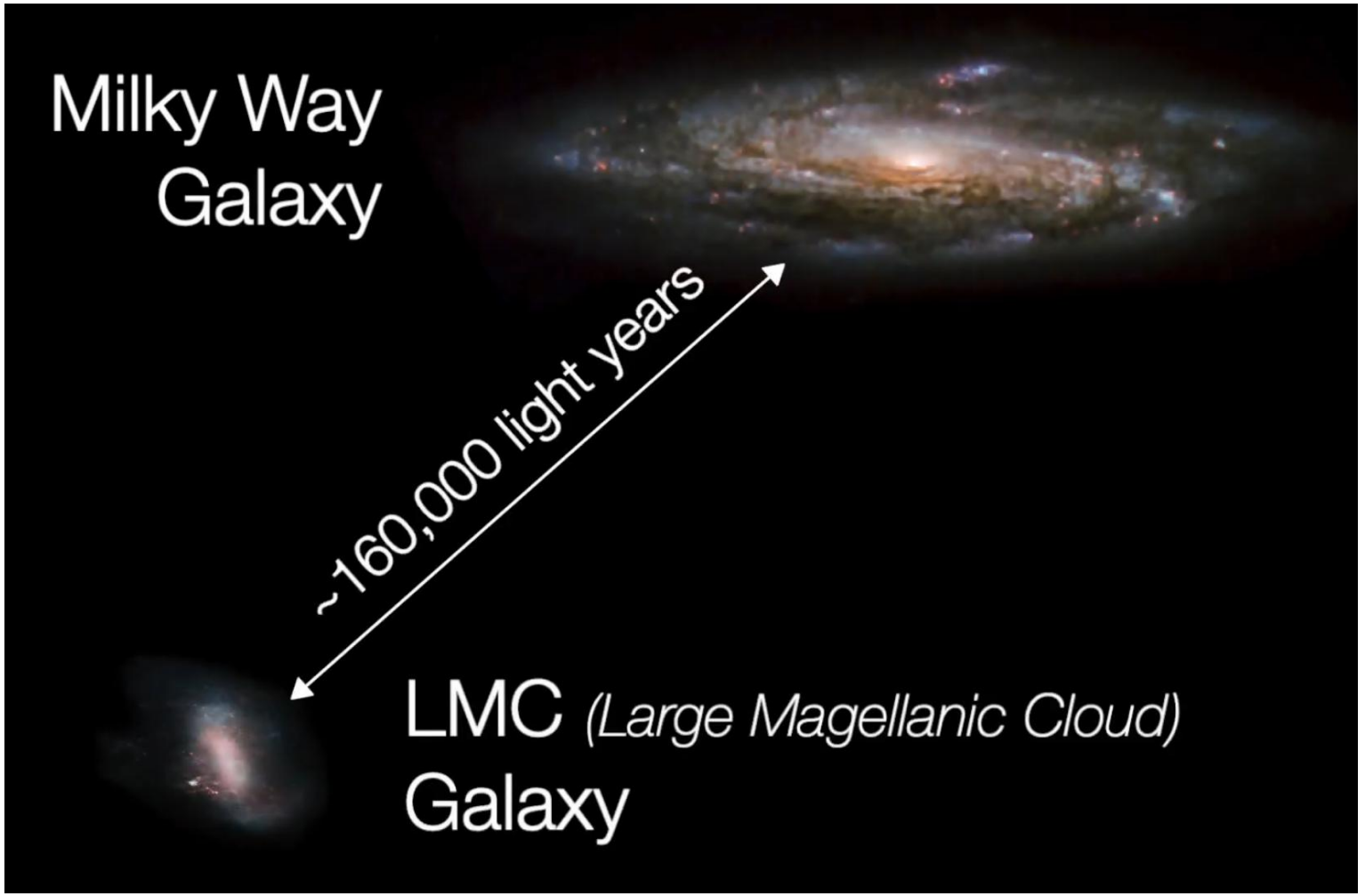
All-Sky Dynamical Response of the Galactic Halo to the Large Magellanic Cloud

Conroy et al. (2021)

Speaker: Zitao Hu

2021/11/19

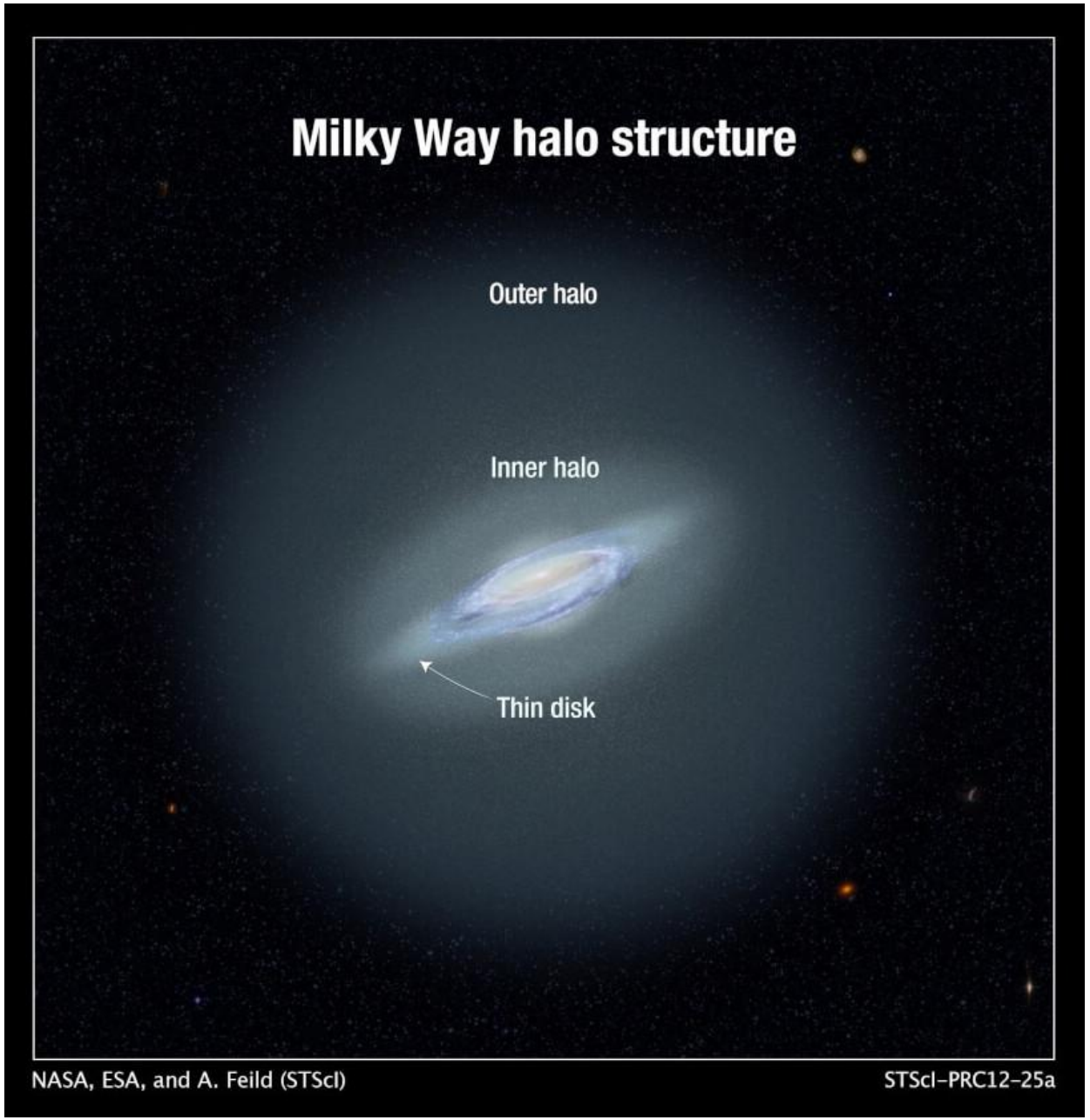
Introduction



Credit: NASA/ESA/JPL-Caltech

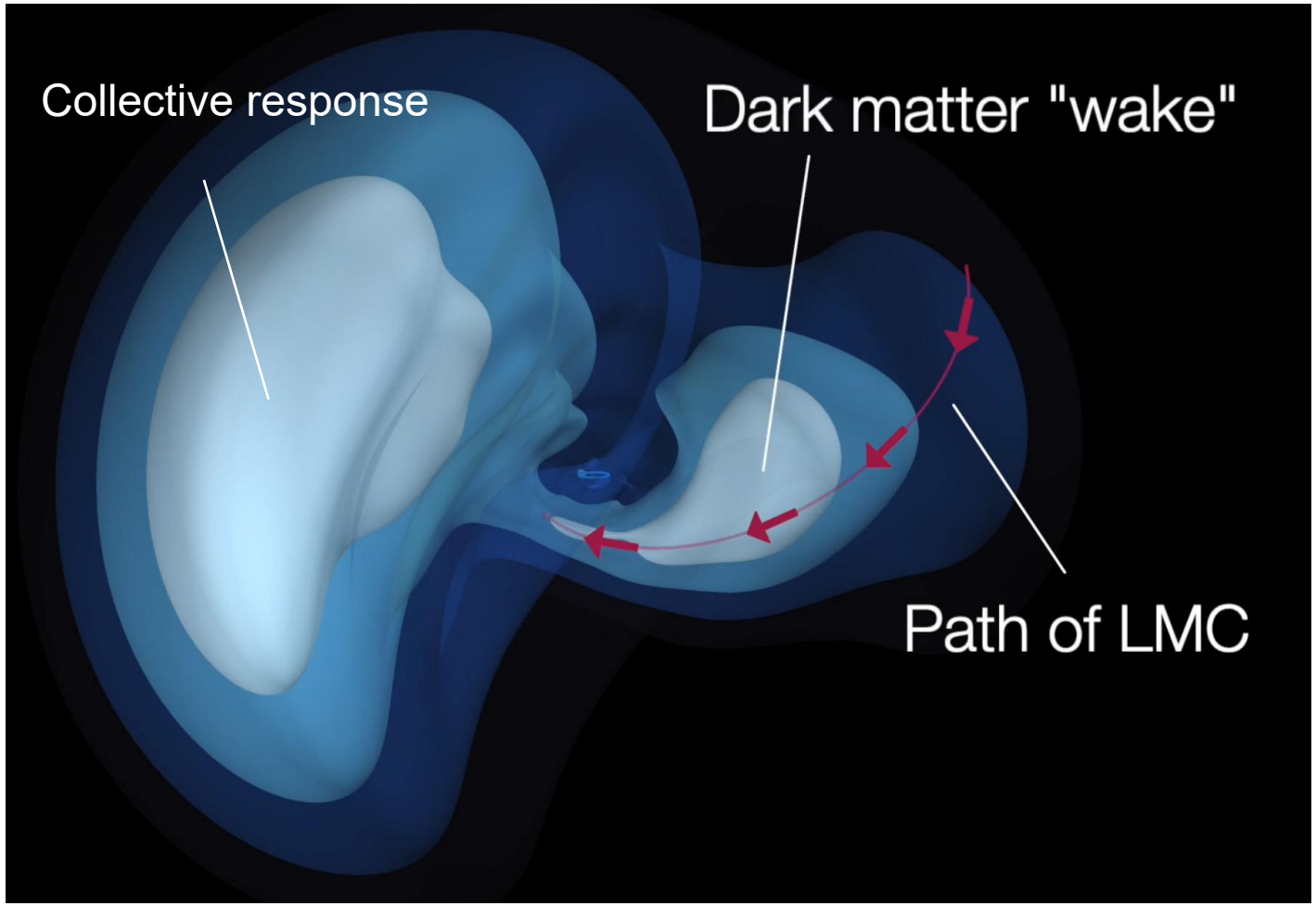
Introduction

- The Galactic disk is surrounded by a spheroidal halo of old stars and globular clusters
- 90% of stars and clusters lie within 30 kpc of the Galactic Center
- The inner portions of the halo have been mapped with a high level of accuracy.



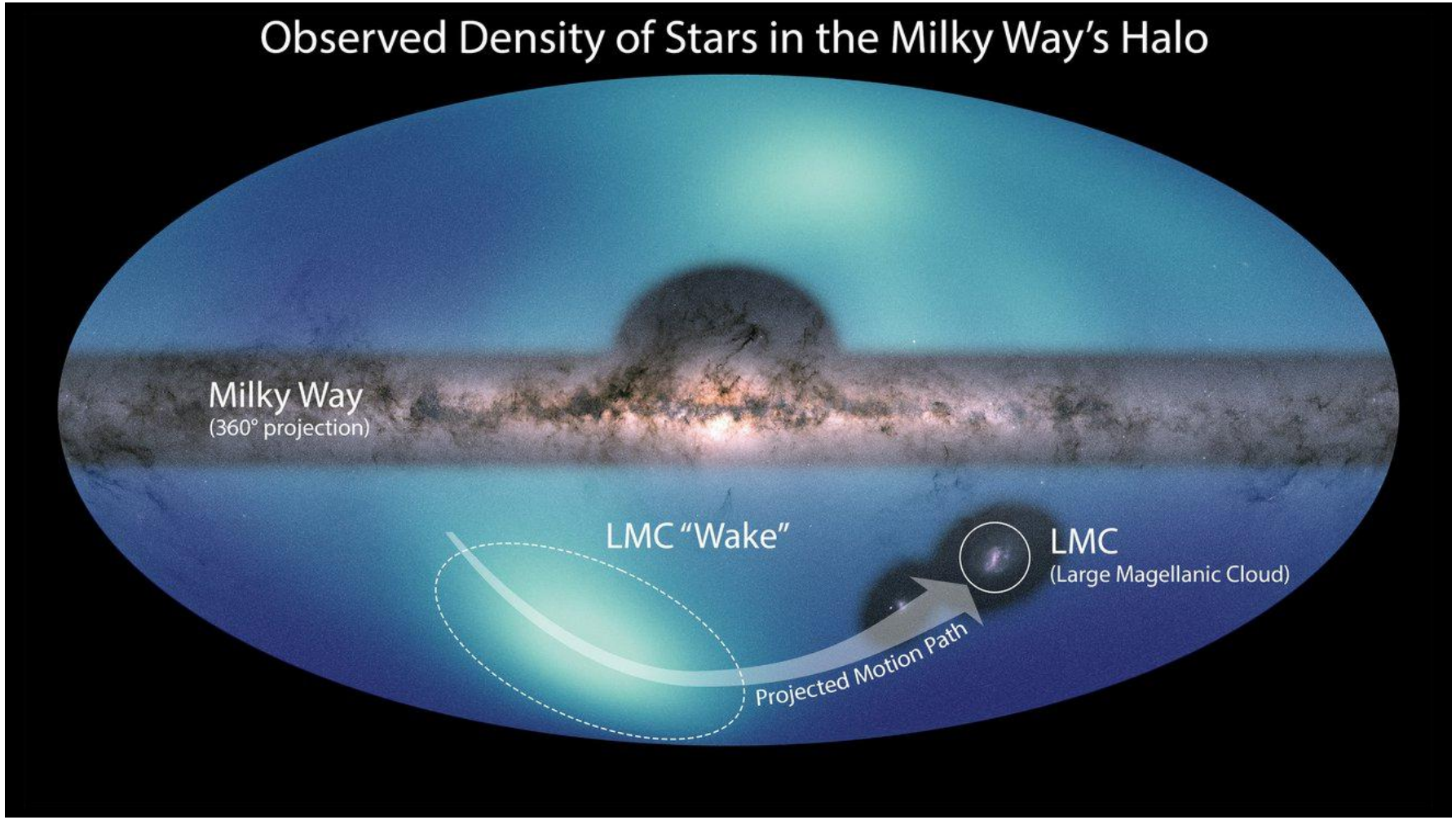
Intoduction

- Dark matter “wake”
  - LMC sails through MW’s halo, its gravity creating a wake in the stars behind it.
- Collective response
  - A density perturbation gives rise to extra gravitational forces, which deflect the stellar orbits in such a way that the original density perturbation is enhanced.



Credit: NASA/ESA/JPL-Caltech

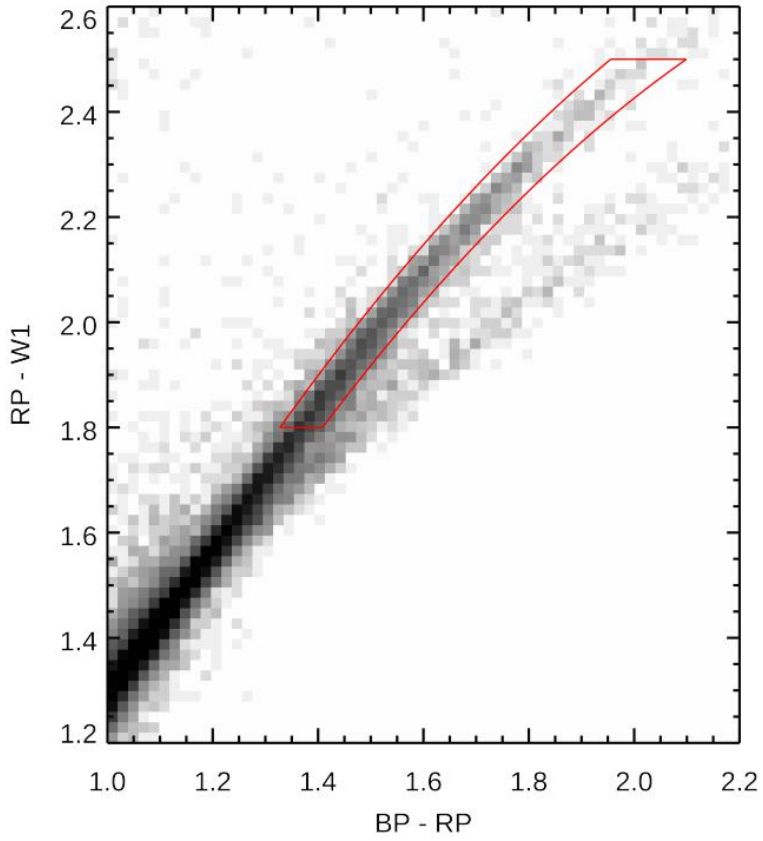
All-Sky Dynamical Response of the Galactic Halo to the Large Magellanic Cloud



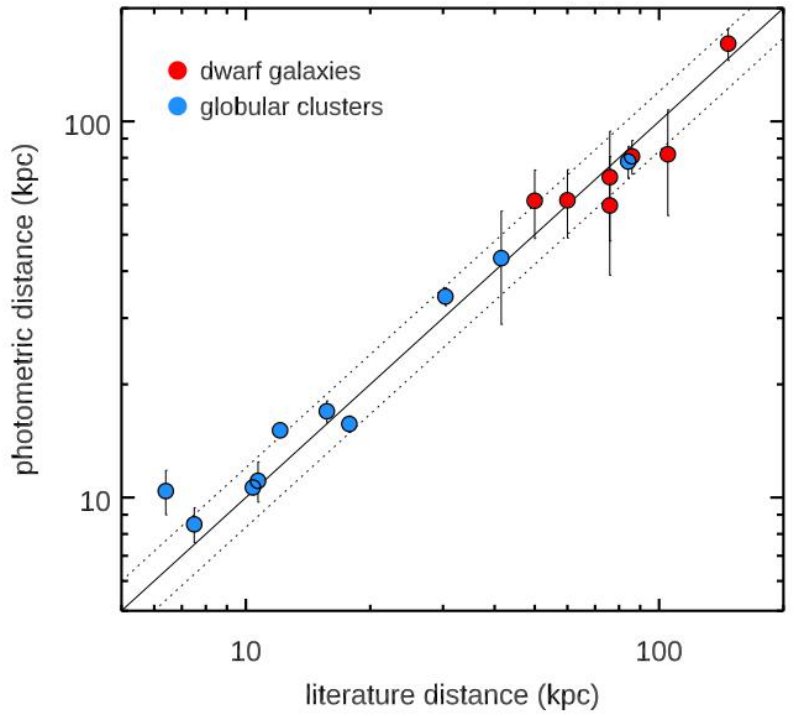
Credit: NASA/ESA/JPL-Caltech

Methods

- a color-based method for identifying red giants (Conroy et al. 2018)

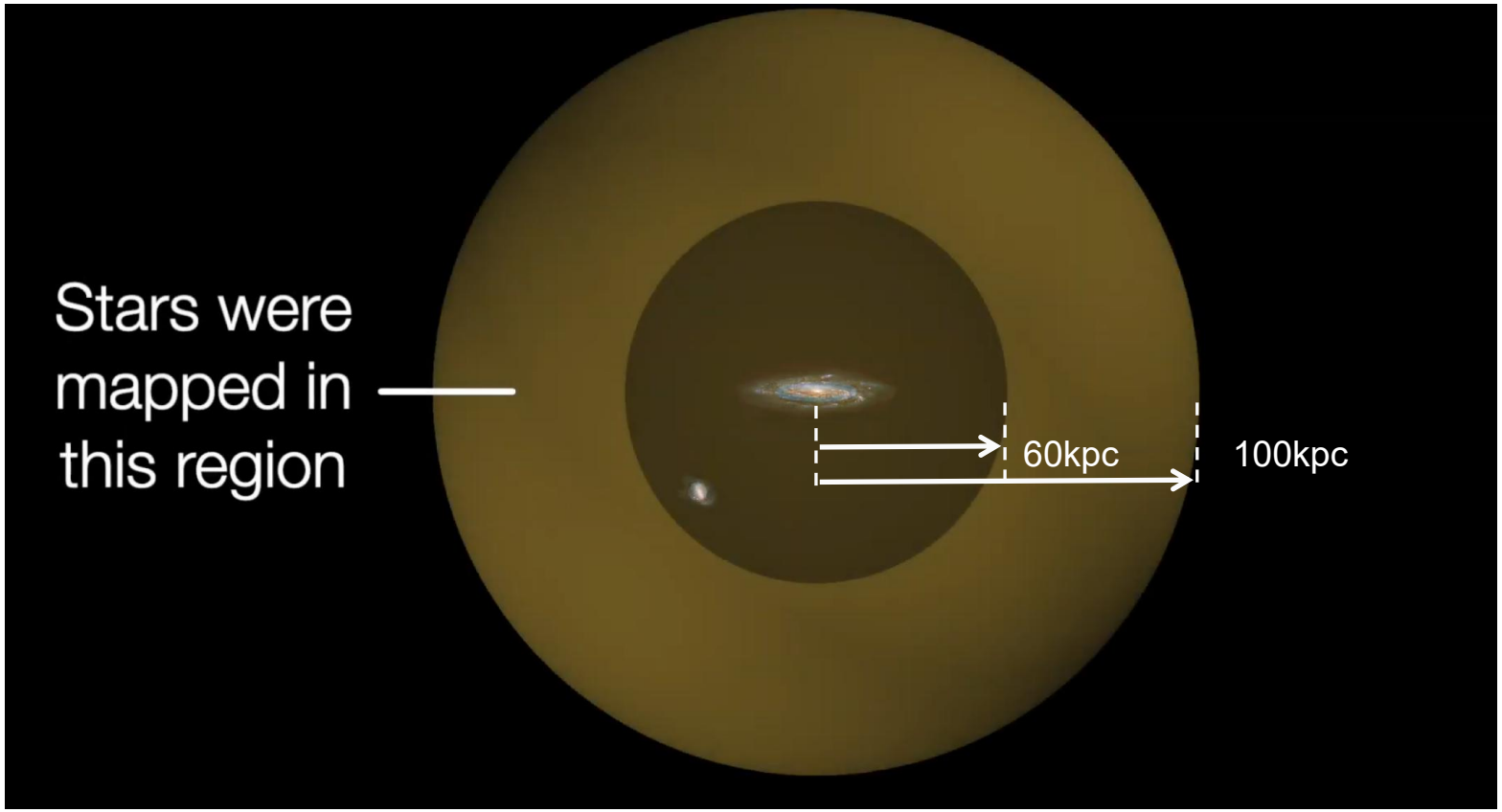


- Distances are estimated by using MIST stellar isochrones (Choi et al. 2016)



Methods

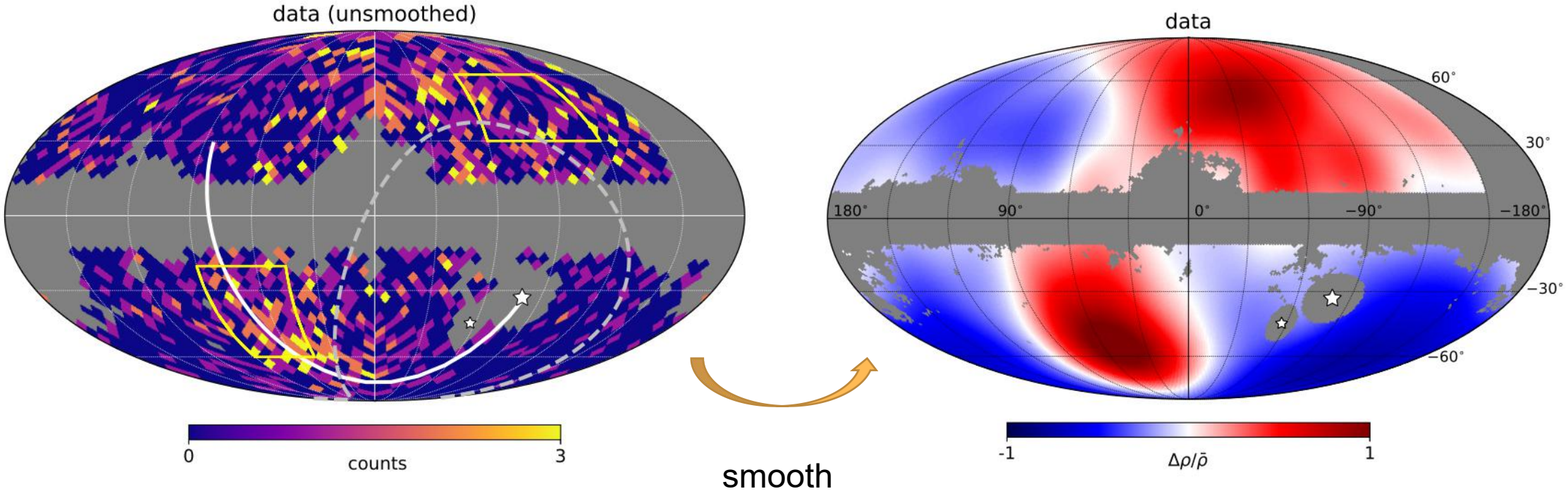
- K giants
- Galactocentric distances
  - $60 < R_{gal} < 100$ kpc
- Data sources
  - optical photometry from Gaia Early Data Release3
  - infrared photometry from WISE



Credit: NASA/ESA/JPL-Caltech

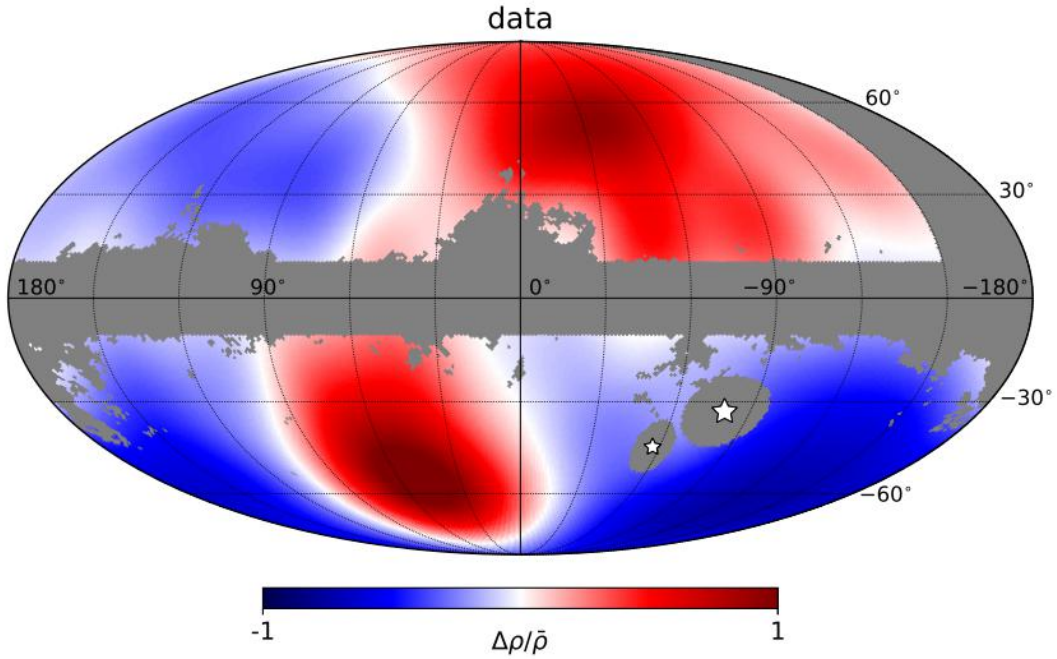
Results

- Mollweide projection map with 1301 stars
- smoothed by a Gaussian beam with FWHM = 30°



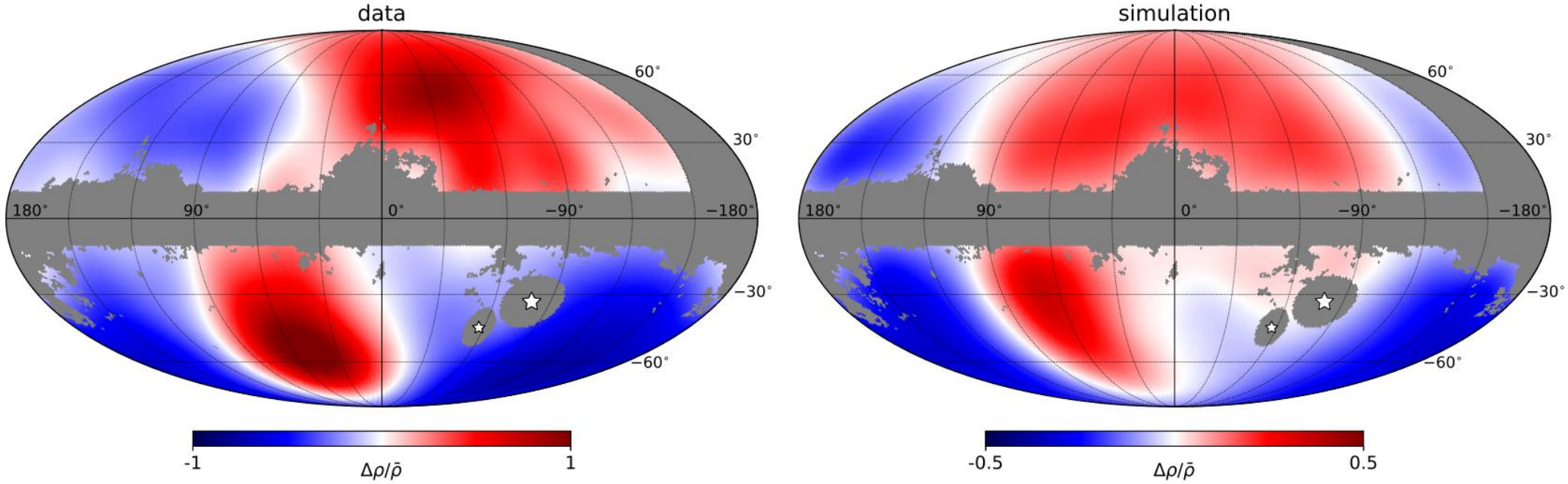
Implications

- The outer halo of our Galaxy is in a state of significant disequilibrium.
- The very strong observed local wake is independent evidence that the Magellanic Clouds are on their first passage around the Galaxy.
- The local wake provide stringent new constraints accurately trace the orbital path of the LMC.



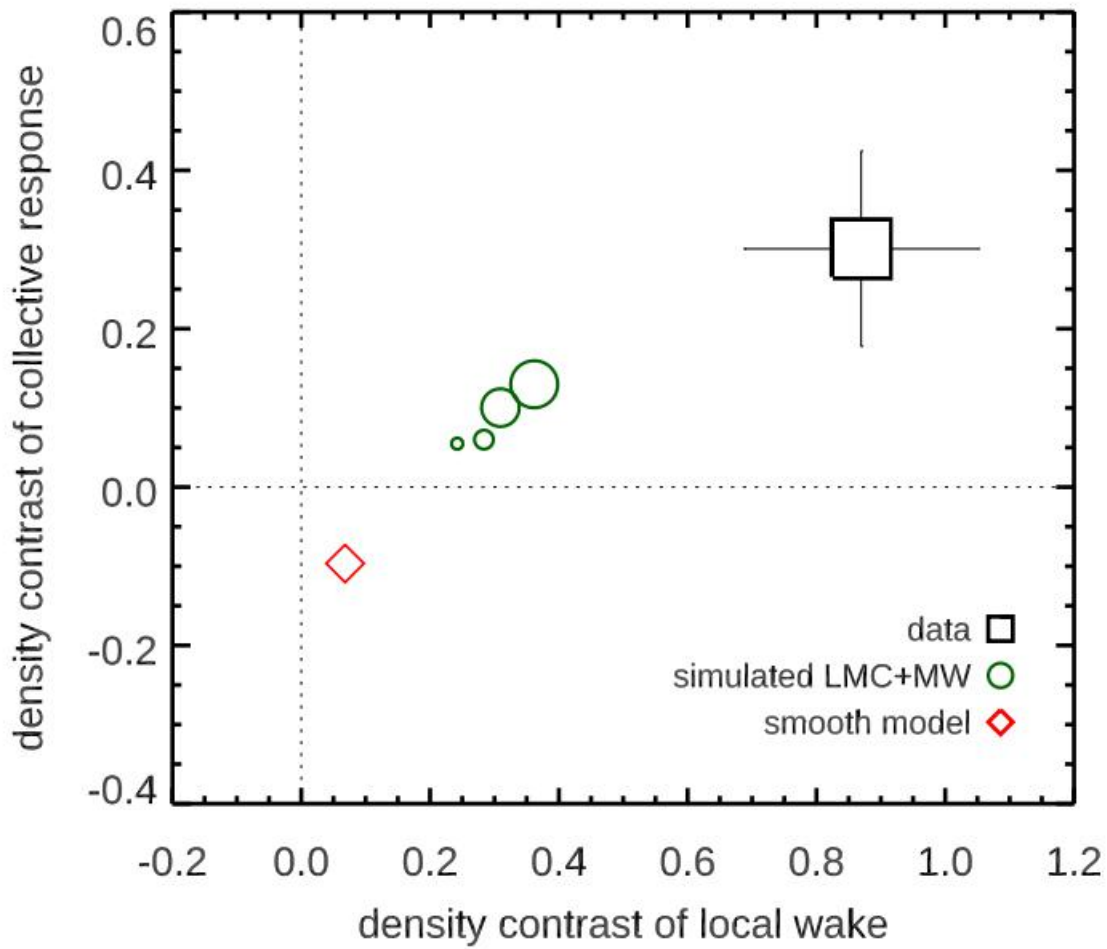
Simulation Results

- N-body simulation
- Quite striking agreement, especially in the Southern hemisphere
- The agreement is not perfect: peak density, asymmetric northern hemisphere



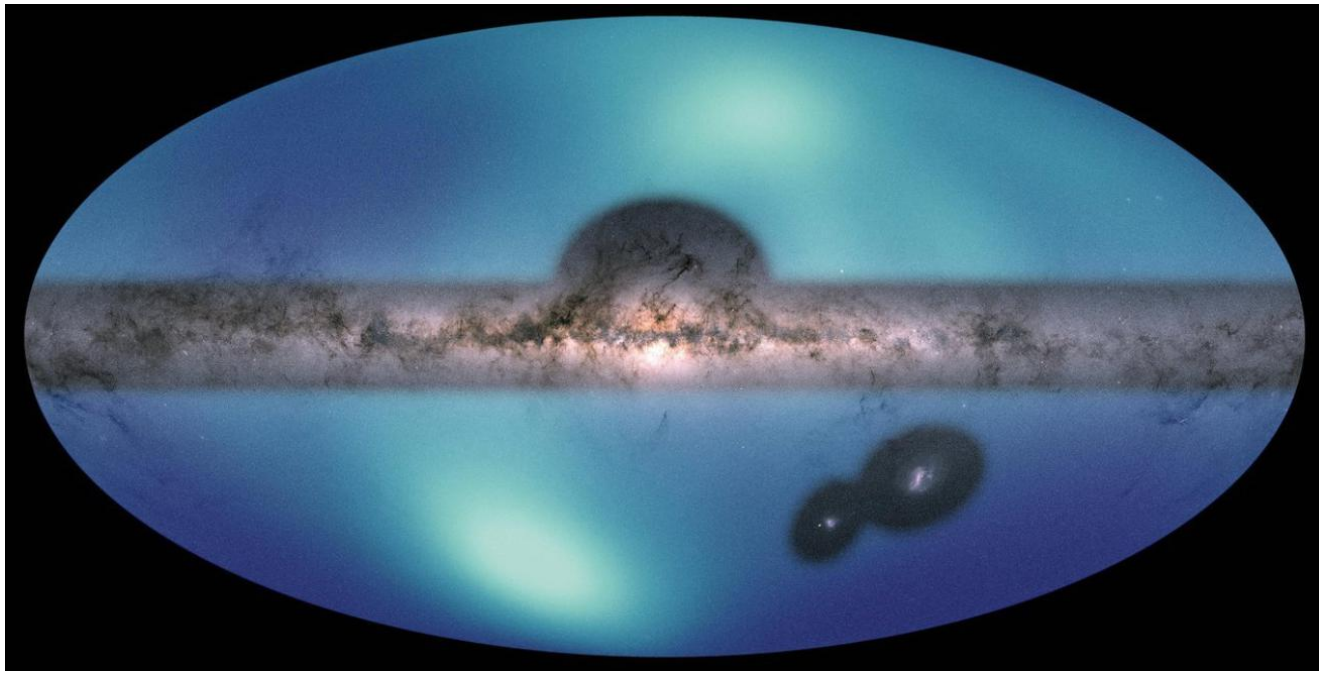
Simulation Results

- LMC halo mass: $(0.8, 1, 1.8, 2.5) \times 10^{11} M_{sun}$
- Possible reasons:
  - the orbit of the LMC
  - the distribution of orbits within and shape of the Milky Way halo
  - the impact of the SMC
  - initial setup of simulation was smooth
  - nonstandard dark matter and alternative gravity models
  - ……



Take-home message

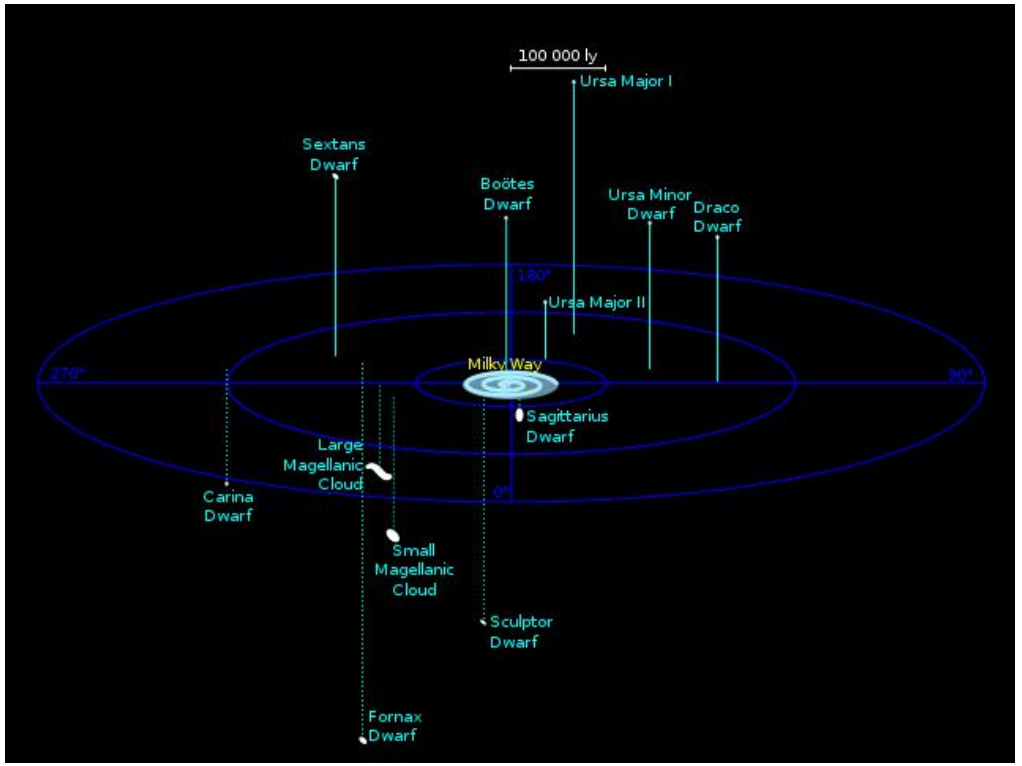
- The outer halo of our Galaxy is in a state of significant disequilibrium.
- The very strong observed local wake is independent evidence that the Magellanic Clouds are on their first passage around the Galaxy.
- The local wake provide stringent new constraints accurately trace the orbital path of the LMC.



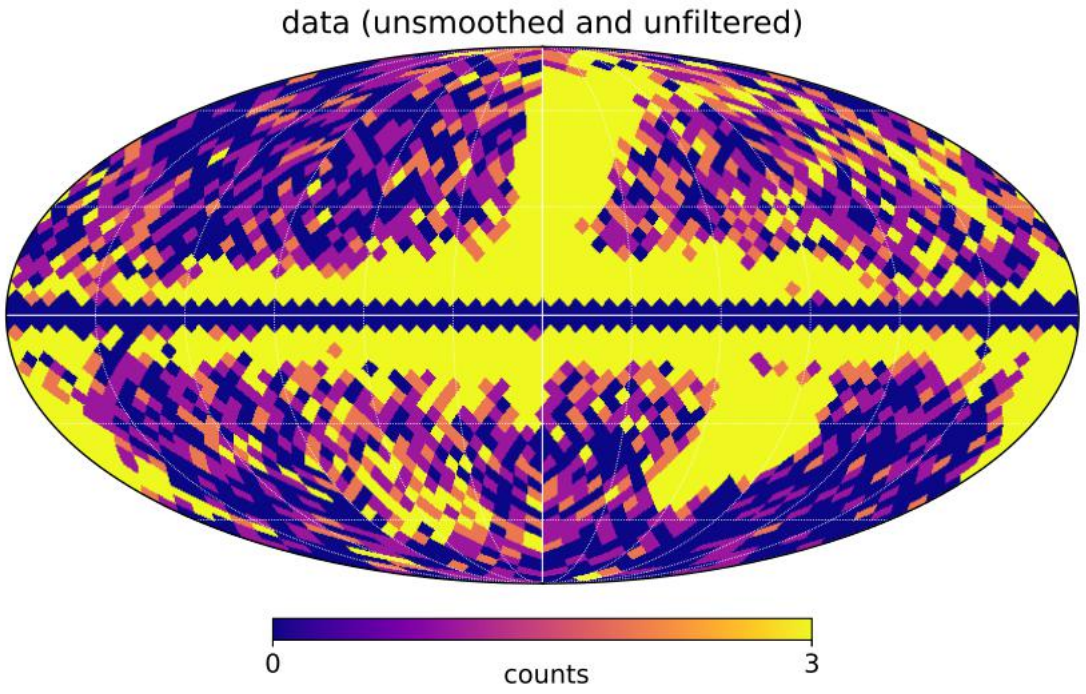
Credit: NASA/ESA/JPL-Caltech

Possible Questions

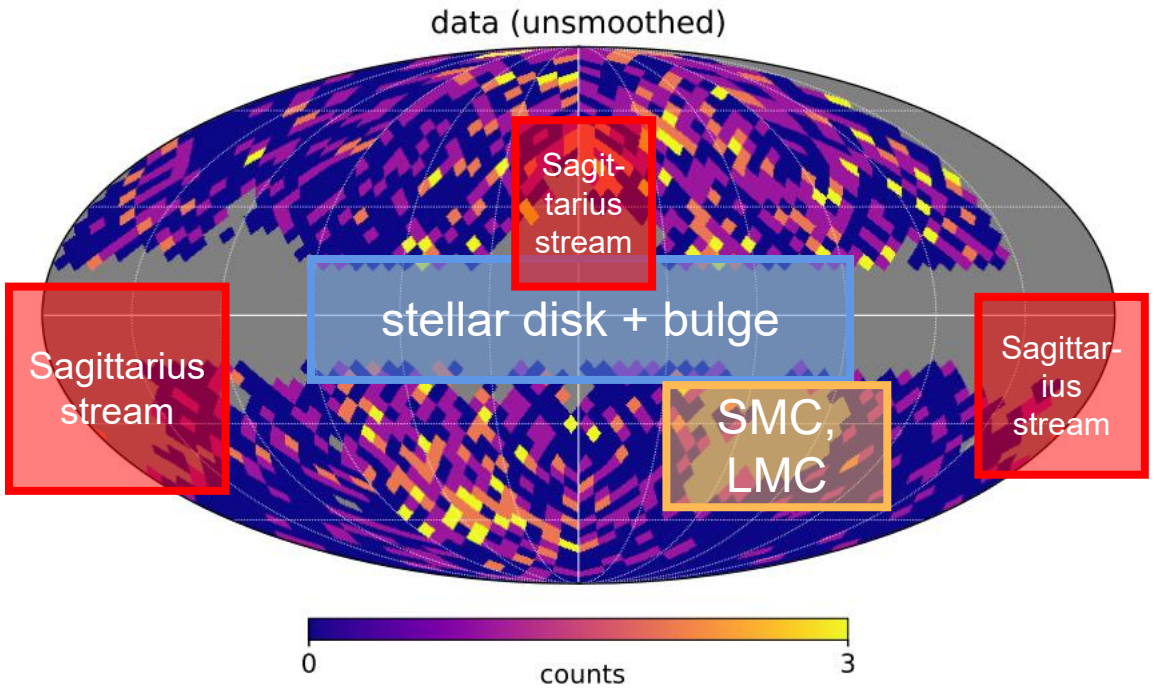
- Why use K giant samples?
- How about other sattlelites?
- Is 1301 stars enough?
- How to improve?
    - Further progress could be made employing an all-sky map of RR Lyrae.



Identification of giants

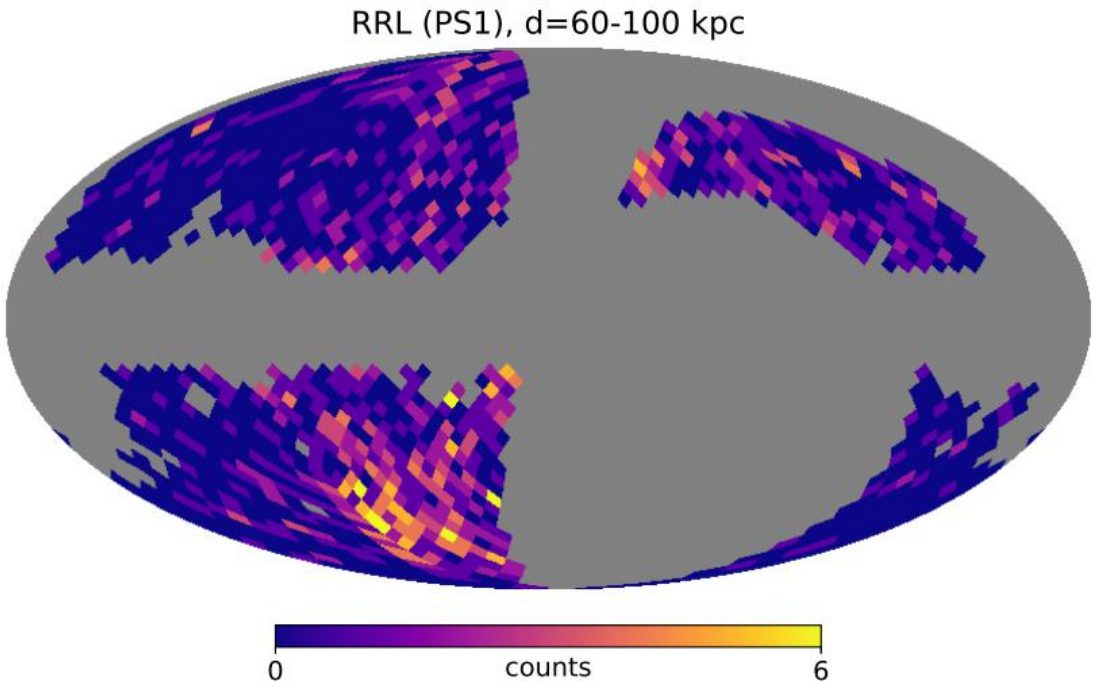


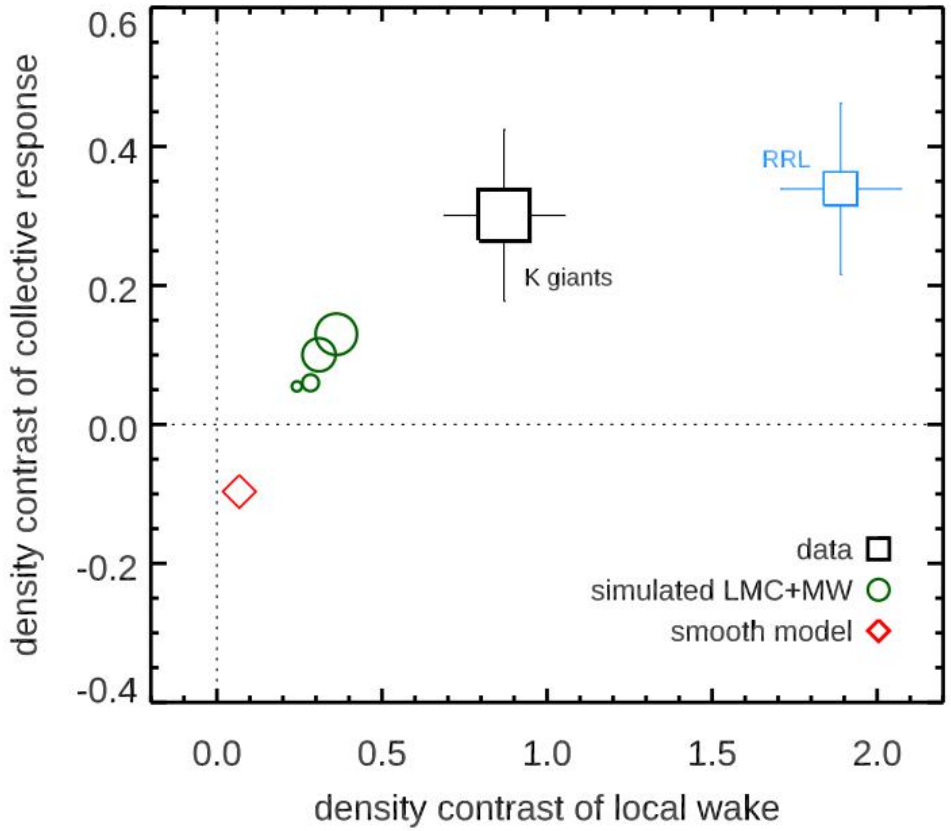
146,926 stars



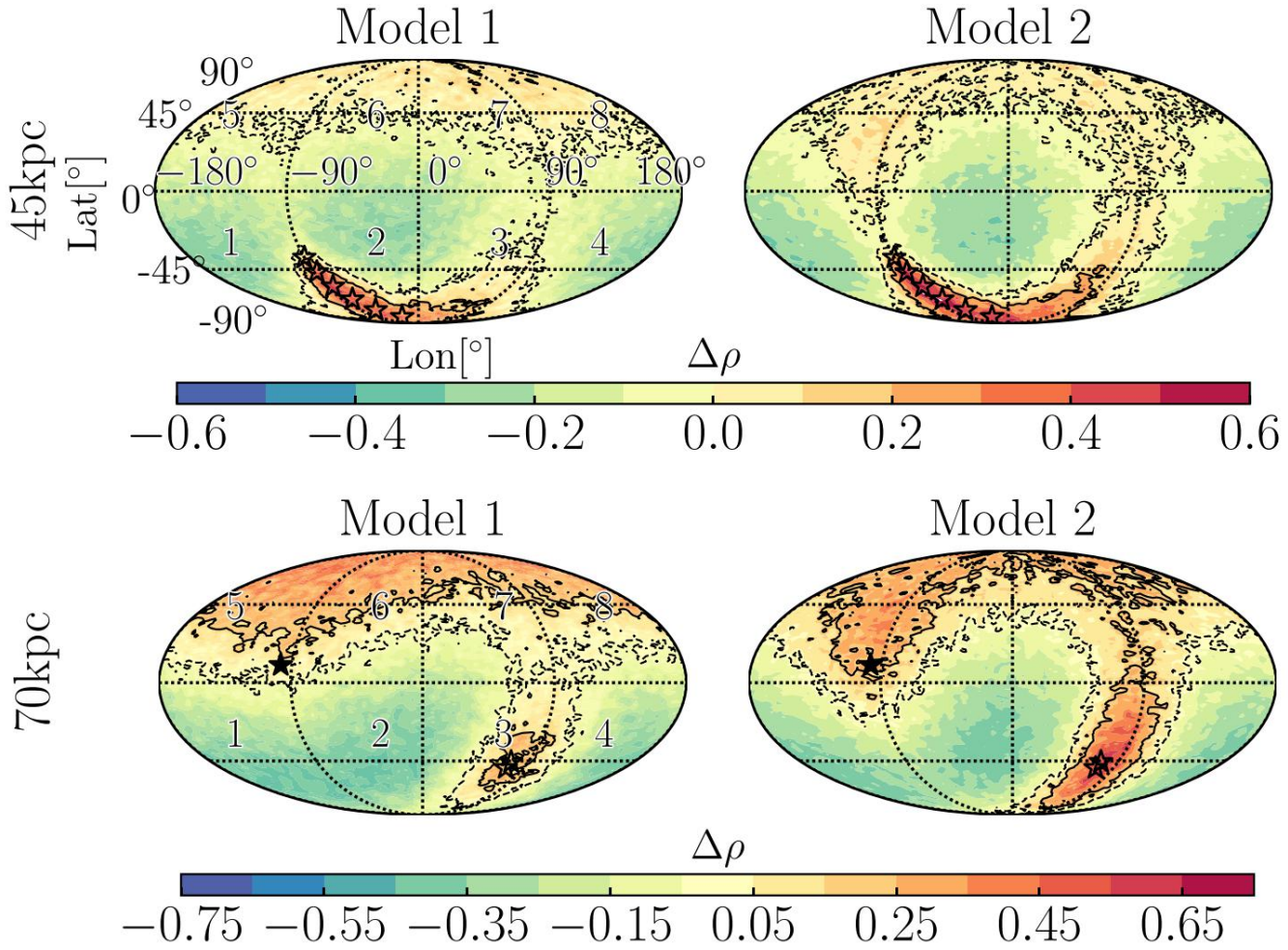
1,301 stars

The stellar halo probed by RR Lyrae





Models



Garavito-Camargo et al. 2019