Stellar population studies in the mini-JPAS survey: a test bench for J-PAS

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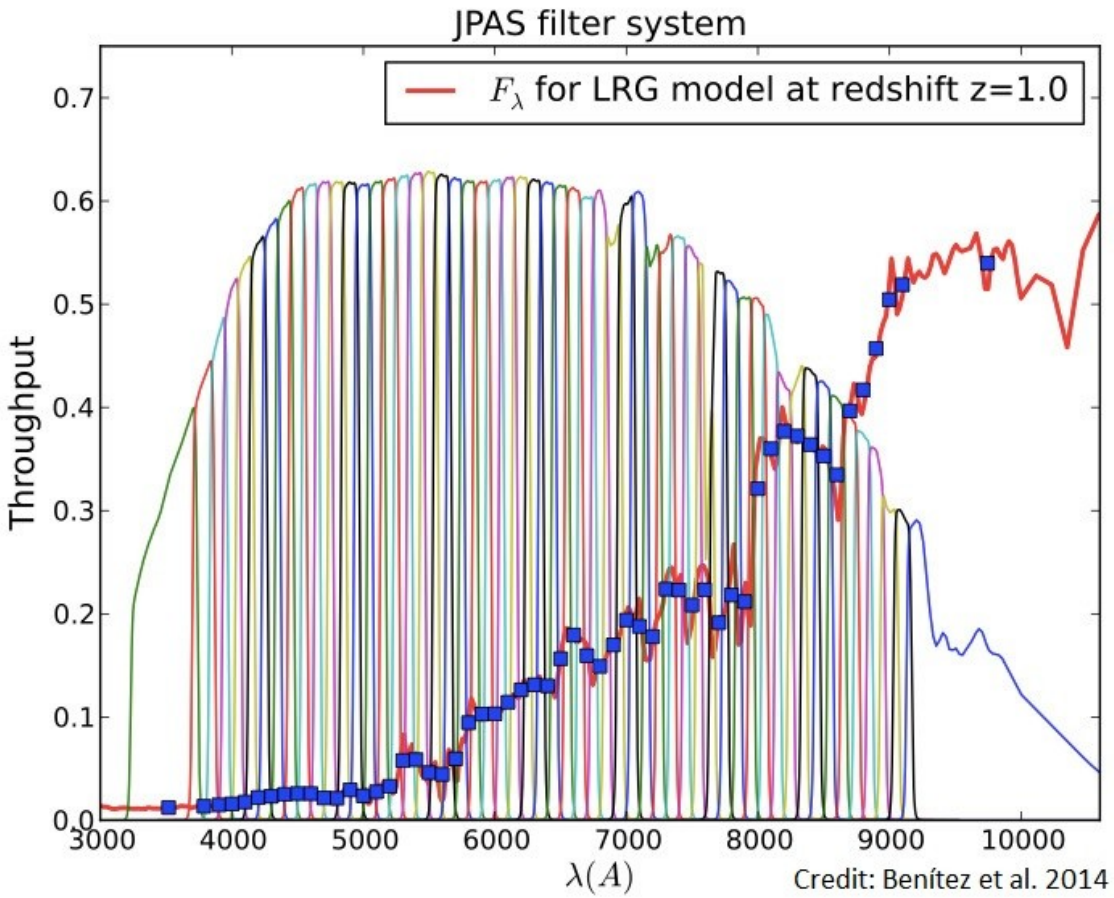
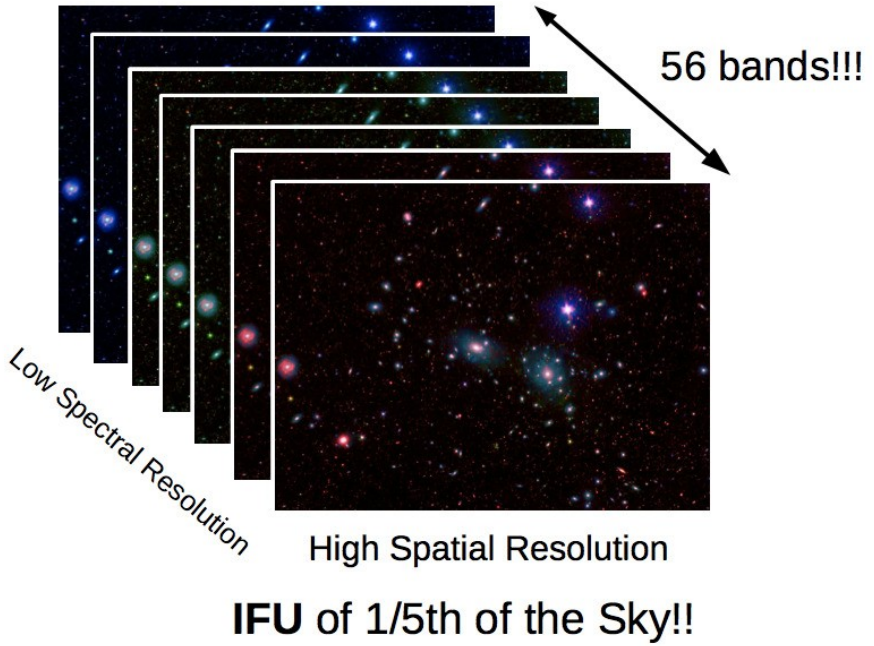
The Javalambre Physics of the Accelerating Universe Astrophysical Survey (J-PAS, see Benítez et al. 2014) is an unprecedented photometric survey planning to observe 8500 deg² of the sky from the Observatorio Astrofísico de Javalambre (OAJ). Even tough this survey will start this year, there is already a first data release referred as mini-JPAS (Bonoli et al. 2020), which was used by the J-PAS collaboration to perform the first scientific exploitation of the data. In our case, we aimed at determining the stellar population parameters of galaxies (age, metallicity, extinction, stellar mass, luminosities, star formation histories) using this kind of data. All this with the ultimate goal of discarding any kind of biased result from our group's SED-fitting codes and remarking the robustness of J-PAS to explore the stellar content of galaxies since redshift z=1. After running the SED-fitting code MUFFIT (Díaz-García et al. 2015), we found that galaxies exhibit a bimodal distribution of colours in rest-frame colour diagrams, which is tightly related to their stellar content. This bimodality is even more clear after correcting colours for extinction effects, which reveals that extinction is an important parameter to perform a proper spectral-type classification of galaxies: quiescent and star-forming. Our galaxy evolution group has already a collection of tools to properly determine stellar population properties of galaxies from the J-PAS survey and set milestones on the assembly and evolution of the stellar content of galaxies.

1. Context and motivations

The state-of-the-art multi-filter surveys, such as the **Javalambre Physics of the Accelerating Universe Astrophysical Survey** (**J-PAS**; Benítez et al. 2014 and Bonoli et al. 2020) can provide an alternative way to explore the **stellar content of galaxies through SED-fitting techniques**. This kind of photometric surveys, typically deeper than spectroscopy, can easily observe large samples of galaxies at intermediate redshift (z=1).



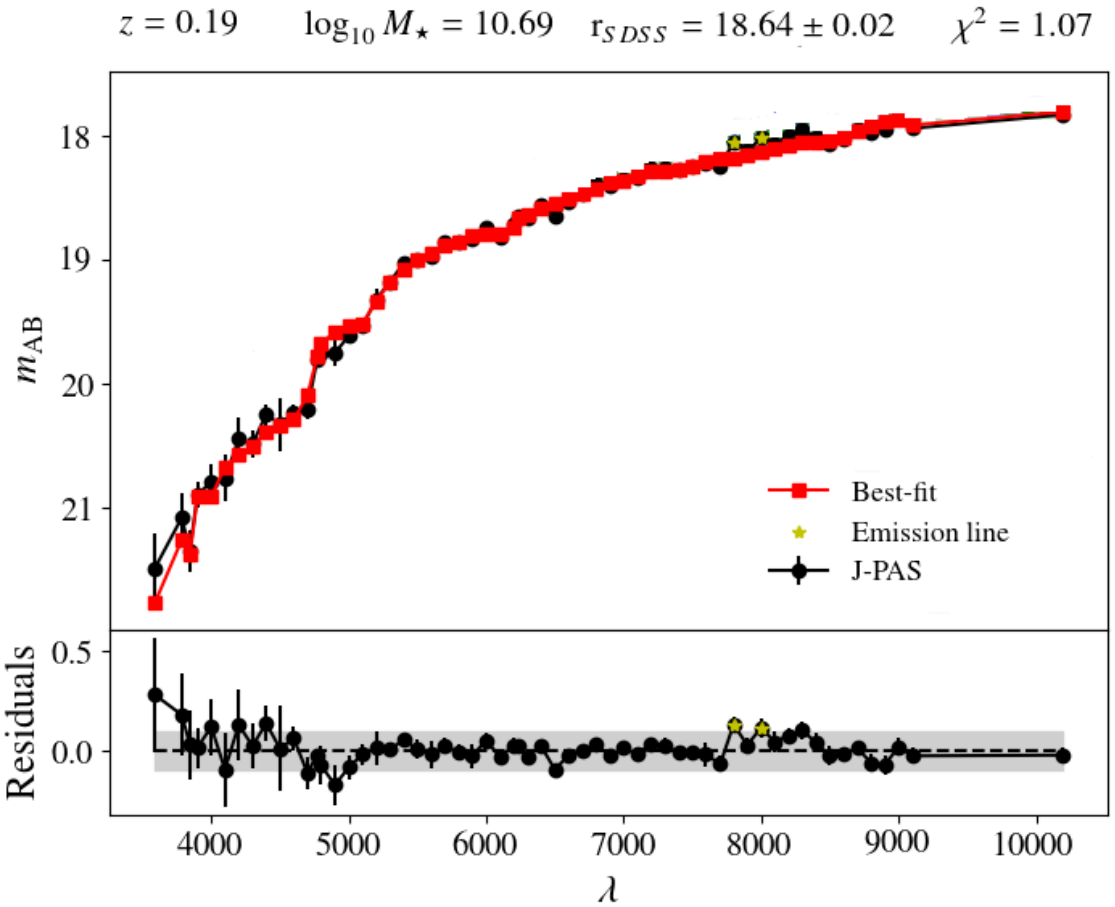


IFU of 1/5th of the Sky!!

The photometric system of J-PAS survey is composed of 5 broad- and **54 narrow-band filters** (SDSS-like and top-hat bands of FWHM=145 Å, respectively) → **half-way between classical photometry and spectroscopy.**

2. Stellar population parameters in mini-JPAS: the SED-fitting code MUFFIT

MUFFIT (**MU**lti-**F**ilter **FIT**ting for stellar population diagnostics, Díaz-García et al. 2015) is a generic SED-fitting code devoted to retrieving stellar population parameters of galaxies and stars from multi-filter photometric data. Main features of the code: **χ^2-test**, **composite stellar population models** (two burst-model or mixture of simple stellar population models, SSPs), **detection and removal of emission lines**, and **Monte Carlo approach** for uncertainties.



Inputs

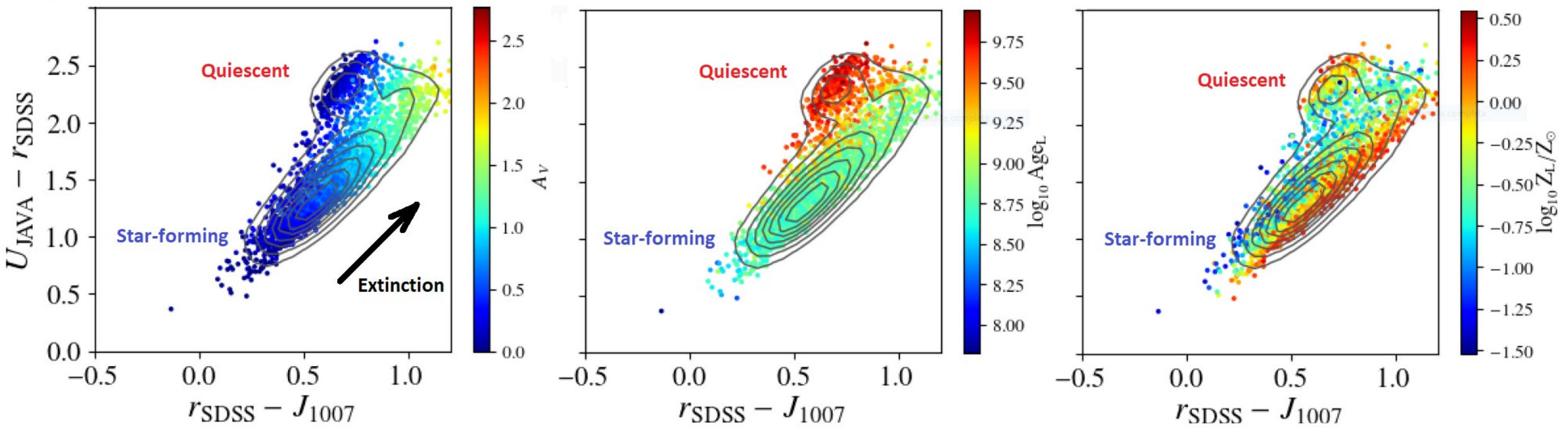
1) Photometric system and photometry:
   mini-JPAS galaxies up magnitude r≤22.5 AB
2) Spectroscopic models:
   Bruzual & Charlot 2003 SSPs (IMF of Chabrier 2003)
3) Extinction law:
   Fitzpatrick et al. 1999
4) Photo-*z* probability distribution functions:
   mini-JPAS photo-*z* (more details in Bonoli et al. 2020)

Outputs

Mass-weighted and luminosity weighted age, metallicity, extinction, luminosities, and stellar mass.

3. Stellar content of mini-JPAS galaxies across rest-frame colour-colour diagrams

Using the results obtained by MUFFIT, we built rest-frame colour-colour diagrams: (uJAVA - r) versus (r - J1007), similar to the UVJ colour-colour diagram (Williams et al. 2009).



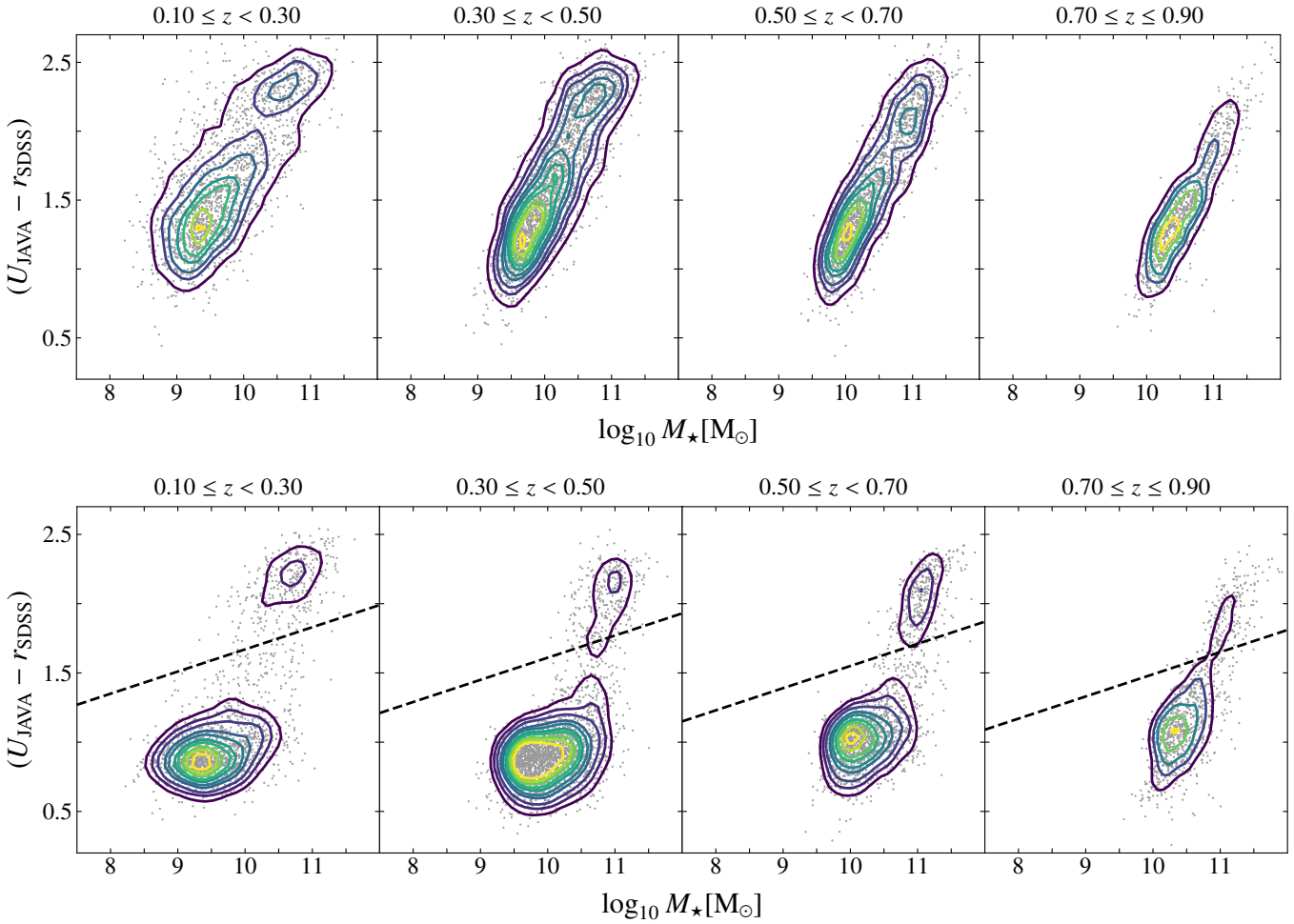
There are correlations between the positions of the galaxies in these diagrams and their stellar population properties. As expected from previous works (see e.g. Díaz-García et al. 2019 Paper-II and references therein), **quiescent galaxies populate the upper parts of the diagrams and exhibit very evolved stellar populations with very low dust content**, whereas **star-forming galaxies lie on the bluer parts and present a younger and more dusty stellar content**.

4. Galaxy classification by spectral type in the mini-JPAS survey

Following the methodology presented by Díaz-García et al. (2019, Paper-II) and using the results obtained by MUFFIT, we built the rest-frame (uJAVA - r) colour versus stellar mass diagram (top panels), as well as the same version of this diagram after correcting for extinction (bottom panels).

The 'green valley' of galaxies is largely populated by dusty star-forming galaxies, which is revealed after accounting for the extinction obtained by MUFFIT.

An accurate determination of the intrinsic extinction of galaxies is key to differentiate quiescent galaxies from dusty star-forming galaxies and avoid contamination from obscured star-forming galaxies



5. Conclusions and future work

1) **We are getting very promising results revealing the robustness of J-PAS to explore the stellar content of galaxies up to redshift *z*=1**. This will allow us to set milestones on the assembly of the stellar content of galaxies, offering a more continuous view of galaxy formation than the fossil record approach.

2) **Galaxies exhibit a bimodal distribution** of colours in rest-frame diagrams (e.g. UVJ-like and mass-colour diagrams), which is tightly **related to their stellar content**.

3) **An accurate determination of the intrinsic extinction of galaxies**, which needs precise and well-calibrated photospectra, **is essential to differentiate quiescent galaxies from dusty star-forming galaxies** and it is also important for the selection of the well-known green valley galaxies to avoid contamination from obscured star-forming galaxies.

4) **This fact may be critical to perform future studies involving number densities and spectral types**, such as luminosity and stellar mass functions, which in turn may constrain the different quenching channels studied nowadays.

5) **Other interesting properties related to the stellar content of galaxies and its evolution** (such as formation epoch, environment effects, quenching mechanisms, etc.) **can be studied in a self-consistent way using J-PAS data**, making possible a proper analysis and interpretation of the correlations between different physical parameters (González Delgado et al. 2020, in prep.).

In the J-PAS collaboration there are more groups using alternative SED-fitting codes also getting successful results (González Delgado et al. 2020, in prep.)