ALMA [OIII] 88μm emitters

Signpost of Early Stellar Buildup and Reionization in the Universe

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ABOUT THE PROJECT

During the epoch of reionization or EoR (400 Myr to 1 Gyr after the beginning of the universe) matter stopped being neutral. The causes and origin of this phenomenon are not yet fully understood. New information of galaxies in the EoR such as their physical properties, age of stellar population and emission fraction of ionizing photons will allow us to further deepen our knowledge of this objects.

GO1 JWST proposal #1840 (*Álvarez-Márquez+21)* will shed light on the epoch of reionization by means of studying a sample of high redshift, [OIII] $88\ \mu m$ emitting galaxies previously detected with radio interferometer ALMA (Atacama Large Millimetric Array) in order to understand how their light can ionise atoms. The main scientific goals are:

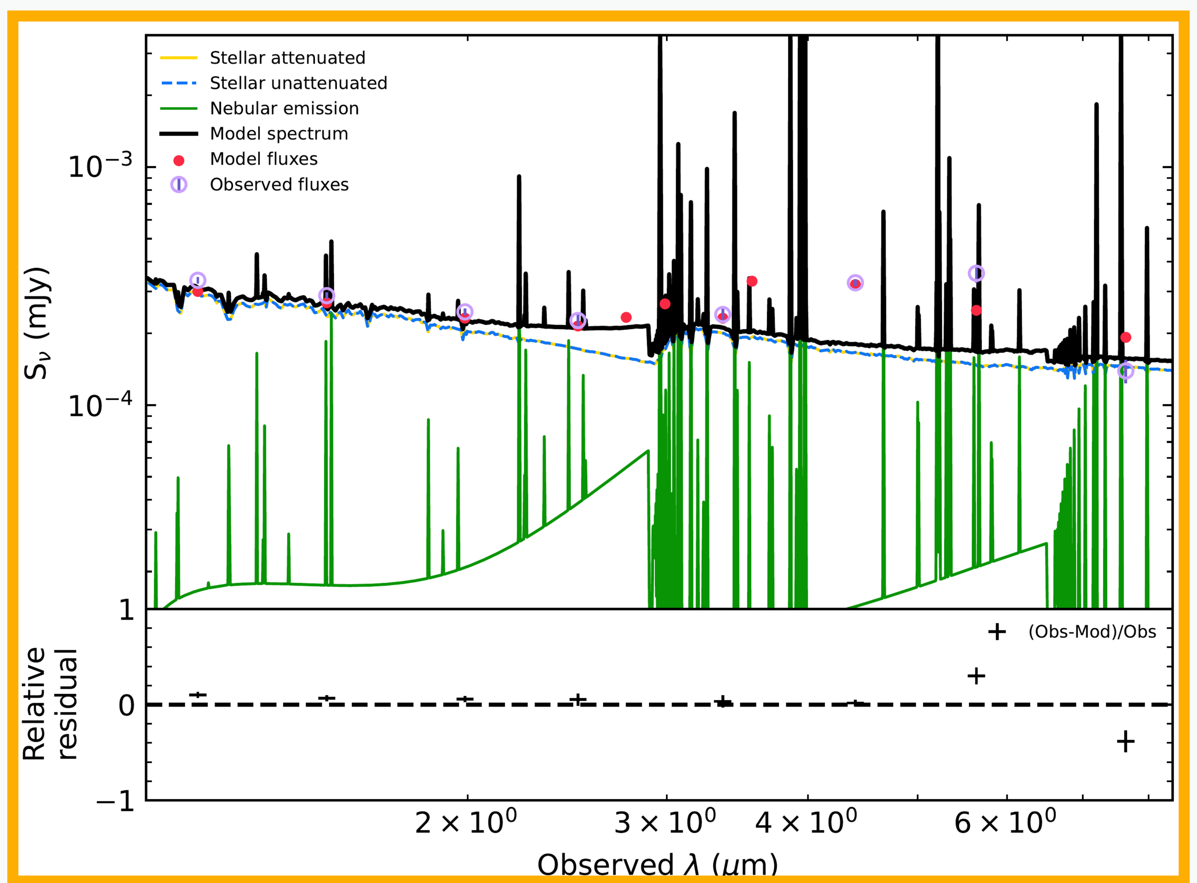
- Determining the **stellar and gaseous structure of galaxies**. By means of deep imaging of rest frame UV and optical bands with NIRCam; structure of **stellar populations of different ages** and **ISM** can be determined at sub kpc-scale.
- Establishing **stellar population's age and mass** of [OIII] $88\ \mu m$ emitting galaxies. There are evidences of old stellar populations in galaxies of the sample. By performing Spectral Energy Distribution (SED) fitting, star formation history (SFH) and physical properties of each system can be estimated.

SED FITTING

SED fitting makes use of photometry from NIRCam (GO1, this work) and MIRI (GTO) + spectroscopy from NIRSPec (GO1).

CIGALE (*Boquien+2019)* has been the used software. It has some key advantages: flexibility in generating SED models, bayesian inference, and extension to X-ray and radio wavelengths.

By performing SED fitting, physical properties and SFHs have been derived for a variety of galaxies: with star formation bursts in the present (≤ 25 Myr) [a], past (≥ 100 Myr) [b] and in both cases [c]. The dual star formation case [c] is specially relevant because it can help date the start of star formation in the universe.



SED fitting results for FL939 (unique burst in the present time) [a]. Observed/simulated fluxes (purple reticles) and model fluxes (red dots) can be seen. Values of physical parameters match with SED fitting predictions for FL939.

A in detailed study of dual burst systems is in progress , because of their more complex SFH.

FL939 : $z = 6.94$, SFR $= 26\ M_\odot/yr$, $M_{UV} = -21.7$ mag, $M_\star = 1.34\times10^9 M_\odot$

BEST FIT : $z = 6.94$, SFR(10Myr) $= (26\pm6)\ M_\odot/yr$ $M_\star = (1.0\pm0.3)\times10^9 M_\odot$

NIRCAM PHOTOMETRY

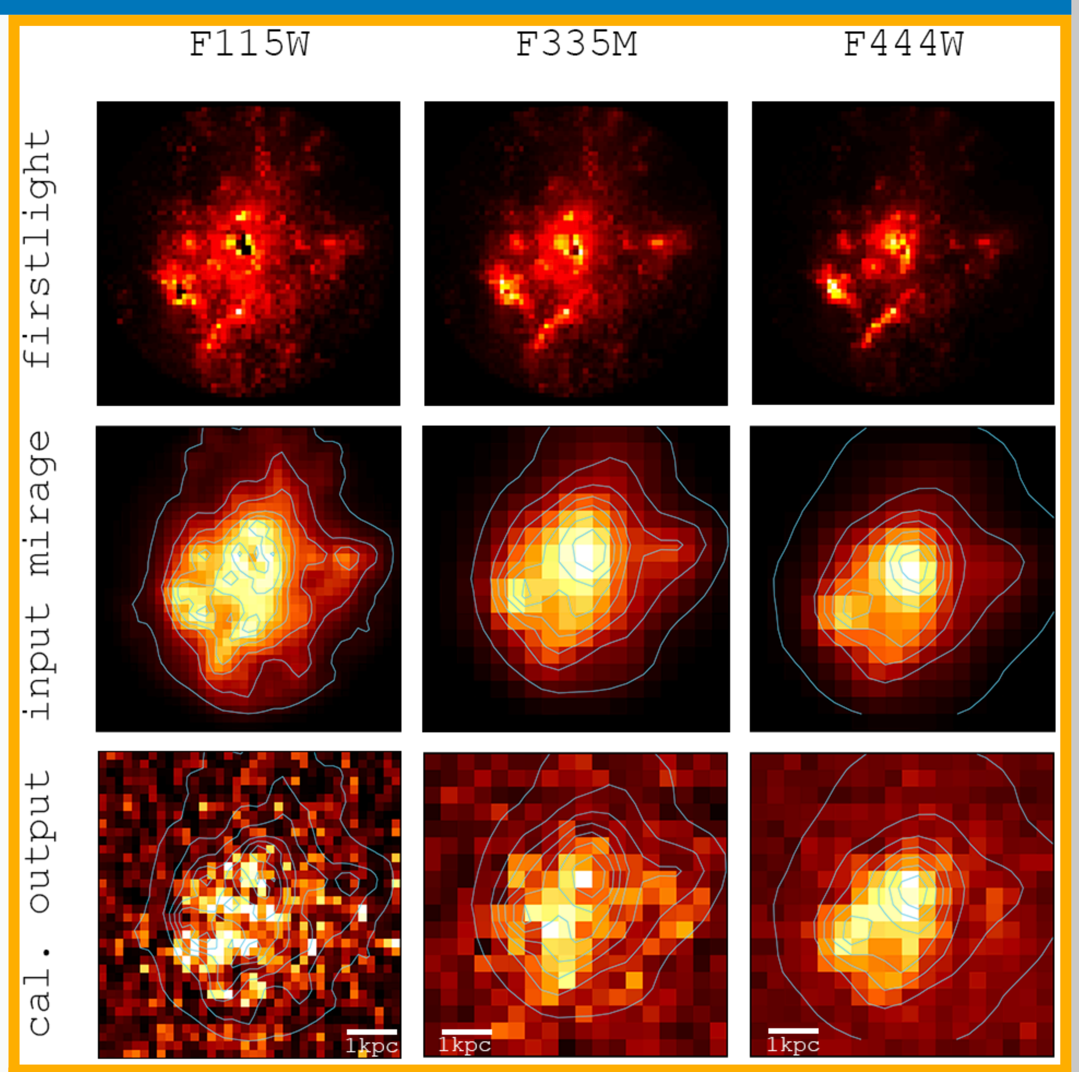
NIRCam observations provide information about physical structure of EoR galaxies and serve as photometrical inputs to SED fitting. Simulations of observations for two objects similar to the ones in the sample shown in *Álvarez-Márquez+21* have been prepared using data from FIRSTLIGHT cosmological simulation, presented in *Ceverino+17*.

The set of images prepared for both candidates FL939 (above) and FL895 (below) depict different steps of the processing pipeline:

ROWS: 1) firstlight: artificial band images from FIRSTLIGHT simulation. 2) input mirage: resampled FIRSTLIGHT image used as input to MIRAGE with blue contours that are also shown in the third row. 3) cal. output: fully calibrated NIRCam simulated images after running MIRAGE and JWST's imaging pipeline.

COLUMNS: F115W ($1.15\mu m$) band samples the restframe UV, and traces young stellar populations. F335M ($3.35\mu m$) samples the post Balmer-break region, that is a good estimator of the star population age. F444W ($4.44\mu m$) samples the optical continuum and strong nebular emission lines such as [OIII] $5007Å$. Different morphology in each band traces distribution of stars and ISM in the galaxy.

As can be seen in the images, the main morphological features are recovered with NIRCam observations. Binning of blue channel band F115W (with half the kpc/px than other bands in the red channel) or co-adding multiple bands can increase SNR, useful for studying outer regions of the galaxies.



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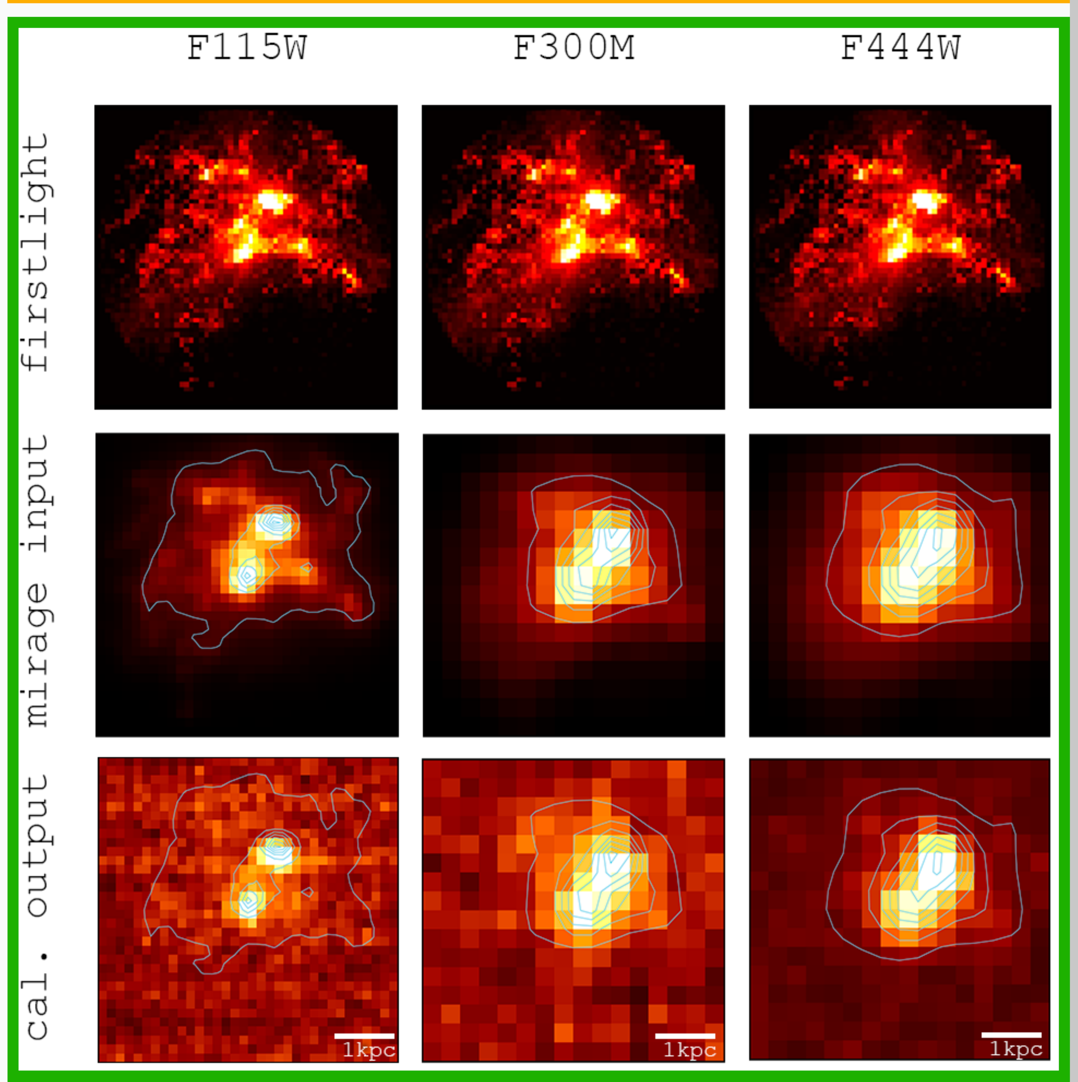

FL895 : $z = 6.14$, SFR $= 3.9\ M_\odot/yr$, $M_{UV} = -19.7$ mag, $M_\star = 1.51\times10^8 M_\odot$

CONCLUSION

The two main results from this work are:

NIRCam imaging will unveil ISM and stellar population distribution of EoR galaxies.

SED fitting will estimate SFH, physical parameters and probably recover the presence of old star populations.

REFERENCES

Ceverino, Daniel, Monthly Notices of the Royal Astronomical Society, 2017, Volume 470, Issue 3, p.2791-2798.

Álvarez-Márquez, Javier et al, JWST Proposal, 2021. Cycle 1, ID. #1840.

Boquien et al, 2019, A&A, 622, 103.

Rafael Navarro, 2022