ALMA [OIII] 88μm emitters

Signpost of Early Stellar Buildup and Reionization in the Universe

R. Navarro Carrera
rnavarro@iaa.es
Supervisors:
J. Álvarez Márquez
L. Colina Robledo

About the Project

During the epoch of reionization or EoR (400 Myr to 1Gyr 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 parameters, age of stellar population and emission fraction of ionizing photons will allow us to further deepen our knowledge of this objects.

Future GO1 JWST proposal #1840 *Álvarez-Márquez et al. (2021)* 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 ALMA in order to understand how their light can ionise atoms.

Main scientific goals are:

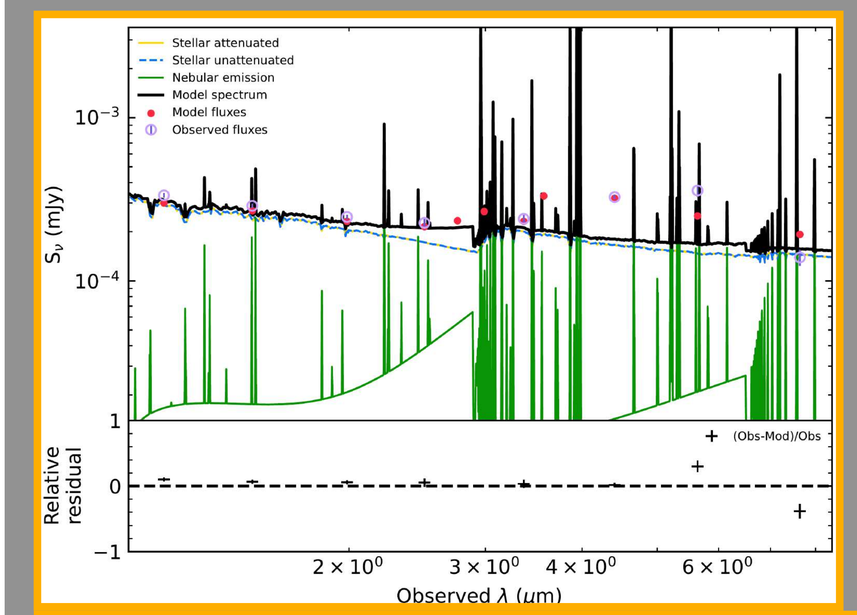
- Determining the **stellar** and **gaseous structure** of galaxies. By means of deep imaging with NIRCam in rest frame UV and optical bands; structure of **stellar population of different ages** and **ISM** can be determined at sub kpc-scale.
- Establishing **stellar population's age and mass** of [OIII]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

SED fitting

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

CIGALE *Boquien et al. (2019)* is the chosen SED fitting software. It has some key advantages: flexibility in SED generator models, bayesian inference, and extesnion to X-ray or radio emission.

Studying the sample, physical parameters and SFHs have been derived for a variety of galaxies: with star formation bursts in the present (≤ 25 Myr), past (≥ 100 Myr) and in both cases. The dual star formation case is specially interesting for dating the start of star formation in the universe.



SED fitting results for FL939, comparison between observed fluxes (purple reticles) and model fluxes (red dots) can be seen.

Values of physical parameters match with SED fitting predictions for FL939.

A more detailed study for dual burst systems is being done, because their more complex SFH.

FL939 : z = 6.94, SFR = 26 $M_\odot$/yr, $M_{UV} = -21.7$ mag, $M_\star = 1.34 \times 10^9 M_\odot$

BEST FIT : z = 6.94, SFR(10Myr) = (26 ± 6) $M_\odot$/yr $M_\star = (1.0 \pm 0.3) \times 10^9 M_\odot$

NIRCam photometry

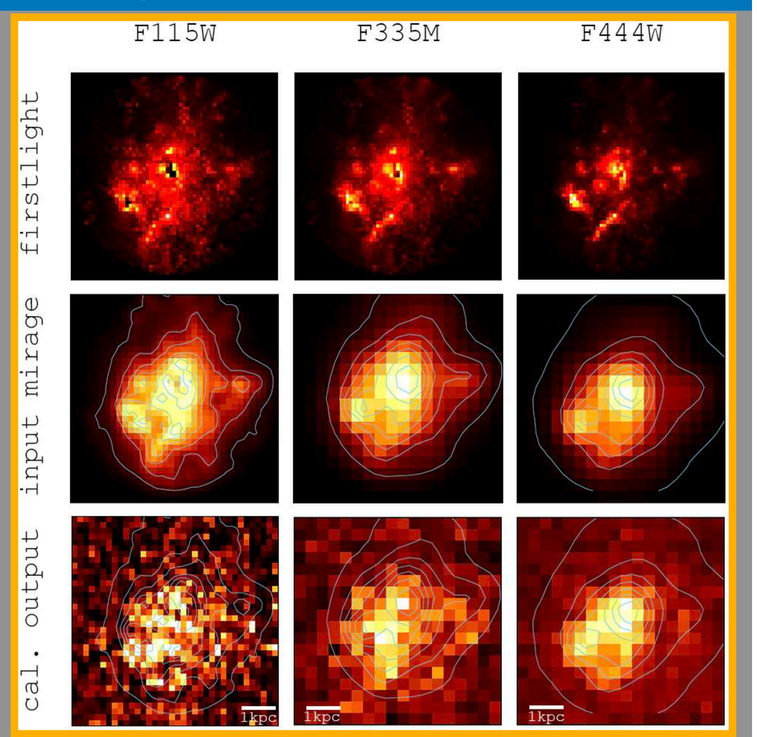
NIRCam observations will provide information about physical structure of EoR galaxies and serve as photometrical inputs to SED fitting. Simulations of observations for two objects similar to the ones in the sample shown in *Álvarez-Márquez et al. (2021)* have been made using data from FIRSTLIGHT cosmological simulation, presented in *Ceverino (2017)*.

The set of images of candidates FL939 (above) and FL895 (below) depict different steps of the processing pipeline.

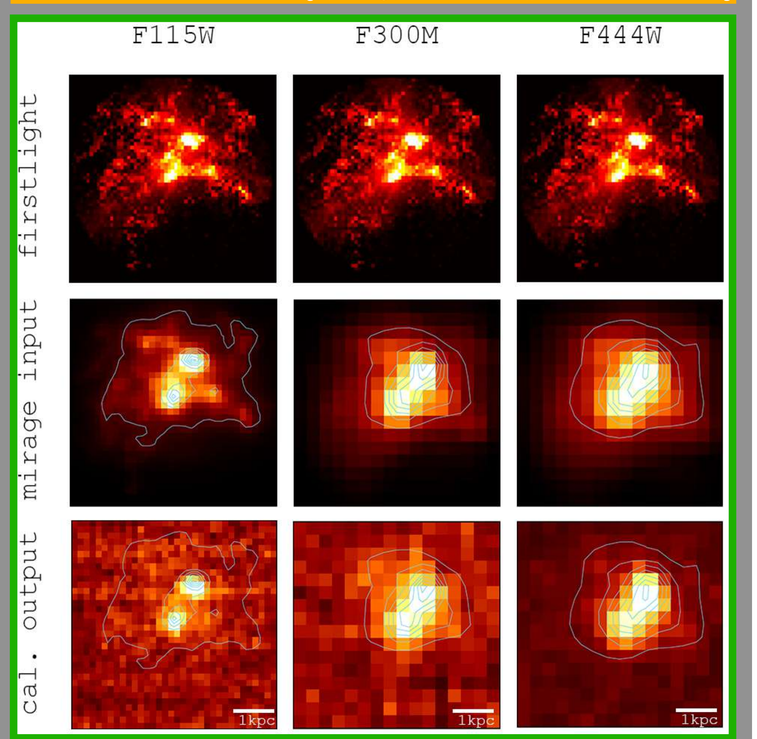
Rows: 1) firstlight: direct data from FIRSTLIGHT simulation. 2) input mirage: Resampled FIRSTLIGHT image used as an input of MIRAGE and blue contours also present in final image. 3) cal. output: Fully calibrated NIRCam simulated image combining MIRAGE and the JWST calibration pipeline.

Columns: F115W band samples the restframe UV, and is a good proxy for young star population. F335M samples the post Balmer-break region, a good estimator of the star population age. F444W samples the optical restframe and strong nebular emission lines such as [OIII]. Different morphology in each band shows 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-band F115W (with half kpc/px than the red-band bands) or co-adding different bands can increase SNR, useful for studying outer regions os the systems.



FL939 : z = 6.94, SFR = 26 $M_\odot$/yr, $M_{UV} = -21.7$ mag, $M_\star = 1.34 \times 10^9 M_\odot$



FL895 : z = 6.14, SFR = 3.9 $M_\odot$/yr, $M_{UV} = -19.7$ mag, $M_\star = 1.51 \times 10^8 M_\odot$

Conclusions

NIRCam imaging will unveil ISM and stellar pop. structure of EoR galaxies

SED fitting will estimate SFH, physical params. and probably recover presence of old star pop.

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