

The Clouds are Breaking

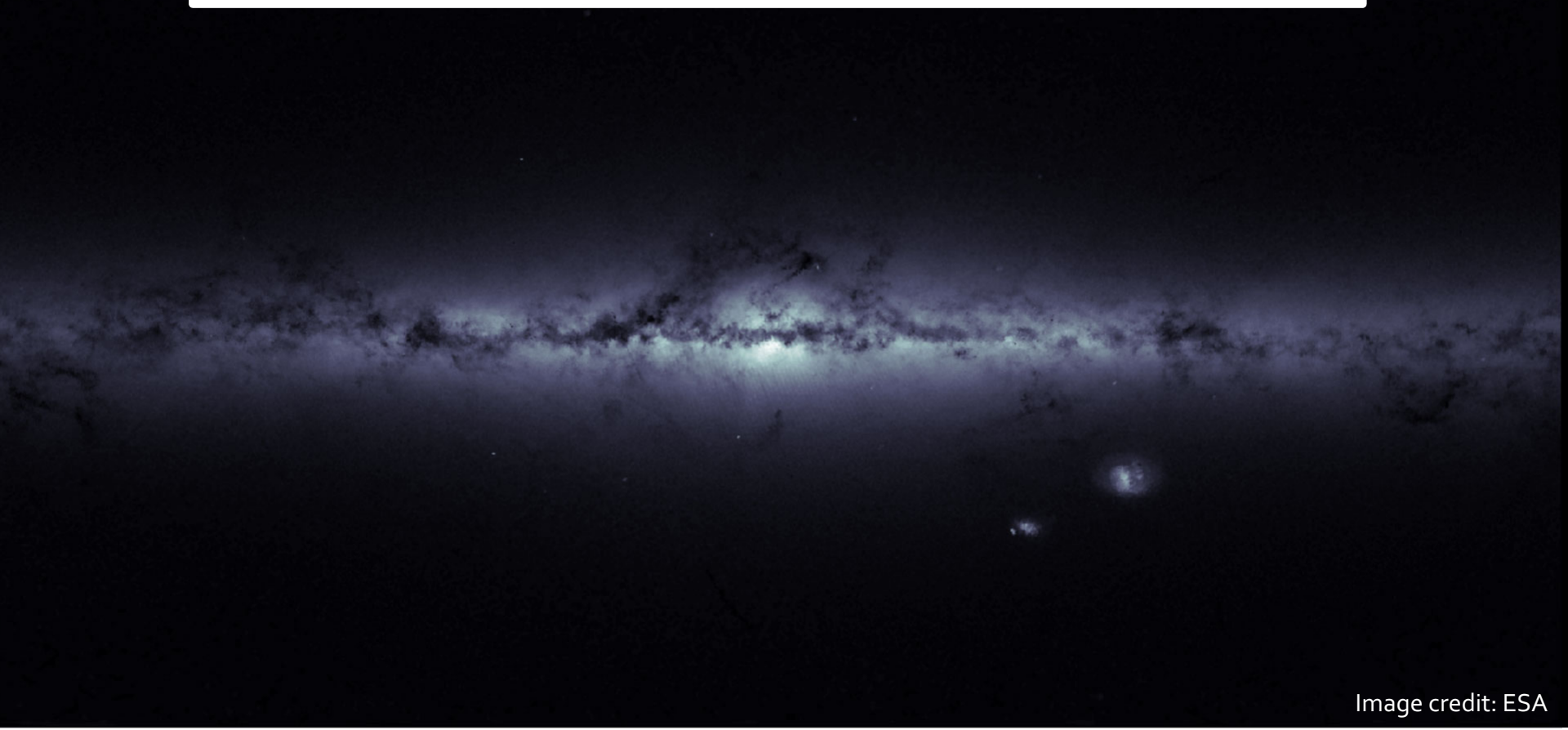


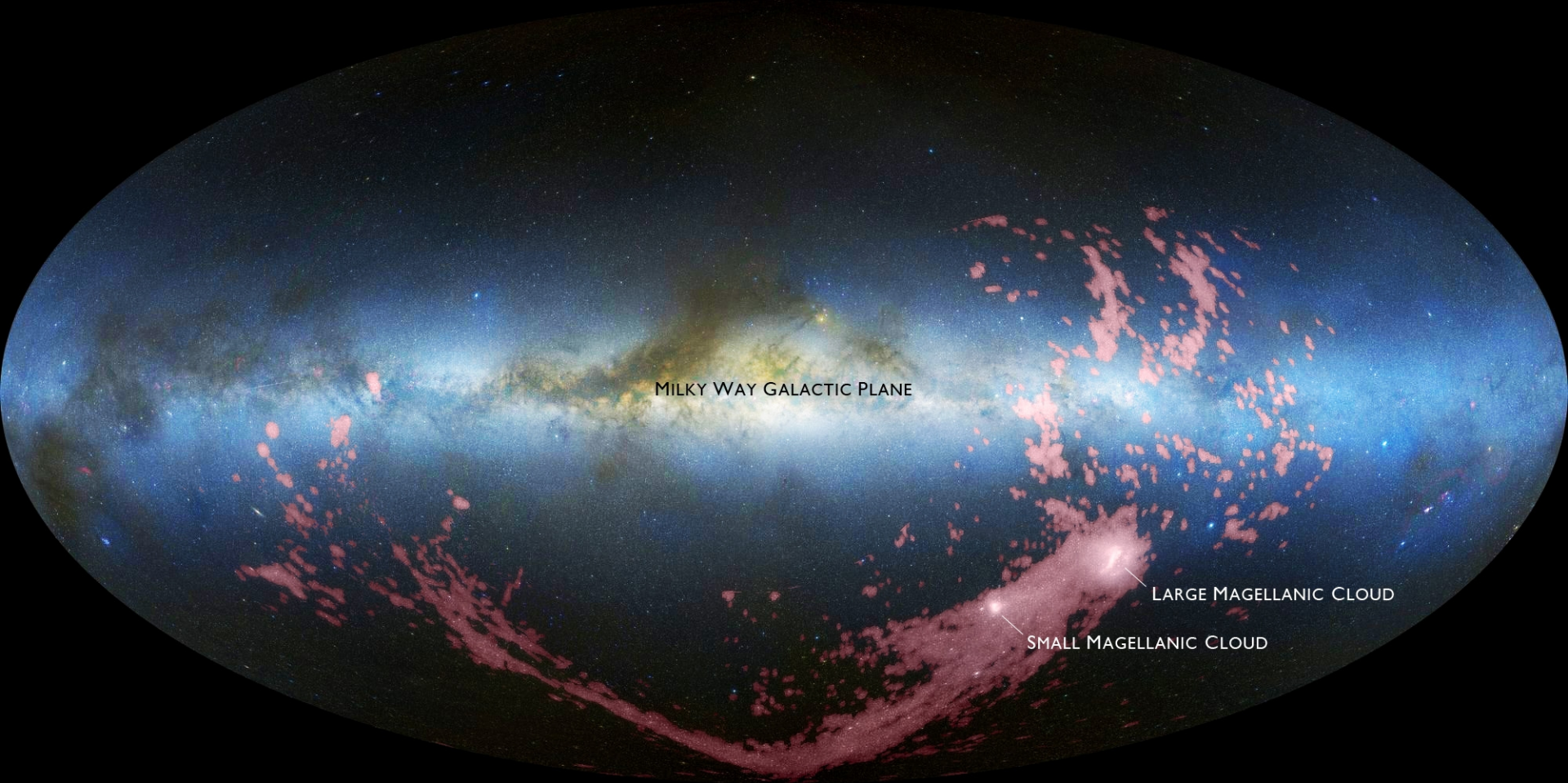
Image credit: ESA



Alis Deason – Royal Society URF

THE
ROYAL
SOCIETY

The Magellanic Clouds



MILKY WAY GALACTIC PLANE

LARGE MAGELLANIC CLOUD

SMALL MAGELLANIC CLOUD

Pair of massive dwarf galaxies.

SMC: $M_{\text{star}} \sim 3 \times 10^8 M_{\text{Sun}}$

LMC: $M_{\text{star}} \sim 2 \times 10^9 M_{\text{Sun}}$

Image credit: David Nidever

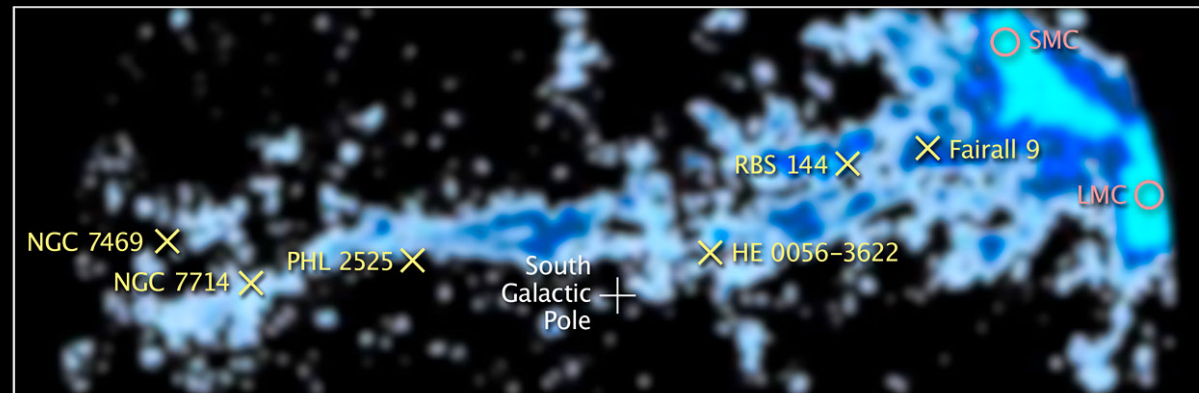
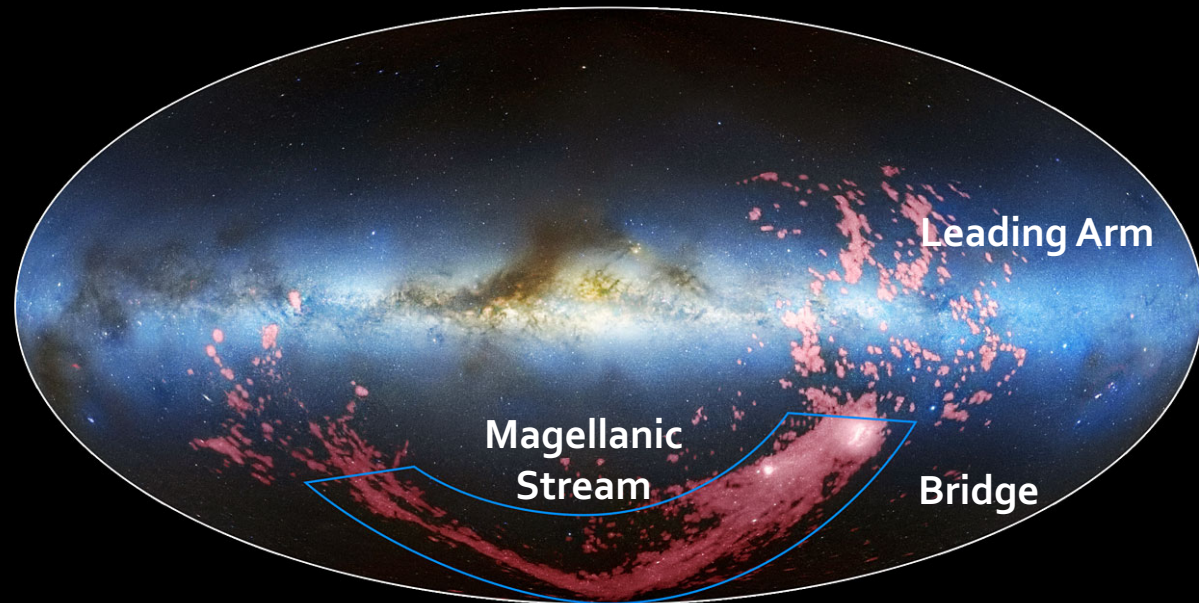
Gaseous Magellanic system

At least 200 deg long.

Likely result of **tidal interactions** between the Clouds and **ram-pressure** forces exerted by the Galactic hot halo.

Benchmark for hydrodynamical simulations of accreting gas and cloud/halo interactions.

Where are the stars?



Outskirts of the Clouds

The outskirts of the LMC and SMC are invaluable testing grounds for the various formation mechanisms of the Magellanic system.

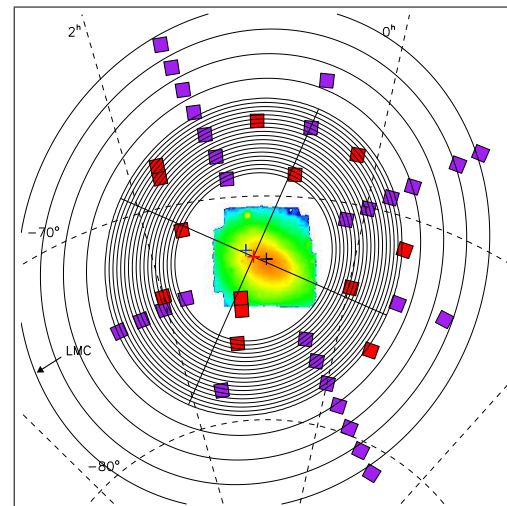
The long-awaited confirmation of the *stellar counterpart to the Magellanic stream*, which is predicted by all tidal models, will likely be uncovered in the low surface brightness regions surrounding the Clouds.

Evidence for *past interactions between the two dwarfs, and disturbances due to the MW tidal field* should be more apparent in these low-density regions.

Low density LMC/SMC in areas of high foreground ($b \sim -30$ deg).

Relatively high extinction.

Southern sky relatively unexplored!



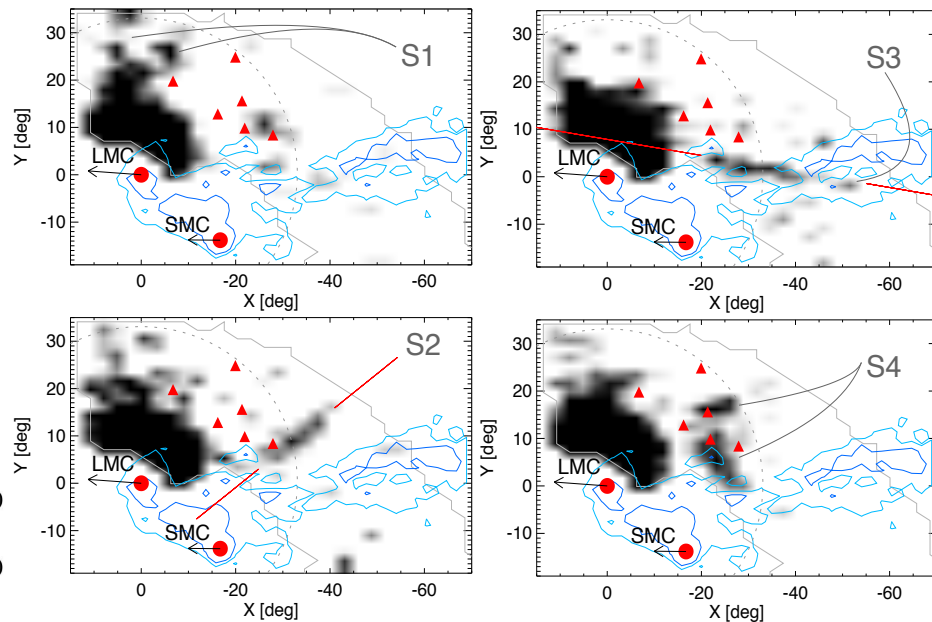
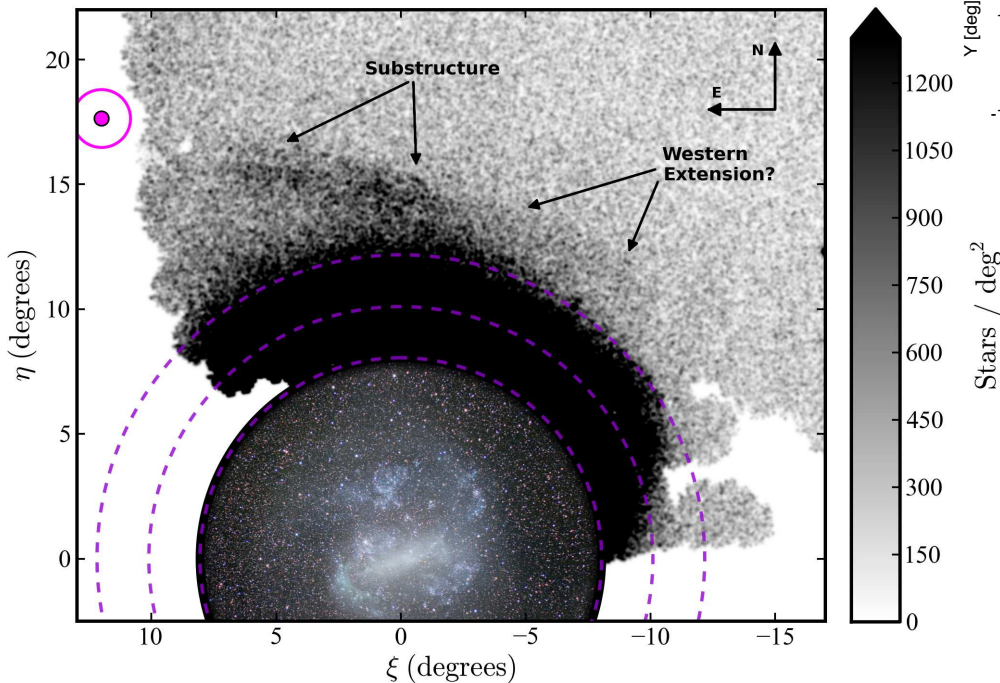
Nidever et al. (2011)
MAPS survey.

Outskirts of the Clouds: 2016

(DES/DECam)

Mackey et al. (2016)

Northern Structures:
Likely stripped LMC disc due to tidal interactions with MW and/or SMC
(cf. Besla et al. 2016).



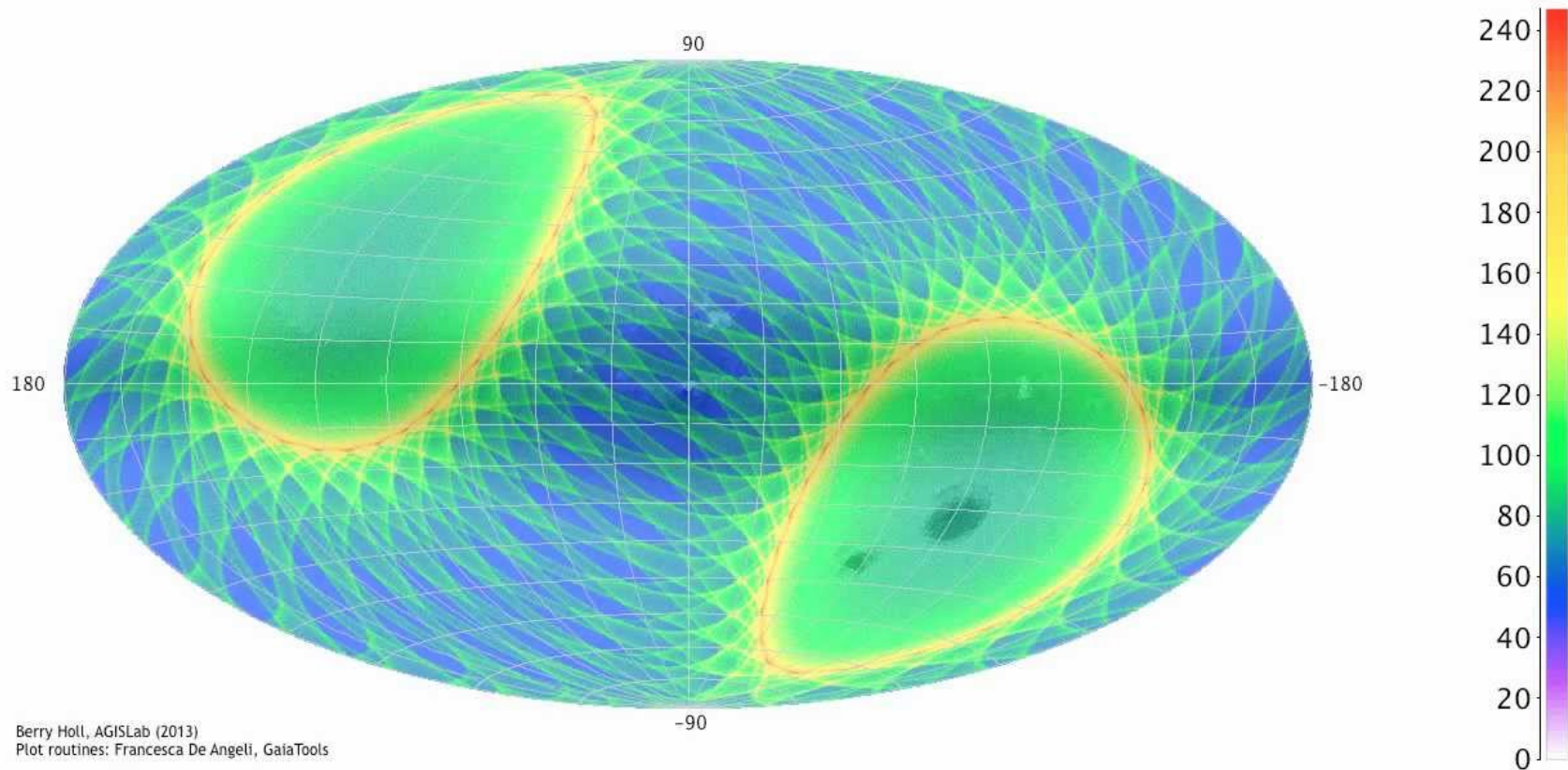
Belokurov & Koposov (2016)

“Lumpy” stellar halo out to 25-50 kpc.

Discovery of a number of narrow streams and diffuse debris clouds.

Gaia: Variable Star Machine

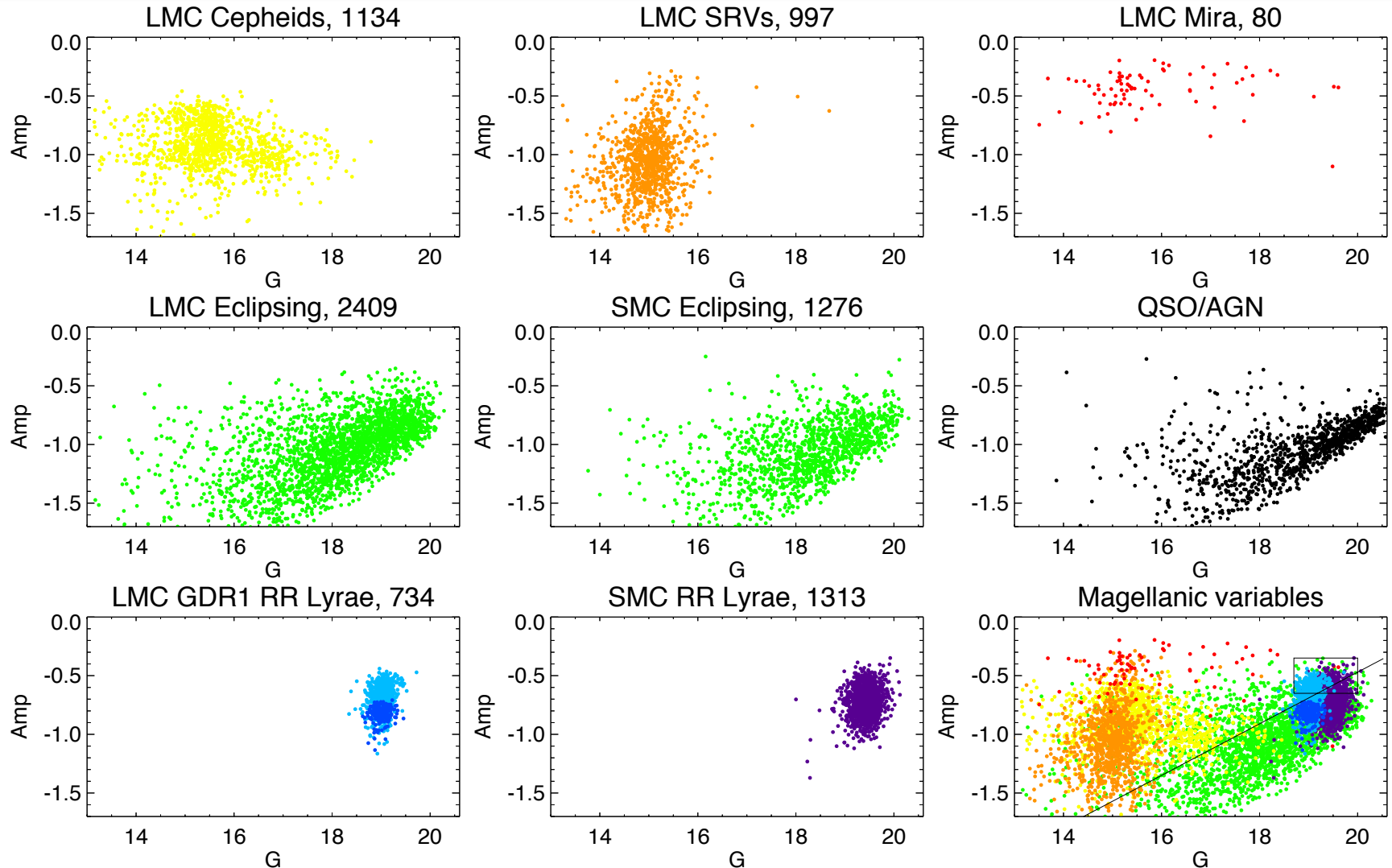
NSL field transits after 5 years in: **Galactic** coordinates



Data Release 1:
"Variability Amplitude "

$$A = \sqrt{N_{\text{obs}}} \sigma(F) / F$$

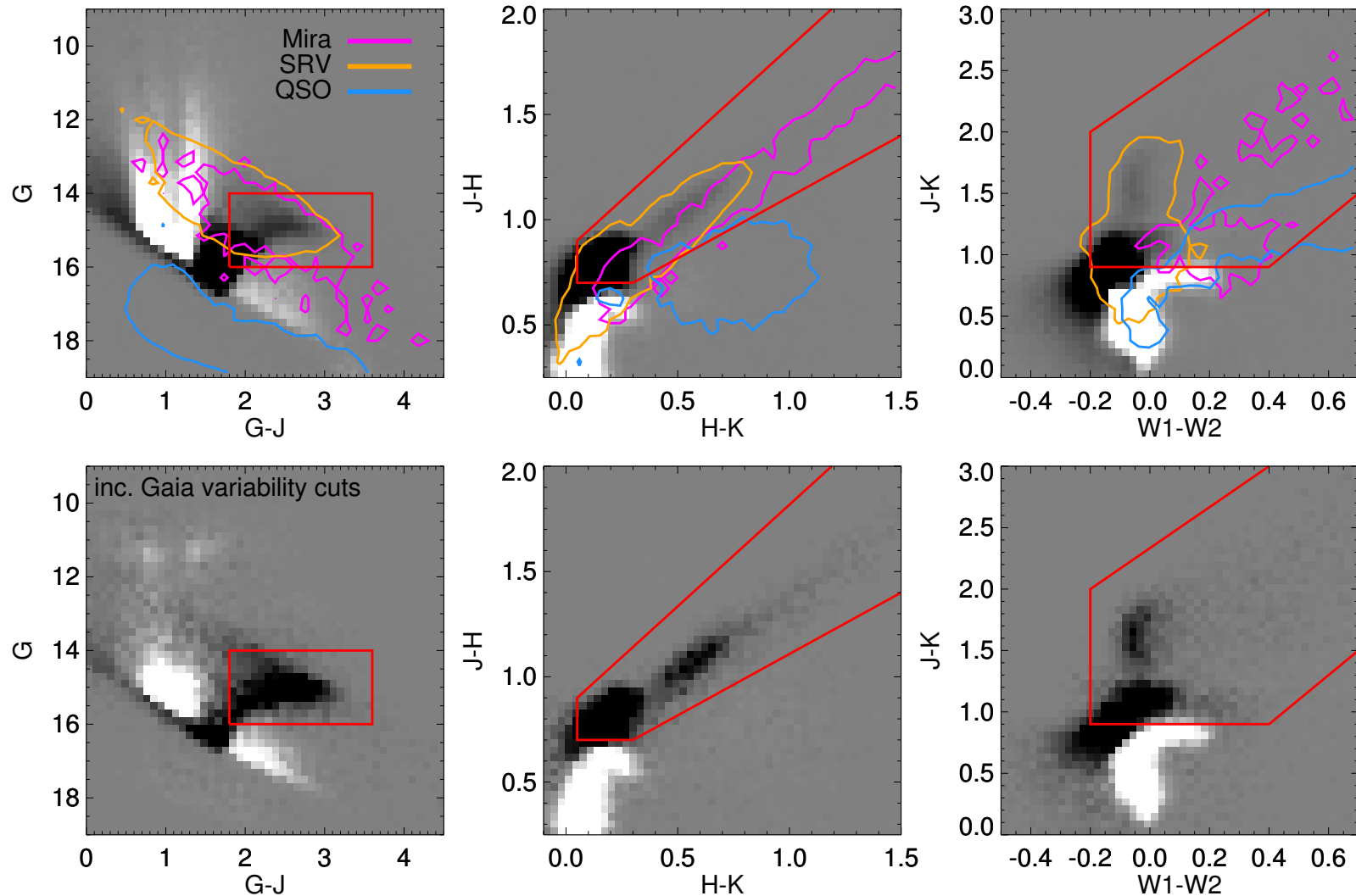
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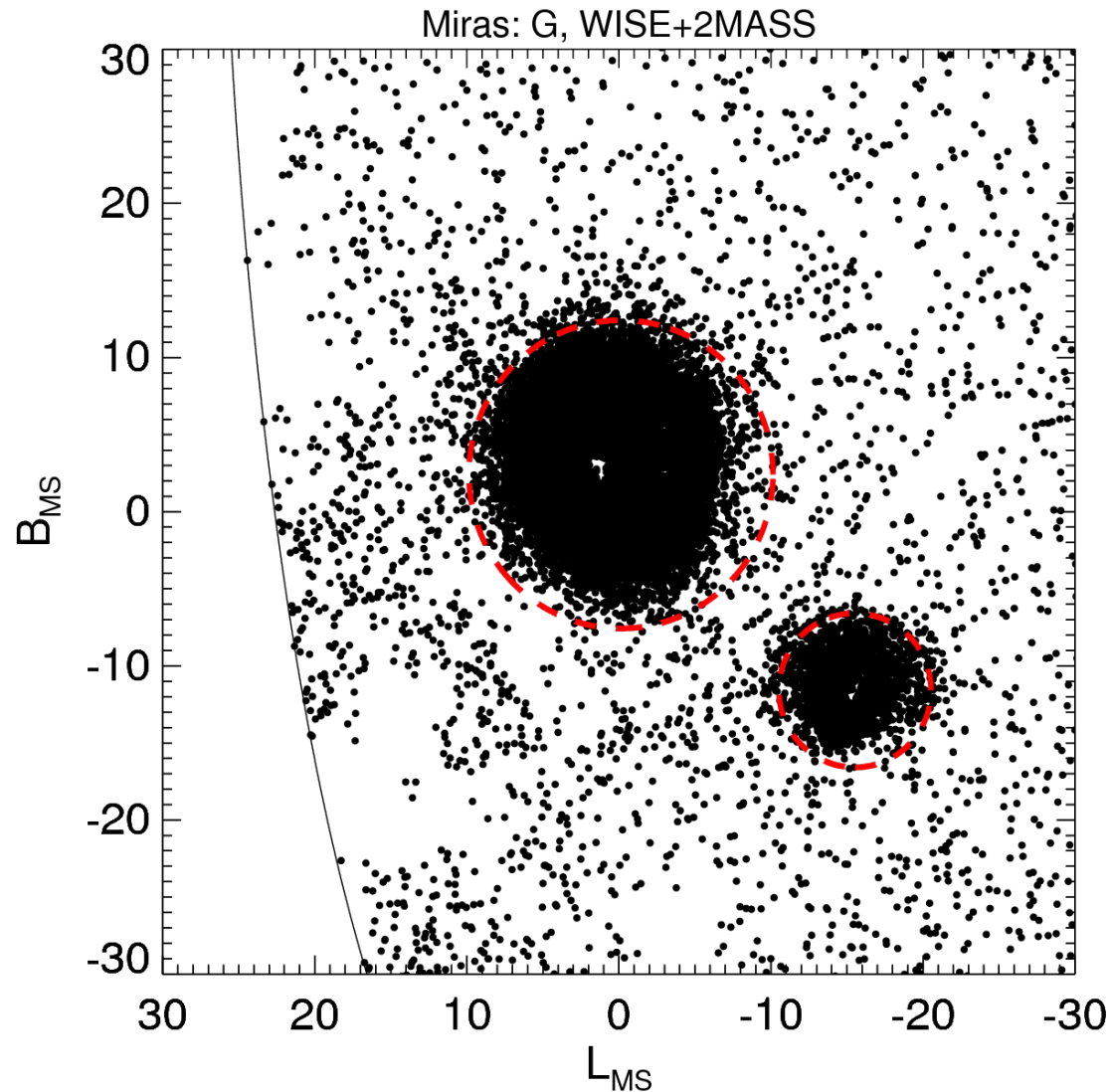
Known variable objects in the Magellanic Clouds

Magellanic Mira Variables

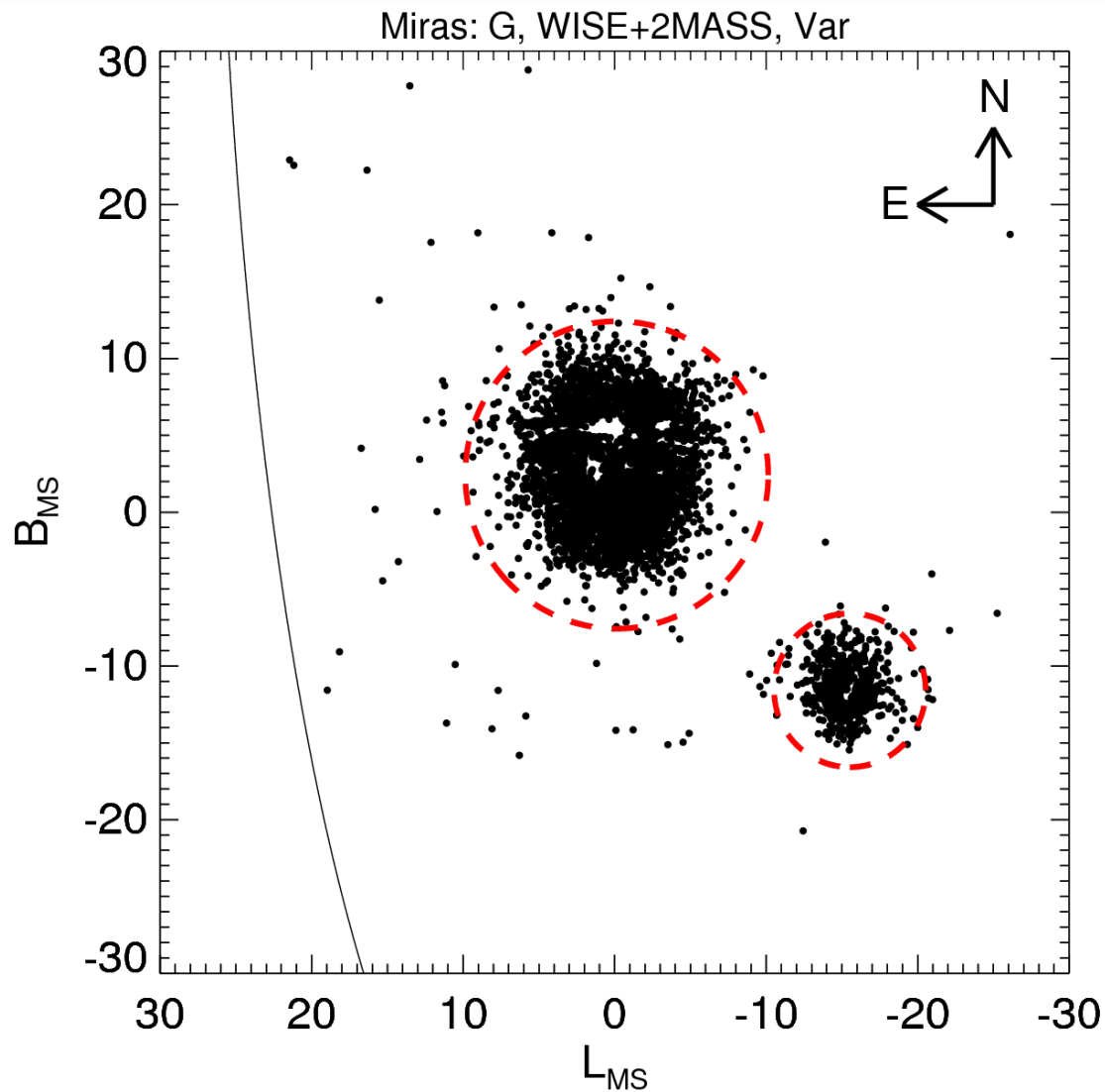
IR photometry from 2MASS+WISE



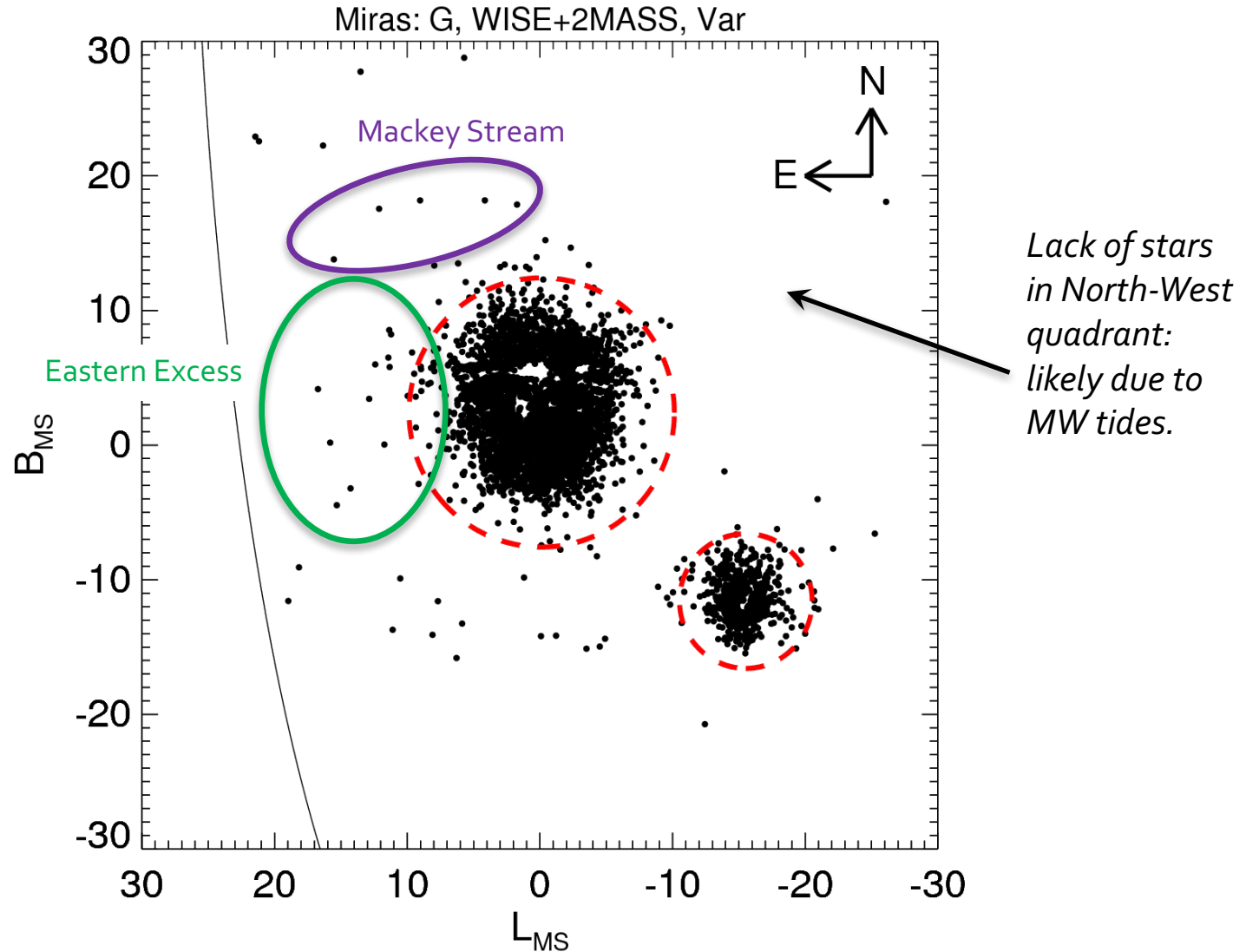
Magellanic Mira Variables



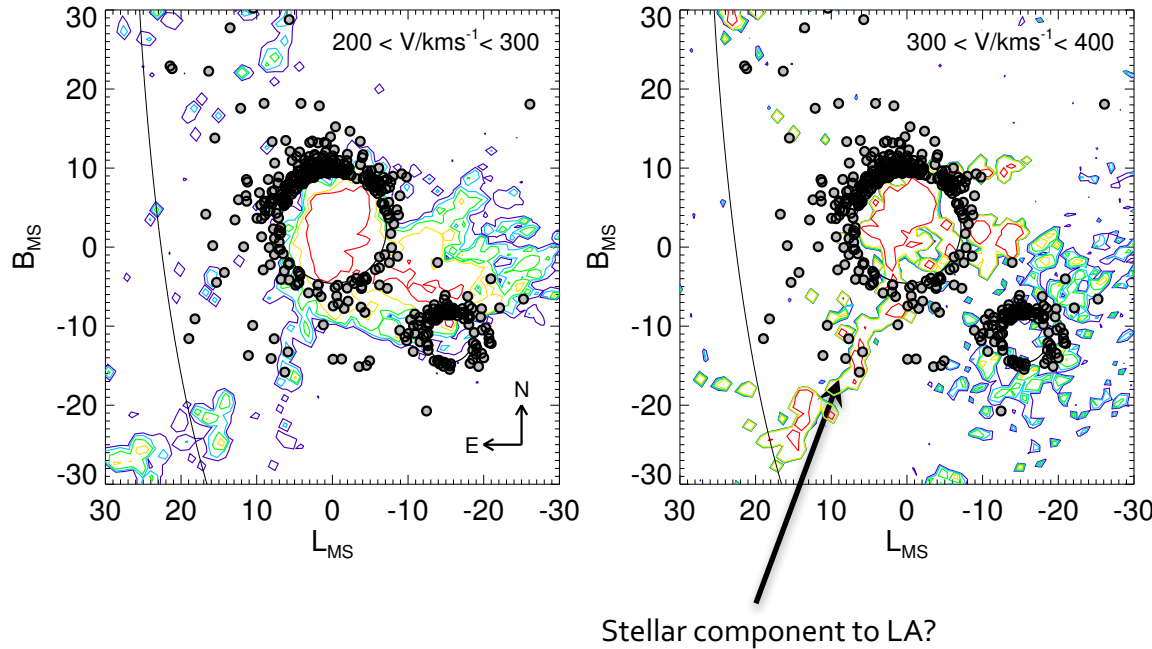
Magellanic Mira Variables



Magellanic Mira Variables

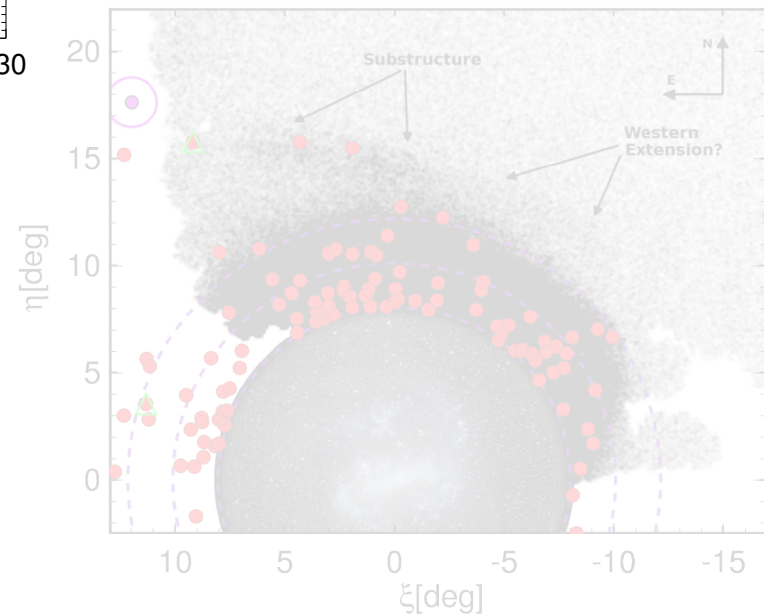


Magellanic Mira Variables

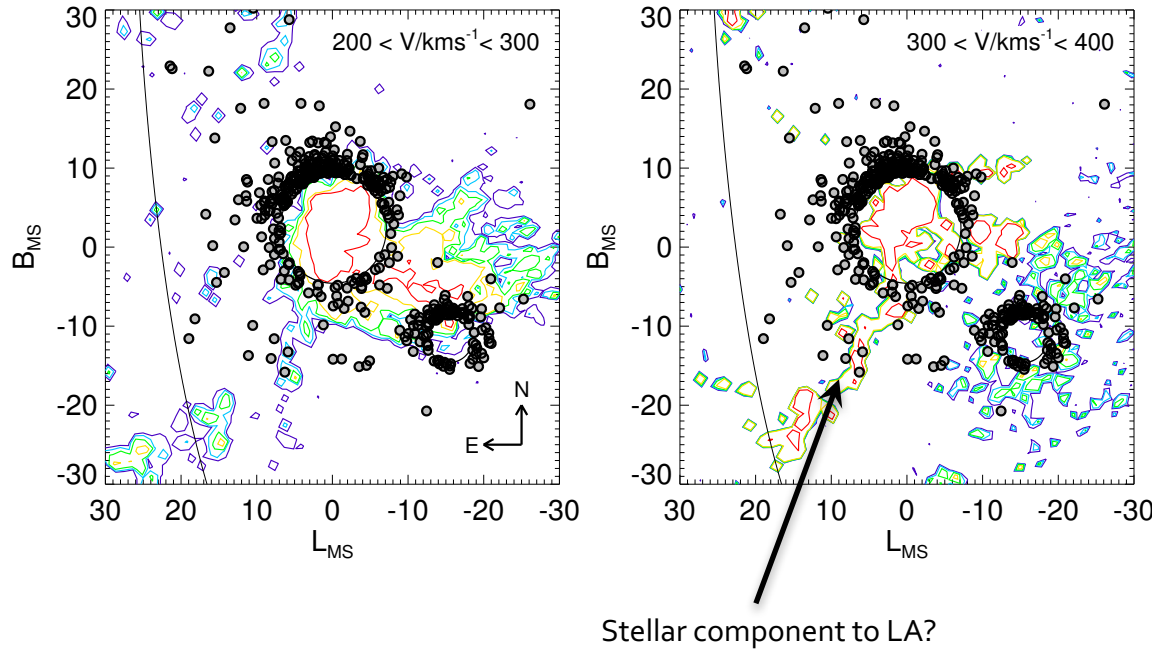


Stars generally don't trace HI gas distribution.
 Evidence for Miras in Leading Arm?

Mackey et al. 2016 stream:
 Stripped LMC disc.
Why is the stream so thin in Miras?

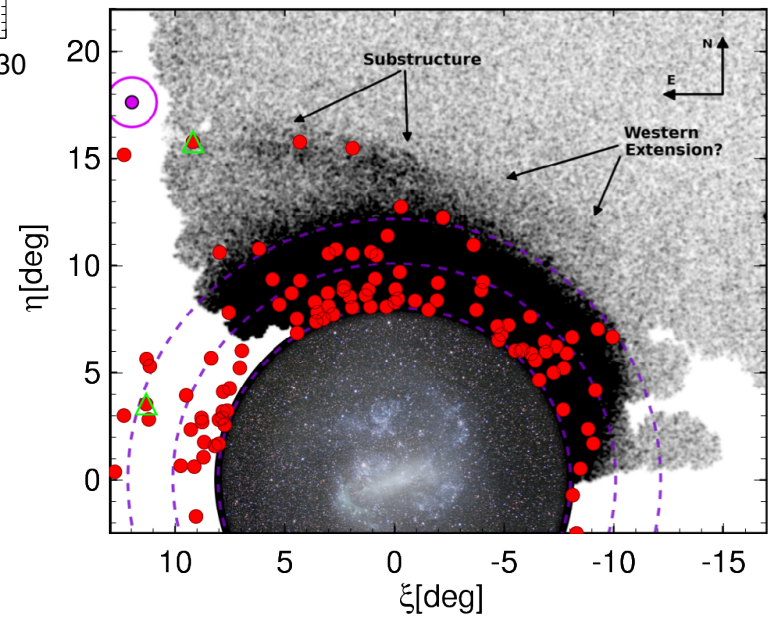


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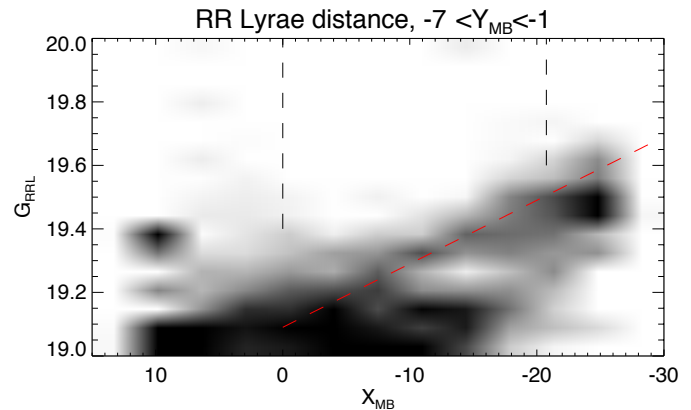
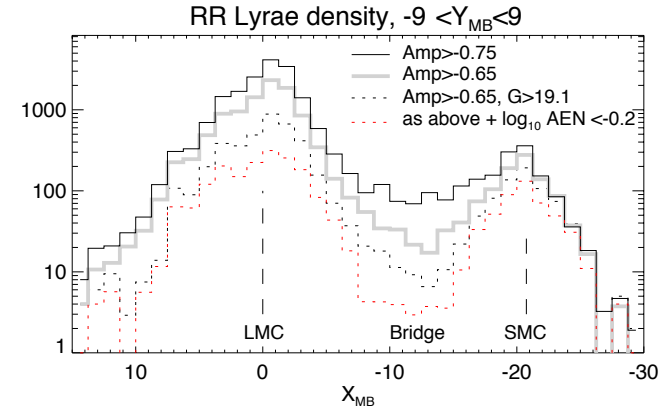
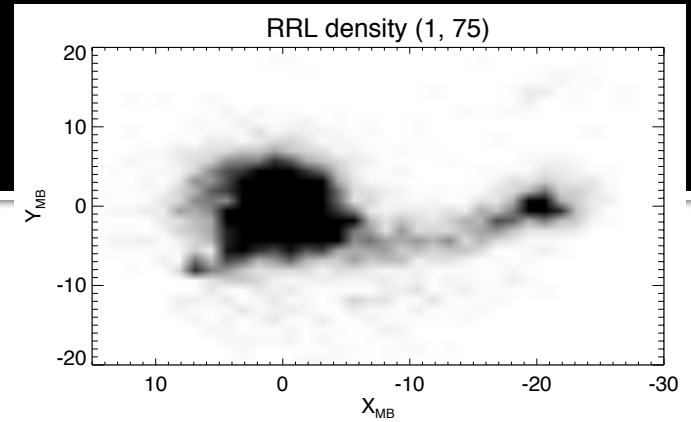
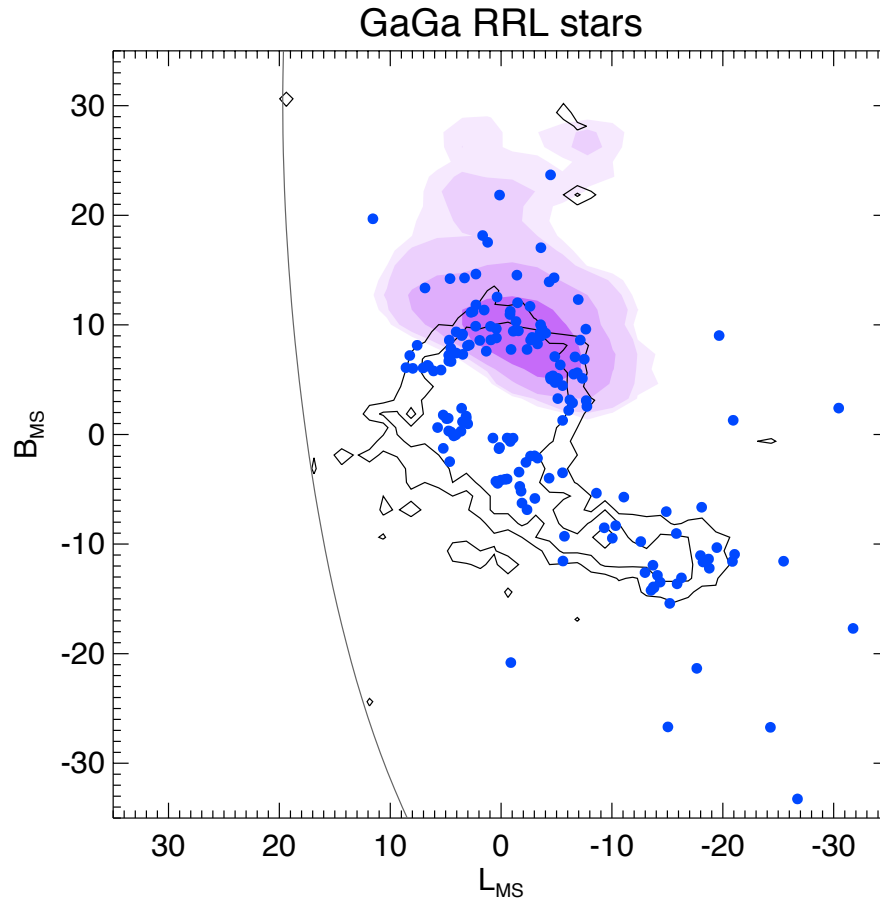


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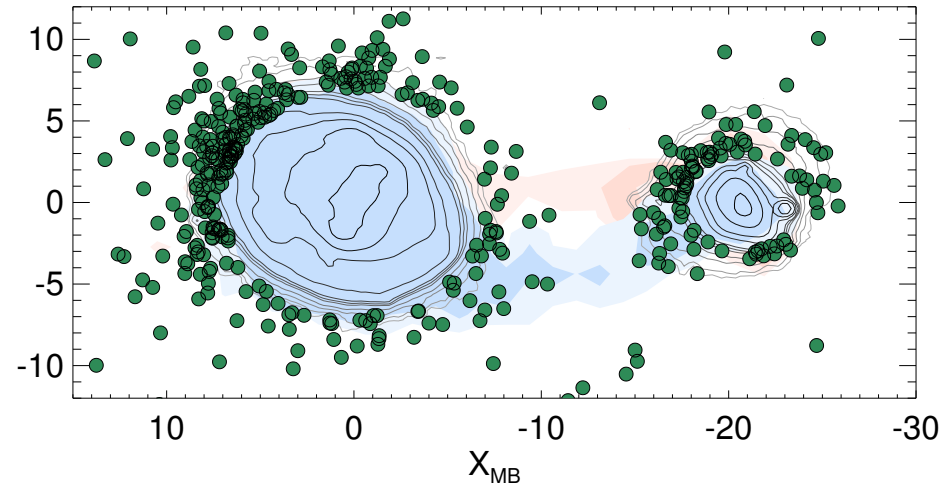
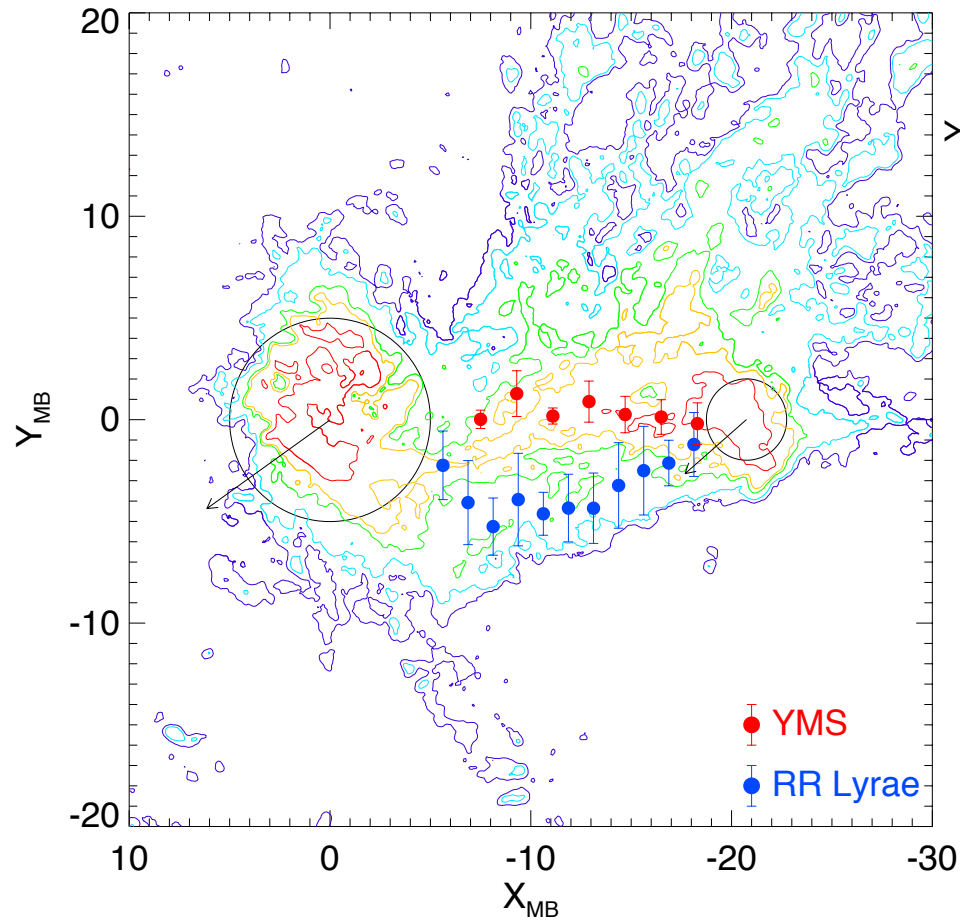
RR Lyrae



A stellar bridge between the LMC and SMC

Lack of distance gradient suggests "bridge" could be due to overlap between LMC and SMC populations.

Two "Bridges"

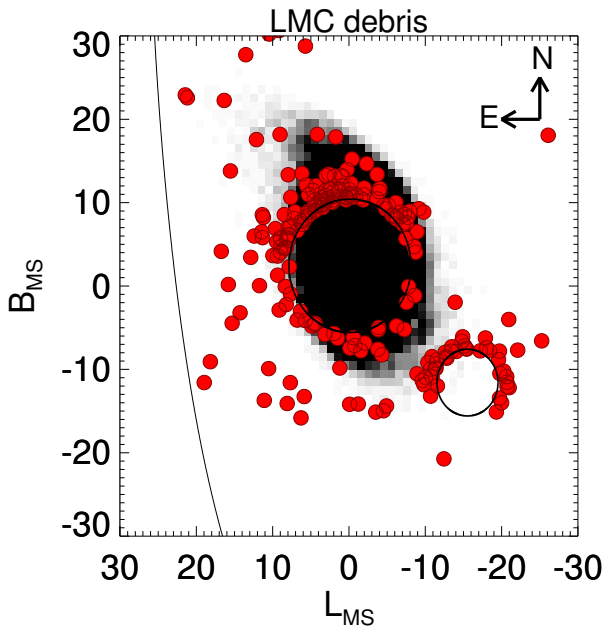


Young Main Sequence (YMS) trace the HI density:
likely formed in-situ.

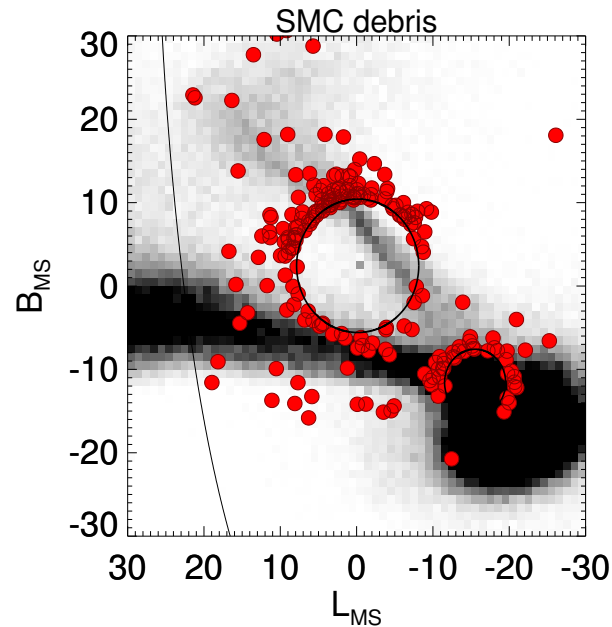
RRL "bridge" is offset by ~ 5 deg. Tidal stripping of
SMC (and maybe LMC).

Extension of Miras at $(X, Y) \sim (-10, -5)$ near the LMC,
and $(X, Y) \sim (-16, -4)$ by the SMC point along the
RRL bridge.

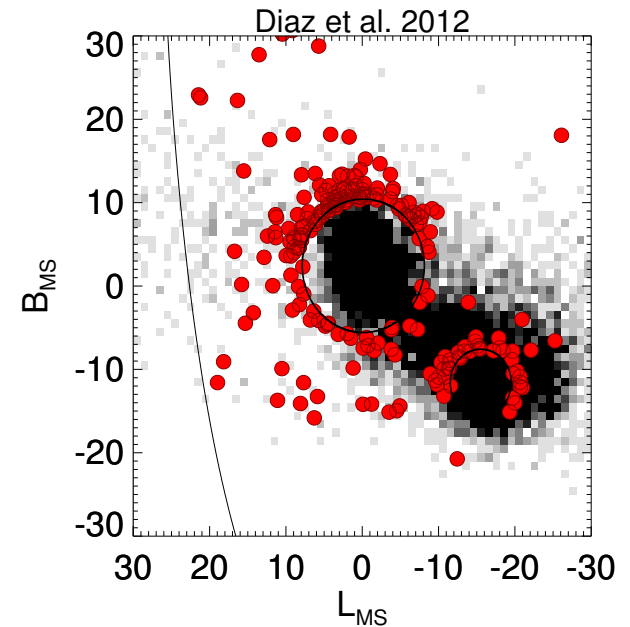
Simulations



LMC disc disrupting in MW potential: tuned to explain Mackey stellar stream.



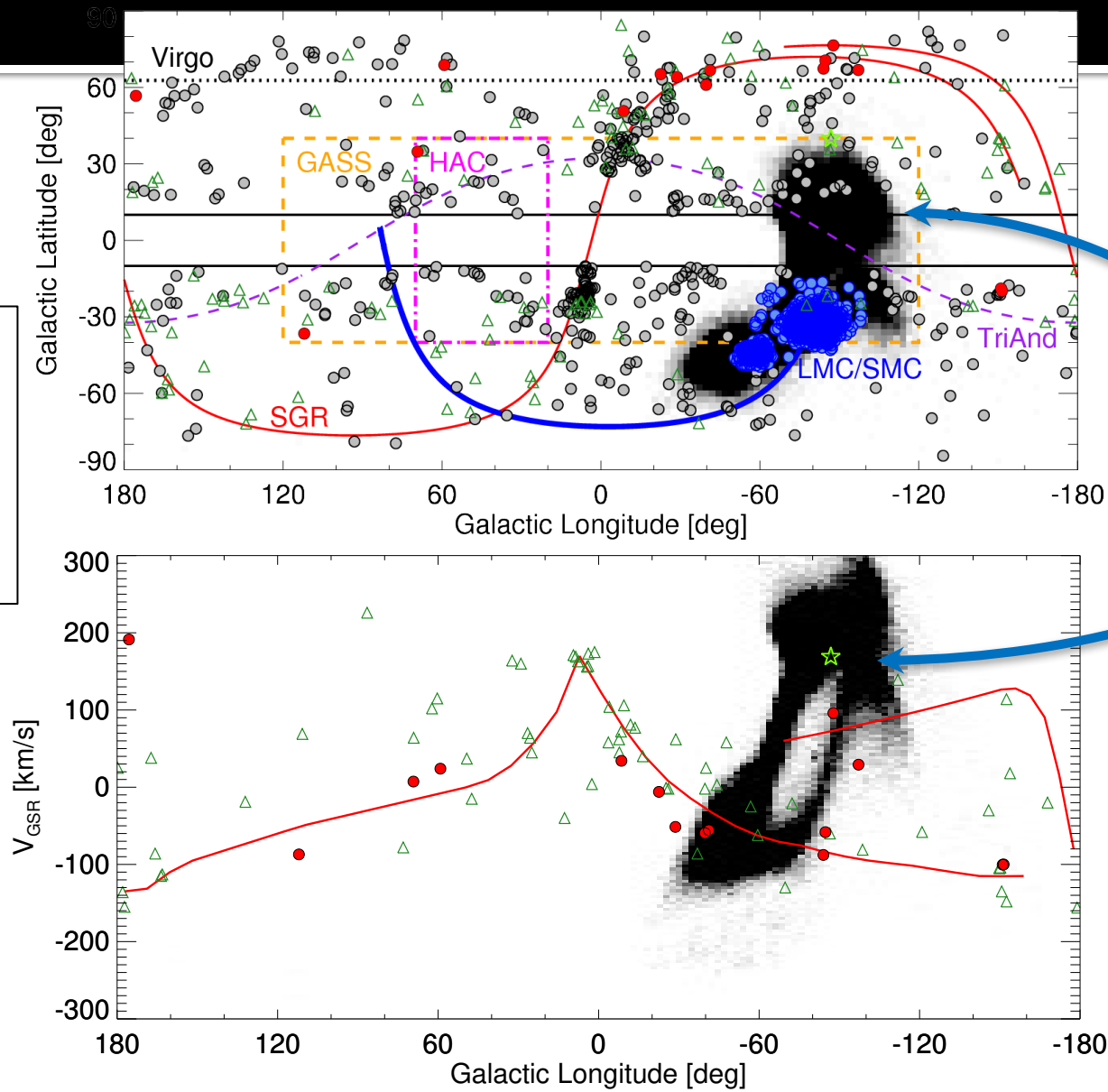
SMC debris from interactions with LMC: tuned to match RRL bridge.



SMC debris from interactions with LMC: tuned to match HI bridge.

Miras likely mix of *stripped LMC disc stars* (e.g. Mackey stream) and *stripped SMC stars* from interactions with LMC (e.g. Eastern excess).

Miras: Tracers of Massive Substructure



Miras can be used to trace other massive structures. Abundant in Sgr dwarf/stream.

Summary

- ❑ *Gaia* is a **variable star machine** – even with DR1!
- ❑ Outskirts of the Magellanic Clouds show evidence of past **interactions** with each other and the MW.
- ❑ Follow-up **spectroscopic campaigns** will be vital in order to inform models of the Magellanic system.

