



UNIVERSITY OF TARTU
Tartu Observatory



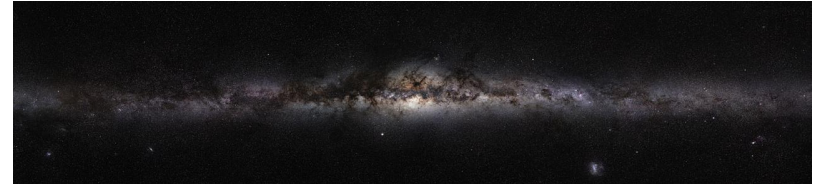
Milky Way analog galaxies in the J-PAS Sky Survey

Teet Kuutma (teet.kuutma@ut.ee), Antti Tamm, Boris Deshev,
Jaan Laur, Elmo Tempel

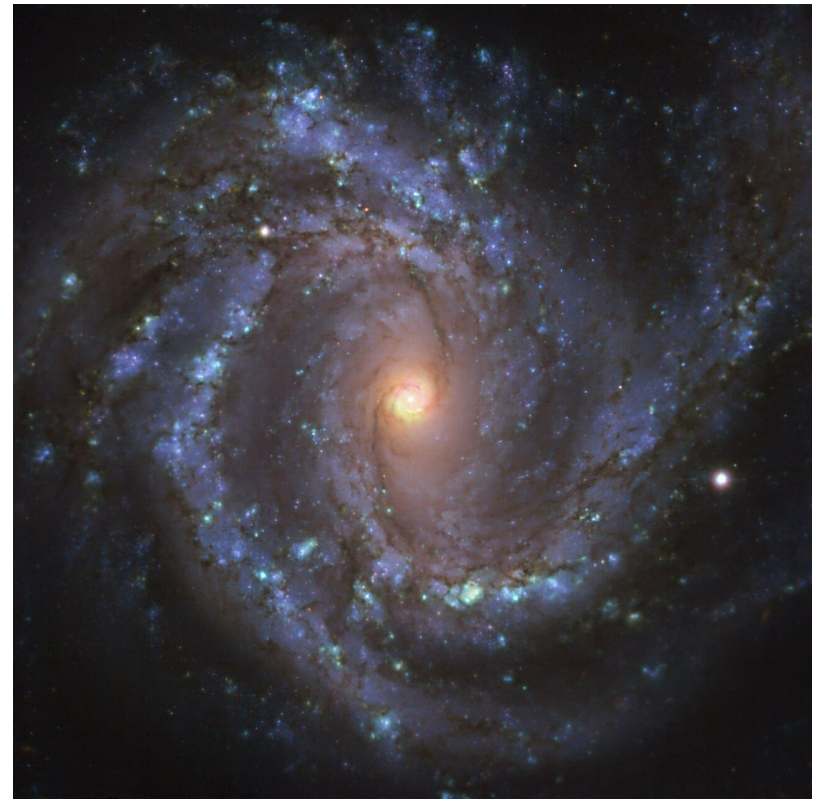
Nordic-Baltic Astronomy Days 2026
Turku, Finland
27/5/2026

Milky Way analogs (MWAs)

- The position of the Solar System inside the Milky Way disk allows detailed study of stars inside our Galaxy.
- At the same time, sightlines on the plane of the disk are obscured by dust and density of stars near the Galaxy core.



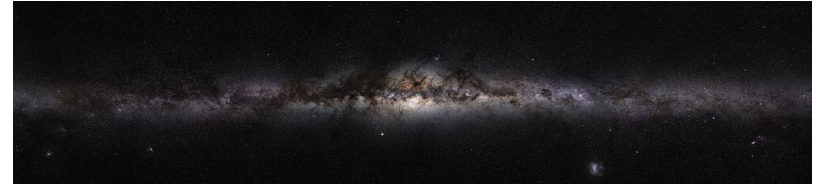
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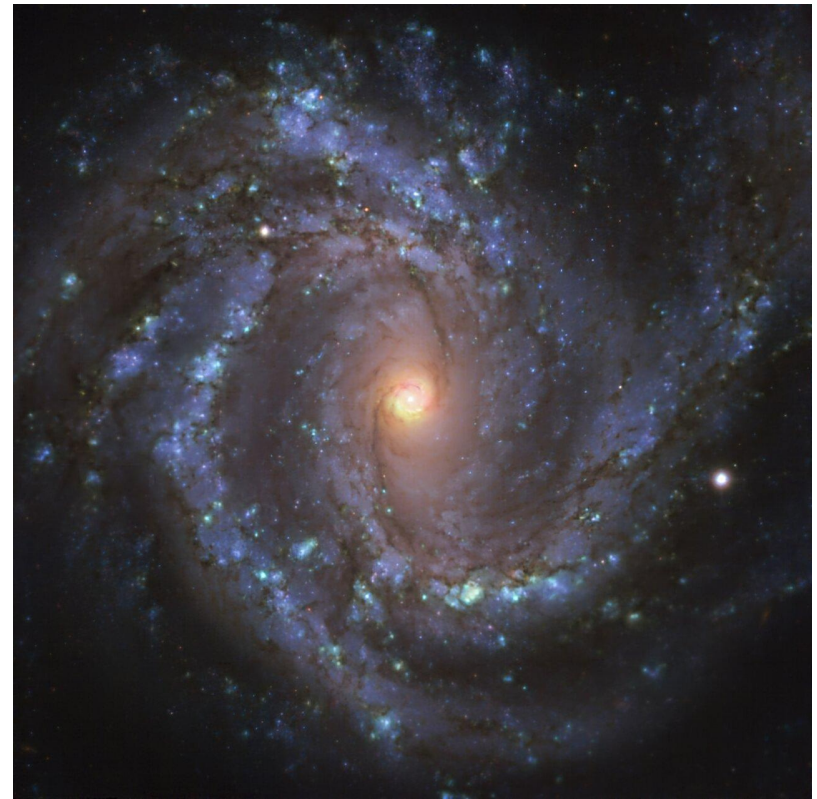
Milky Way analogs (MWAs)

- The position of the Solar System inside the Milky Way disk allows detailed study of stars inside our Galaxy.
- At the same time, sightlines on the plane of the disk are obscured by dust and density of stars near the Galaxy core.

Other galaxies with similar structure to ours can be studied to draw conclusions about the Milky Way.



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Milky Way analogs (MWAs)

Characteristic of the Milky Way from
Tuntipong et al. 2024:

- Stellar mass $(5 \pm 1) \times 10^{10} M_{\odot}$
- SFR $1.78 \pm 0.36 \text{ Myr}^{-1}$
- Bulge-to-total ratio 0.30 ± 0.10
- Disc effective radius R_e $3.86 \pm 1.01 \text{ kpc}$

But also environment.

- Local Group specifics
 - 2 bright spirals $\Delta_{\text{mag}} < 0.5$
 - Large luminosity gap after the second member $\Delta_{\text{maggap23}} > 2$



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J-PAS

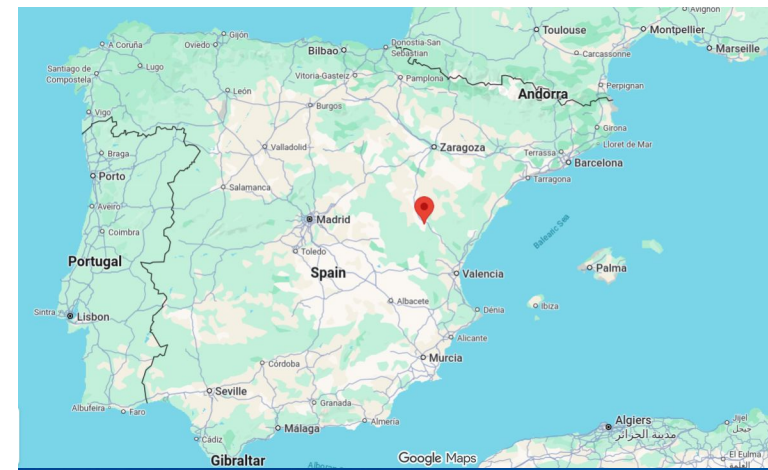
Javalambre Physics of the Accelerating Universe Astrophysical Survey

Goals:

- Observe thousands of square degrees of the sky.
- Measure positions and distances to galaxies, creating a 3D map of the universe.
- Use 56 narrow band filters covering the optical range.
- Produce catalogs with legacy value.

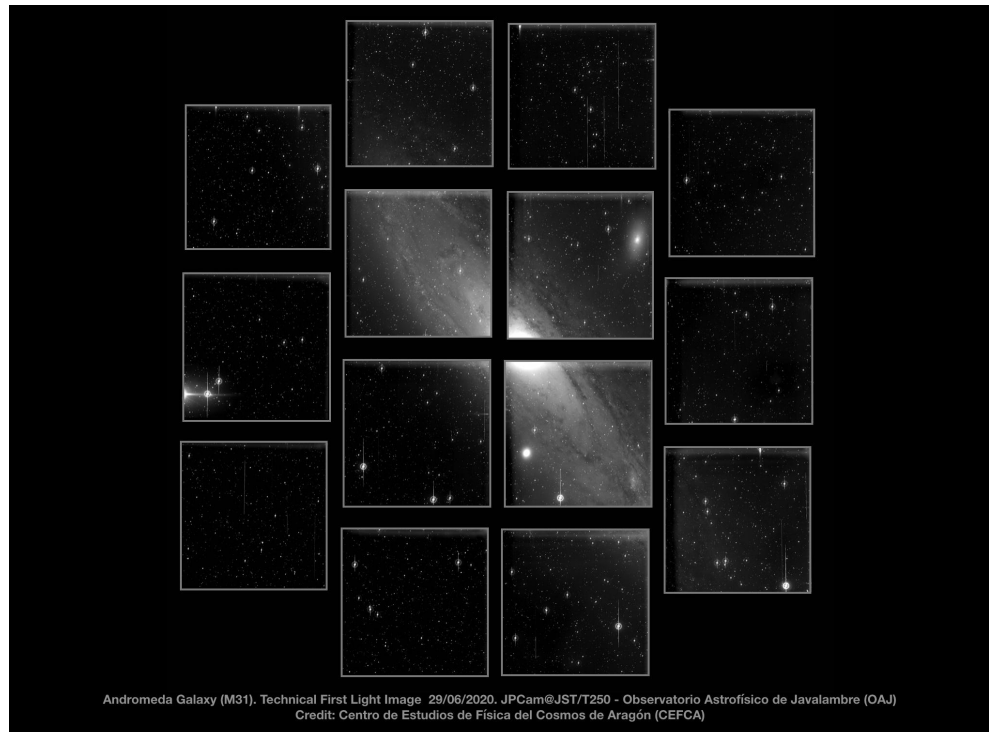
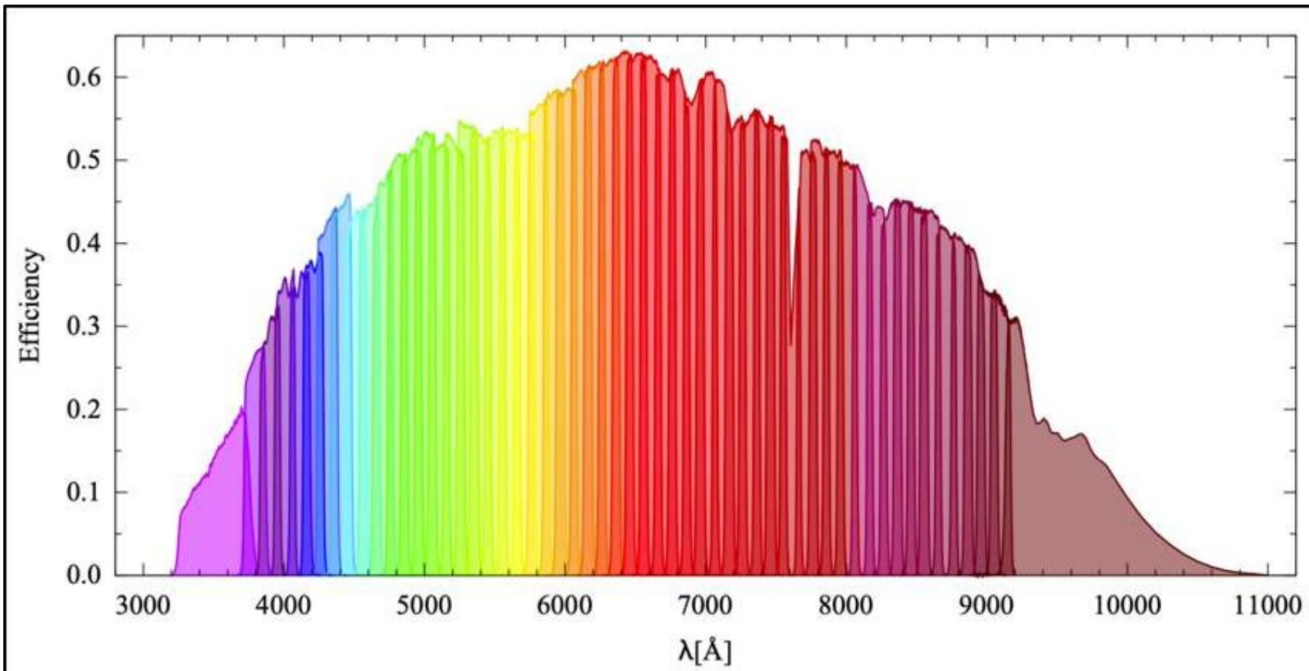
Location:

- Observatorio Astrofísico de Javalambre in Aragon, Spain. Altitude 1957m.
- Observatory managed by Centro de Estudios de Física del Cosmos de Aragón (CEFCA) in Teruel, Spain.
- Main telescopes: T250 and T80.

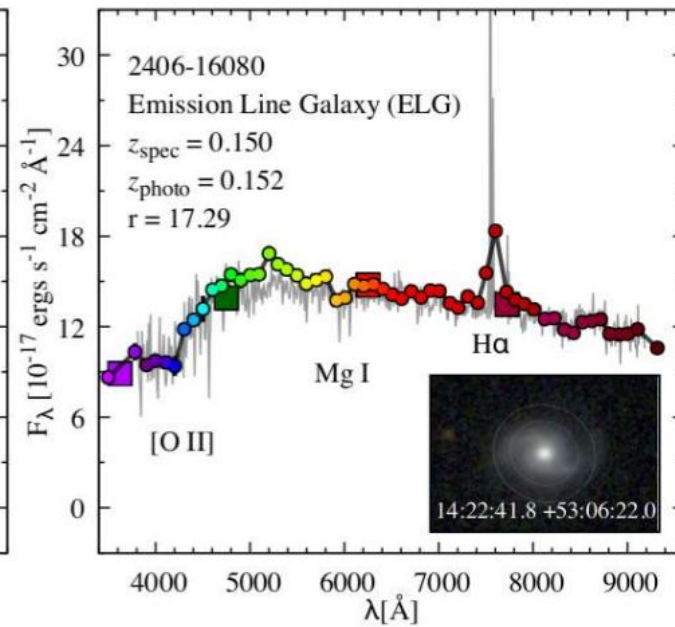
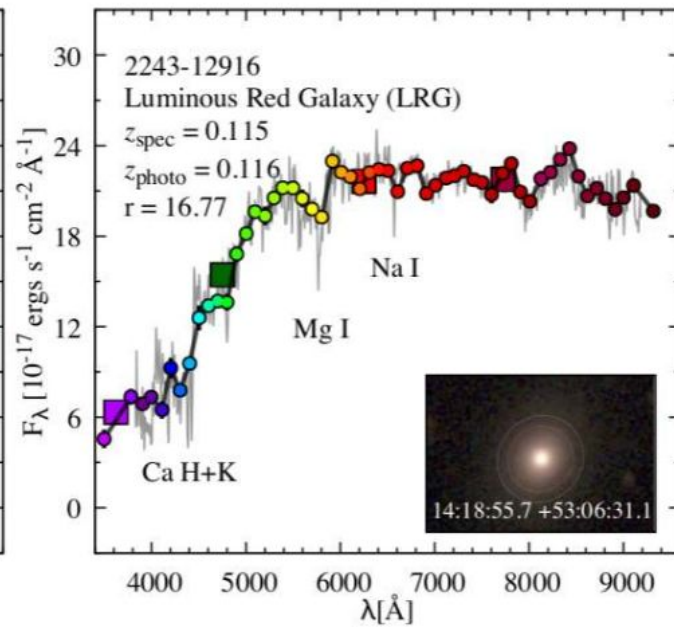
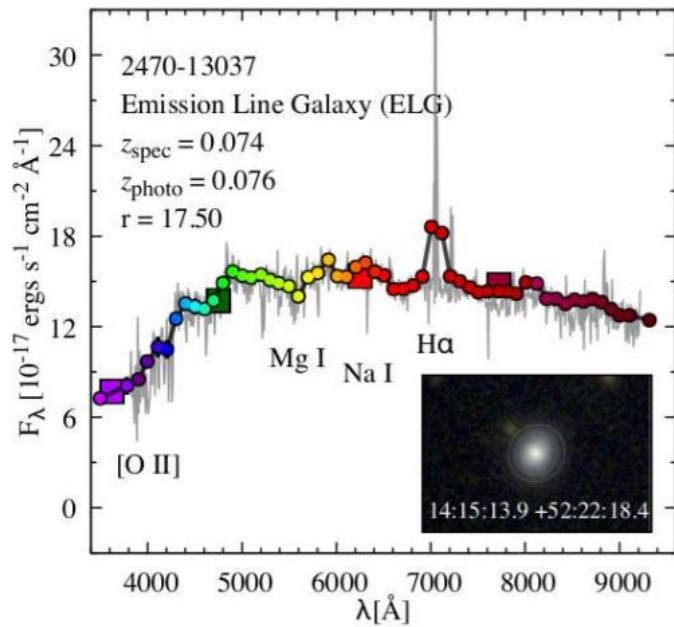
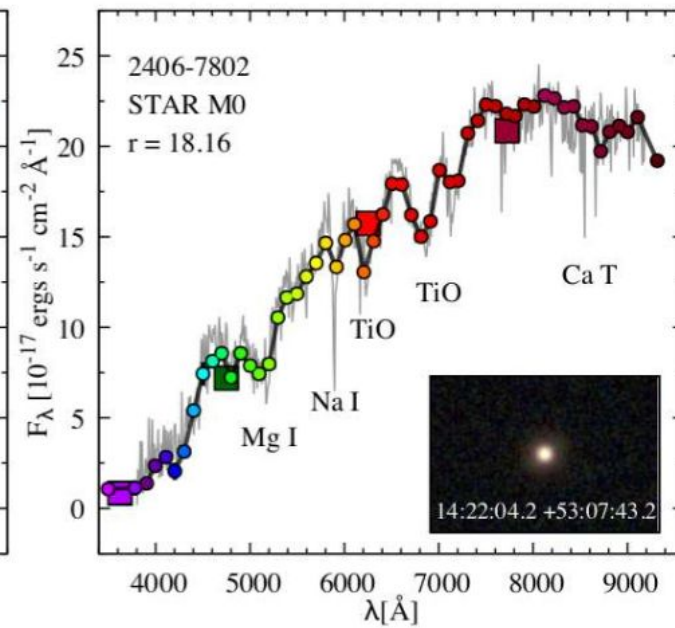
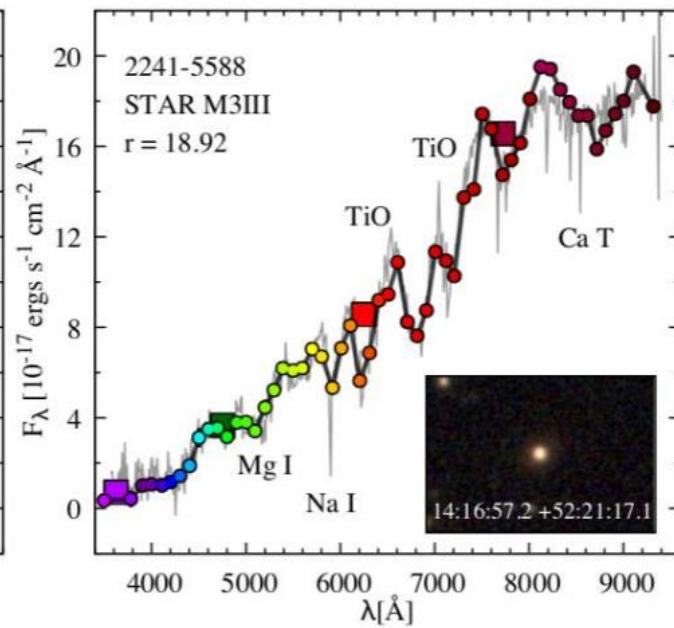
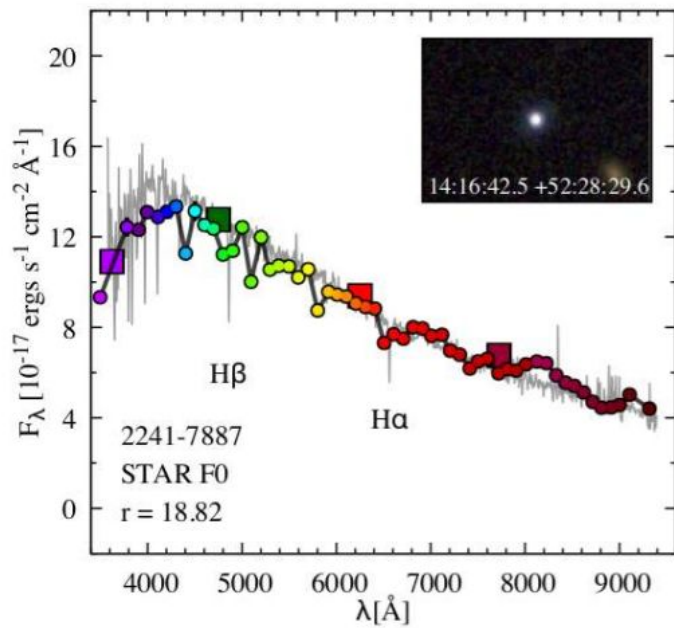


T250 & JPCAM

- Main mirror 2.5 m
- FoV 4.7 deg²
- CCD 14 × 9k × 9k
- Pixel scale 0.23 "pix⁻¹
- Filters 54 narrow, 2 medium, 1 broad (iSDSS)
- Public data: Early Data Release - 12 deg²
(www.j-pas.org)

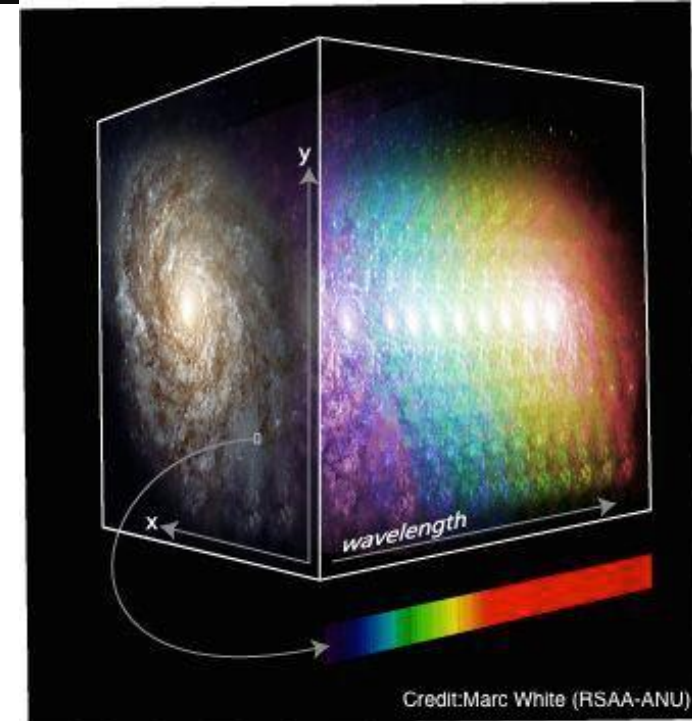
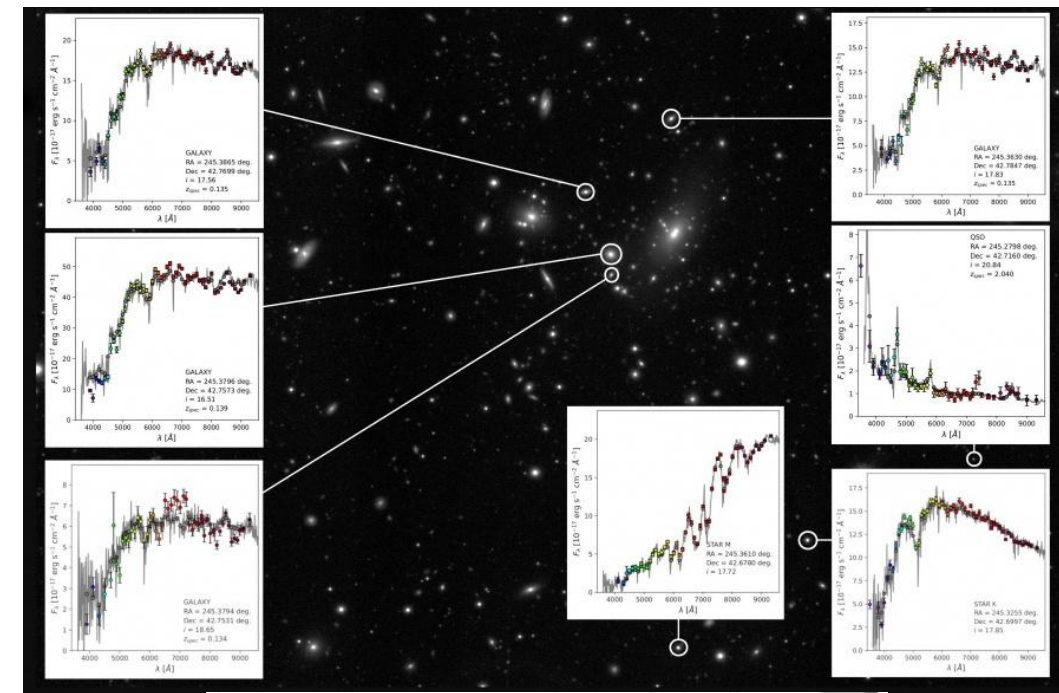


Andromeda Galaxy (M31). Technical First Light Image 29/06/2020. JPCam@JST/T250 - Observatorio Astrofísico de Javalambre (OAJ)
Credit: Centro de Estudios de Física del Cosmos de Aragón (CEFA)



Why MWA-s in J-PAS?

The combination of photometric and spectral information allows each image pixel to function like a (low resolution) spectrum.



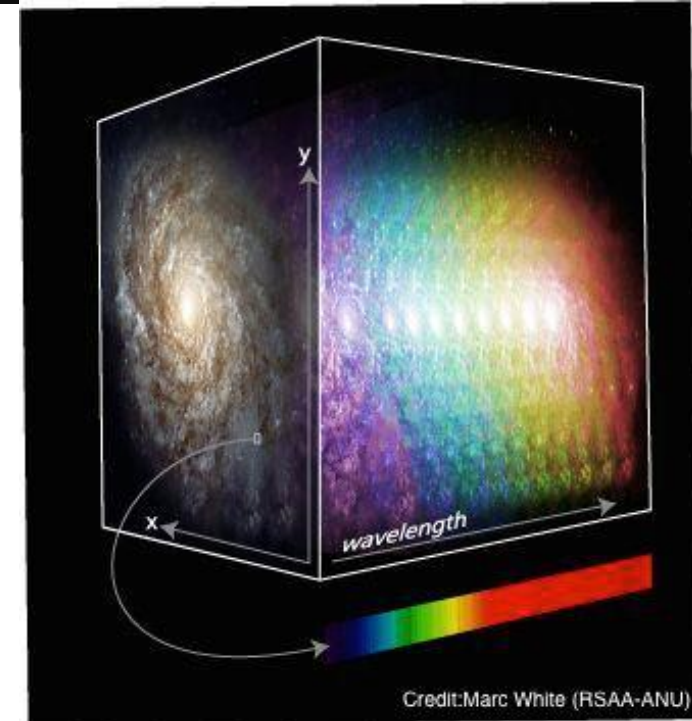
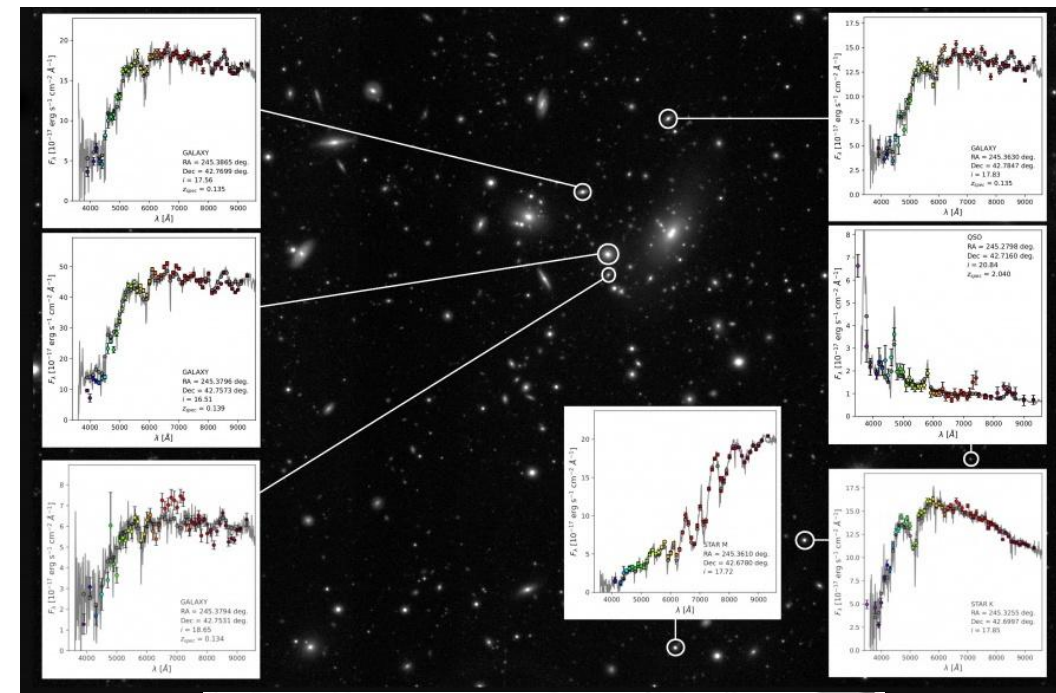
Credit: Marc White (RSAA-ANU)

Why MWA-s in J-PAS?

The combination of photometric and spectral information allows each image pixel to function like a (low resolution) spectrum.

This gives the ability in the same dataset to:

- Accurately determine redshifts to galaxies.
 - Find groups and clusters.
- Find low surface brightness galaxies that may be missed in automated pipelines.
- Study the internal structure of galaxies.
 - Spectra of bulges, disks, bars, ...



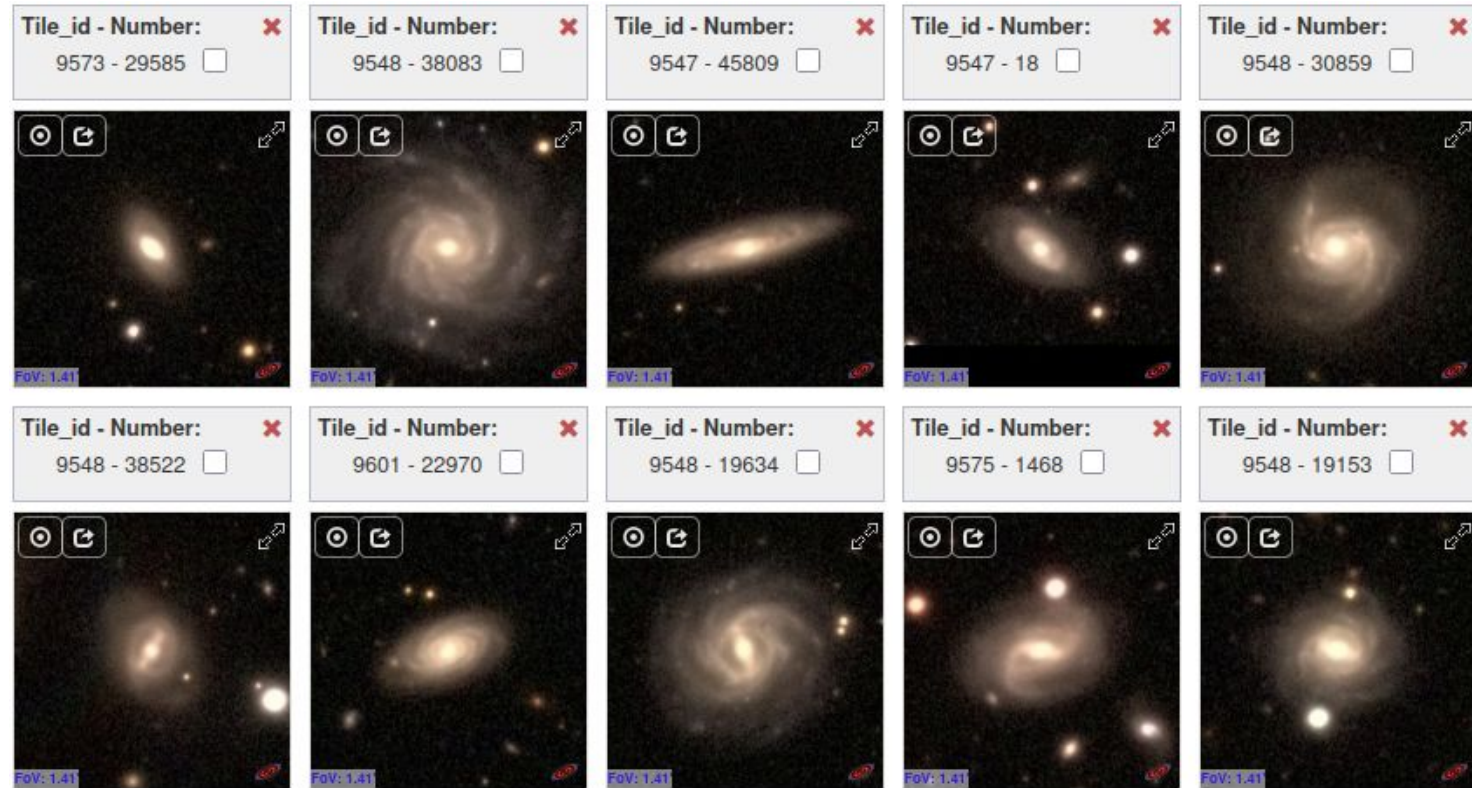
Galaxy selection (WIP)

Galaxy selection based on stellar properties derived from CIGALE (Boquien et al. 2019)

- 56 + 1 fluxes and redshift =>
 - Stellar mass
 - SFR
 - Rest frame colors

Environment considerations

- Local Group analogs (TBD)



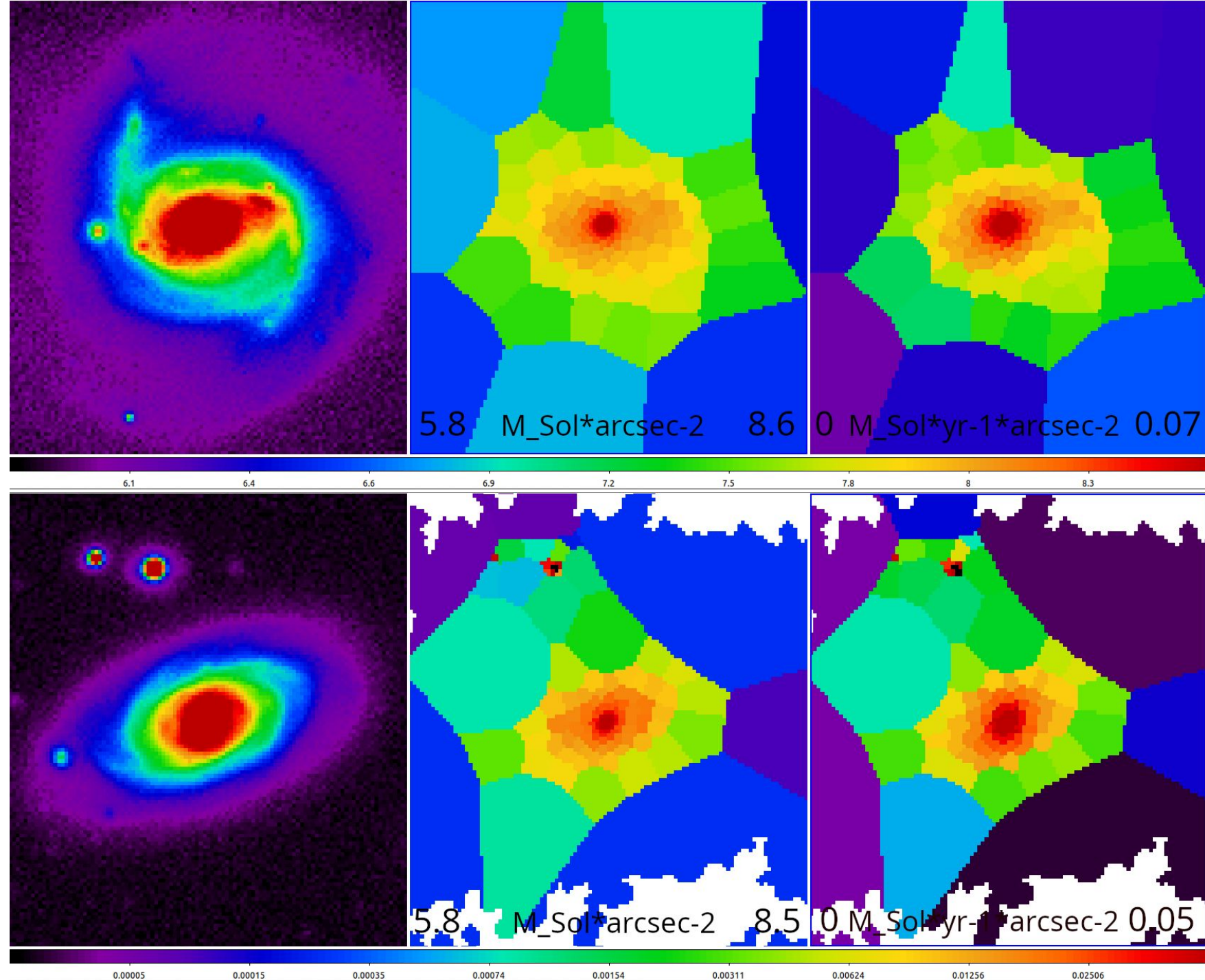
Results (preliminary)

Segments based on areas of SNR 50 or above

- PowerBin (Cappellari 2025)
- CIGALE run separately on each label.
 - M_{Stellar} and SFR per area (arcsec^{-2})

WIP! Optimizations needed:

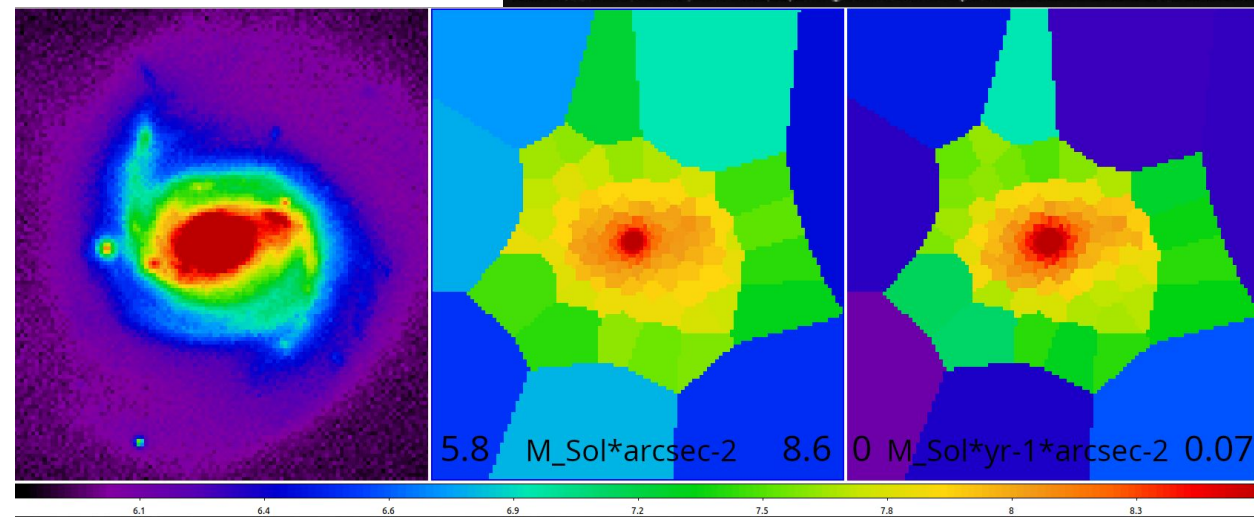
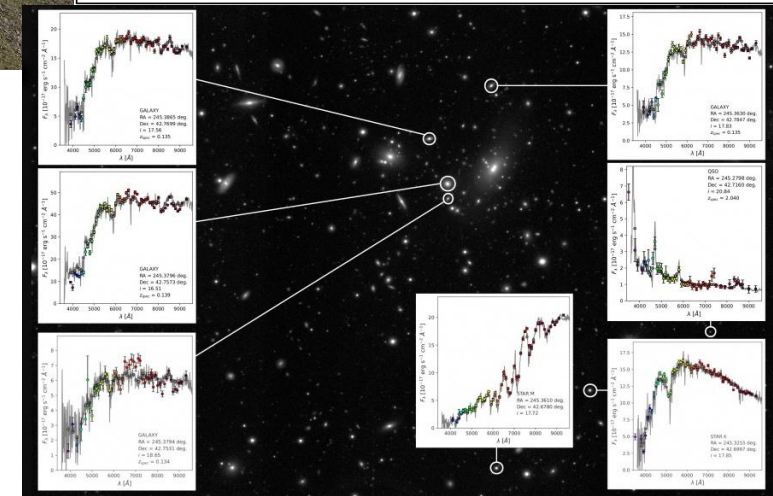
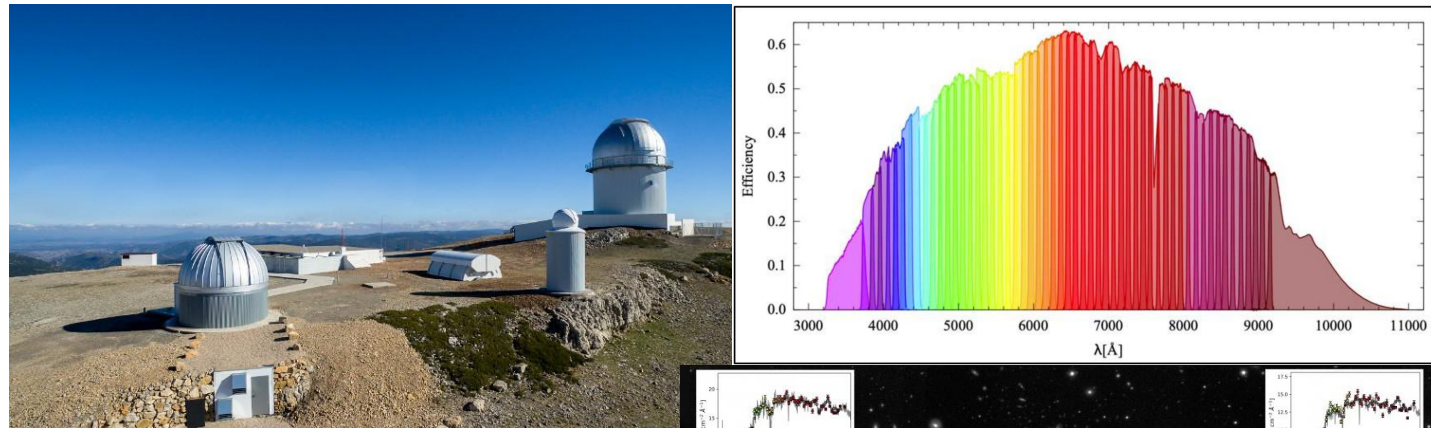
- Masking foreground.
- Binning in galaxy outskirts.
- Look into different segmentation methods (e.g. wavelets).



Summary

- Milky Way analog galaxies can help interpret our Galaxy as a whole
- J-PAS is an ongoing survey observing the sky with 56 narrow-band optical filters.
- J-PAS data can be used to detect and study the structure and environment of MWA-s.

Thank You!



5.8 $M_{\text{Sol}} \cdot \text{arcsec}^{-2}$ 8.6 $0 M_{\text{Sol}} \cdot \text{yr}^{-1} \cdot \text{arcsec}^{-2}$ 0.07

6.1 6.4 6.6 6.9 7.2 7.5 7.8 8 8.3