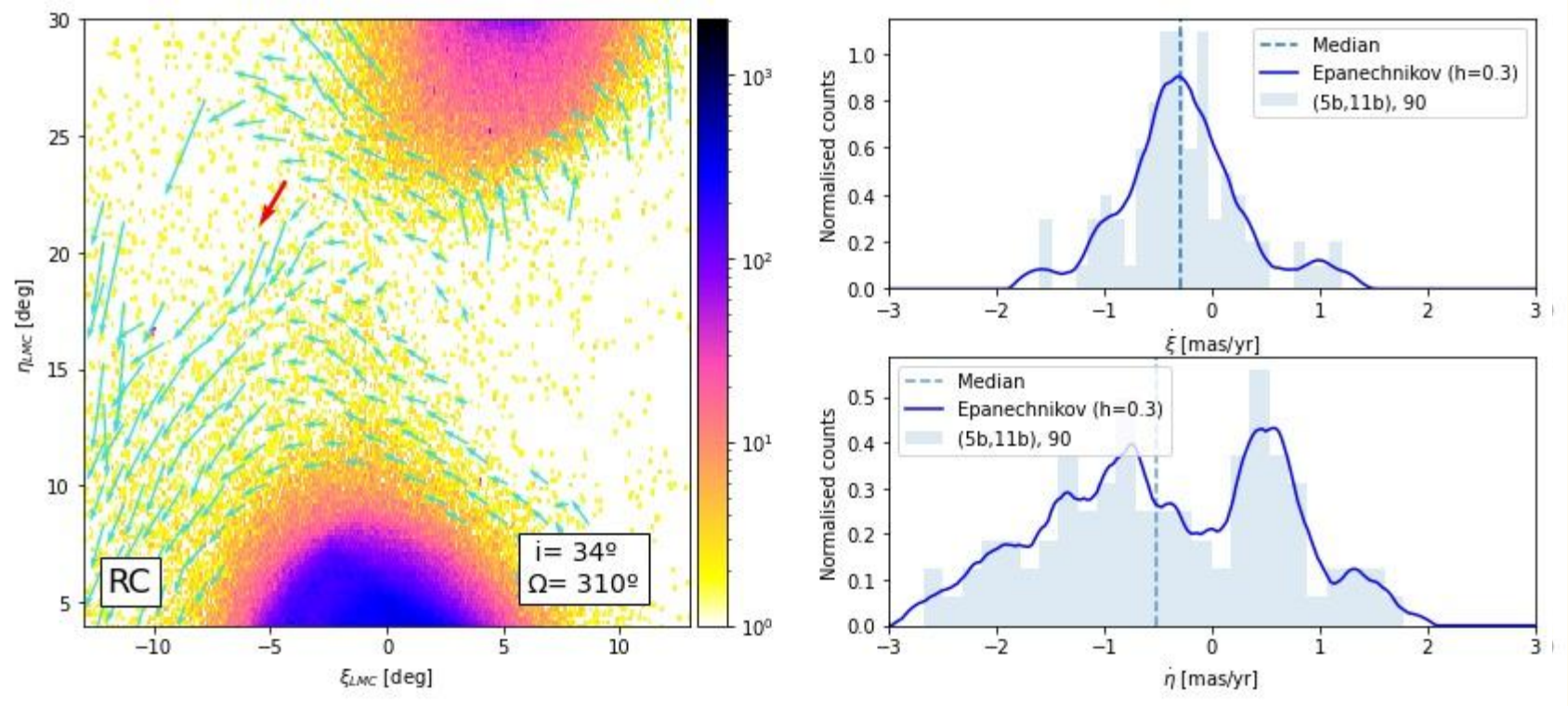
Credit: X.Luri+20



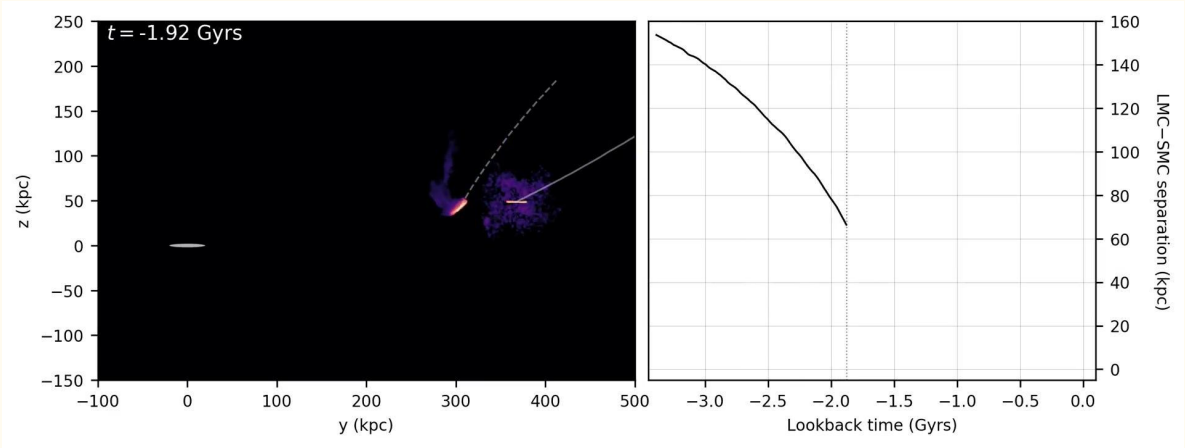
The connection between the SMC and the LMC is clear from the Young evolutionary phases to oldest ones such as the Red Clump (RC). Moreover, the **velocity vector in the region between clouds confirms it.**

4) The Magellanic Bridge

Ó. Jiménez-Arranz et al. (in prep.)



5) LMC/SMC high-resolution N-body simulation



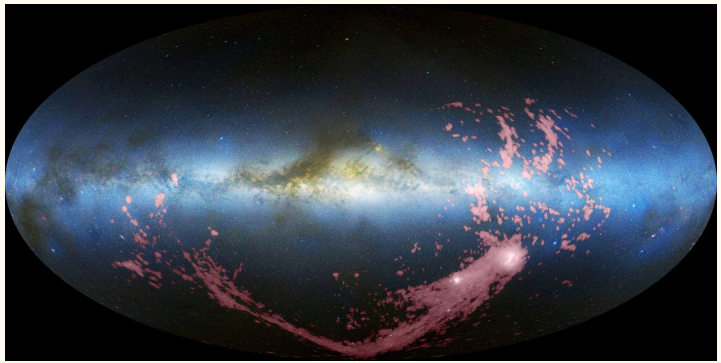
Credit: Lucchini+21

Lucchini's simulation:

- Hydrodynamic simulation (w/ gas)

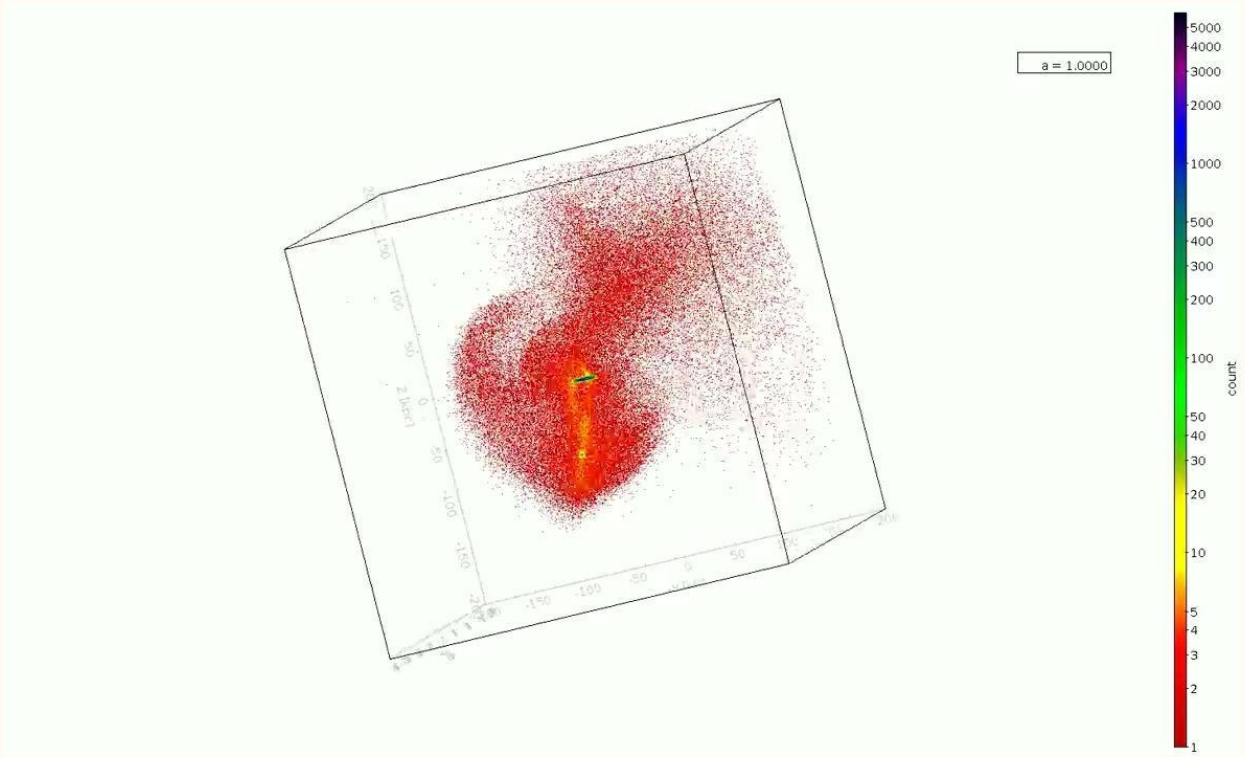
Scientific goals:

- Formation of the Magellanic Stream



The Magellanic Stream
Credit: Science - NASA, ESA, A. Fox, P. Richter et al.

5) LMC/SMC high-resolution N-body simulation



Our simulation:

- N-body simulation, i.e, just stars and gravity, no gas.
- High spatial, temporal and mass resolution - specific numbers TBC.

Scientific goals:

- MC orbital analysis
- LMC spiral ams dynamics
- Magellanic Bridge
- LMC warp
- ...

OCRE Open Clouds for Research Environments

Ó. Jiménez-Arranz et al. (in prep.)

Conclusions