J-PLUS and the Galaxy Star Formation Rate in the Local Universe

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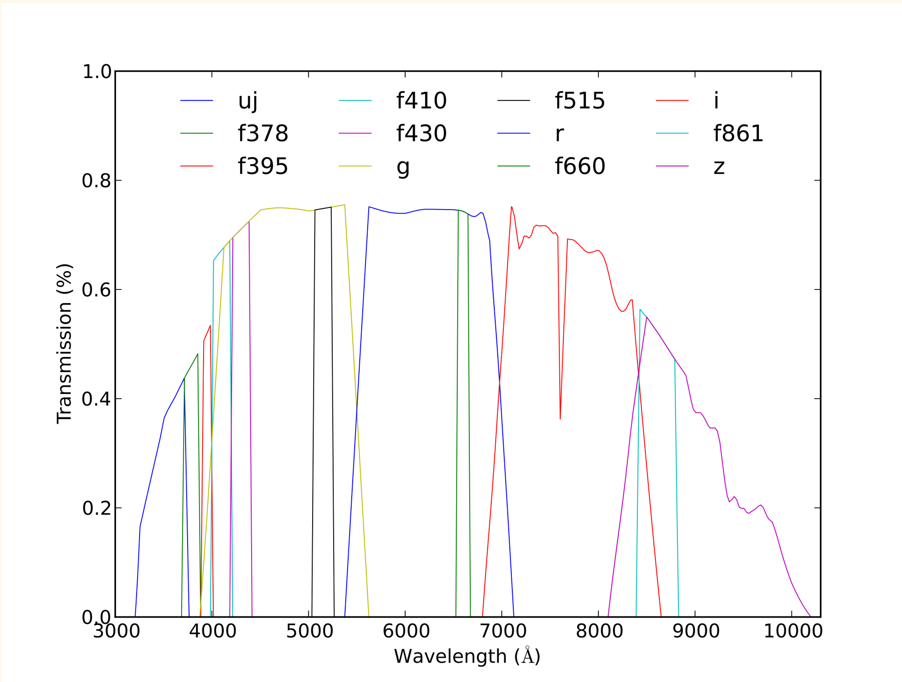
J-PLUS: Overview & Goals

The Javalambre Physics of the Local Universe Survey (J-PLUS) is a large photometric survey that will cover $\sim 8000\ deg^2$ with a set of 5 broad filters (SDSS filter set) and 7 narrow ones. It will be carried out from the Observatorio Astrofísico de Javalambre (OAJ) at the Pico del Buitre, Teruel, Spain. In addition to its main goal, which is the photometric calibration of the J-PAS survey, it has been designed to acquire the $H\alpha$ flux of the galaxies in the nearby Universe ($z \leqslant 0.015$) up to $r \sim 23$ (AB). This opens J-PLUS to the field of galaxy evolution, as $H\alpha$ flux is an excellent footprint of the new-born stars. With this information one can study multiple aspects of the so called star formation rate (SFR), which is the number of mass that is transformed from gas to stars per unit time. With a survey like J-PLUS, we expect to observe thousands of emission line galaxies in different bands, which will allow us to study the properties of the SFR as a function of different parameters, such as stellar mass, environment, or local properties in those spatially resolved galaxies. With this in mind, we expect to place a robust anchor to the SFR in the $z = 0$ Universe.

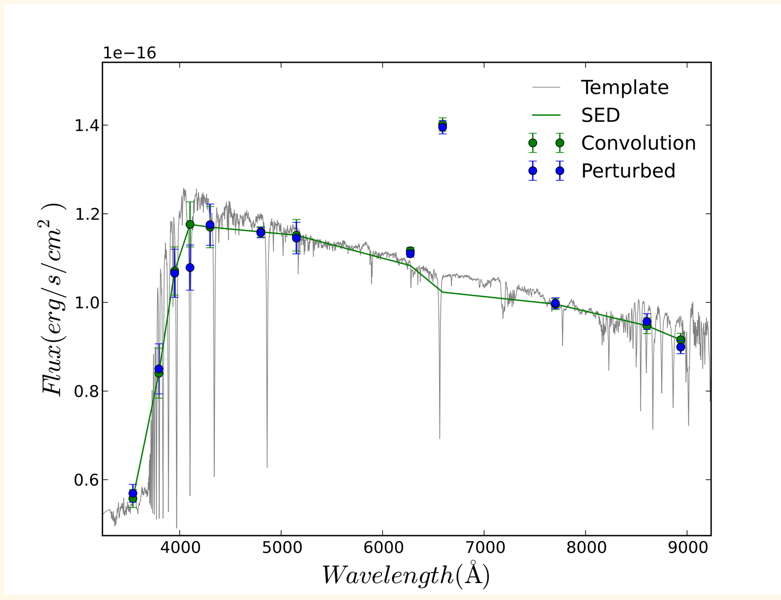


J-PLUS Filters' transmission once the quantum efficiency of the T80cam and the atmospheric transmission have been taken into account.

1.A - Preparing mock data

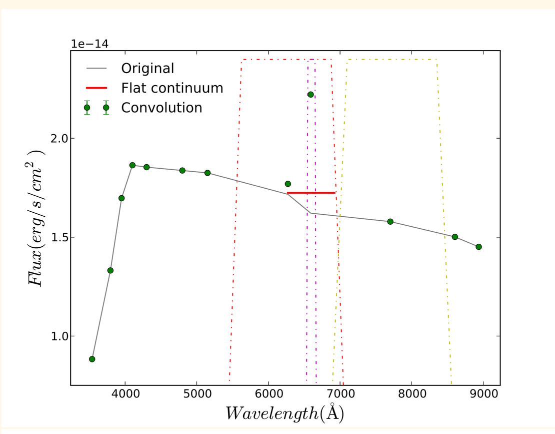
To test all methods to obtain $H\alpha$ flux from J-PLUS photometric data, we first created a sample of mock data. To do so, we created several Bruzual & Charlot 2003 [1] (BC03 hereafter) Simple Stellar Populations spectra (SSP hereafter). We added an artificial gaussian line of known flux in $\lambda = 6563$ Å. This is the flux we want to recover. After that, we convolved this mock sample with the theoretical J-PLUS filter transmission curves to mimic real J-PLUS data. To simulate real observations, we perturbed each point with random noise within its expected photometric error, which is given by the J-PLUS Exposure Time Calculator.

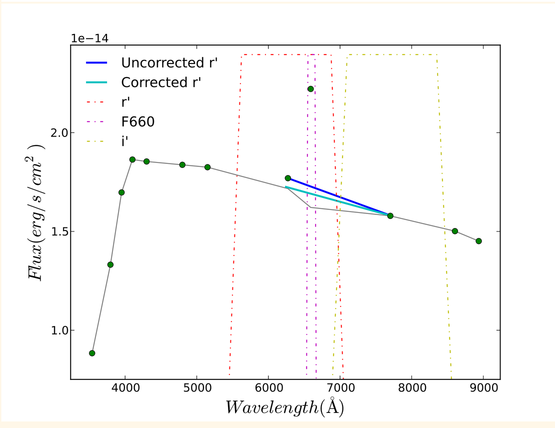
1.B - Preparing mock data



Example of one of the mock galaxies that were created from SSP spectra from BC03 (grey line). Green line is the Spectral Energy Distribution (SED hereafter) as seen by J-PLUS. Green dots correspond to the photometric points observed for this galaxy at magnitude $r' = 18.5$. Blue dots are the points afer adding random noise. Note the F660 point, which would correspond to the $H\alpha$ emission line.

2.A - Methods





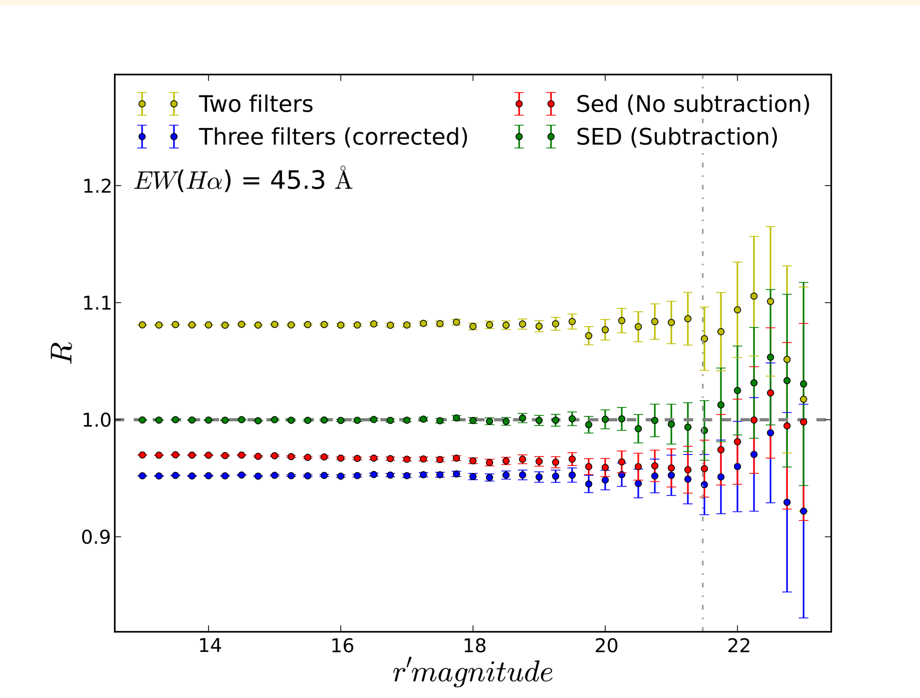


Figure 1 (top left) and **Figure 2 (bottom left):** Two examples that ilustrate how to extract $H\alpha$ flux using Methods 1 and 2 (Panel 2.B). In grey, the SED of a BC03 template. **Figure 3 (right):** Vertical axis represents the fraction of the recovered $H\alpha$ flux in relation to the expected value with several methods. We can see that methods 1 and 2 are biased. These measurements do not correspond to the mock galaxy on the right.

2.B - Methods

To infer the $H\alpha$ flux from photometric data we explore three different approaches:

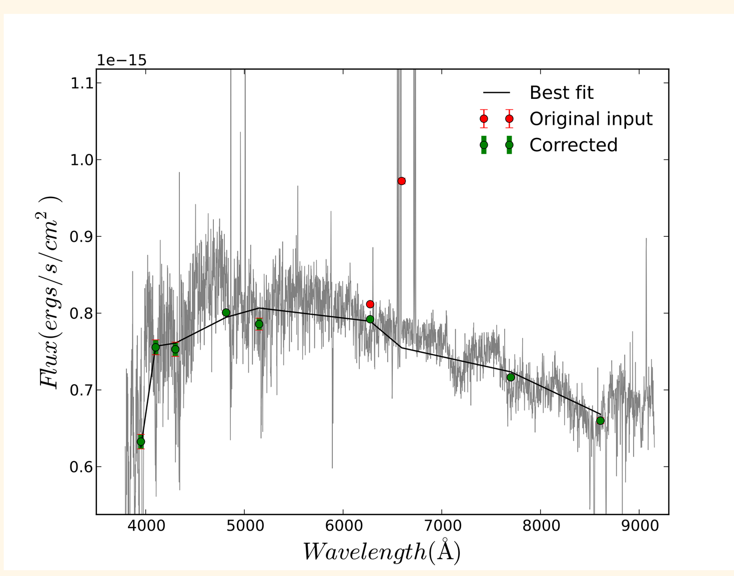
1. Use the information of a broad filter and a narrow one, and assume a flat continuum. See Figure 1 in Panel 2.A.
2. Use the information of two broad filters and a narrow one, and assume a linear continuum. We can remove $H\alpha$ contribution to r' flux to get a better estimation of the continuum. See Figure 2 in Panel 2.A.
3. Fit the SED of the galaxy to find a reliable continuum. To that aim we do a a χ^2 minimization to 5040 BC03 SSP spectra with different ages, metallicites and extinctions, excluding the $H\alpha$ point. We can recursively subtract the $H\alpha$ contribution to the r' flux to get a better fit.

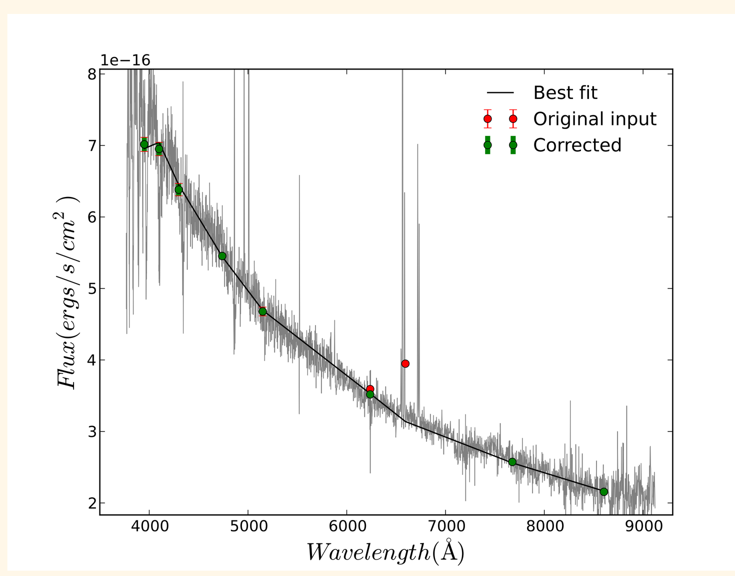
To test each methodology, we performed 1400 Monte Carlo simulations at different magnitudes (see results in Figure 3 in Panel 2.A). Though both methods 1 and 2 correct the contibution of $H\alpha$ to r', they bias our results, while method 3 performs better.

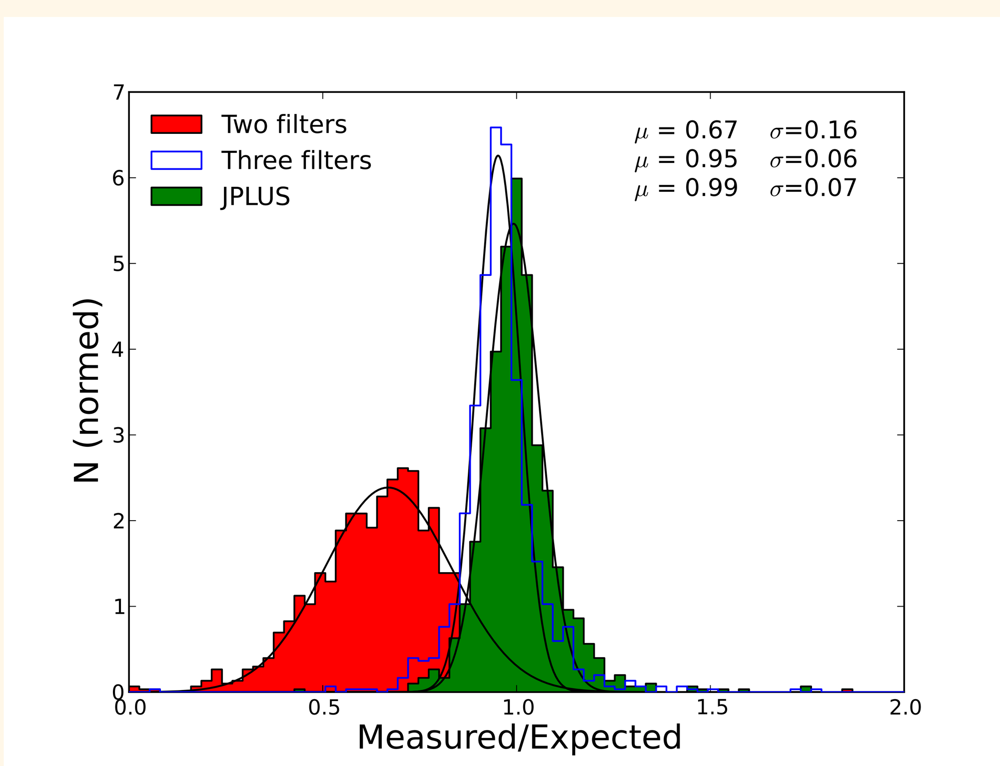
3.A - Measurements on SDSS galaxies

We applied the SED fitting routine with r' filter correction on a sample of 1134 SDSS spectra and compared our measurements with the spectroscopic DR10 ones, as given by Thomas et al. 2013. [2] In the right, we can see the results for the measurements of the $H\alpha$+[NII] doublet. We can see how the two methods that don't fit a SED are biased.

3.B - SDSS measurements







Top: Two SDSS galaxies (grey line) as seen by J-PLUS (red dots) and after the r' correction (green dots). Solid black line is the Best Fit to one SSP of the 5040 BC03 templates
Left: Histogram showing the ratio of the recovered flux of the $H\alpha$+[NII] doublet compared to the spectroscopic measurements in SDSS DR10 with three different methods. The Two and Three filters methods, which correspond to methods 1 and 2 in the upper panel, are biased, while the SED fitting routine minimises this bias.

References

[1] Bruzual, G. Charlot, S. (2003). Stellar population synthesis at the resolution of 2003. MNRAS, 344,1000-1028
[2] Thomas et al., Stellar velocity dispersions and emission line properties of SDSS-III/BOSS galaxies. MNRAS, 431, 1383-1397.

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