Properties of Submillimeter Galaxies in a Semi-analytic Model using the "Count Matching" Approach: Application to the ECDFS

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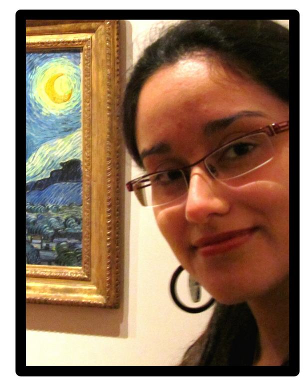
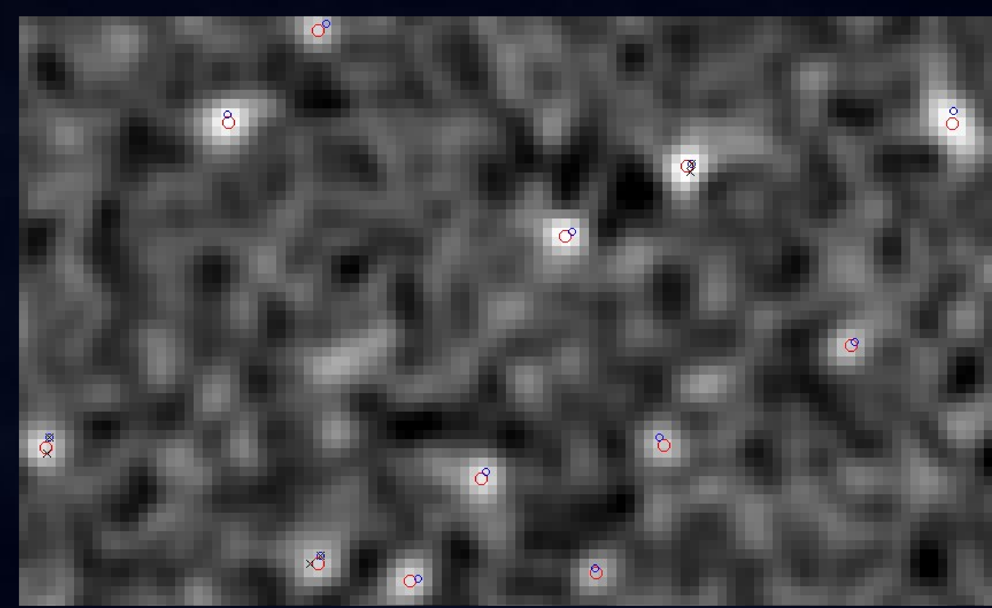


MOTIVATION

Fitting submillimeter galaxies (SMGs) into the current theory of galaxy formation has been a challenge since their discovery. They are the most luminous star-forming sources at the epoch where galaxy formation peaks, being detected by their redshifted FIR emission from warm dust in the submm wavebands. Recent ALMA observations of the Extended Chandra Deep Field South (ECDFS) show that the brightest sources detected by LABOCA (LESS, Weiss et al. 2009) are comprised by emission from multiple fainter sources (ALESS, Karim et al. 2013).

With the aim of exploring the properties of SMGs in this field, and in analogy to the now-standard abundance matching approach, we perform a "Count Matching" approach through lightcones drawn from a semi-analytic model. We choose various physical galaxy properties given by the model as proxies for their submillimeter luminosities, assuming a monotonic relationship so that the combined LABOCA plus bright-end ALMA observed number counts are reproduced.



Example: section of the simulated map (lightcone #1, MDS proxy).
Red big circles: extracted sources.
Blue small circles: matched input sources.
Black crosses: components of the blended source.
The map resolution is 6''/pix.

METHODOLOGY

After turning the catalogs of galaxy positions and fluxes given by the different proxies into submillimeter maps (LABOCA beamwidth), we perform a source extraction. With this we study the effects of the observational process in the recovered counts, as well as the galaxy properties derived from the detected sources for each proxy.

We perform a cross-match between the extracted sources and input ones (brighter than 0.4 mJy), assigning the properties of the brightest source within the search radius to the extracted one. In addition, when finding multiple sources for a given extraction, we compute the separation in redshift between the components of the blended source.

Exploring the distribution of properties as redshift, SFR, stellar mass and host halo mass can help us to find the best proxy. Moreover, sources with the highest submm fluxes will have different clustering depending on the assumed proxy, since the sources with the highest value of a given property will be clustered in a particular way.

APPLYING THE TECHNIQUE: STEPS

a) Select a galaxy sample. We construct 10 lightcones from the semi-analytic model SAG (Cora 2006, Lagos et al. 2008). Each lightcone covers 30'x30', having an orientation in the sky such that the repetition of structure is minimum. All sources belonging to one lightcone comprise a unique galaxy sample.
b) Choose a physical galaxy property (given by SAG) as a proxy for the 870 μm luminosity, and sort the galaxy values of that proxy in increasing order.

c) Assign a submm flux to each galaxy according to

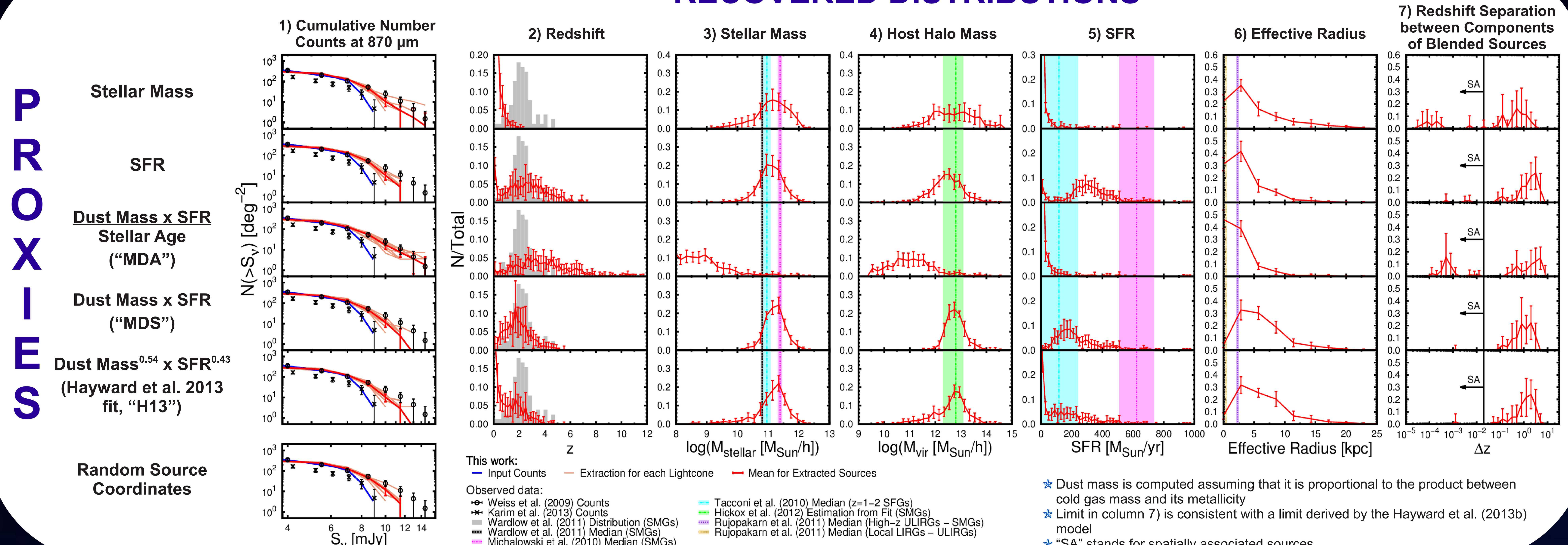
$$N\left(\frac{\mathrm{Proxy}}{f_k\, D_L^2}\right) > y = N(\mathrm{Flux} > x)$$

with D_L luminosity distance and f_k a factor giving the corresponding k-correction, assuming an Arp220 spectrum. Submillimeter fluxes are drawn from a Monte Carlo simulation following the observed cumulative number counts, where we have combined the LABOCA counts at low fluxes and ALMA counts at fluxes brighter than 8 mJy (we want to test whether we are able to recover LESS counts after simulating the observational process, while avoiding biases in the counts arising from targeting only LESS sources and not other regions in the ECDFS having S/N slightly lower than the LESS threshold.

CONCLUSIONS

* For all proxies, there are lines of sight giving counts consistent with those derived from LABOCA observations. This is found even for input sources with randomized positions in the simulated map.
* MDS proxy gives redshift, stellar mass and host halo mass distributions consistent with observed ones. Our model still is not able to reproduce the observed SFRs assuming a Salpeter IMF.
* The majority of components of blended sources are spatially unassociated. However, for the stellar mass and MDA proxies the amount of sources being spatially associated is not negligible.

RECOVERED DISTRIBUTIONS



* Dust mass is computed assuming that it is proportional to the product between cold gas mass and its metallicity
* Limit in column 7) is consistent with a limit derived by the Hayward et al. (2013b) model
* "SA" stands for spatially associated sources

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