M | ASTRONOMY

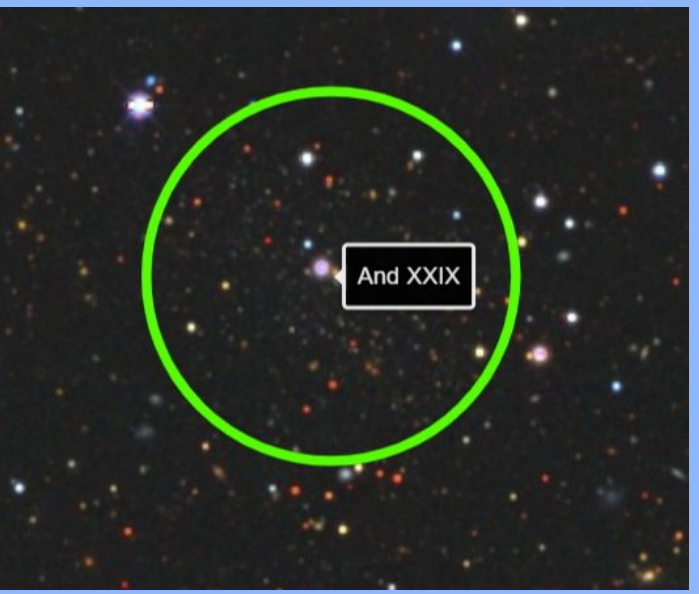
Uncovering Ultra-Faint Galaxies (UFD) in the Local Group

The Missing Satellite Problem

Yanbo Pan

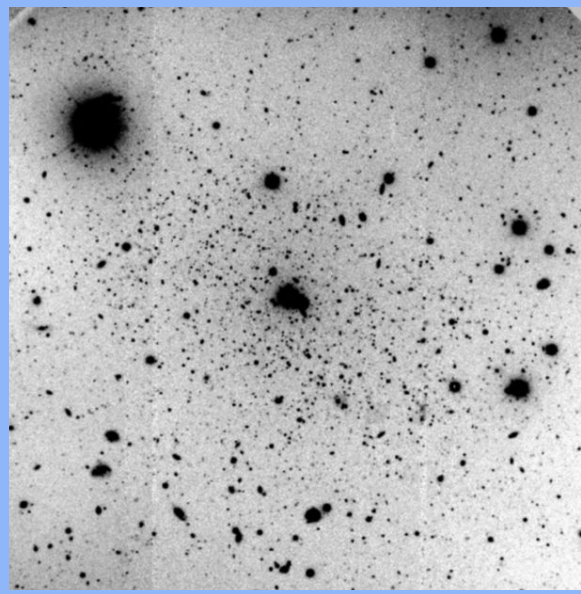
Advisor: Eric Bell

Collaborator: Benjamin Radmore



DELVE Image of And XXIX

(Bell et al., 2011)



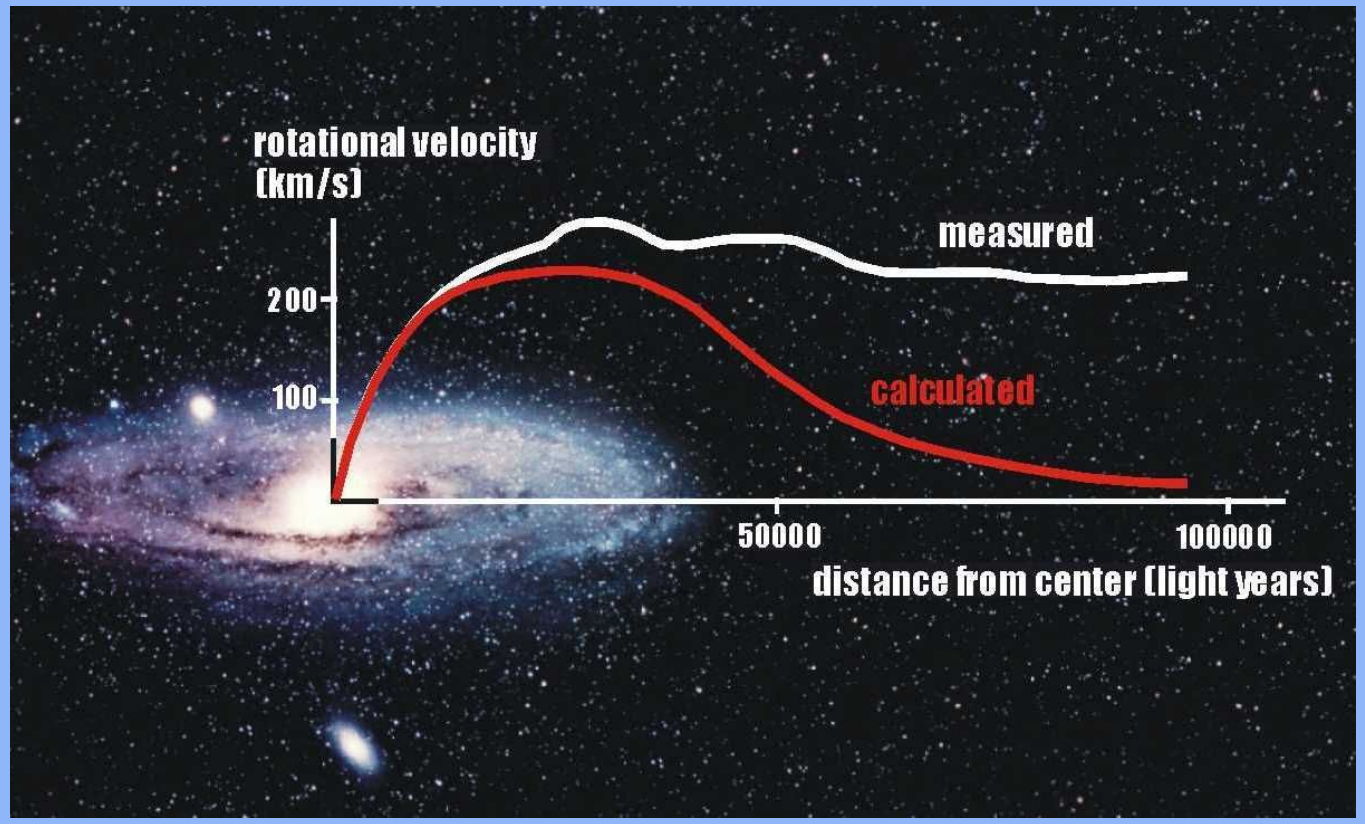
r-band image of And XXIX

Outline

- Introduction
  - What is Dark Matter (halo)?
- Background
  - Why study ultra-faint dwarfs (UFD) helps us to understand dark matter?
- Our work
  - Dataset
  - Methodology
    - Cluster searching
    - Star-Galaxy classification
  - Future step

What is dark matter?

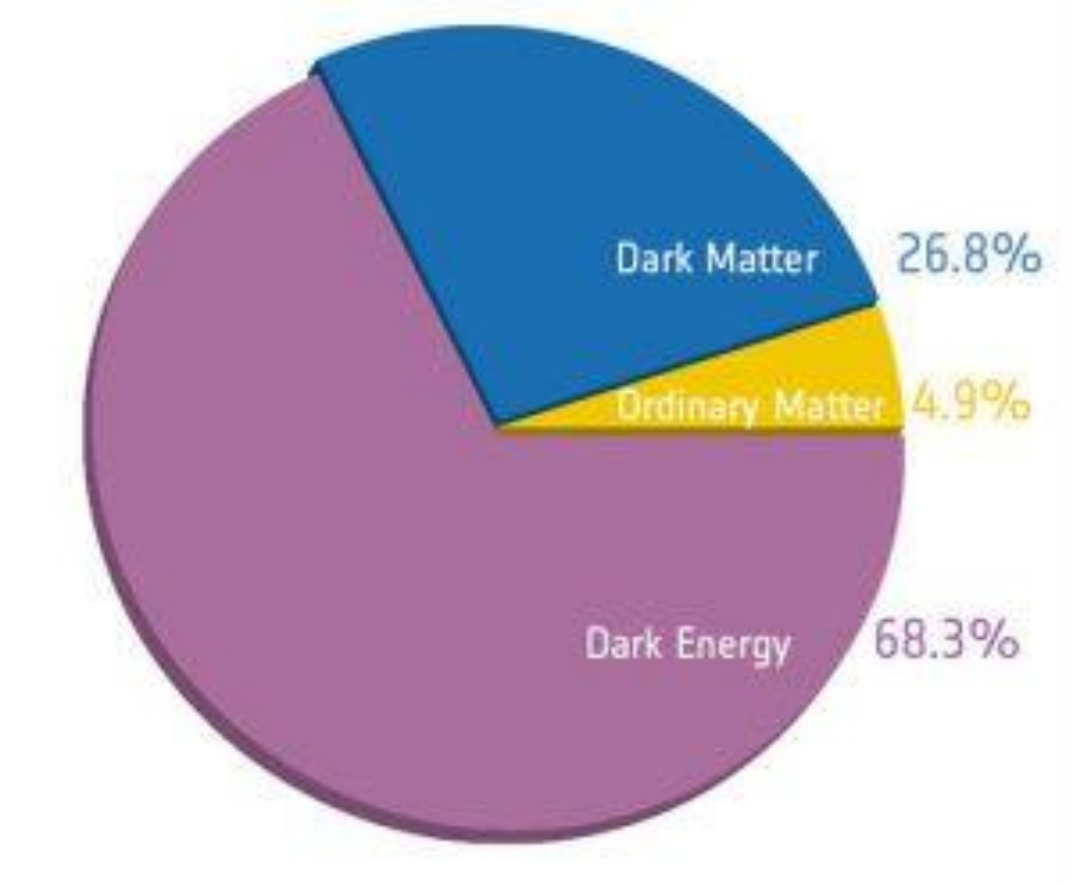
Simulation credit: ESO/L. Calçada



The rotation curve of the Andromeda galaxy

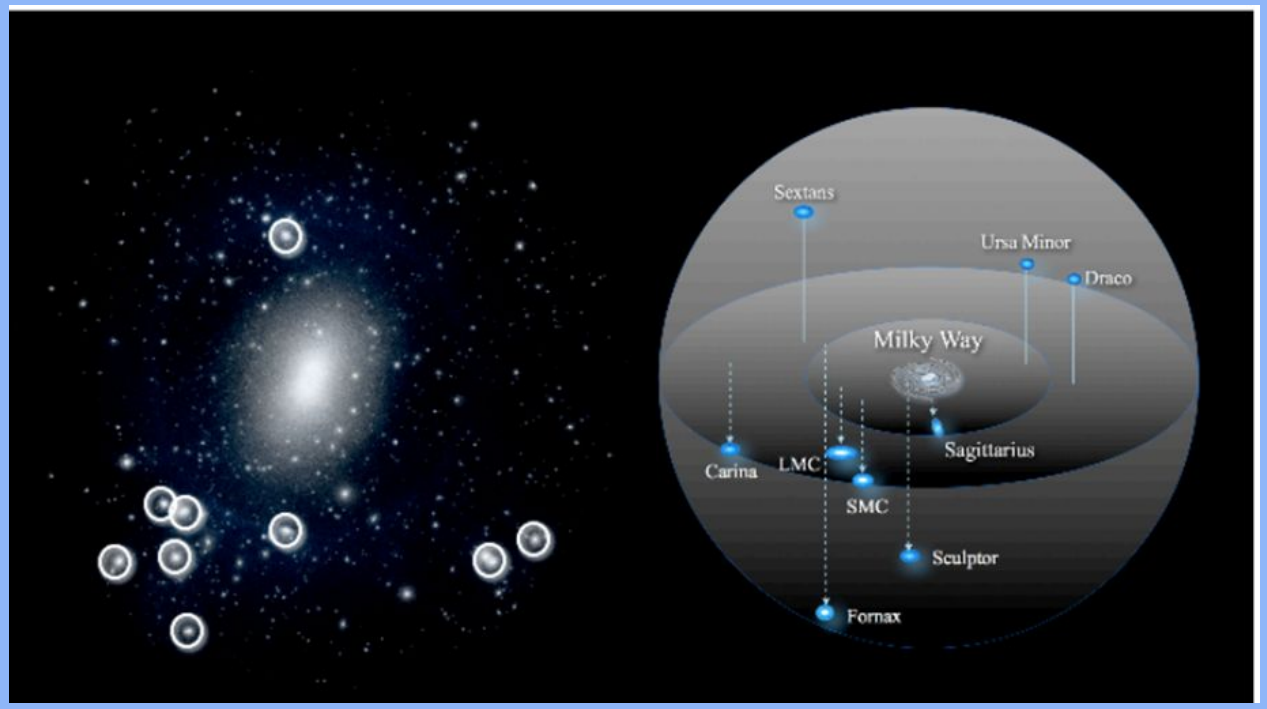
Credit: Queen's University

But, what does dark matter look like?

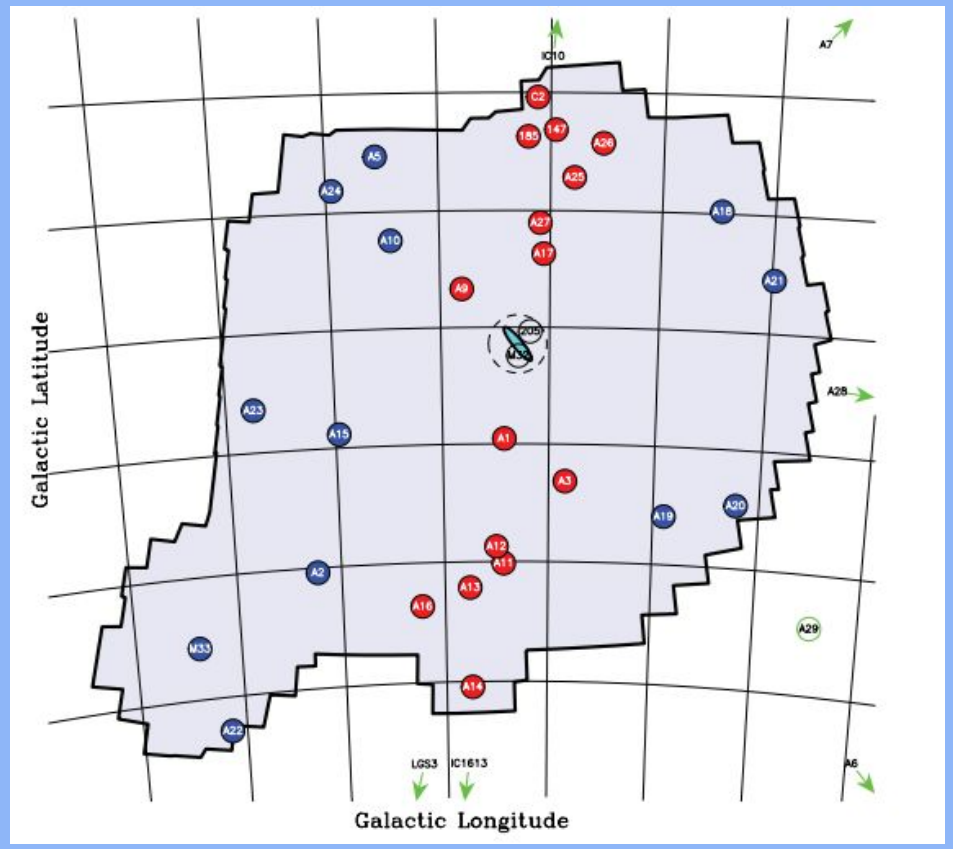


(NRAO, 2022)

Why study ultra-faint galaxies?



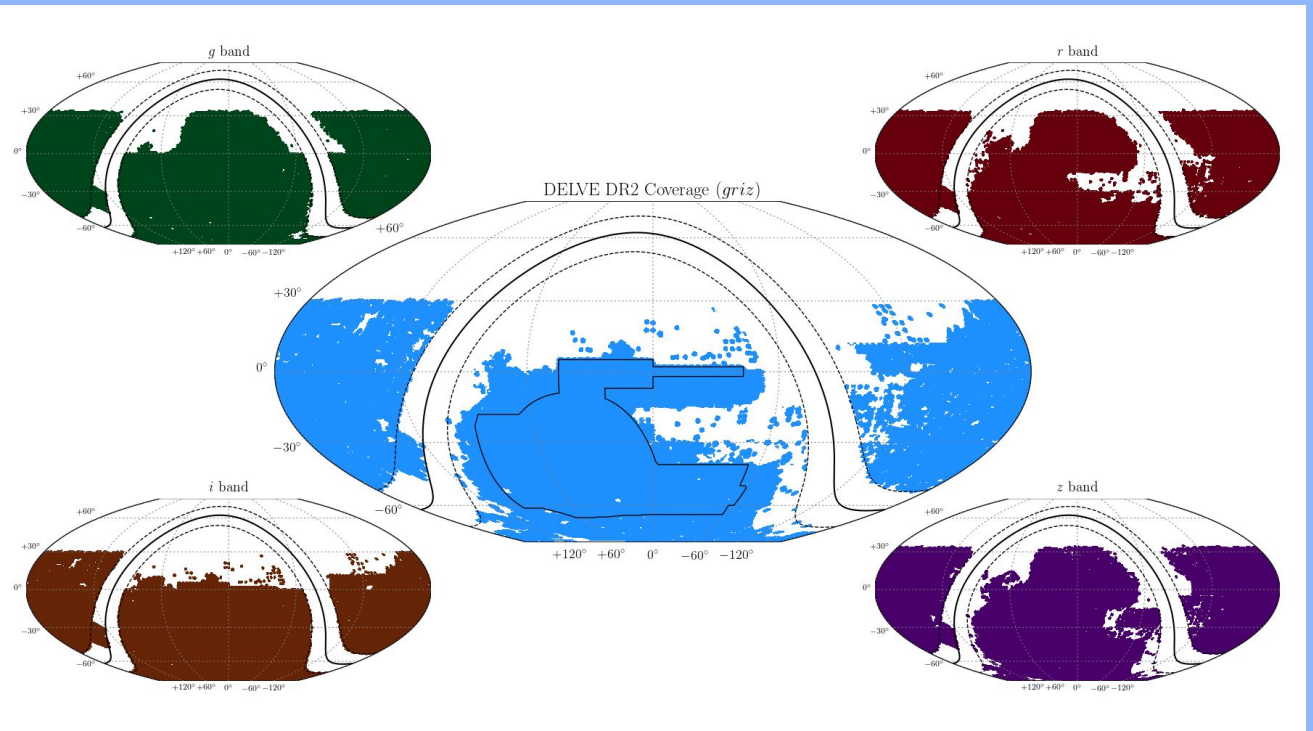
Dwarf/Satellite galaxies seen in (*left*) a simulation with a Milky Way sized halo, and (*right*) observations of the Milky Way from sky surveys.



The distribution of dwarf galaxies around the Andromeda galaxy (M31)

Dataset

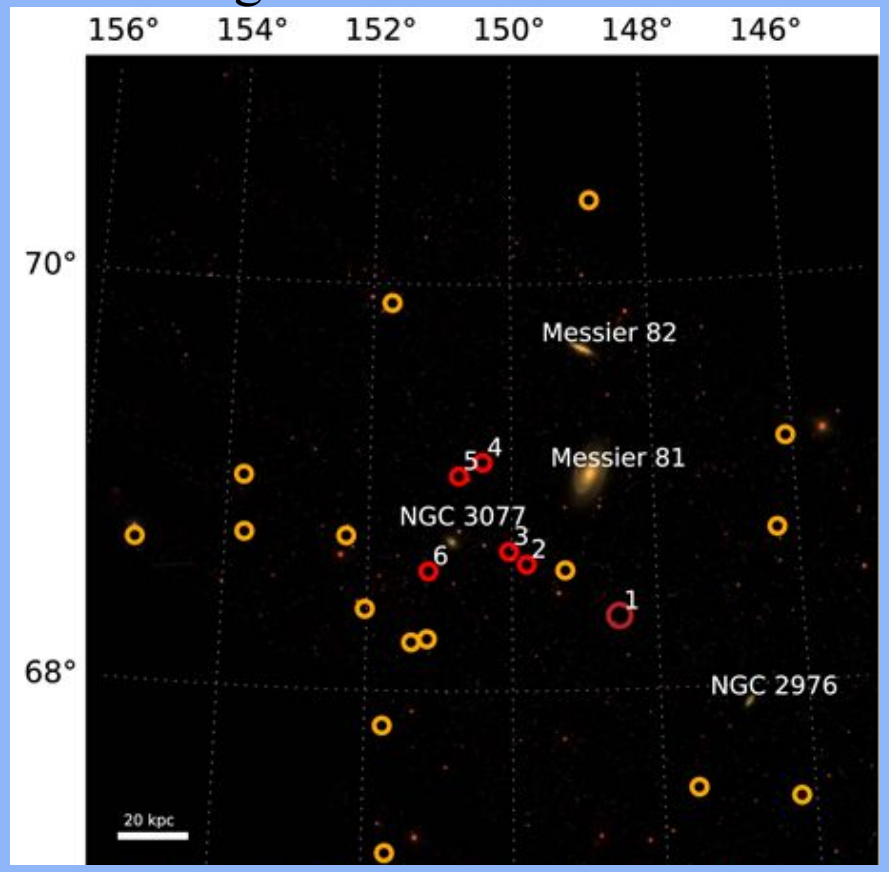
- The Pan-Andromeda Archaeological Survey (PAndAS)
  - galaxy archaeology
- The DECam Local Volume Exploration Survey (DELVE)
  - DECam data with 126 nights of novel observations

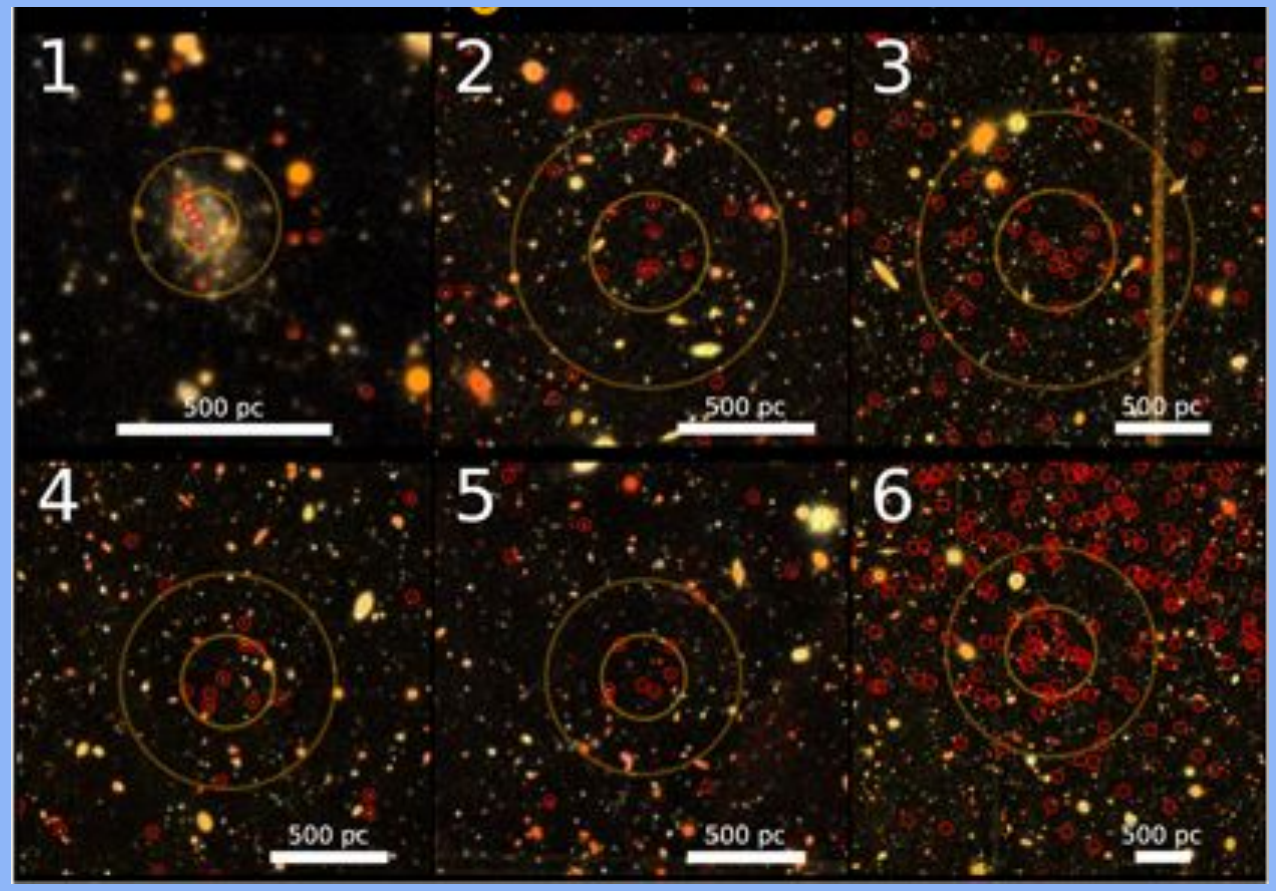


Searching for UFD

Look for highly statistically significant clump of (RGB / HB) stars

These galaxies are invisible!

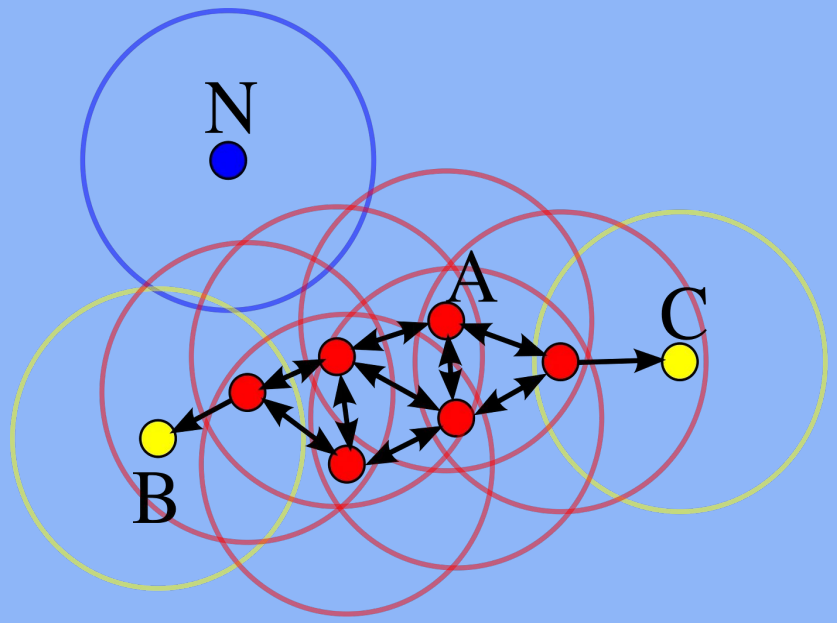




The distribution of known dwarf galaxies (orange) and M81 sample (brick red shows the definite dwarf M81

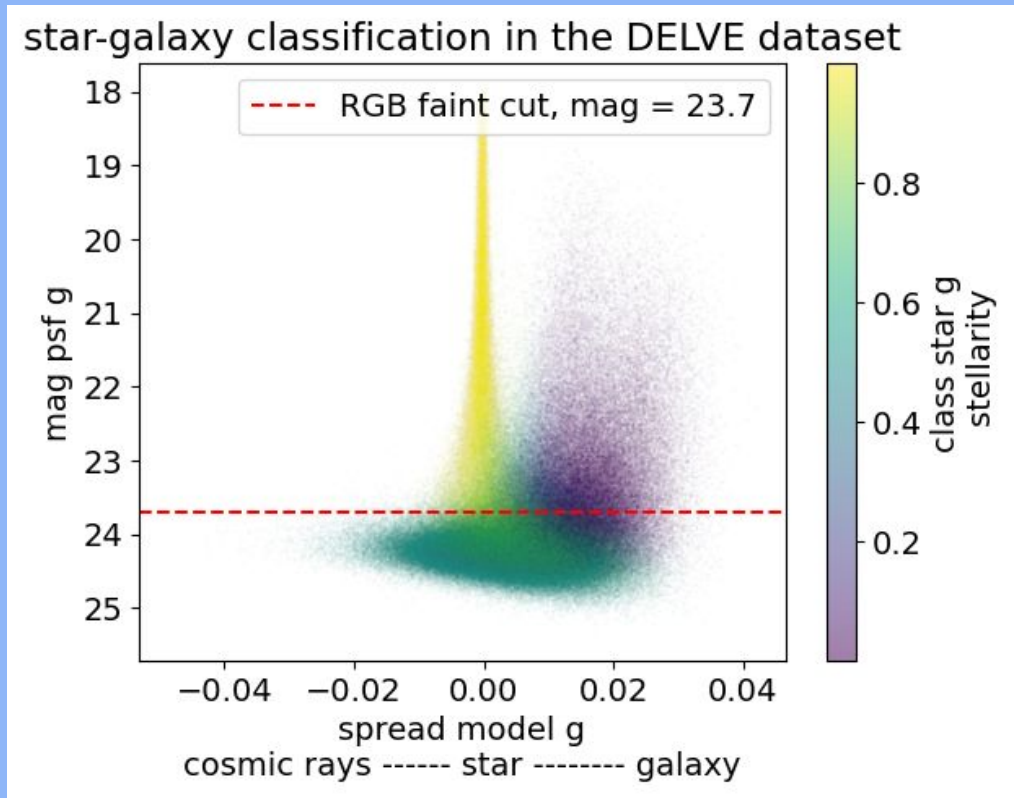
Current progress

- Adopt cluster searching algorithm (DBSCAN) to detect potential dwarf galaxy candidates
  - Recovered several known dwarf galaxies
    - And II, And XIV, And XXIX
  - Fit potential stellar evolution model to our candidate dwarfs



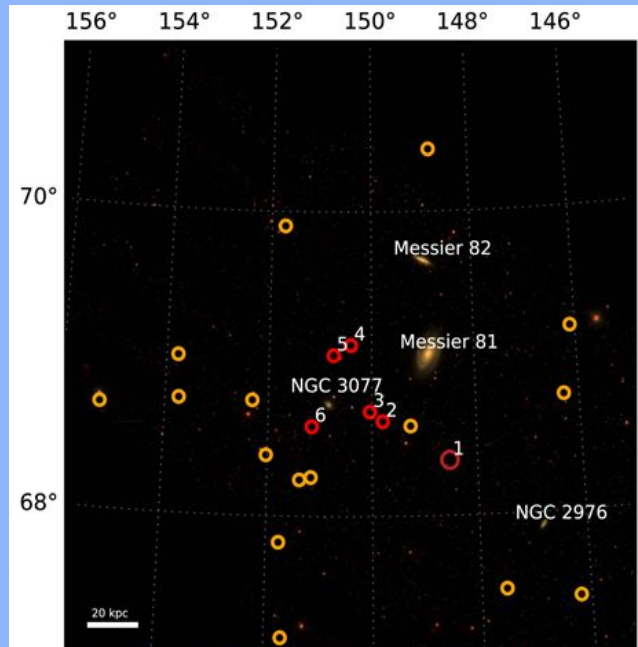
Current progress

- Search for potential ultra-faint dwarfs within 15 degrees radius of M31
  - Classify DELVE objects into star and galaxy class by point spread model measure



Significance of the finding missing satellites

- Testing cosmological constraints of the Lambda Cold Dark Matter (ΛCDM) model through studying the dark matter.
- Provide insights into the process of tidal stripping between the host galaxies and their satellite galaxies.



References

Bell, E. F. et al. (2011). Andromeda XXIX: A new dwarf Spheroidal Galaxy 200 kpc from Andromeda.

Bell, E. F. et al.. (2022). Ultrafaint dwarf galaxy candidates in the M81 Group: Signatures of group accretion.

Cerny, W. et al. (2023). Pegasus IV: Discovery and spectroscopic confirmation of an Ultra-faint dwarf galaxy.

Doliva-Dolinsky, A. et al. (2023). The PAndAS view of the Andromeda Satellite System.

Drlica-Wagner, A. et al. (2022). The DECAM Local Volume Exploration Survey Data release

Fouesneau, M. (2022). EZPADOVA. Retrieved 2023, from https://github.com/mfouesneau/ezpadova

Simon, J. D. (2019). The faintest dwarf galaxies

Thanks for listening!

- Questions?