Characteristic Emission of Star-Forming High Redshift Galaxies: Testing the IR Template

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Introduction

In anticipation of JWST data, today's study of early Universe galaxies focuses on preparations for efficient data handling. This work focuses on checking the validity of one of the methods published recently that is meant to reduce the number of models needed to be tested during SED fitting, while still estimating the galaxy parameters reasonably well. The SED fitting code CIGALE is used, with the focus on the dust emission models provided. For brevity, only the fits obtained the Draine et al. (2014) (DL2014) model are used on this poster.

The data used

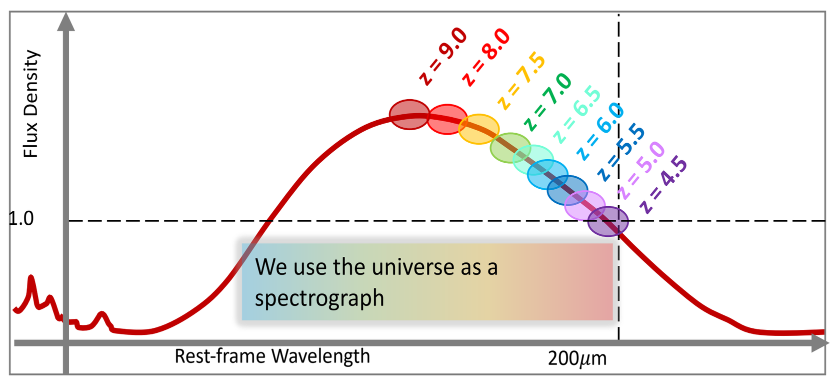
We have chosen to test our method on an older dataset from Bouwens et al. (2016). We use flux data for 78 objects with redshifts 4.8<z<9.8, on which we perform SED fitting. First, we fit the data with a "full range" of models, i.e. a large number of input parameters, to estimate the physical parameters. These are the data points against which we compare our new results. Second, we compute the parameters from a much smaller number of models (computation that can be handled by a personal laptop), using the IR template described in this poster. The template is built from a different dataset where each object had 5 data points in the UV-optical and a S/N>1.5. Of our sample, only three objects met this selection (and are indeed used). Thus, the Bouwens et al. (2016) data is a good place to start investigating the validity of this method.

Method: Using the Universe as a spectrograph

In our previous work (Burgarella et al. 2022), we constructed an IR template based mainly on the ALPINE data sample with an addition of a few other well-studied galaxies in the redshift range 4.5<z<6.2. The steps are the following:

1. Fit the SEDs of the sample and normalise each individual galaxy SED at the rest-frame 200 μm flux
2. Construct a composite IR SED from the normalised ALMA Band 6 or 7 fluxes of all galaxies, this time in the observer frame. When shifted to the observer frame, the flux of the ALMA Bands is at a different wavelength for each galaxy, due to the difference in redshift (figure below, left)
3. Fit again these data, as if they are from one object, to create a SED template representative of the entire studied sample

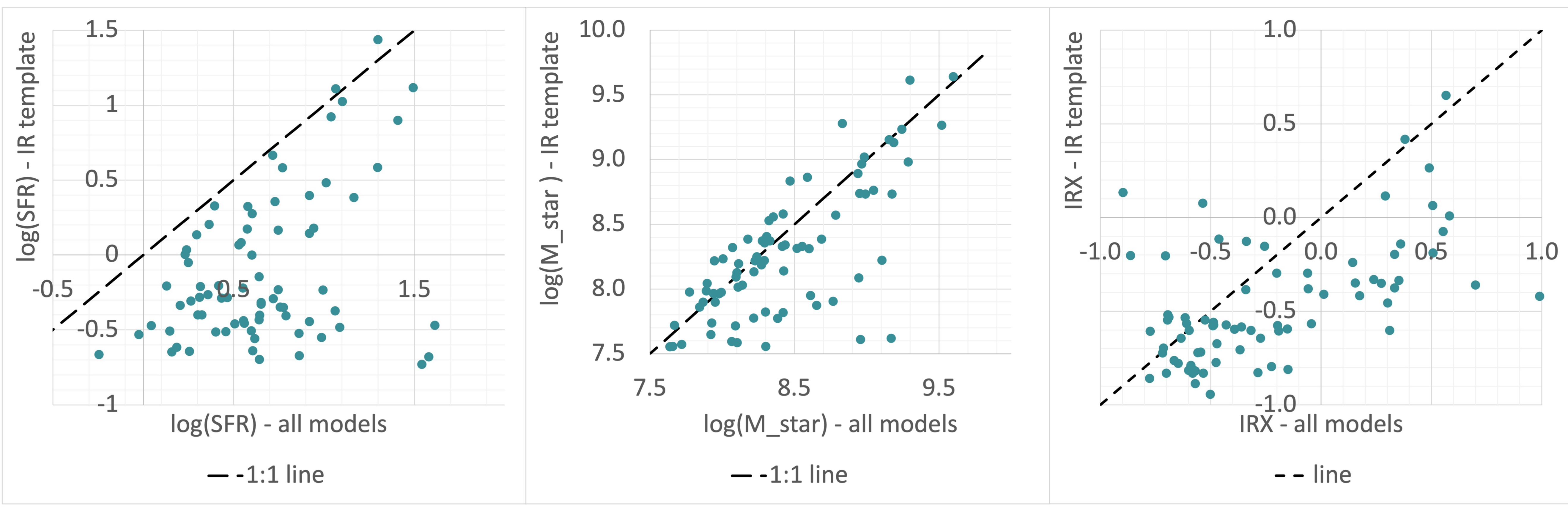
The table (right) contains the input parameters of the dust emission models used in CIGALE. In this work, only the DL2014 model is shown.



	PL+G_MBB	PL+OT_MBB	DL2014
α_{MIR}	2.23±0.63	2.00±0.82	N/A
β_{RJ}	1.43±0.47	0.87±0.28	N/A
T_{dust}[K]	65.5±5.1	54.1±6.7	N/A
q_{PAH}	N/A	N/A	0.47
α	N/A	N/A	2.39±0.44
u_{min}	N/A	N/A	18.1±12.7
γ	N/A	N/A	0.54±0.35
$L_{dust}/10^{20}$ [W]	2.84±0.14	2.43±0.12	2.57±0.13

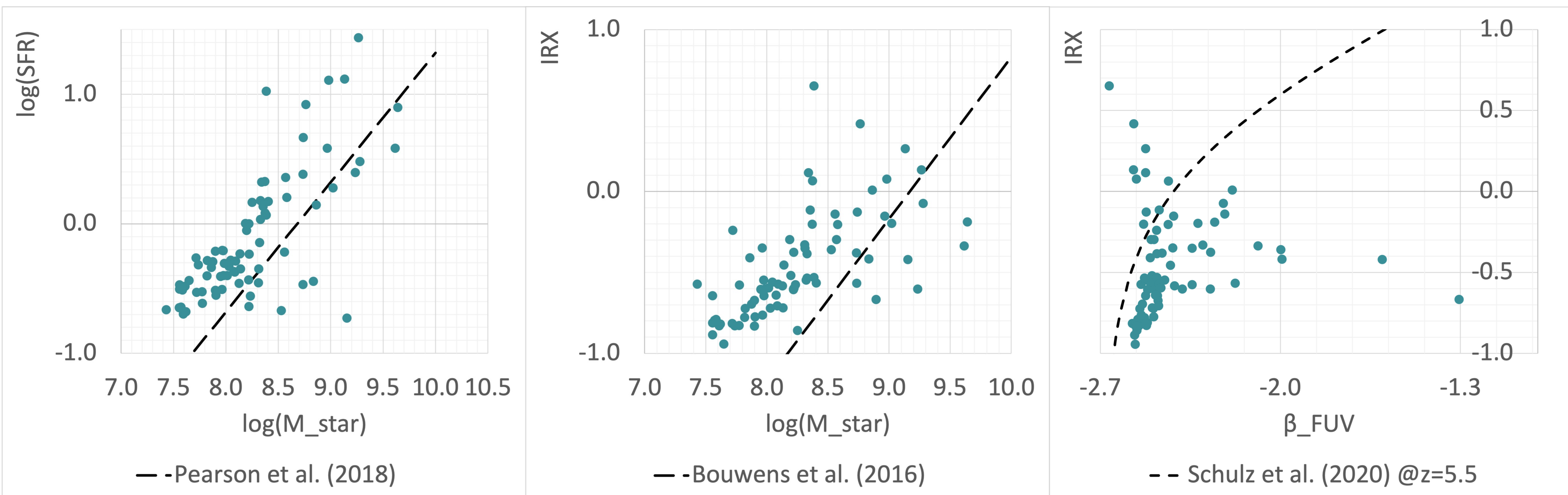
SED Fitting results

We show some of the main galaxy parameters (Star Formation Rate - SFR, stellar mass - M_{star}, and Infrared excess - IRX) resulting from the SED fitting. The x-axis shows the results from the SED fitting with the full range of models, while the y-axis represents the results obtained using the IR template. As seen from the 1:1 line on each plot, the stellar mass is in very good agreement in both runs, while the SFR and IRX are underestimated.



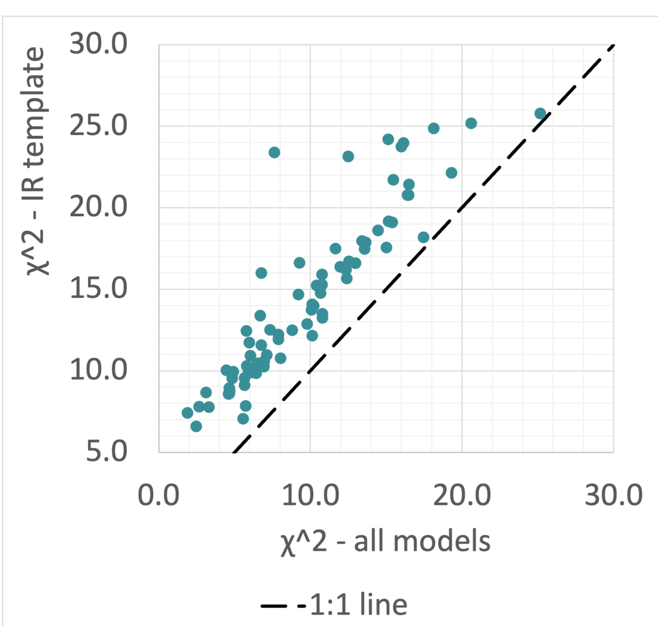
Diagnostic plots

To further investigate the SED fitting results obtained by using the IR template, we check the main statistical galaxy properties, as represented by the following diagnostic plots. We compare to the main sequence to the model of Pearson et al. (2018), the IRX-M_{star} from Bouwens et al. (2016) and the IRX-β_{slope} relation by Schultz et al. (2020), for redshift z=5.5. The overlap is not the greatest, but the main laws can still be noticed.



Conclusion: quality, cost or both?

- Definitely lowered the cost significantly
- How much did we lose on quality? We check the χ^2 of the models with vs. without template
- We see an average difference of around $\Delta\chi^2 = 4.6$



References

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