Stellar population properties of galaxies in the J-PAS era

1st Reunión nacional AstroHEP-PPCC24
Zaragoza (Spain)
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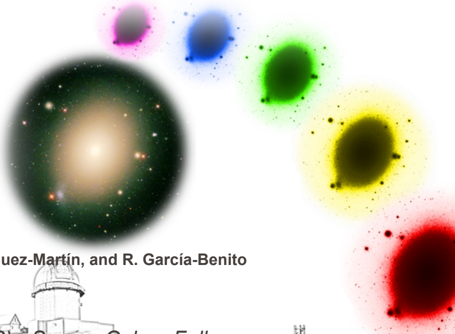

Luis Alberto Díaz García on behalf of

R.M. González Delgado, G. Martínez-Solaeche, J.E. Rodríguez-Martín, and R. García-Benito

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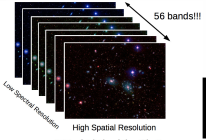
1. Introduction and aims

The **J**avalambre **P**hysics of the Accelerating Universe **A**strophysical **S**urvey (J-PAS, Benítez et al. 2014)



IFU of 1/5th of the Sky!!

J-PAS (ongoing)

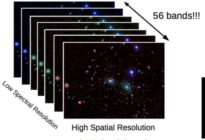
- Area 8000 deg^2
- JPCam (14 CCDs)
- Photometric system: 54 narrow bands
- Galaxies $r \leq 22.7$ AB
- $\delta z/(1+z) \sim 0.003$ for LRGs (**or better!**)

Stellar populations group at IAA-CSIC

- Rosa M. González Delgado (**head**)
- Luis A. Díaz-García (SO postdoc)
- Ginés Martínez Solaeche (**PC contract)**
- Julio Rodríguez Martín (SO predoc)
- Rubén García Benito

(Active J-PAS members in the group)

The Javalambre Physics of the Accelerating Universe Astrophysical Survey (J-PAS, Benítez et al. 2014)



IFU of 1/5th of the Sky!!

miniJPAS (completed)

- Area 0.9 deg^2
- Pathfinder camera (1 CCD)
- J-PAS photometric system
- Galaxies $r \leq 22.7$ AB
- $\delta z/(1+z) \sim 0.003$ for LRGs

Main aims and goals (J-PAS-like data)

- Developing of **SED-fitting codes**
- **Galaxy evolution** studies up to intermediate redshift
- The **role of environment** on galaxy evolution
- Measuring **emission lines and ML techniques**

UPDATED version of the MUlti-Filter FITting code for stellar population diagnostics (Díaz-García et al. 2015; A&A 582, A14).

BaySeAGal (Amorim et al. in prep., see also González Delgado et al. 2021).

MUFFIT features:

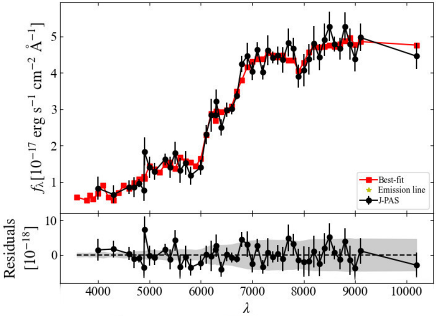
- Error weighted χ^2-test
- CSP: two burst models
- Removal of emission lines
- MC simulations for errors
- Attenuation law
- **Photo-z** PDFs

BaySeAGal features:

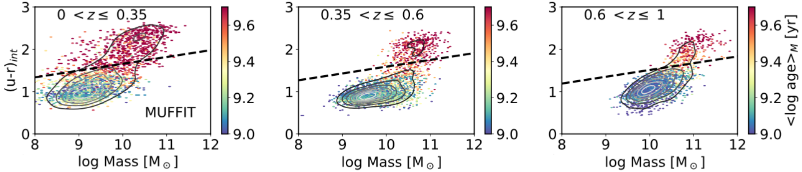
- Bayesian treatment $\mathcal{L} \propto \exp(-\chi^2/2)$
- Parametric SFH: exponential- and delayed-τ SFR laws
- Removal of emission lines
- MCMC method
- Attenuation law
- Best photo-z

As a result, we obtain **photo-z, luminosities (all bands), stellar masses, rest-frame colours, age, metallicity, extinction**... along with **uncertainties and correlations**.

LRG at redshift $z = 0.55$



Using our SED-fitting results, we performed a **first study about the stellar content of miniJPAS galaxies**: reliability and consistency of the results and characterization of the uncertainties (**González Delgado, Díaz-García, et al. 2021**).



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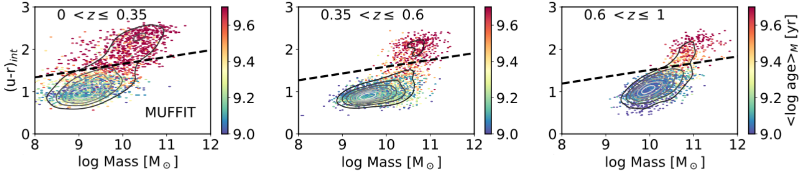
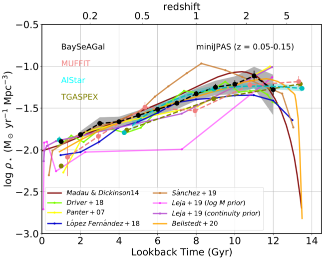


By the galaxies at $0.05 \leq z \leq 0.15$ in the miniJPAS survey **we obtained the SFRD** ("fossil record" approach) **in agreement with previous works**



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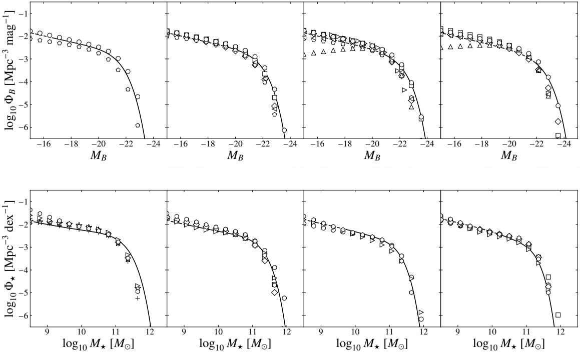
MCMC method to determine **the stellar mass and luminosity functions of miniJPAS galaxies (0.9 deg^2) up to $z \sim 0.7$** using results from our SED-fitting codes (**Díaz-García et al. 2024, accepted in A&A**)

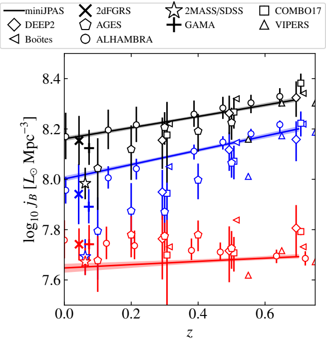


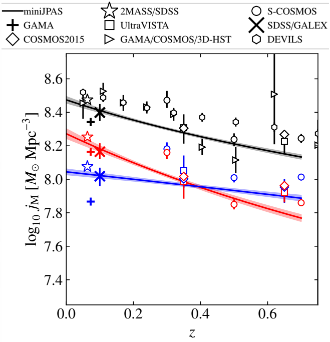
In good agreement with previous spectroscopic and photometric studies such as **ALHAMBRA, COMBO-17, COSMOS, DEEP2, DEVILS, GAMA, SDSS, UltraVISTA, zCOSMOS, etc.**

2. Stellar population properties of galaxies

2.4 Cosmic evolution of the stellar mass and luminosity density of galaxies

From the stellar mass and luminosity functions of miniJPAS galaxies, we constrain **the cosmic evolution of the stellar mass and luminosity densities of galaxies up to** $z \sim 0.7$ (**Díaz-García et al. 2024, accepted for publication in A&A**)





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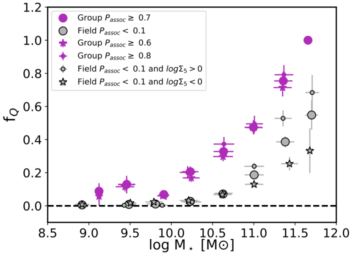
EXCELENCIA SEVERO OCHOA

In collaboration with the Cluster and Lensing J-PAS group, we are able to explore the role of environment to quench galaxies (all details in **González-Delgado et al. 2022**).



At increasing stellar mass, the fraction of red/quiescent galaxies increases in groups (QFE from <10% to 60% at 10^{10} and $10^{11.5}$ $M_\odot$). Similar result for transition galaxies

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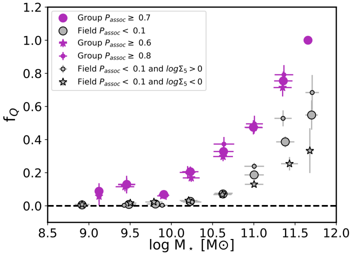

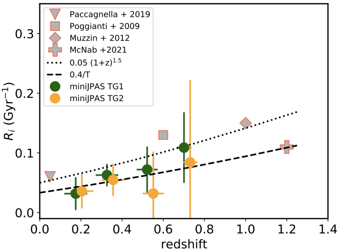

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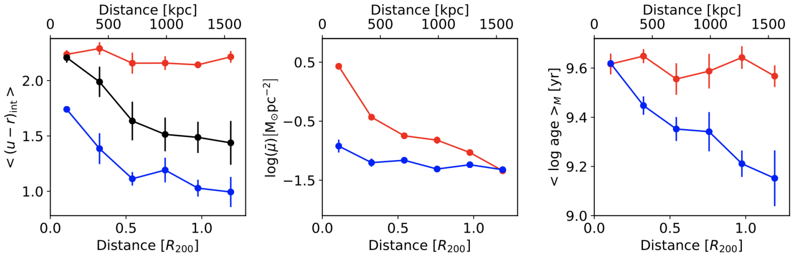
The fraction of field star forming galaxies that are quenched per unit of time evolves with redshift due to environment (it also depends on redshift).

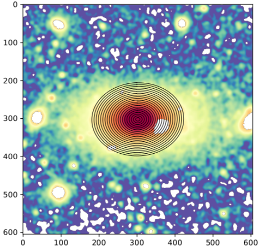
Variation of the stellar population properties of galaxies as a function of the cluster-centric radius: the mJPC2470-1771 case ($R_{200} \sim 1300$kpc and $M_{200} \sim 3 \times 10^{14} \mathrm{M}_{\odot}$; **Rodríguez-Martin et al. 2022**)

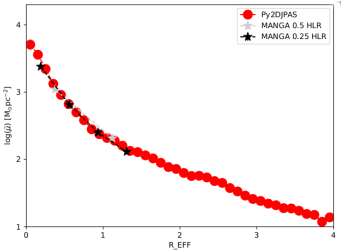


The red, older, more massive galaxies are mainly located in the inner part ($d < 0.5$ R$_{200}$) of the cluster. The blue and SF galaxies are more numerous at ($d > 0.5$ R$_{200}$).

Py2DJPAS: tool to analyse the resolved stellar population properties of galaxies in J-PAS and J-PLUS (**Julio E. Rodríguez-Martin**)

Photospectra of the different regions $\rightarrow$SED-fitting codes + ANN techniques





Once J-PAS is complete, **resolved stellar population properties and ionized gas distribution up to 2-3 half light radius** for more than 100k extended galaxies at $z < 0.1$. Test case: galaxy 2470-10239 (included in the MaNGA sample)

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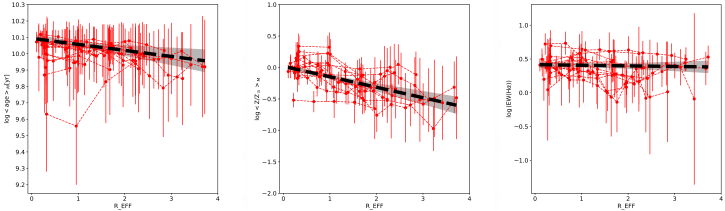
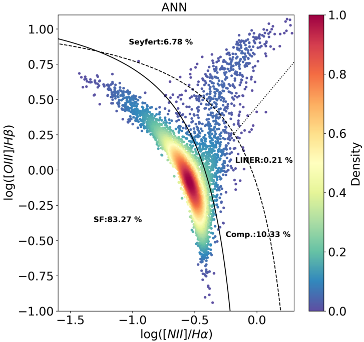
Preliminary results: radial profiles of 24 quiescent/red galaxies of $\log_{10} M_{\star} > 10.7\ M_{\odot}$



We have ~ 63 spatially resolved galaxies (including disky/star-forming galaxies) in miniJPAS to study in detail!

Method based on artificial neural networks (ANNs) for measuring and detecting emission lines in galaxies up to $z = 0.35$ (**Martínez-Solaeche, et al. 2021, 2022, 2023**)



The **BPT diagram** agree with previous studies including results based on the Hα emission line.

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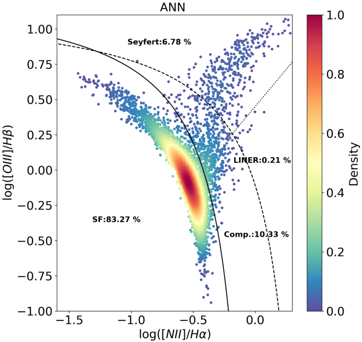
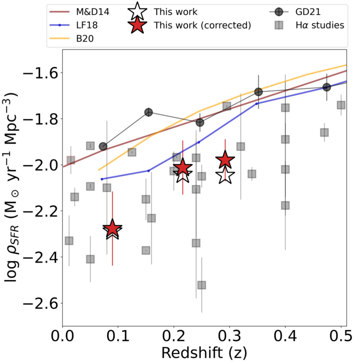
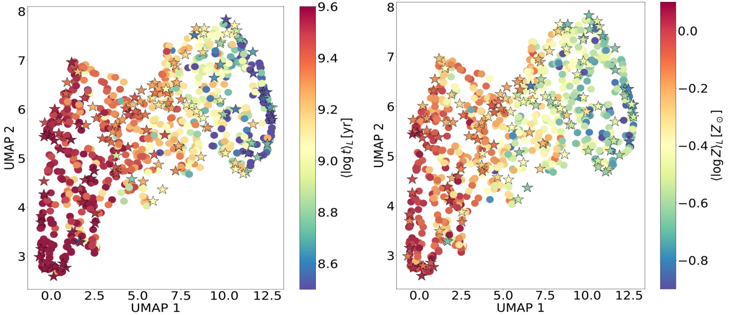




The **BPT diagram** and the cosmic evolution of **the SFR density since** $z = 0.35$ agree with previous studies including results based on the Hα emission line.

Contrastive learning (CL) for building **representations of galaxy properties to facilitate a variety of downstream tasks**: galaxy classification, parameter estimation, etc (Martinez-Solaeche et al. 2024, accepted for publication in A&A; for eCALIFA galaxies and it **can be extended to J-PAS**).



5. Summary

- We developed **SED-fitting codes and techniques** that yield **consistent stellar population results for J-PAS-like galaxies**.
- Robust determination of the evolution of **the parametric stellar mass and luminosity functions of miniJPAS galaxies up to** $z \sim 0.7$.
- We are able to explore **the role of environment to quench galaxies** up to intermediate redshift and determine **the variation of the stellar population properties of galaxies in clusters as a function of the cluster-centric radius**.
- We are working on tools for the determination of **stellar population properties of spatially resolved galaxies from multi-filter surveys**.
- We developed **new methods** based on ANNs that is **aimed at measuring and detecting emission lines in galaxies**.

Ready to perform very potential stellar population studies with the incoming J-PAS survey involving stellar population properties, environment, emission lines, radial profiles, etc. in a close future!

Thanks for your attention!

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