First results of the GOYA survey: low-mass star-forming galaxies at different redshifts with the MOS mode of EMIR

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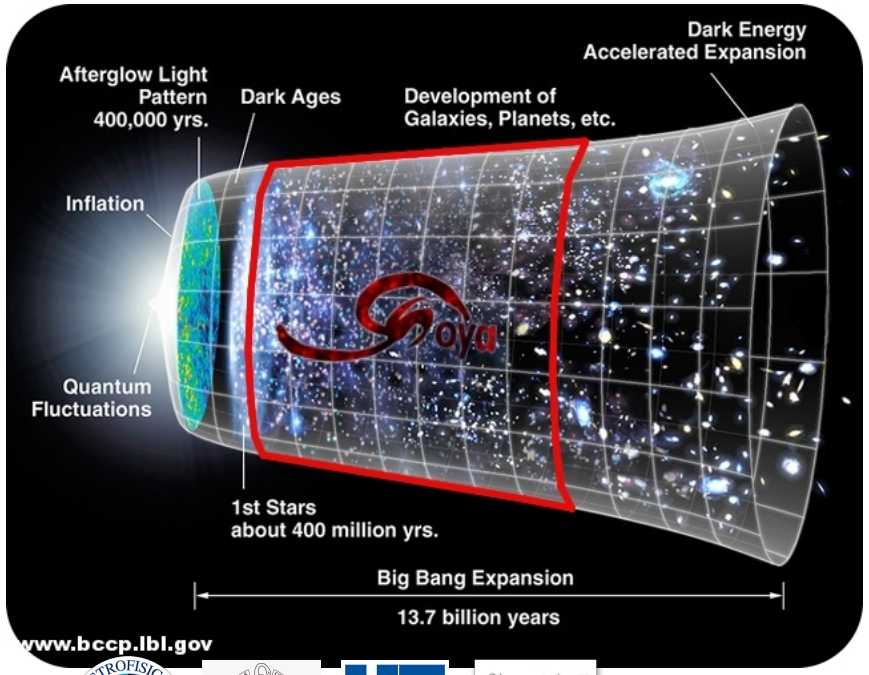
Abstract

GOYA (Galaxy Origins and Young Assembly) is a survey of the high-redshift universe using EMIR, the near-infrared camera and multi-object spectrograph (MOS) of GTC. GOYA encompasses several scientific projects to address key questions on cosmological galaxy evolution. We survey the Extended Groth Strip (EGS) field using the multiple capabilities of the EMIR MOS mode. In particular, we present the first results of the spectroscopic study of a sample of low-mass star-forming galaxies at intermediate redshifts ($0.7 < z < 1.5$), specially selected to study the formation redshift and cosmic role of dwarf galaxies.

For the data reduction, we used pyemir (https://pyemir.readthedocs.io/), a pipeline developed in order to facilitate the automatic reduction of EMIR data taken in both imaging and spectroscopy mode. For a total exposure time of 2.8h the faintest galaxy detected with the J grism was JAB=23.4. These preliminary detections are in very good agreement with the estimations provided by the EMIR ETC, and confirm EMIR as a powerful instrument to obtain nIR spectroscopy of faint targets.

GOYA (*GALAXY ORIGINS AND YOUNG ASSEMBLY*)

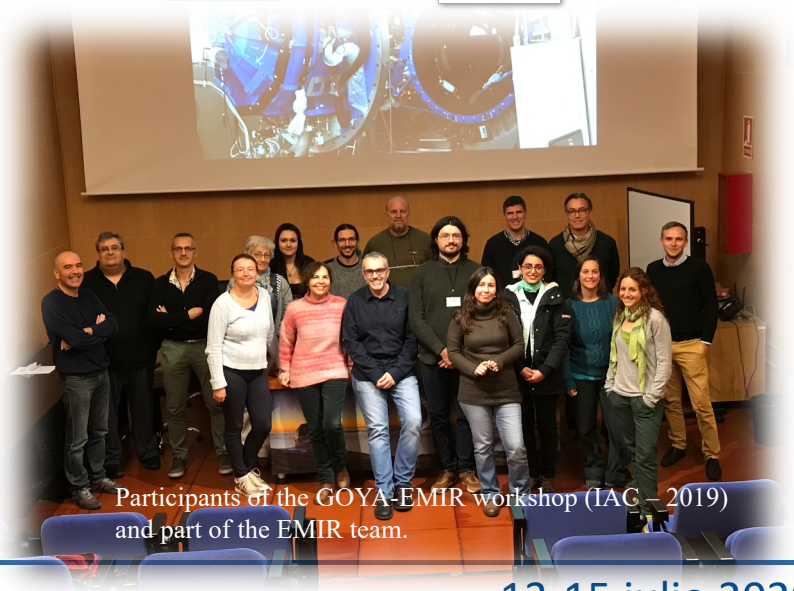
Survey of the high-redshift universe using EMIR.
Several scientific projects to address key questions on cosmological galaxy evolution, including the star-formation history of low-mass star-forming galaxies, the mass assembly, stellar populations and IMF of the most massive galaxies, and the identification and characterization of the sources of cosmic reionization.



GOYA main scientific projects

- **MAGINASTE** (*MAssive Galaxies through INfrAred SpecTroscopy with EMIR*)
- **First generation of galaxies**
- **Low-mass star-forming galaxies**

  → **Aim**: observe a representative sample of low-mass galaxies ($\log M_{\odot} < 9$) at intermediate redshifts ($0.8 < z < 1.7$) to study the formation redshift and cosmic role of dwarf star-forming galaxies.



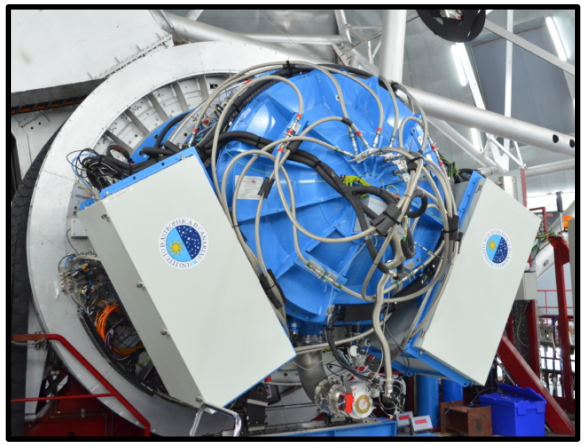
Participants of the GOYA-EMIR workshop (IAC – 2019) and part of the EMIR team.

Instrumental setup

EMIR FEATURES

Teledyne HAWAII-2 IR detector
2048 x 2048 pixels
32 channels / 4 quadrants
FoV: 4' x 6.67'
Plate scale: 0.1945"/pix
Readout noise: 5.23 ADU single read
Gain: 4.2 e-/ADU
Dark current: < 0.15 e-/sec
Spectral range: 0.9 - 2.5 μm
Spectral resolution: 4000 - 5000 JHK bands
987 YJ- HK bands

Especrografo Multiobjeto Infra-Rojo

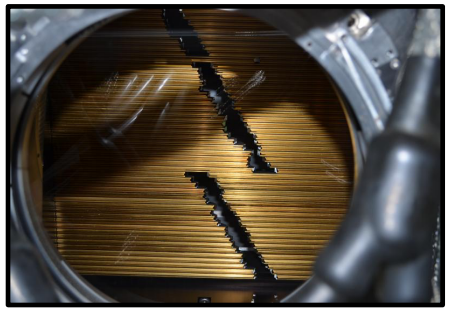


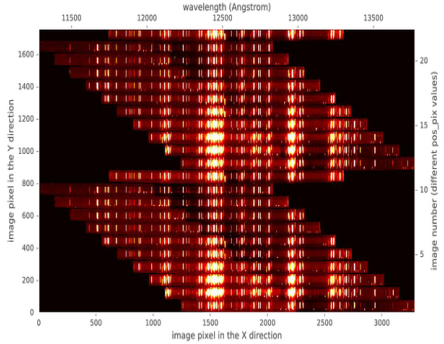
EMIR

GRAN TELESCOPIO CANARIAS · GTC ·

CSU (Configurable Slit Unit)

Allow to configure and observe
in real time up to **53 slits!**



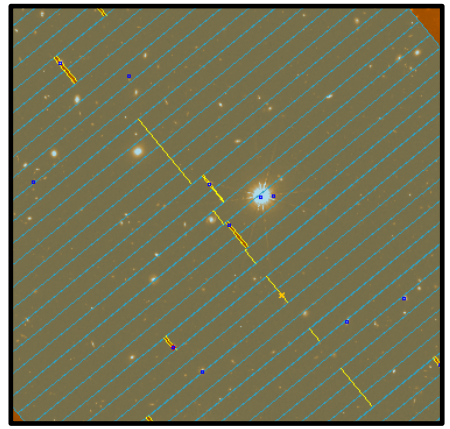


Tools

EMIR Optimized Slits Positioner (OSP)

Design of the masks

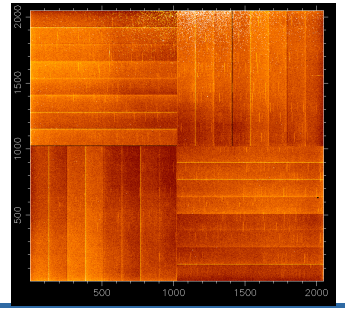
- At least, there must be 3 reference stars (*GAIA*).
- Good astrometry is essential.
- Set double slit for ABBA pattern.

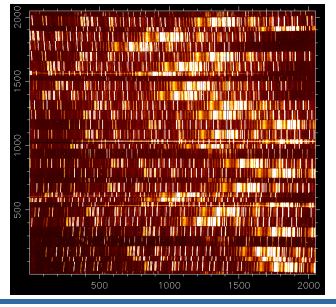


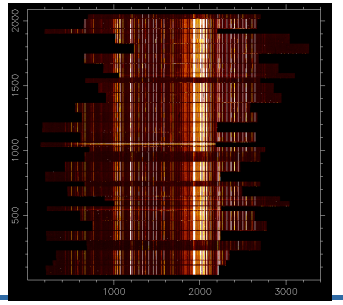
Data reduction pipeline - PYEMIR

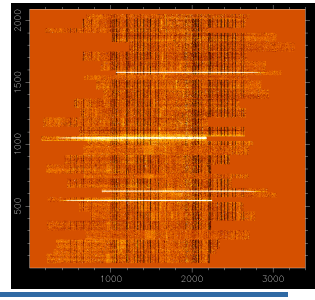
- Application of bad-pixel mask
- Flatfielding
- Rectification and wavelength calibration
- Subtraction of consecutive images

Raw frame → Raw spectra → Reduced spectra → Final image



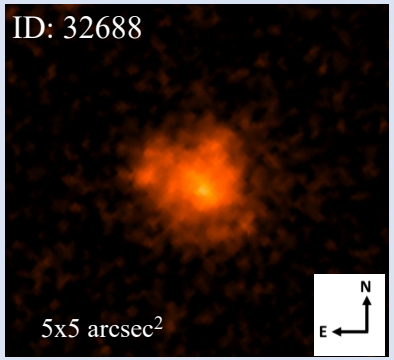


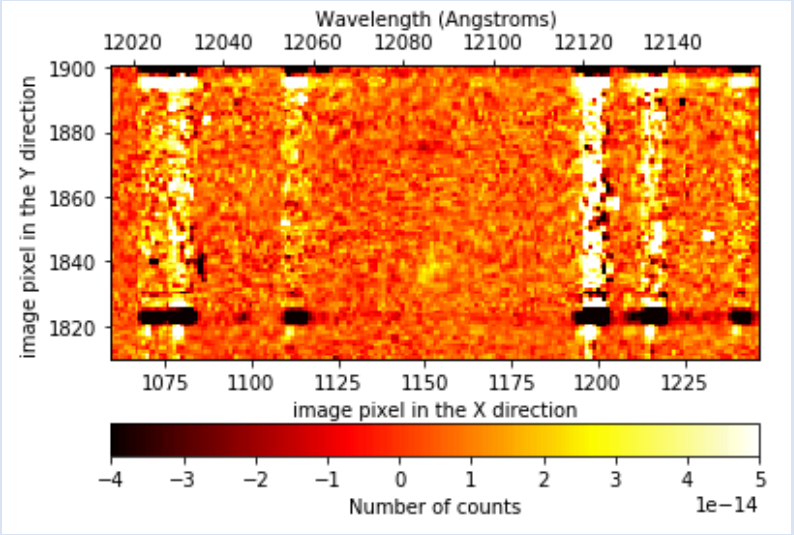




First results of GTO with EMIR@GTC

EMIR: log(Hα Flux) = -16.19 erg/s/cm^2

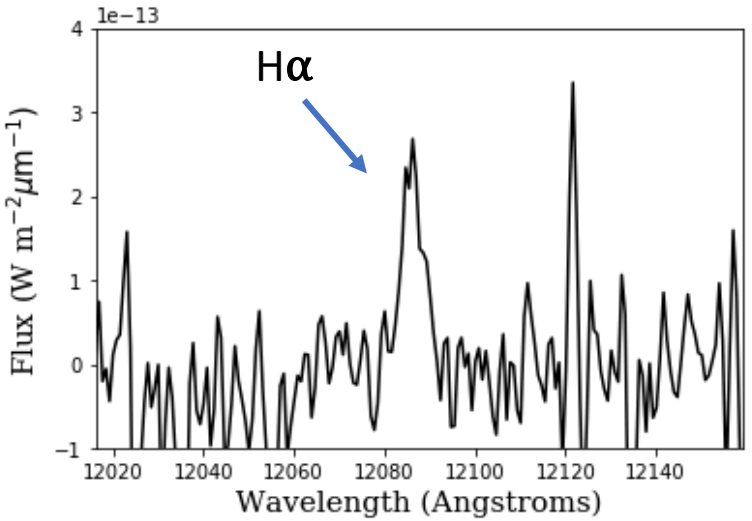


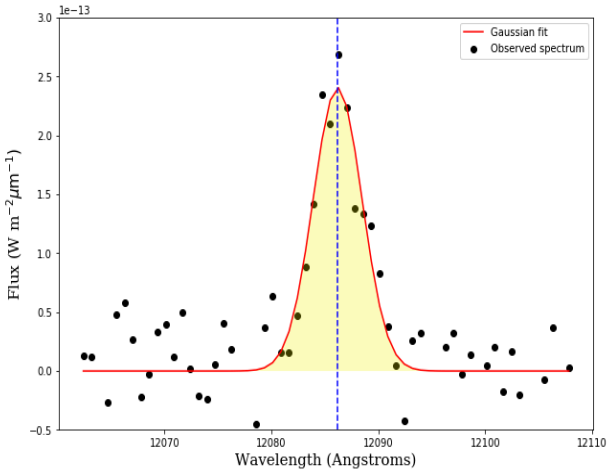


z = 0.8412

log (Mass/M$_\odot$) = 9.83

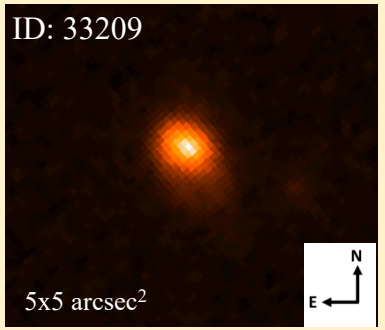
mag_F125W (AB) = 22.34

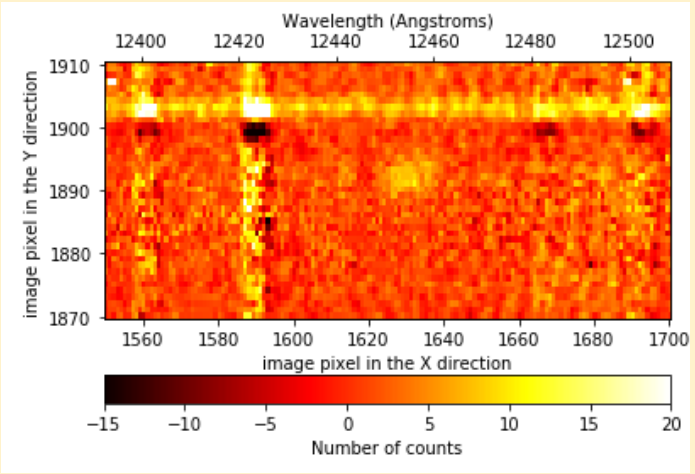




J band
5.2h

EMIR: log(Hα Flux) = -15.35 ± 0.06 erg/s/cm^2

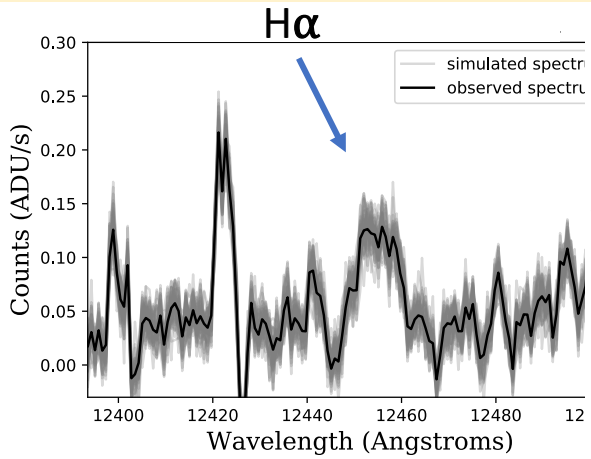


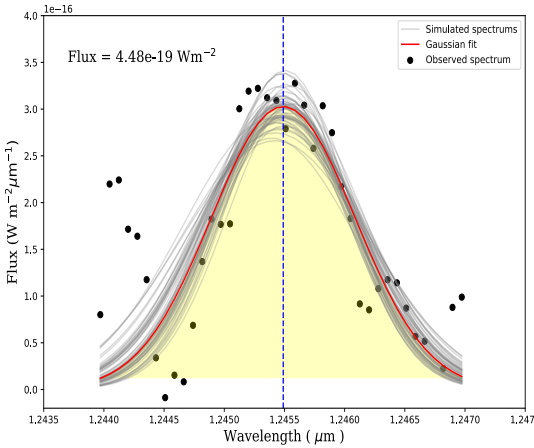


z = 0.897

log (Mass/M$_\odot$) = 9.76

mag_F125W (AB) = 21.87

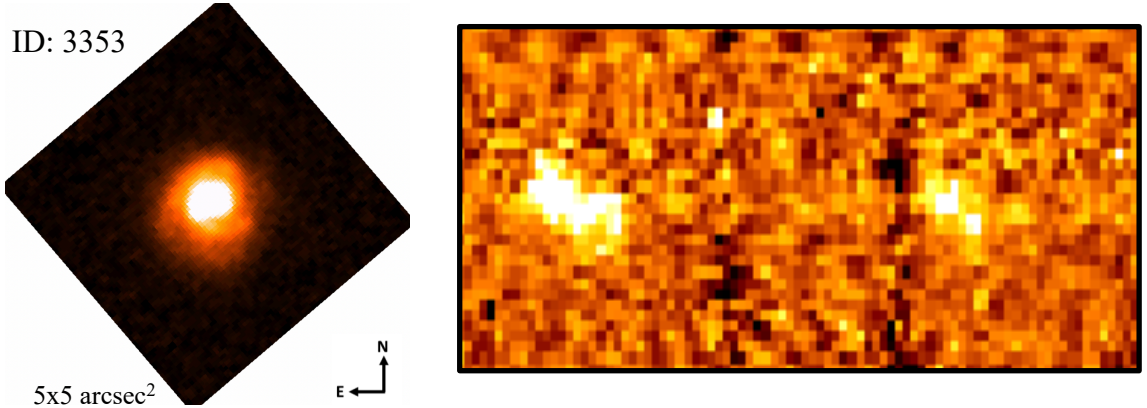




First results of GTO with EMIR@GTC

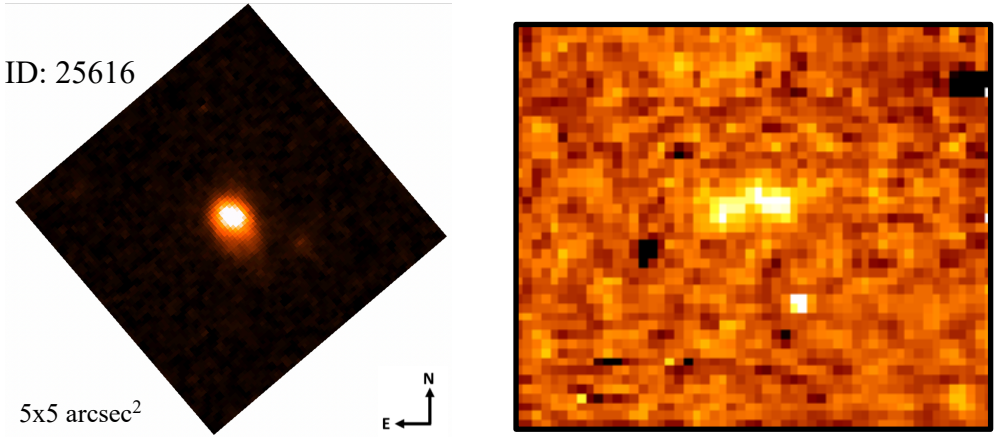
Hα+NII emitter

z_{spec} = 0.7909, J_{AB} = 20.31, log(Mass) = 10.3 $M_{\odot}$



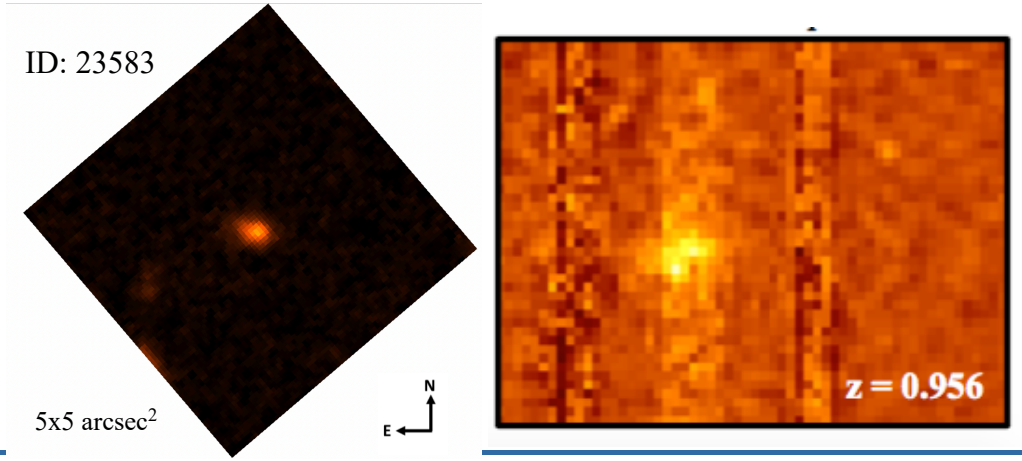
Hα emitter

z_{spec} = 0.8970, J_{AB} = 21.78, log(Mass) = 9.38 $M_{\odot}$



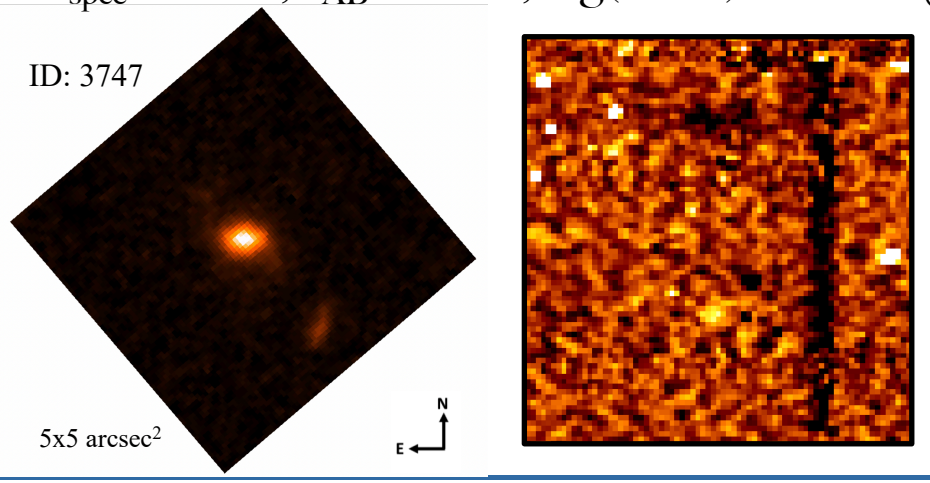
Hα emitter

z_{spec} = 0.956, J_{AB} = 23.39, log(Mass) = 8.41 $M_{\odot}$

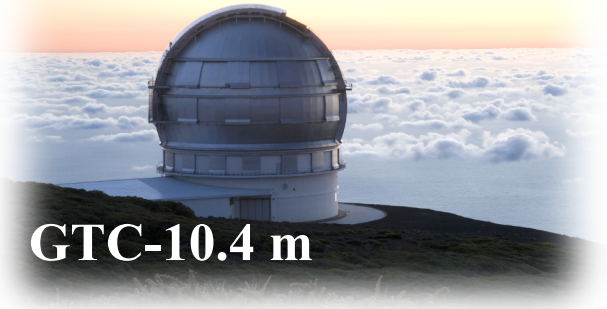


[OIII]5007 emitter

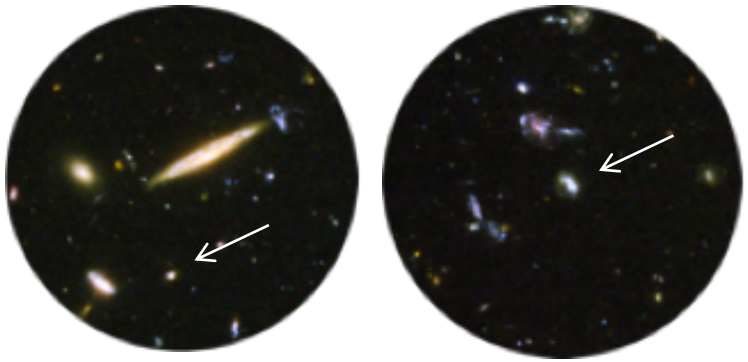
z_{spec} = 1.473, J_{AB} = 22.33, log(Mass) = 9.77 $M_{\odot}$



Gran Telescopio Canarias (GTC)

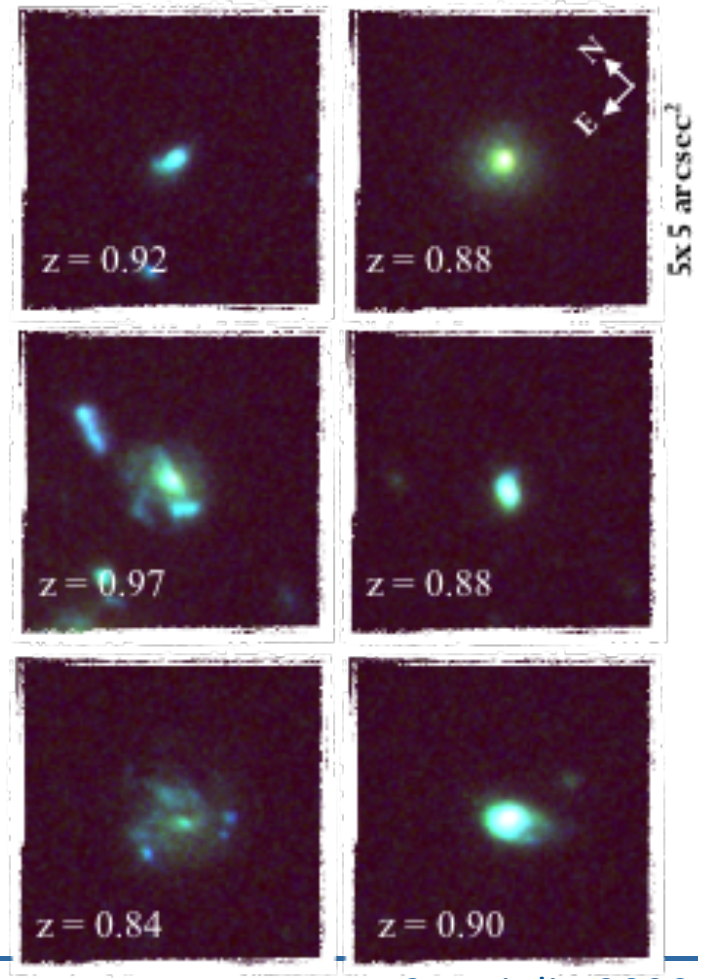


Prospects for the future:



- We have developed the tools to design the observations and to reduce the nIR data.
- EMIR is ready to detect objects at intermediate redshifts.
- The replacement of the EMIR's detector is in advanced planning.

We expect to reduce the level of noise of the images and thereby to improve the SNR of the detections. This will allow us to reach fainter objects and to complete the study with lower masses galaxies at intermediate redshifts.



- We will estimate their star formation histories (SFHs) to trace back their stellar mass assembly and to compare with predictions of models.
- We will study the cosmic role of the dwarf star-forming galaxies and determine their physical properties.