The Main Sequence of Star Forming Galaxies Beyond Herschel's Confusion Limit

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Introduction

The main sequence of star forming galaxies (MS) is a remarkably tight correlation between the star formation rate (SFR) and stellar mass (M_*) of star forming galaxies. Its existence is understood to be a result of every galaxy having its star formation regulated by similar quasi-static processes. Thus, understanding the MS helps with understanding these processes.

The far-infrared (FIR) and sub-mm regime is important for accurately determining the SFR of an object; it is the result of ultra-violet emission being absorbed and thermally re-emitted by dust. However, *Herschel* deep cosmological surveys suffer from source confusion, limiting our ability to determine the FIR flux densities of distant or low mass objects.

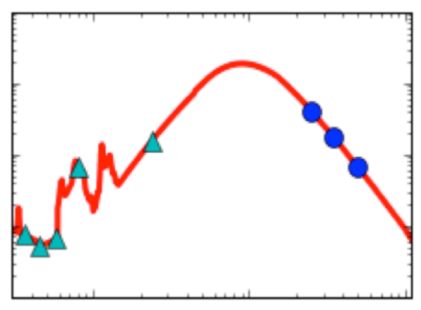
In this work, XID+ and CIGALE are used to de-blend the SPIRE maps in the COSMOS field. This results in a catalogue of over 225 000 objects which we then use to examine the MS.

De-Blending and Generating SFR and M_*

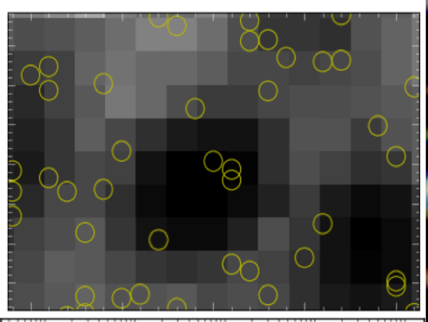
Multi-wavelength input catalogue: COSMOS2015

Id	J	H	...
0	10	4	384
...	29	123	982

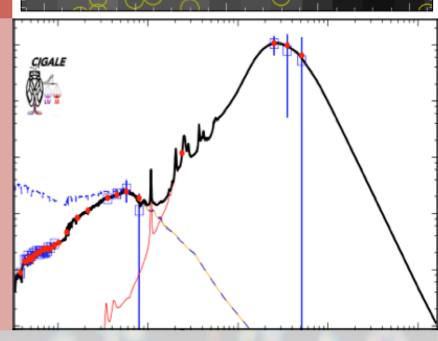
Use the multi-wavelength catalogue in CIGALE to predict SPIRE flux densities



Using the CIGALE predictions as flux density priors to de-blend SPIRE maps in XID+

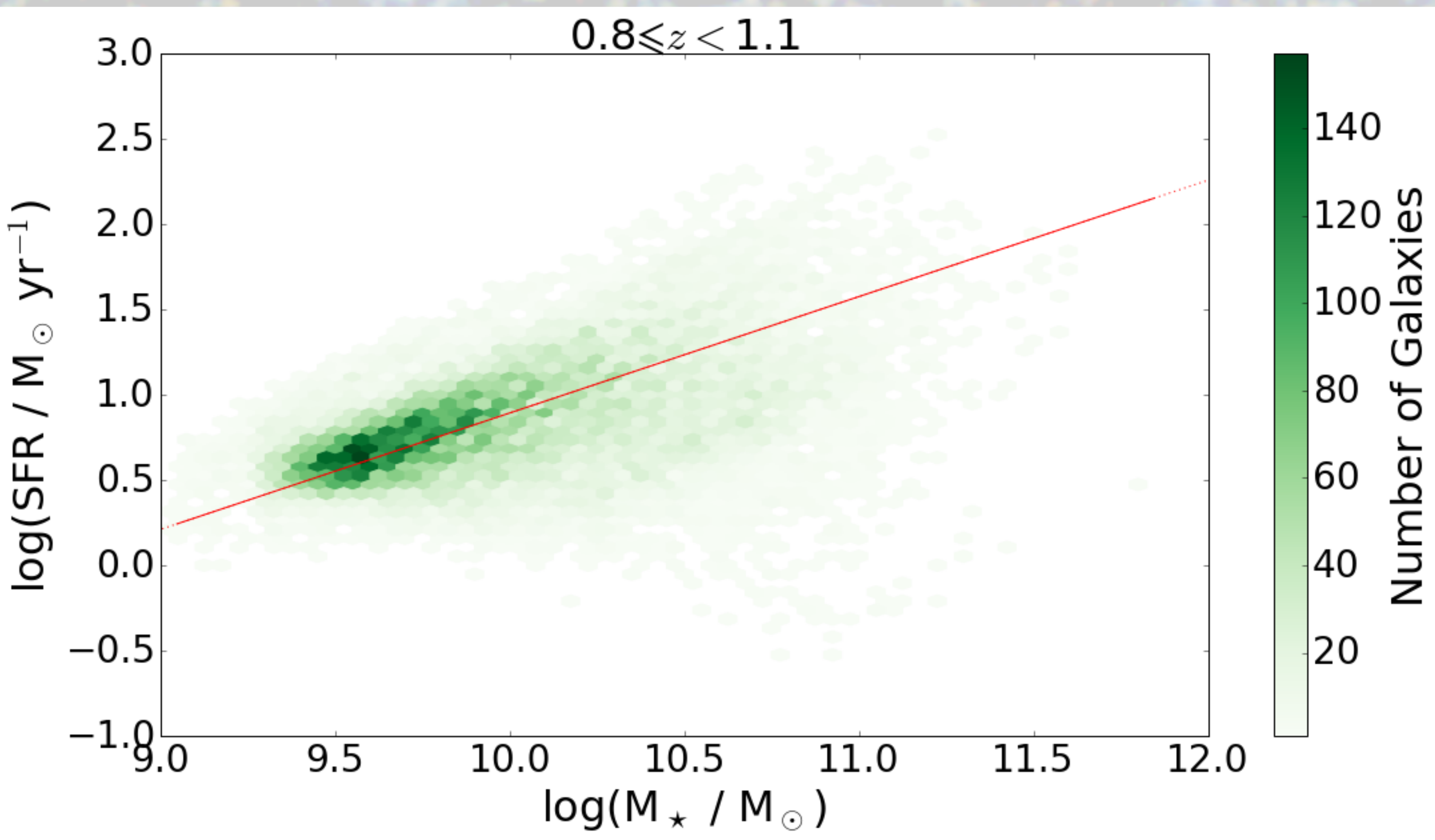


Use the multi-wavelength catalogue and XID+ flux densities in CIGALE to derive M_* and SFR



To de-blend the *Herschel* SPIRE images, we use UV to near infrared data, from the public COSMOS2015 catalogue, and CIGALE to predict the expected flux density in each band. These predictions are fed into XID+ and are used as flux density priors. XID+ then extracts the flux densities for each object in the prior list from the SPIRE images. The SPIRE flux densities are added to the COSMOS2015 catalogue and CIGALE is run again to generate the SFR and M_* of each object.

Finding the Main Sequence



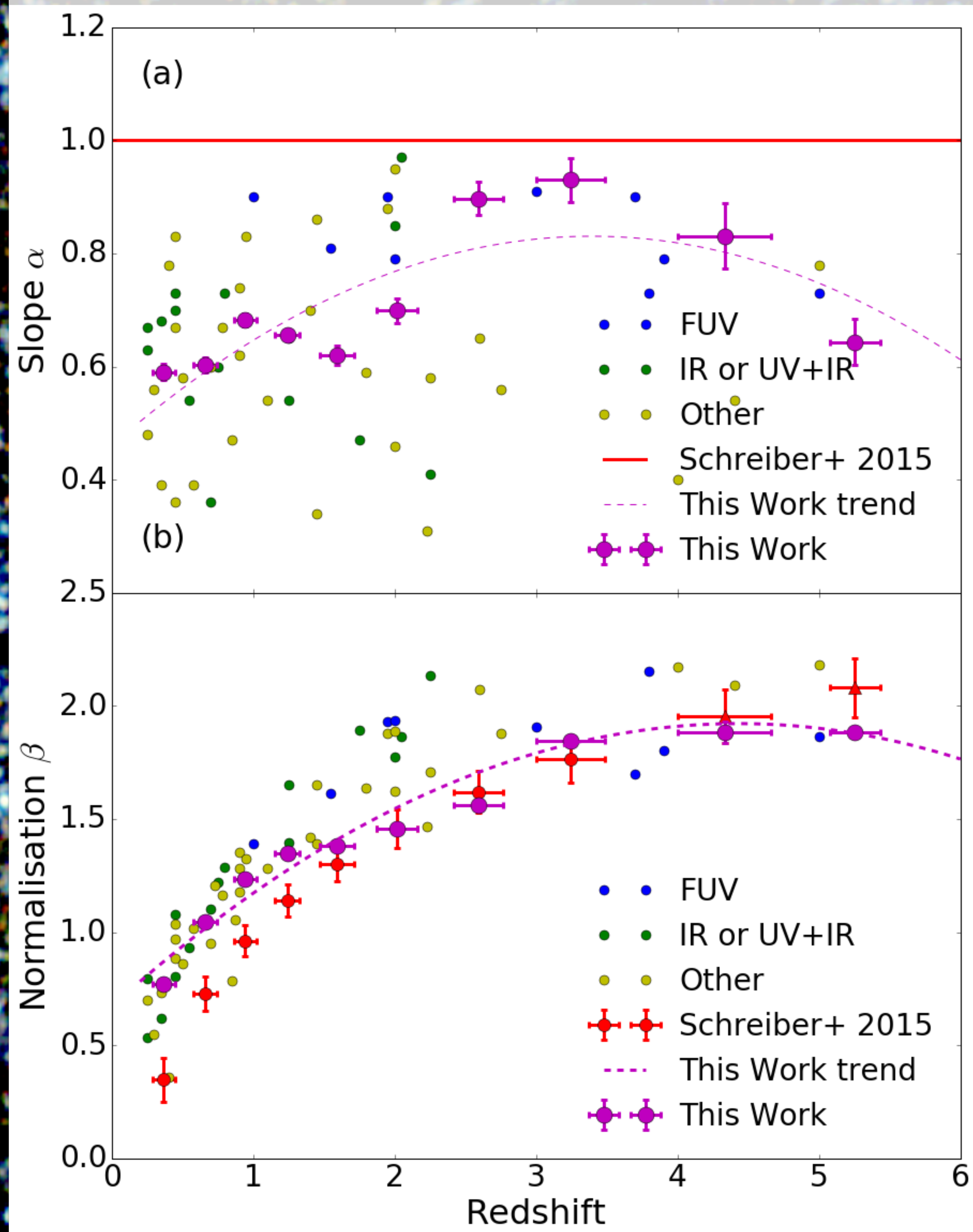
We bin the objects by redshift and find the star forming galaxies using a UVJ colour cut. We then fit the MS to all the star forming objects in the redshift bin, an example of which is shown above. We try both a simple power law as well as a power law with a turn over. From these MS, we find very little evidence of a turnover at high mass.

The Main Sequence from z = 0.2 to z = 6

With little evidence for a high mass turnover, we find that the MS takes the form

$$\log(\mathrm{SFR}/M_\odot\ \mathrm{yr}^{-1}) = \alpha(\log(M_*/M_\odot) - 10.5) + \beta.$$

In the figure below, we compare our parameters for α (panel a) and β (panel b) in each redshift with the works in Speagle et al. (2014, Sp14), a large compilation of MS, for data that uses far ultraviolet (FUV, blue), infrared data (IR or IR+UV, green) or other (yellow) SFR tracers, and Schreiber et al. (2015, Sc15), a work on the MS using stacked *Herschel* data.



The slope (α) is typically found to be similar to the results in Sp14. Our steeper slopes with respect to the 'other' SFR tracers at high redshift, are possibly a result of dust obscured star formation being reveled by the *Herschel* data at high masses. Sc15 uses a slope fixed at unity so no meaningful comparison can be made. The normalisation (β) is consistent with Sp14. Compared with Sc15, it begins higher before becoming consistent at z = 1.4. The reason for why our normalisation is higher at low redshifts is unclear.

Conclusions

Using de-blended *Herschel* SPIRE data, we have constructed the MS over the redshift range $0.2 \leq z < 6$. We find very little evidence for a high mass turnover with a simple power law providing the best fit to our data. Typically, we find slopes consistent, or slightly steeper than that of literature. The steeper slopes are likely due to hidden star formation being revealed by the use of *Herschel* data. The normalisation of the MS is consistent with other works.

Speagle et al. 2014, ApJS, 214, 15
Schreiber et al. 2015, A&A, 575, A74

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