How reliable are galaxies physical parameters estimation for LSST main sequence sample?

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Aim & Abstract

In the last 20 years the study of the multi-wavelength emission of galaxies from X-rays to radio was found to be necessary to proper analyze **galaxies physical properties**, as galaxy composition is a complex interplay between several components: old and young star, stellar remnants, interstellar medium, dust and supermassive black holes (*Conroy+2013*). More specifically, the ultraviolet (UV) to infrared (IR) SED contains important information about the star formation activity of the galaxy, that is a key observable for understanding the physical process in its formation (*LeFloc+2005, Buat+2019*). Here we study the possible limitations (and needed corrections) of the upcoming ***Large Survey of Space and Time*** *(LSST)* optical data for estimation of the main physical properties of so-called, **main sequence** galaxies. To check it we perform a **Spectral Energy Distribution** (SED) fitting, applied to simulated LSST observations of **real, existing galaxies** with UV-FIR measurement coverage.

HELP

We select a sample of **65.889** galaxies over the redshift range ***0<z<2.5*** from ***ELAIS-N1*** and ***COSMOS*** fields of the ***Herschel Extragalactic Legacy Project*** (HELP) survey. Both surveys are unique as they provides a deep multi-wavelenght observations covering of the spectra from UV to IR. We use **real galaxy observations as prior** to

1. **simulate** LSST fluxes
2. to **compare** real physical parameters for the full UV-FIR measurements

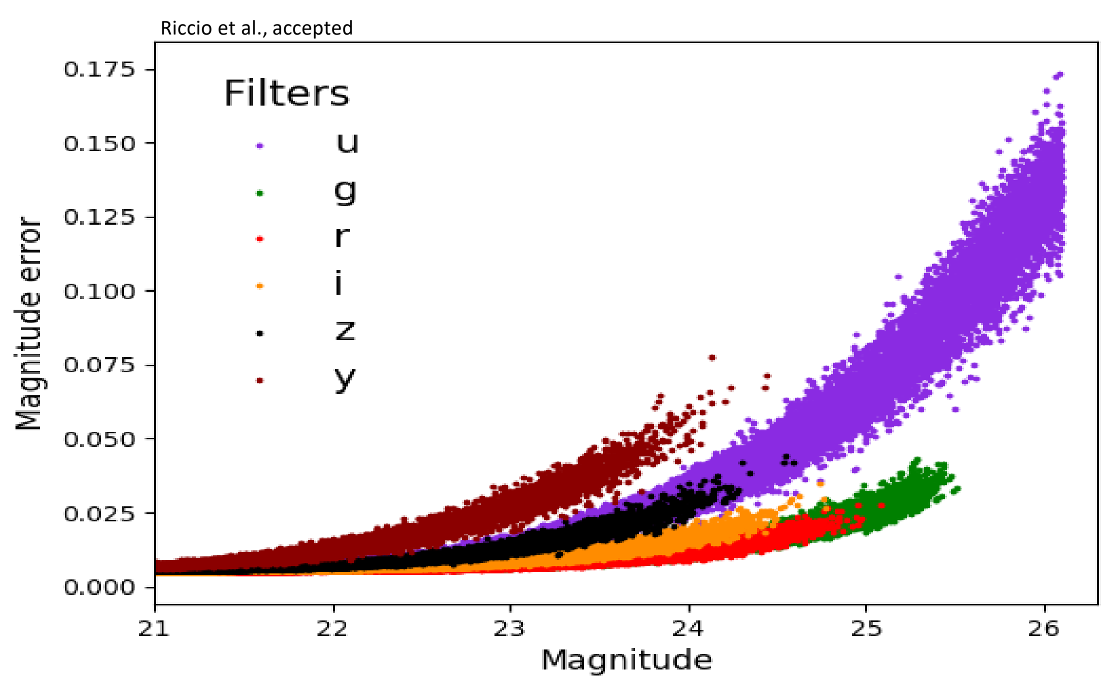

Fig.2: Magnitude errors vs observed apparent magnitudes for simulated LSST observation from the ELAIS-N1 sample. The choice to vary simulation parameters allows us to obtain different errors for similar magnitude values, as we would expect in the case of real observations..

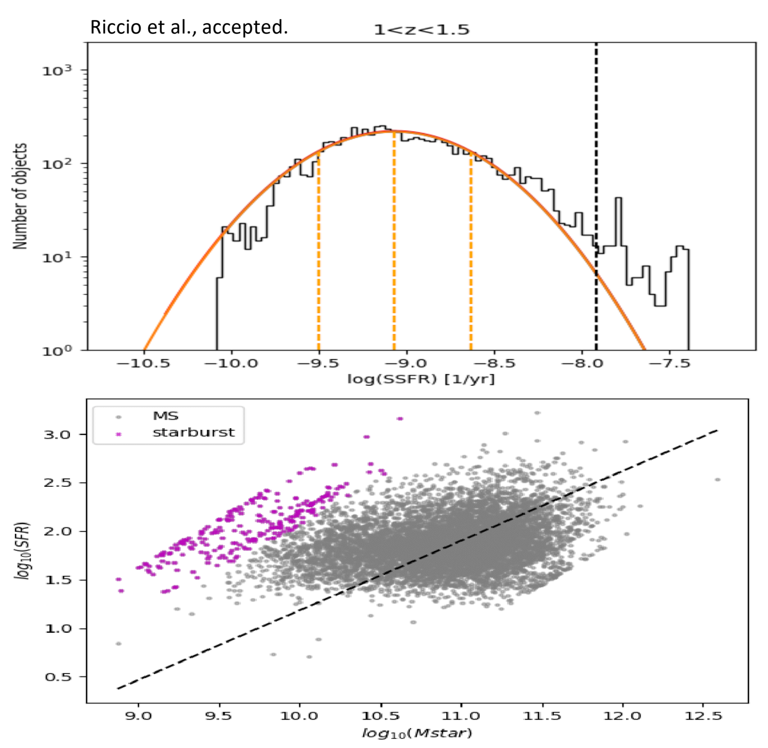

Fig 1: *Upper panel*: sSFR distribution of galaxies in the redshift range 1<z<1.5 . SB galaxies are located on the right side of the black dashed line, 3 σ away from the gaussian's center. *Lower panel*: The MS distribution for the same redshift bin. Magenta circles represent SB galaxies, the black dashed line represent the MS.

Selecting main sequence galaxies & LSST simulations

We estimate the main galaxy physical parameters using ***CIGALE*** (*Boquien+2019*), a bayesian SED fitting code that combines stellar SED with dust attenuation and emission components.

Dividing our sample in 4 redshift bin and fitting the **specific SFR distribution** (SFR over stellar mass, hereafter sSFR) with a gaussian, **we define as starburst**, after *Rodighiero+2011*, all the objects that lies 3σ away from the gaussian mean **(Fig. 1**). We discard ~ 1.5% of the sample as starburst

We simulate observed LSST fluxes in the 6 bands *ugriyz*, using a CIGALE module that takes the SED of the galaxy and the LSST filter as input. To simulate LSST data we take into account only objects having corresponding magnitude less then the LSST 10 year limiting magnitude (*u<26.1, g<27.4, r<27.5, i<26.8, z<26.1, y<24.9, Izevic+2019)*. **The LSST-like uncertainty** were calculated independetly form CIGALE using the LSST simulations software package ***CatSim (Fig. 2)***.

Results

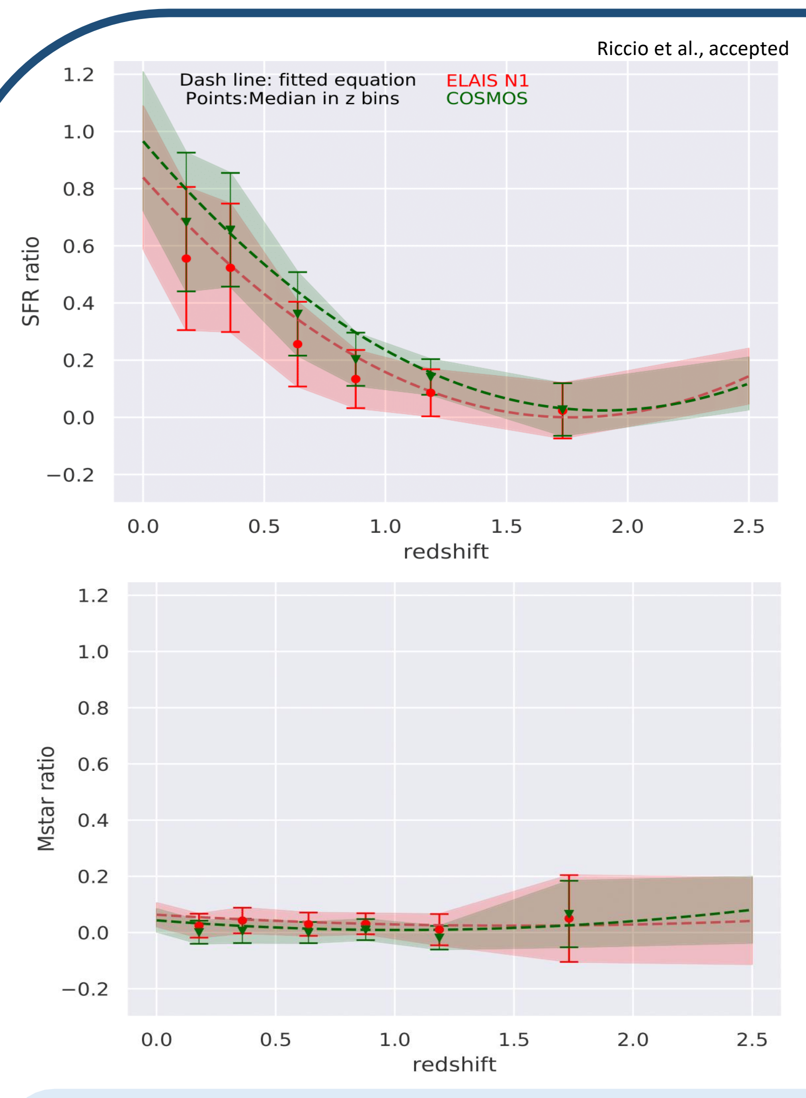

Fig. 3: SFR and Mstar ratio comparison between ELAIS and COSMOS. Y axis shows the logarithm of the ratio between the parameter calculated using LSST bands and the respective using the "real" UV to FIR observations.

We found an overestimation of the SFR, dust mass and dust luminosity estimated with LSST, while the stellar mass is comparable with the "real" value **(Fig. 3)**. The overestimation clearly depends on redshift.

The most "infected" value is SFR. We found a relation that mimic the one between SFR obtained from LSST data and SFR obtained from the full data set (real one):

$$\log_{10}\left(\frac{SFR_{LSST}}{SFR_{real}}\right) = 0.26 \cdot z^2 - 0.94 \cdot z + 0.87$$

We correct the overestimation at all redshift **adding IRAC near infrared observations,** and using an **AFUV-Mstar relation** as prior in the SED fitting process **(Fig. 4).**

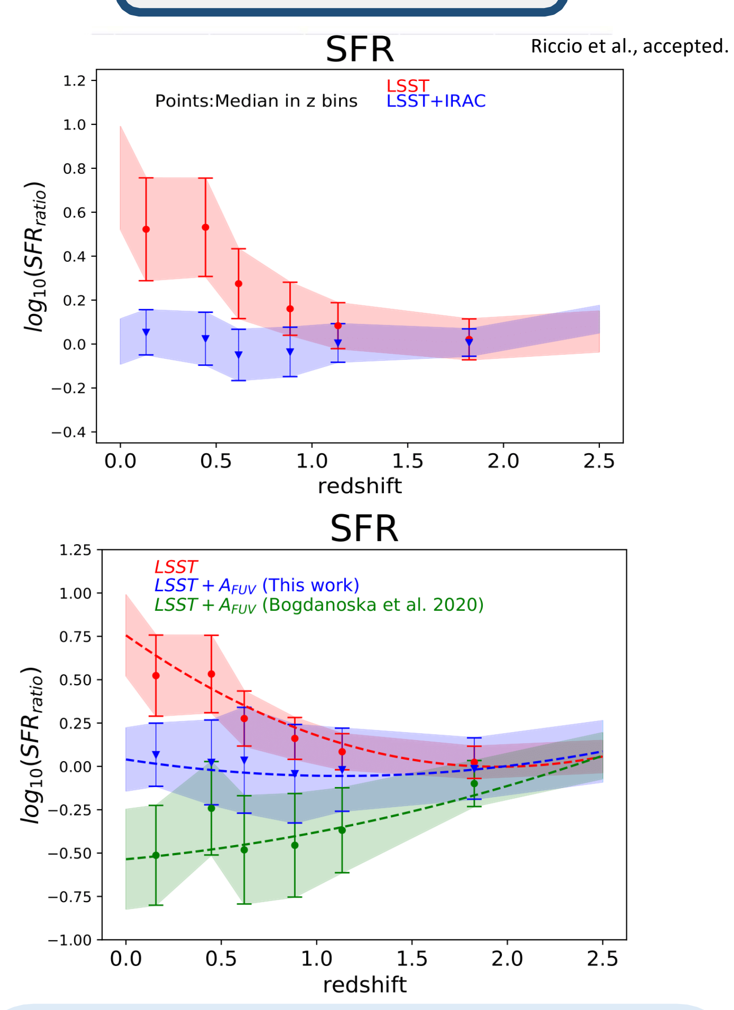

Fig. 4: *Upper panel*: LSST+IRAC . With the addition of NIR observation, the results are consistent with the "real" one. *Lower panel*: LSST+AFUV prior calculated in this work (blue) and LSST+AFUV from the relation in Bogdanoska et al. 2020 (green).