

## JUNAIS

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### Low Surface Brightness Galaxies (LSBs)

- Galaxies with a central disk surface brightness  $\mu_{0,B} >> 21.65 \text{ mag/arcsec}^2$  (Freeman 1970).
- LSBs may account up to 50% of all the galaxies in the universe (Impey & Bothun 1997, Martin et al. 2019).
- Giant LSBs (GLSBs) are a subpopulation of LSBs - with extremely extended and massive ( $\sim 10^{10} M_{\odot}$ ) disk
- In recent years, with powerful instruments (e.g. CFHT, Megacam, MUSE), there is a new interest in these sources.
- LSBs also similar to galaxies with eXtended UV disk (**XUV**) (Thilker et al. 2007).
- Ideal laboratories for the study of Star Formation activities in low density regime.

An extreme case of LSB galaxy !!

#### MALIN 1

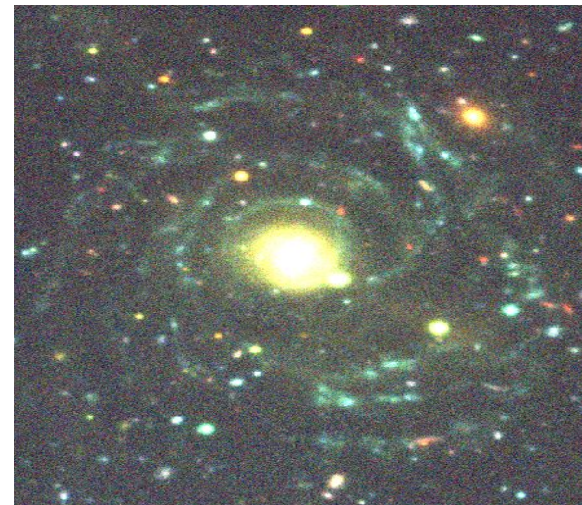
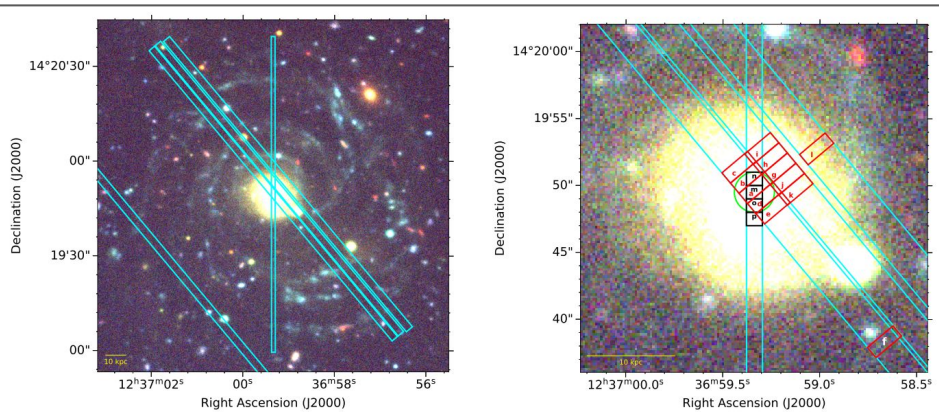


Image credit: CFHT u, g, i

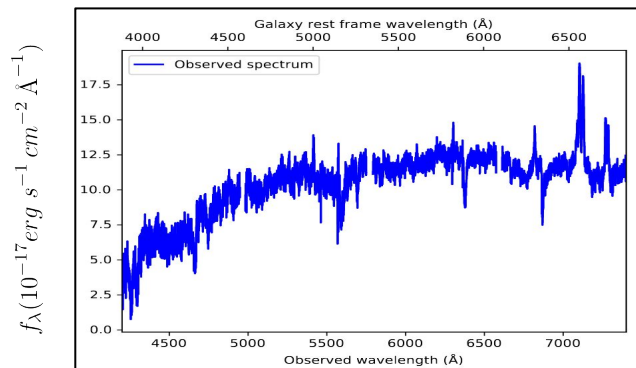
~ 200 kpc diameter

# A new spectroscopic study of Malin 1

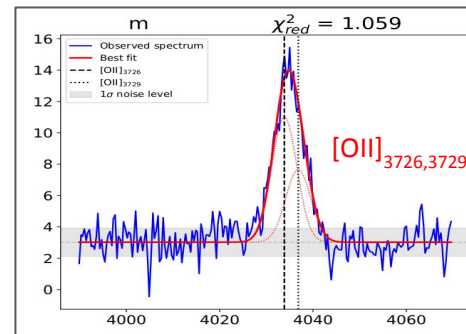
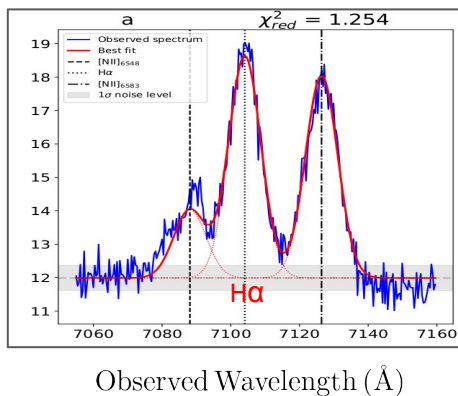
Junais et al. 2020, A&A, 637, A21



- Reduced the longslit spectroscopic data of Malin 1 from IMACS Magellan spectrograph.
- Extracted spectra from 16 different regions including a region at ~25 kpc from center.
- Focussed on the H $\alpha$  and [OII] emission lines => strongest of all
- Extracted a rotation curve for Malin 1 using H $\alpha$  and [OII] emission lines.
- Estimated the local SFR surface density ( $\Sigma_{\text{SFR}}$ ) from the H $\alpha$  line flux

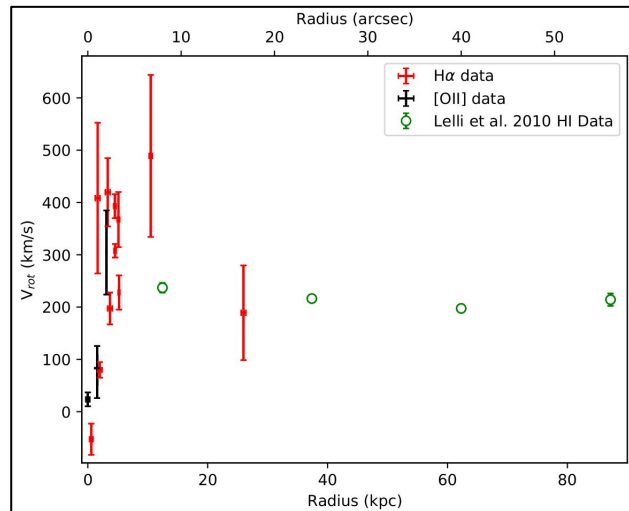


An example spectrum from Malin 1 center

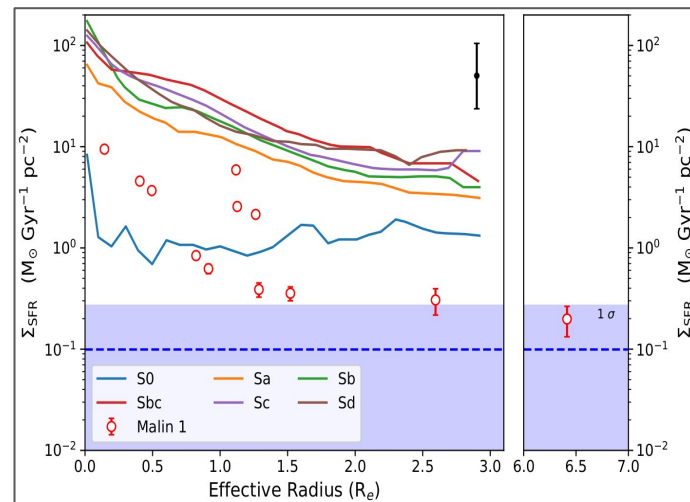


# Results

## A new Rotation curve for Malin 1



## Star formation rate surface density estimate



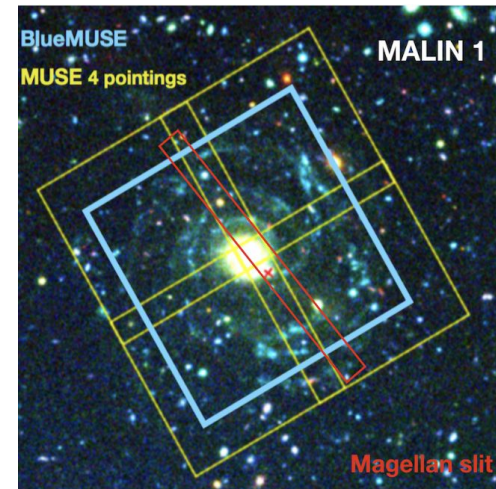
- First time to observe a steep rise in the rotation curve for Malin 1 up to ~400 km/s (inside ~10 kpc)
- Created a new mass model based on the new rotation curve.
- In the inner regions dynamics may be dominated by the stars (but our models couldn't explain the highest velocities)
- At large radii a massive dark matter halo remains necessary.
- We need better quality data (e.g. IFU)

- Steep decrease in  $\Sigma_{\text{SFR}}$  with radius similar to stellar profile
  - Inner region ( $< 1 R_e$ ) : consistent with an early type spiral (S0/Sa)
  - Outer region ( $> 1 R_e$ ) : similar to level found in XUV galaxies
- (The blue dashed line and shaded region indicates the typical  $\Sigma_{\text{SFR}}$  level found in the disk of XUV galaxies; Bigiel+2010)

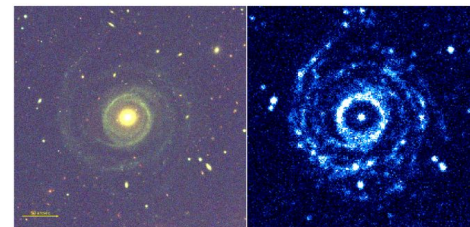
# Conclusions & Perspectives

- A better determination of dynamics and SFR of Malin 1 clearly requires large-IFU observations.
- Malin 1 was recently accepted for MUSE observation (PI-Gaspar Galaz, rank B observation in the cycle of 2021)
- Similar study could be extended to other giant LSBs & XUVs in a broader context with Malin 1 as a prototype.
- Already created a sample of 10 HI selected GLSB/XUV galaxies for follow up spectroscopic & UV observation.
- The upcoming BlueMUSE instrument, with its larger FoV and higher spectral resolution, will be crucial for LSB science.
- With SKA we will be able observe HI in GLSBs at higher redshifts (see Samuel Boissier's talk)
- With deep and more quality data in the future, we will be able to uncover the origin of these giant beasts !!

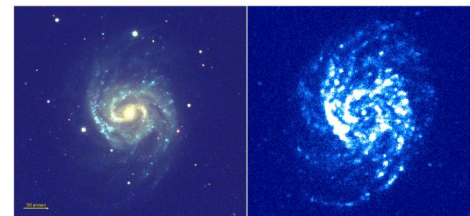
Malin 1 MUSE observation pointings



UGC 6614



NGC 1042



An XUV and GLSB galaxy from the sample