Exploring the feedback mode in Starburst galaxies with WEAVE mini-IFUs in HR

Casiana Muñoz Tuñón
(Instituto de Astrofisica de Canarias)

C. Fariña (ING-IAC), M. G. del Valle-Espinosa (University of Edinburgh), I. García Soriano (ING-IAC), A. Lumbreras-Calle (CEFCA), J. Méndez-Abreu (IAC), G. Tenorio Tagle (INAOE), JM Rodriguez Espinosa (IAC), J Sanchez Almeida (IAC), R. Hinojosa Goñi (Tololo O.) & JA Lopez Aguerri (IAC)

The WEAVE prime focus assembly mounted on the telescope

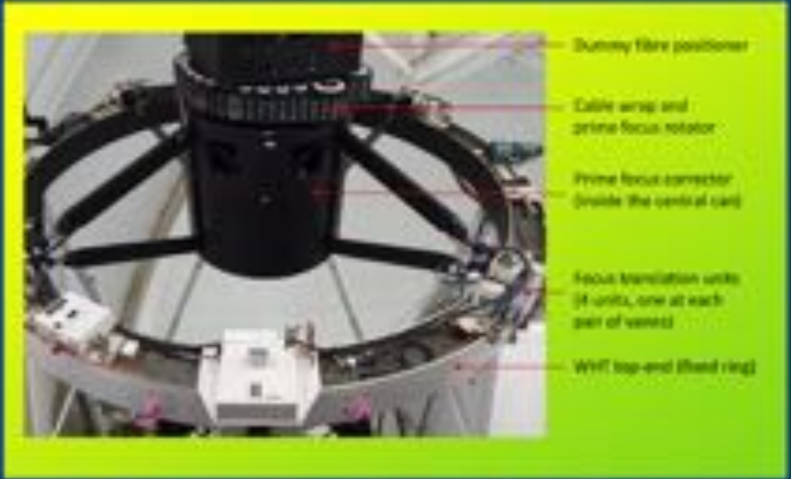
WEAVE (WHT Enhanced Area Velocity Explorer) is a new multi-object survey spectrograph for the 4.2-m William Herschel Telescope (WHT) at the Observatorio del Roque de los Muchachos, on La Palma in the Canary Islands. It will allow astronomers to take optical spectra of up to ~1000 targets over a two-degree field of view in a single exposure (MOS), or to carry out integral-field spectroscopy using 20 deployable mini integral-field units (mIFUs) or one large fixed integral-field unit (LIFU). WEAVE's fibre-fed spectrograph comprises two arms, one optimised for the blue and one for the red, and offers two possible spectroscopic resolutions, 5000 and 20,000.

Please email any enquiries to the WEAVE Project Support Office.

WEAVE in a slide

WEAVE (WHT enhanced-area Velocity explorer)

WIDE Field: 2-deg diameter



Fibre-fed

Observing modes

- 2 MOS plates: ~1000 fibres each
- 20 deployable mIFU: 11 x 12 arcsec^2 (fibres: 1.3" diameter)
- 1 LIFU: 78 x 90 arcsec^2 (fibres: 2.6" diameter)

DUAL BEAM

Red arm

- R ~ 5000 → ~ 579 - 959 nm
- R ~ 20000 → ~ 595 - 685 nm

Blue arm

- R ~ 5000 → ~ 366 - 606 nm
- R ~ 20000 → ~ 404 - 465 nm
  ~ 473 - 545 nm

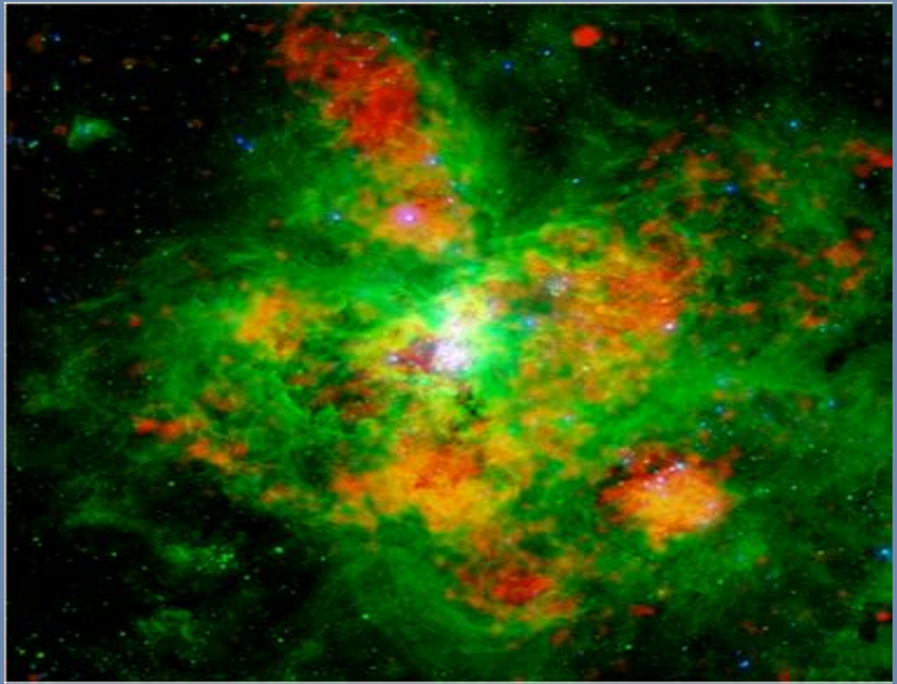
LIFU: R ~ 2500 and 10000

http://www.ing.iac.es/astronomy/instruments/weave/weaveinst.html

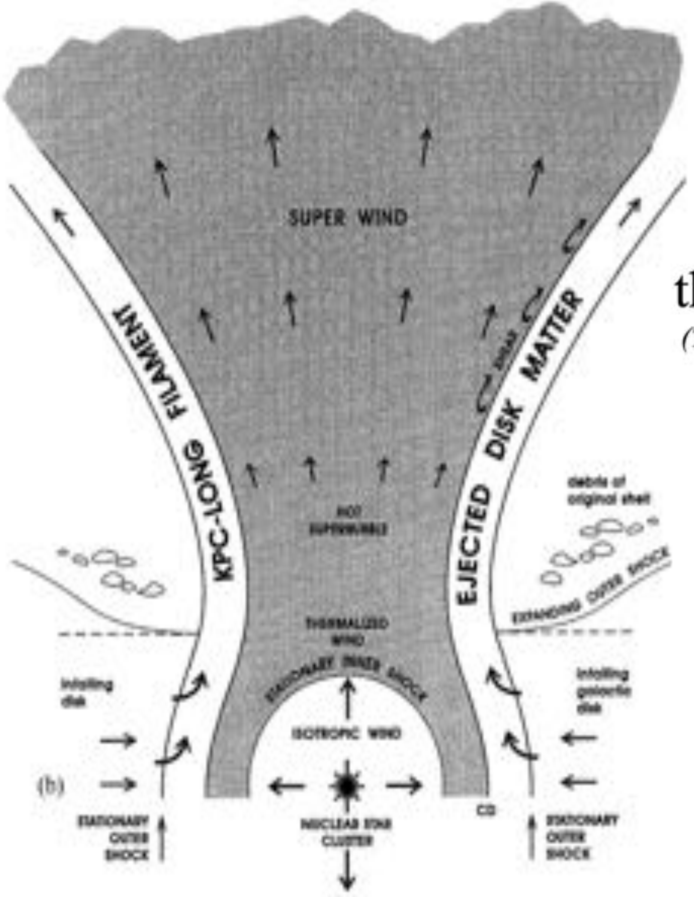
Abstract

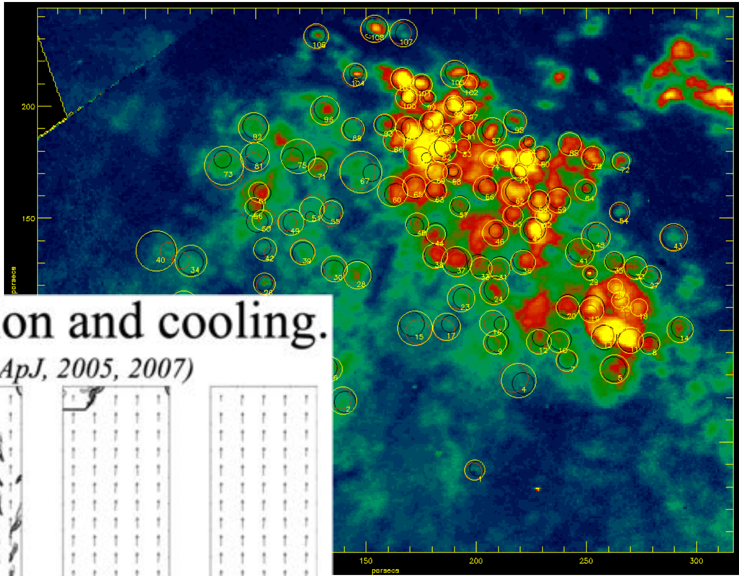
- The negative feedback in star formation (SF) is a fundamental ingredient in galaxy evolution models.
- Our theoretical work showed that for massive and compact young clusters, the stellar feedback may, be positive. This would allow gravity to win over thermal pressure.
- Positive feedback has been generally neglected in most semi-analytic models of galaxy formation and in hydro-dynamical simulations. However, it has a strong influence in the chemical evolution of extreme SF galaxies. Observationally, direct evidences of either negative or positive feedback are still scarce.

- ***SV time was awarded for SF feedback Science case and to observe emission line galaxies in COSMOS . To be observed with WEAVE's mIFUs in HSR to obtain detailed information of the kinematics of the ionized gas of the clusters in SF galaxies, to explore their feedback regime.***



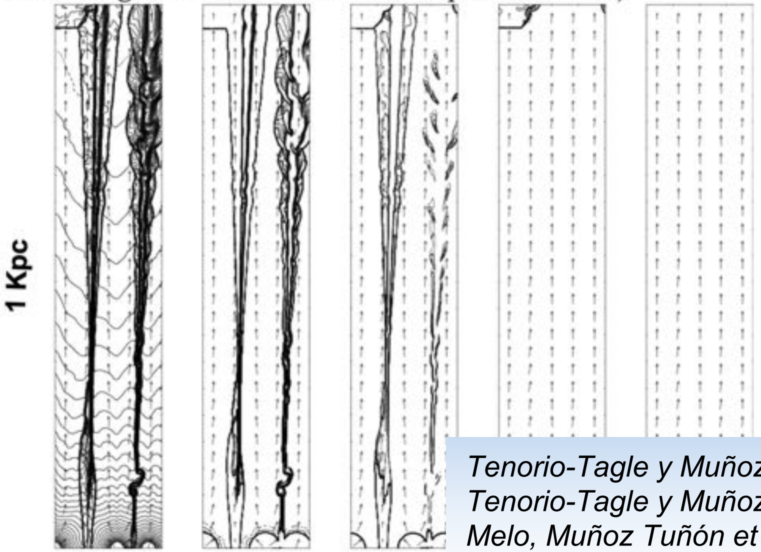
SF Feedback in the nearby universe





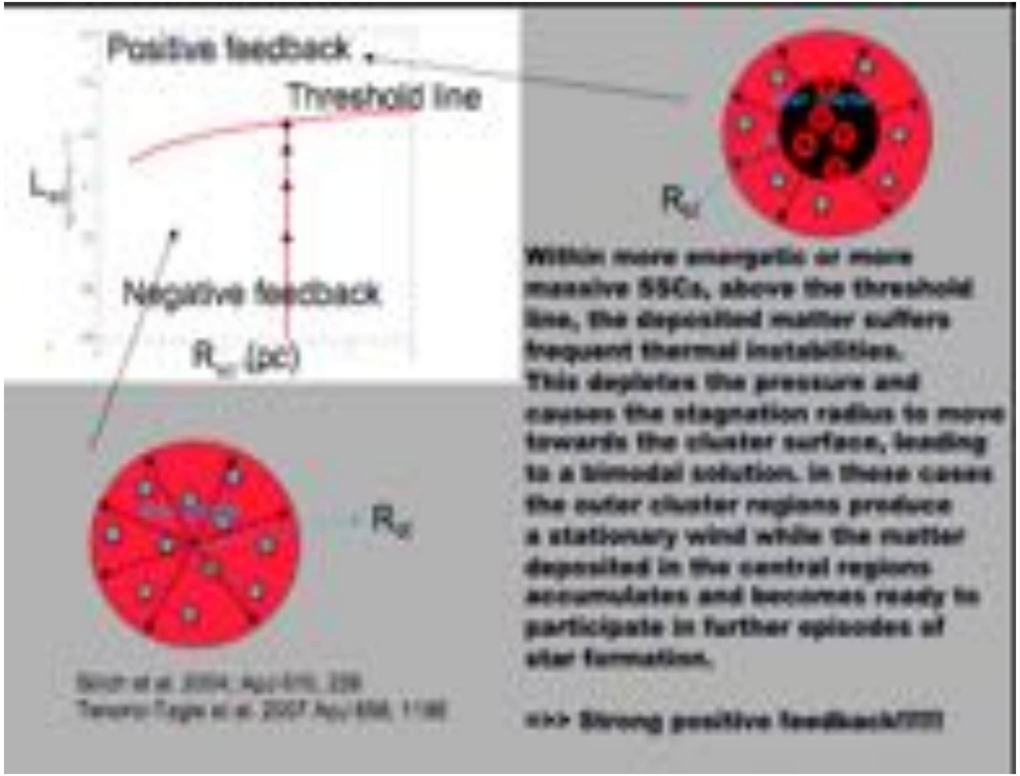
theory: wind collimation and cooling.

(Tenorio- Tagle, Muñoz-Tuñon, Silich…ApJ, 2005, 2007)



Tenorio-Tagle y Muñoz-Tuñón 1997, Ap. J., 478;
Tenorio-Tagle y Muñoz-Tuñón 1998, MNRAS, 293.
Melo, Muñoz Tuñón et al, 2005, ApJ
Tenorio-Tagle, Muñoz Tuñon, etal. ApJ 2005, 2007
Tenorio tagle etal, ApJ 2010

SCIENCE CASE



Negative feedback

Material is swept away from the galaxy and SF is inhibited.

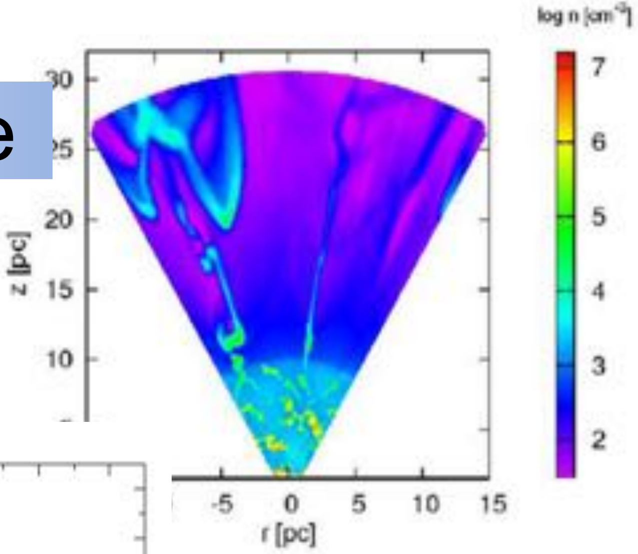
Positive feedback

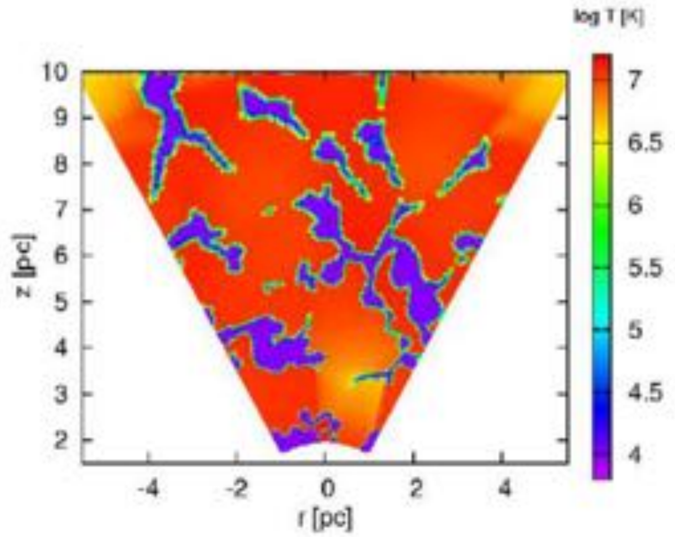
Material remains gravitationally bound and is reprocessed.

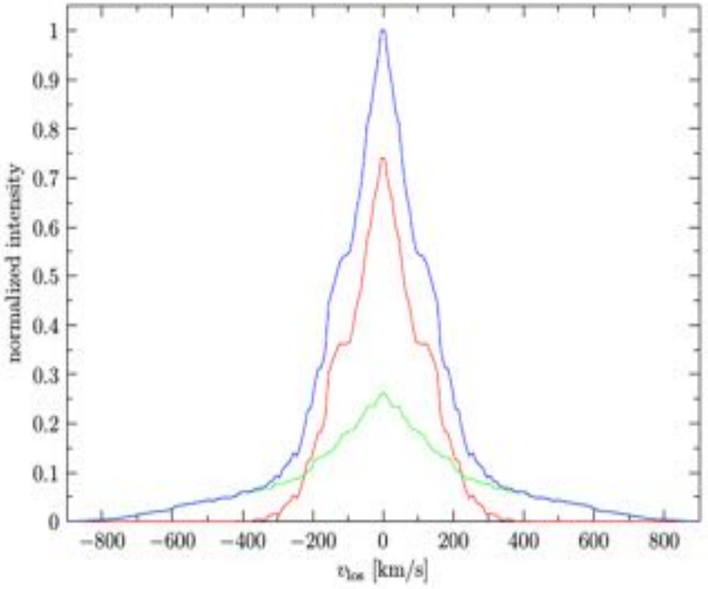
Bimodal regime

Mass accumulation in the central zones and gas expulsion in the outer zones.

Bimodal regime







- Broad recombination lines resulting from two regions:
- Intense and narrower due to re-pressurizing shocks in the dense, inner stellar regions.
- Less intense, broad recombination lines component due to expansion (wind)
- *(Tenorio-Tagle etal, 2010)*

Selection of targets

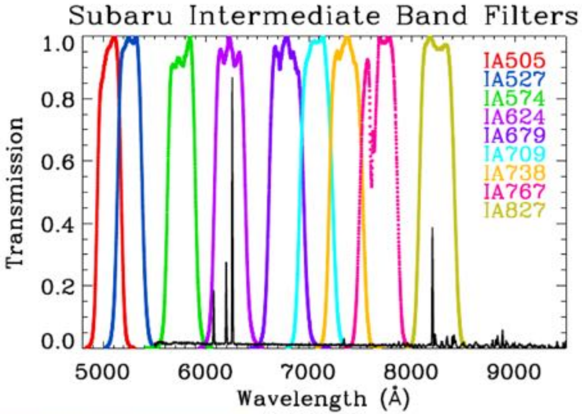
Hinojosa-Goñi , Muñoz-Tuñón & Méndez Abreu, 2016A&A...592

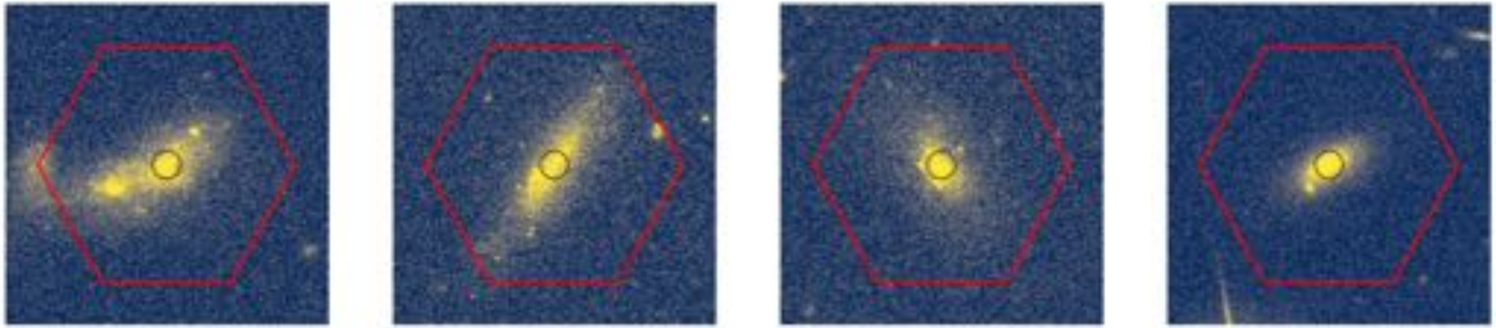
COSMOS configuration

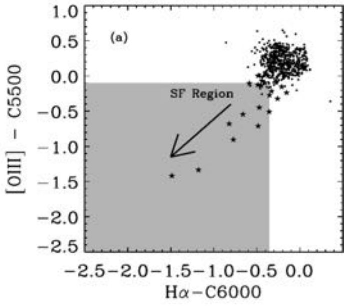
- Starburst galaxies in COSMOS with EW([OIII])>80A (Hinojosa-Goñi et al. 2016)
    - Selected using mediumband photometry
    - Clumps identified from HST images
    - Deep photometric analysis: masses, locations of clumps, etc.

- Selection of extended examples
    - z < 0.04 ([OIII], Hβ and Hα
    - 0.26<z<0.36 ([OII], [OIII] and Hβ)

- Backup samples: from UDS or J-PLUS surveys







Selection of targets

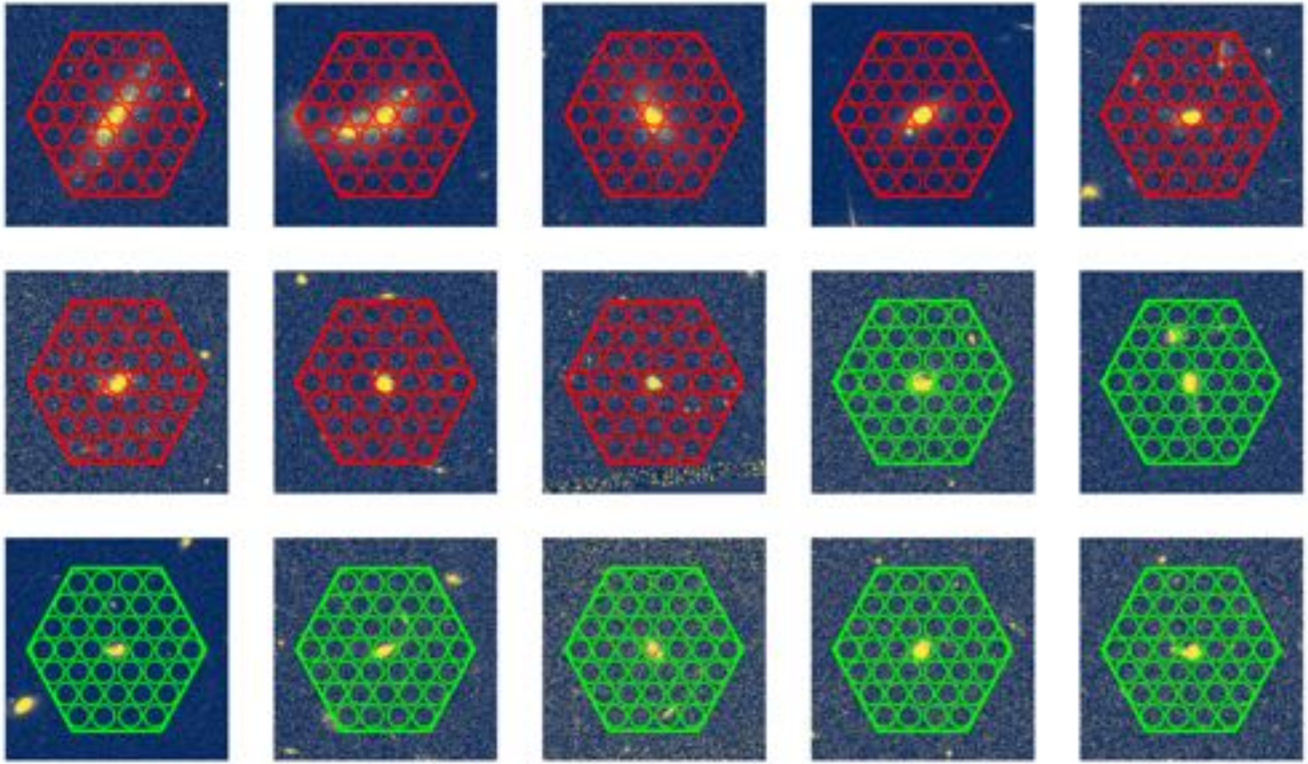
Galaxies with Hα, Hβ and [OIII] lines measureable (red hexagons)

Galaxies with Hβ, [OIII] and [OII] lines measurable (green hexagons)

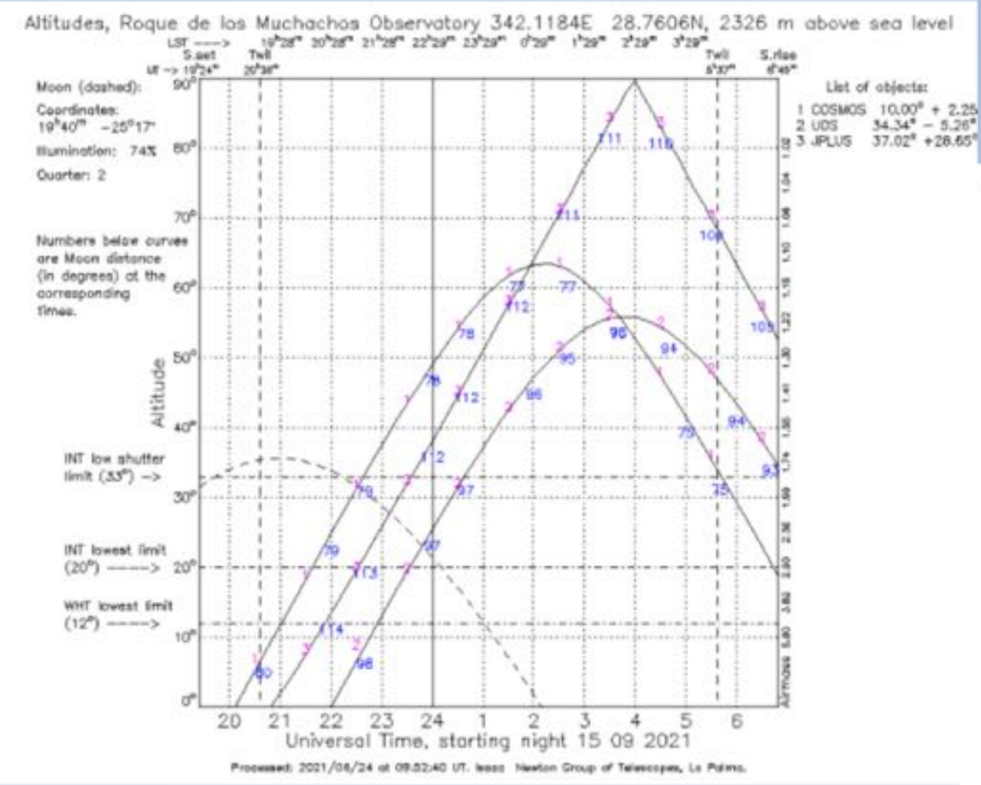
Sample:

Hα and [OIII] integrated fluxes higher than 10^{-17} erg/s/cm^2

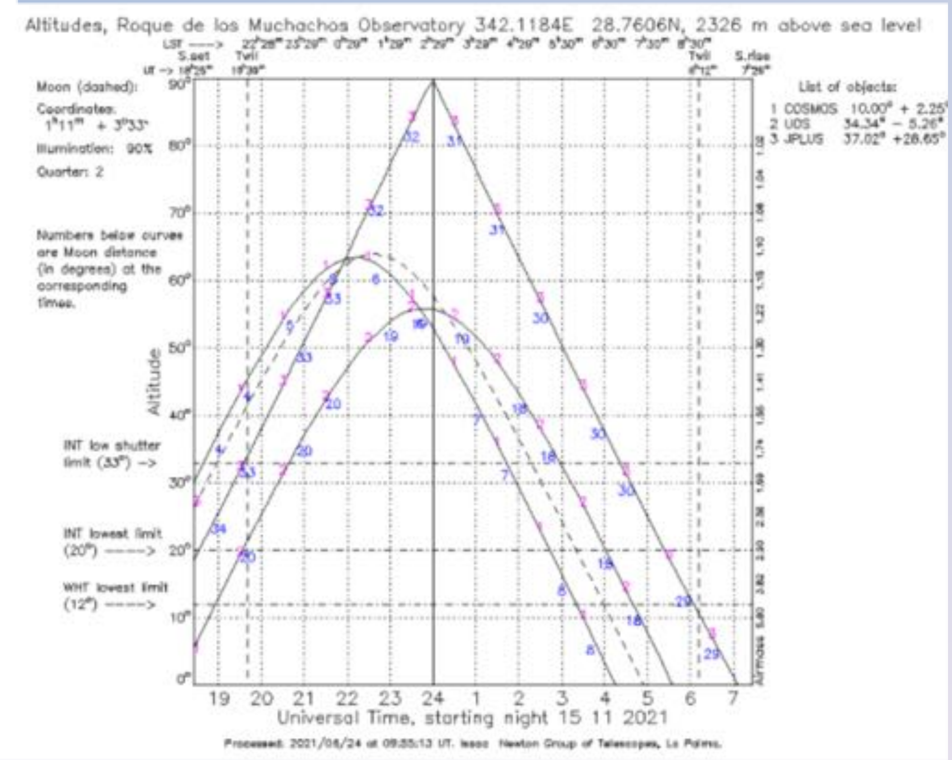
Galaxy sizes: 0.5 to 5 kpc



September

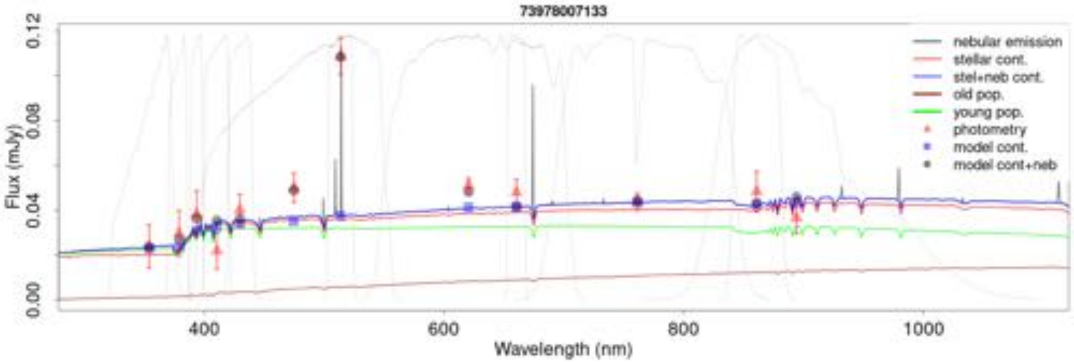


November

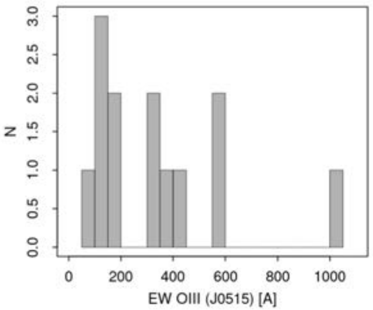


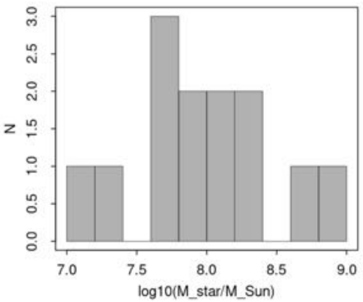
Selection of targets

- Starburst galaxies in J-PLUS with EW([OIII])>100 Å (based on Lumbreras-Calle et al. 2022, arxiv 2112:06938)
  - Selected using the J-PLUS surveys
    - 2000 sq. deg. 5 broadband +7 narrow/medium bands
    - Galaxies with excess of flux in J0515 filter ([OIII])
  - J-PLUS SED fit using CIGALE
    - Stellar masses, ages, extinction of galaxies.
- Selection of ~ 30 extended galaxies in 2 separate fields (1h each)
  - z < 0.04: [OIII], Hβ and Hα



Lumbreras Calle et al. 2022 Arxiv 2112:06938



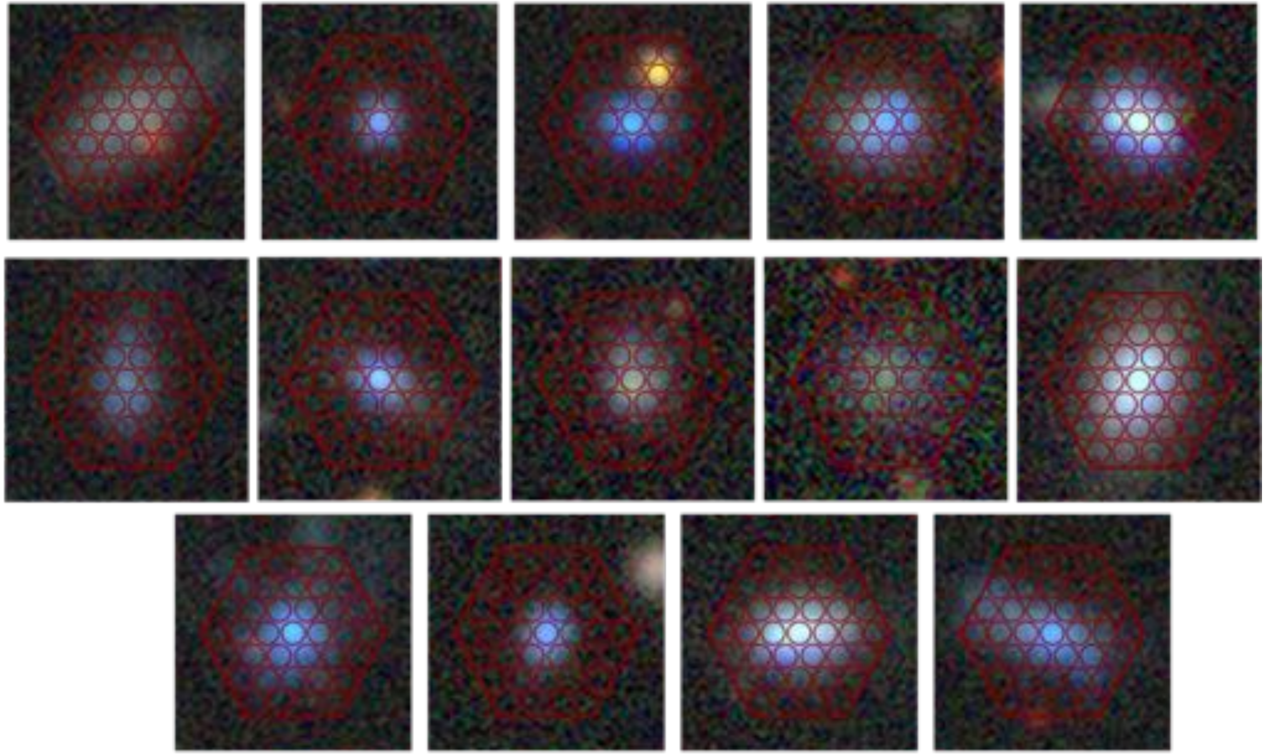


J-PLUS Conf. 1

J-PLUS Conf. 2

Selection of targets

WEAVE mini - IFU footprint over PANSTARRS images of the J-PLUS-1 sample

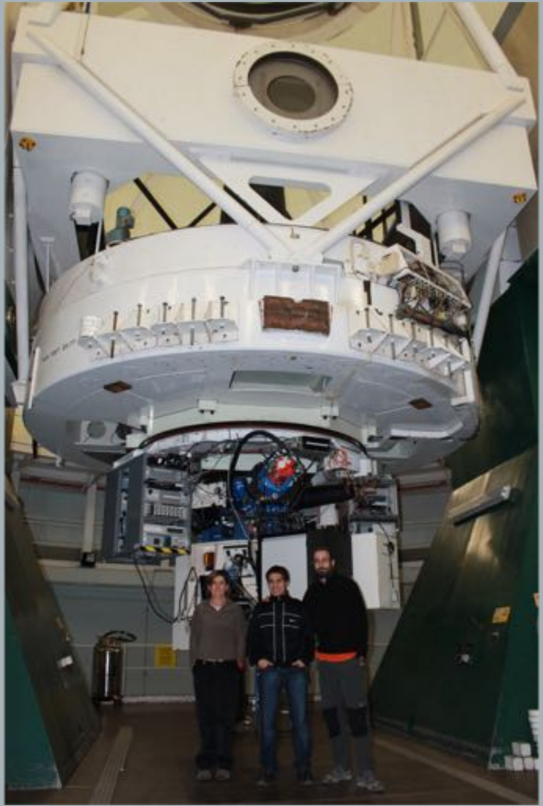


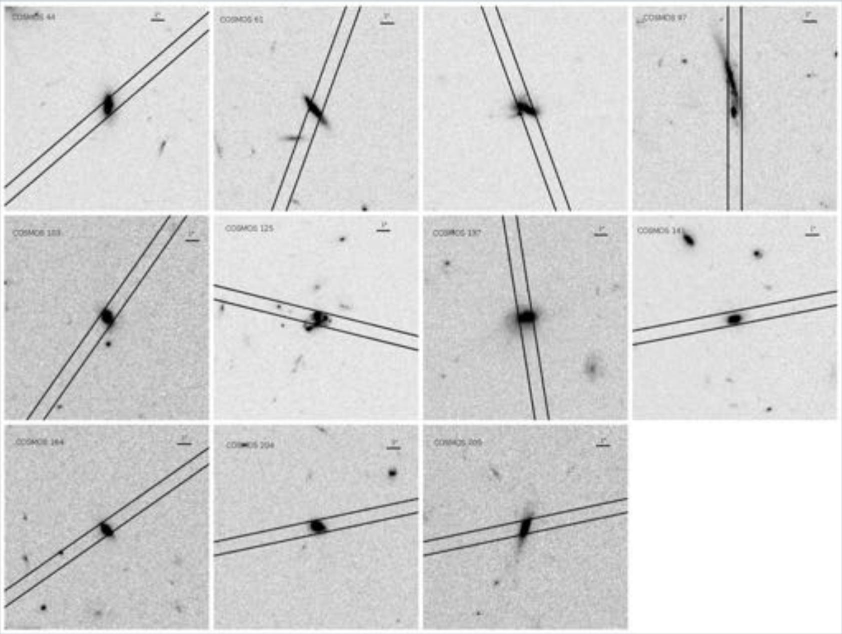
Properties:

Hα and [OIII] fluxes higher than 10^{-15} erg/s/cm^2

Galaxy sizes:
- 0.5 to 2.5 kpc

Stellar masses:
- 7 - 9 log($M_{\odot}$)



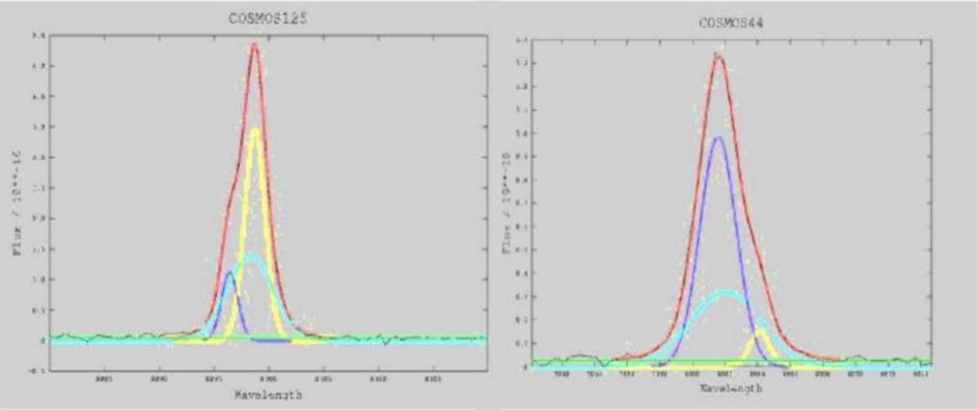


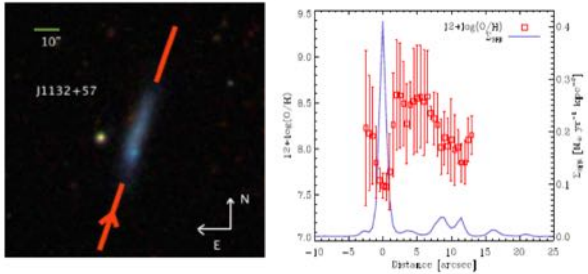
HSR@wht (4.2m at ORM)

Expected results

- Spatially resolved analysis
  - Differential properties of SF clumps
- Shape of emission lines
  - Non-gaussianity
  - Broad+Narrow components at same velocity: proxy for (+)feedback
  - Identification of unresolved clumps
- Dynamical mass estimates for clumps
  - Comparison with photometric values
  - More massive close to the center?

- And also metallicity inhomogeneities
  - Metal poor gas falling into the galaxy





Sánchez Almeida, Muñoz Tuñón et al. ApJ, 2015

Summary

- SF feedback (-/+) is a fundamental ingredient in galaxy evolution models and still to be quantify – evenmore in extreme cases (i.e. dense clusters).

- Our theoretical work showed that for massive and compact young clusters, the stellar feedback may be positive. This would allow gravity to win over thermal pressure. Observationally, direct evidences of either negative or positive feedback are still scarce.

-

- ***-We will use HSR data to determine the SF FB of starburst already known to us. Our targets are clumps in emission line galaxies in COSMOS and JPLUS.***
- ***- For that we have 4 hour SV time with WEAVE's mIFUs in HSR to obtain detailed information of the kinematics of the ionized gas.***

- ***For WEAVE SV will observe 3 fields, one in COSMOS (2hours integration time) , two in JPLUS two fields (one hour each) each with 15 galaxies.***

- ***Observations are expected for November 2022.***


Thanks