ESLAB 2013

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Noordwijk

THE CONNECTION BETWEEN STAR FORMATION AND DARK MATTER HALOS AS SEEN IN THE INFRARED

Material at http://irfu.cea.fr/Sap/Phocea/Page/index.php?id=537

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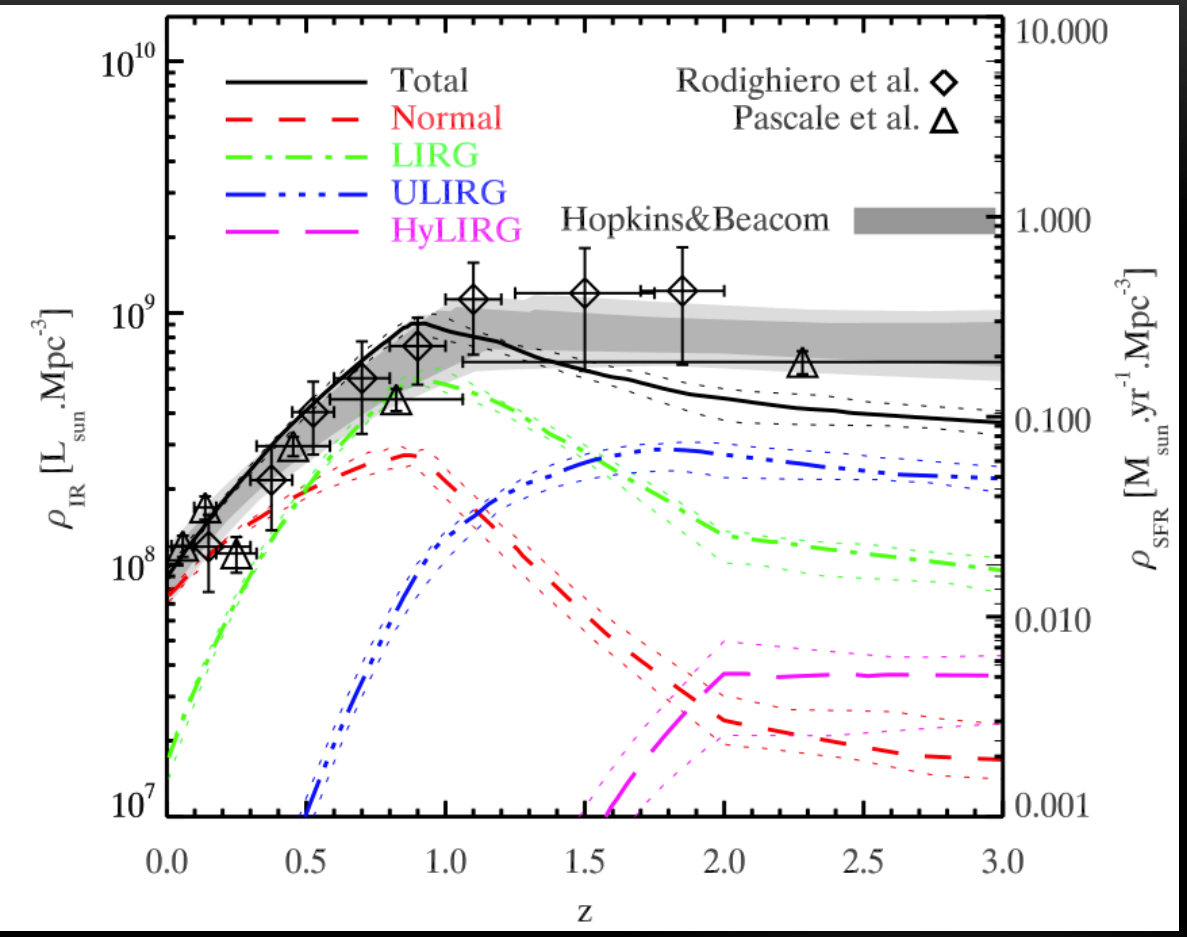
In collaboration with Lingyu Wang, Olivier Doré, Guilaine Lagache, Morgane Cousin, Mark Sargent, Emanuele Daddi, Morgane Cousin, and Hervé Aussel

CEA Saclay

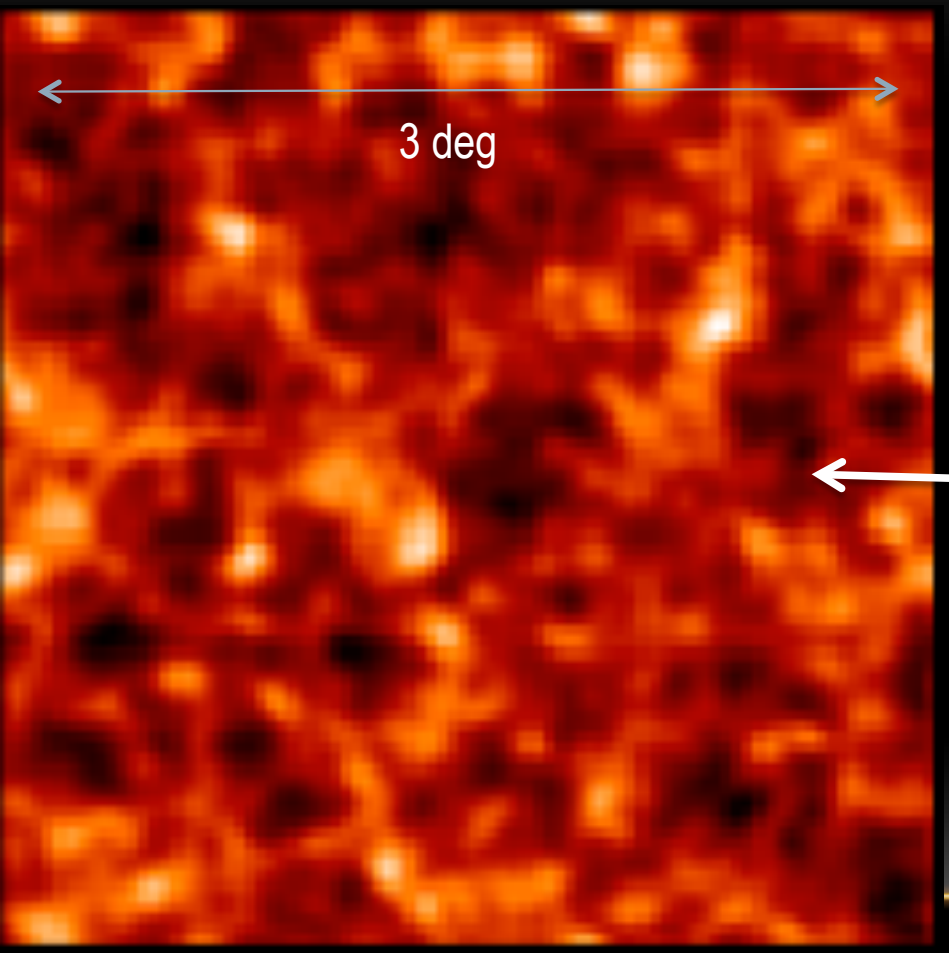
A STRONG DOWNSIZING OF INFRARED GALAXIES



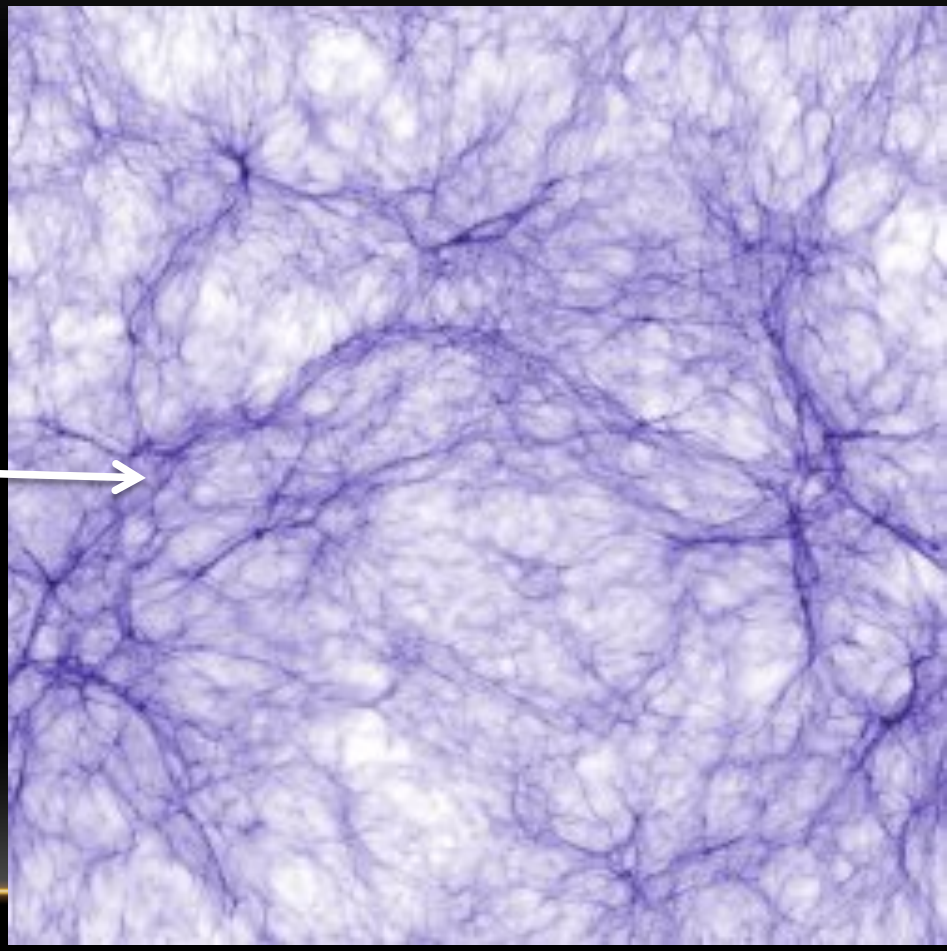
Star formation history as seen in the infrared and contribution of various infrared luminosity classes (Béthermin+11)

- Star formation in the local Universe dominated by “normal” galaxies (<10Msun/yr), but dominated by ULIRGs (>100Msun/yr) at z>2 => Strong downsizing
- How can we explain this strong evolution of infrared properties?
  -> higher merger rate?
  -> intense cold accretion?

COSMIC INFRARED BACKGROUND ANISOTROPIES: A PROBE OF THE LINK BETWEEN LOCI OF STAR FORMATION AND LARGE SCALE STRUCTURES



Fluctuations of the cosmic infrared background (Planck collaboration et al.)



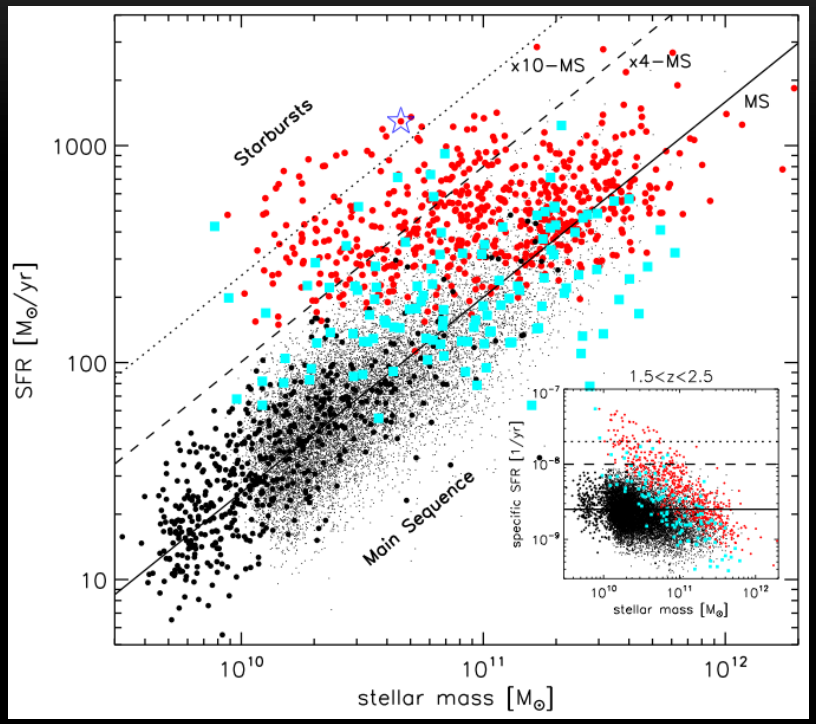
Simulation of large scale structures (Pichon, Teyssier)

INTRODUCTION

- Correlations between observed physical quantities (star formation rate, stellar mass, attenuation)
- Connection between infrared properties and dark matter halo (using stellar mass as intermediate proxy)
- Main results: CIB redshift distribution, contribution of various halos to star formation history, star formation history inside halos.

A “MAIN-SEQUENCE” OF STAR-FORMING GALAXIES SEEN BY HERSCHEL

SFR-$M_\star$ relation at z~2 (Rodighiero+11):



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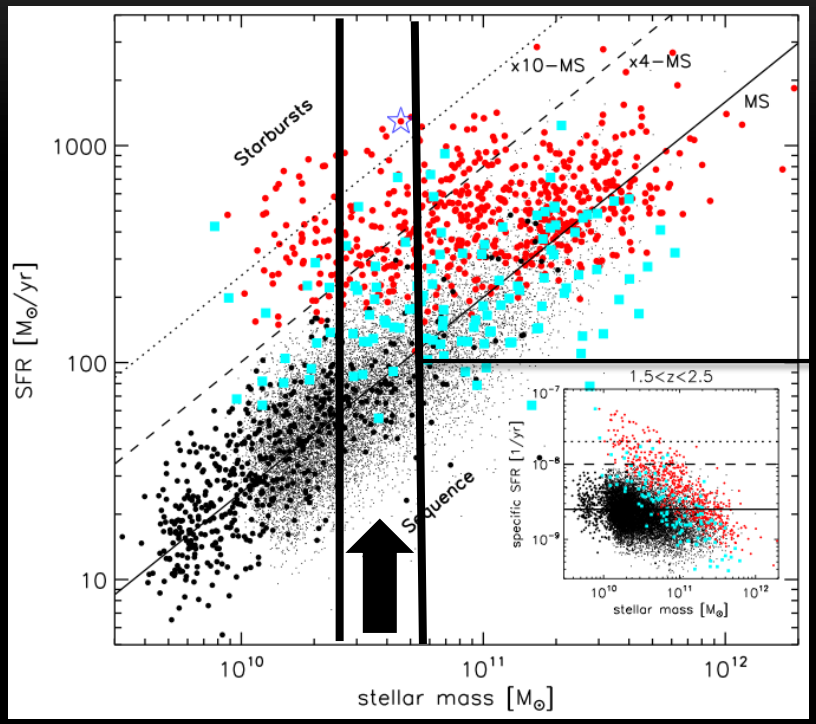
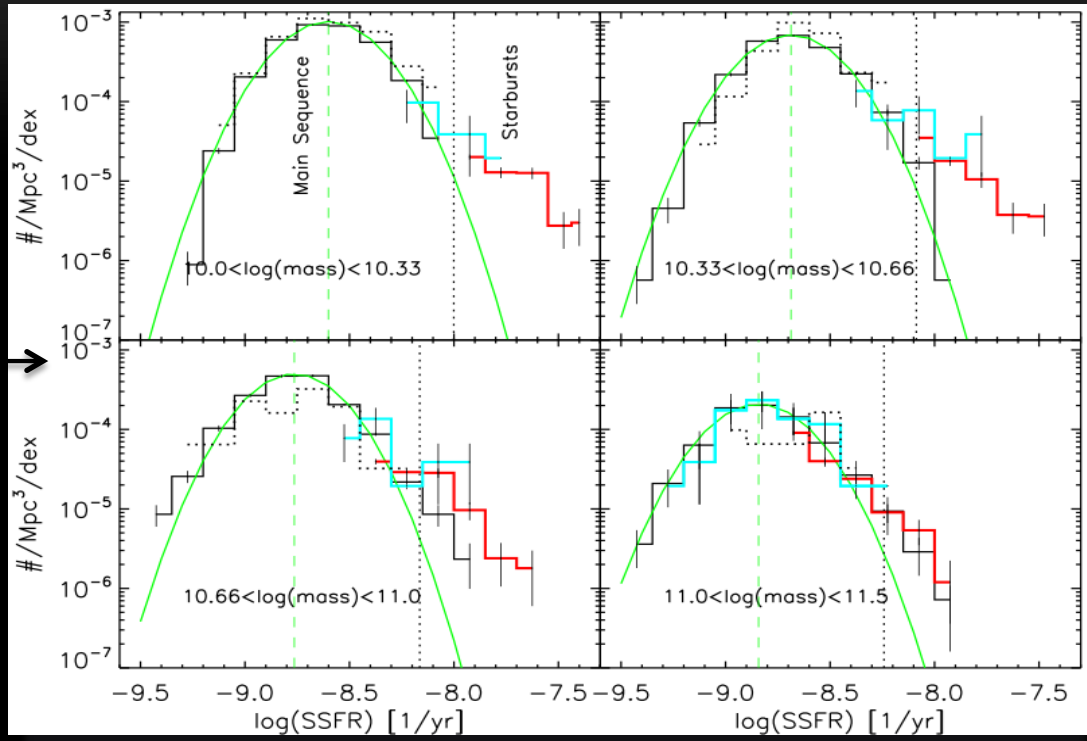


Cross-section through main sequence at fixed $M_\star$

Distribution of sSFR at fixed $M_\star$ at z~2 (Rodighiero+11):



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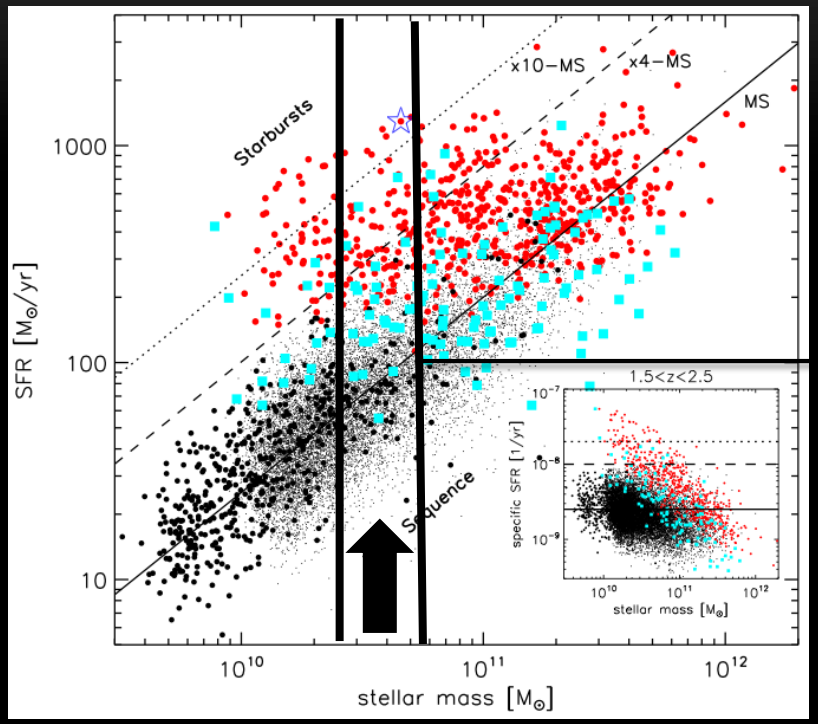

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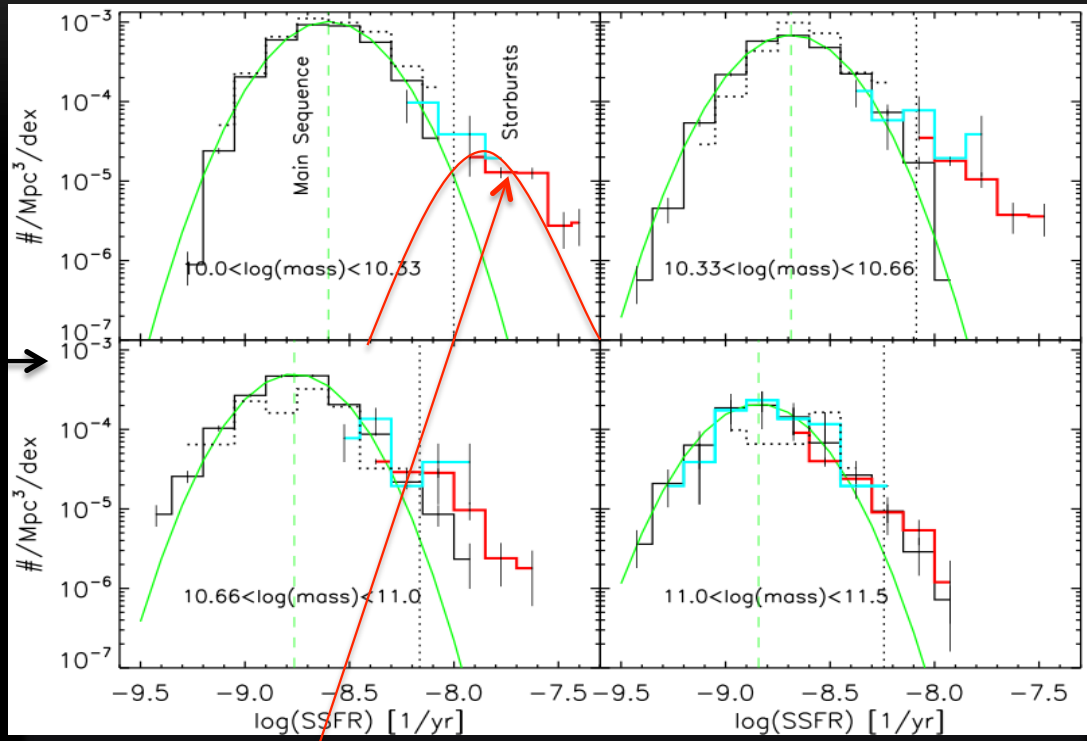
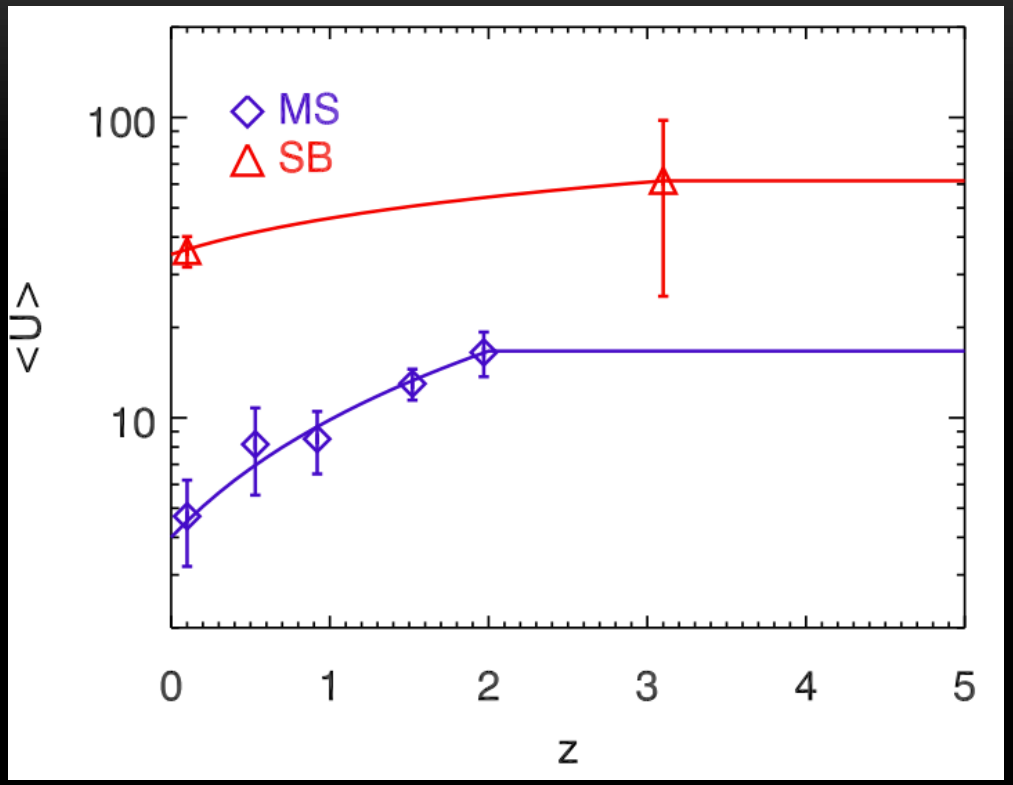


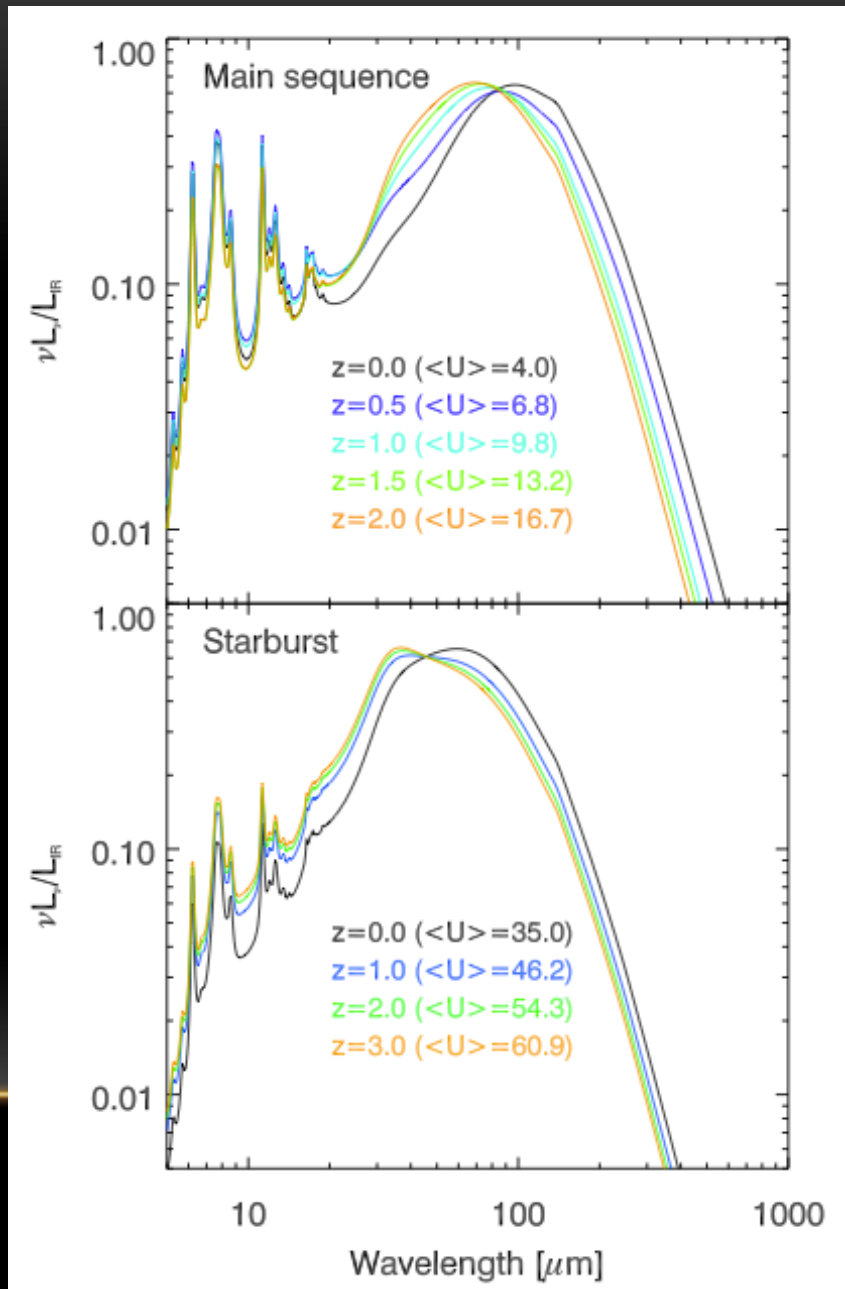
-> Self similar distribution of sSFR

Excess due to starbursts:
- ~15% of the star formation density
- a few % of number density

NEW SED TEMPLATES OF MS AND SB GALAXIES BASED ON HERSCHEL OBSERVATIONS

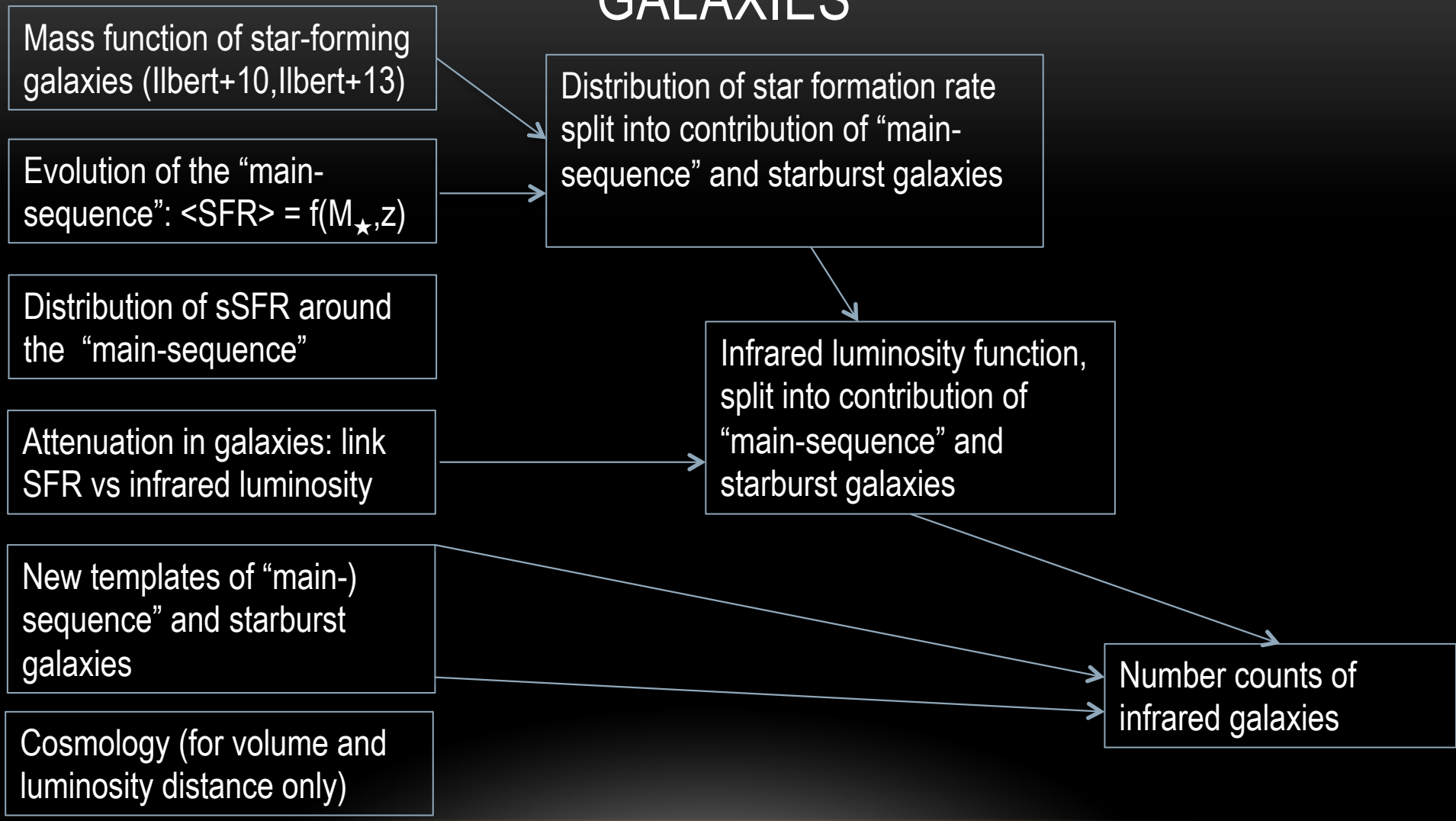


Evolution of <U> (radiation field in Draine&Li model) with redshift.



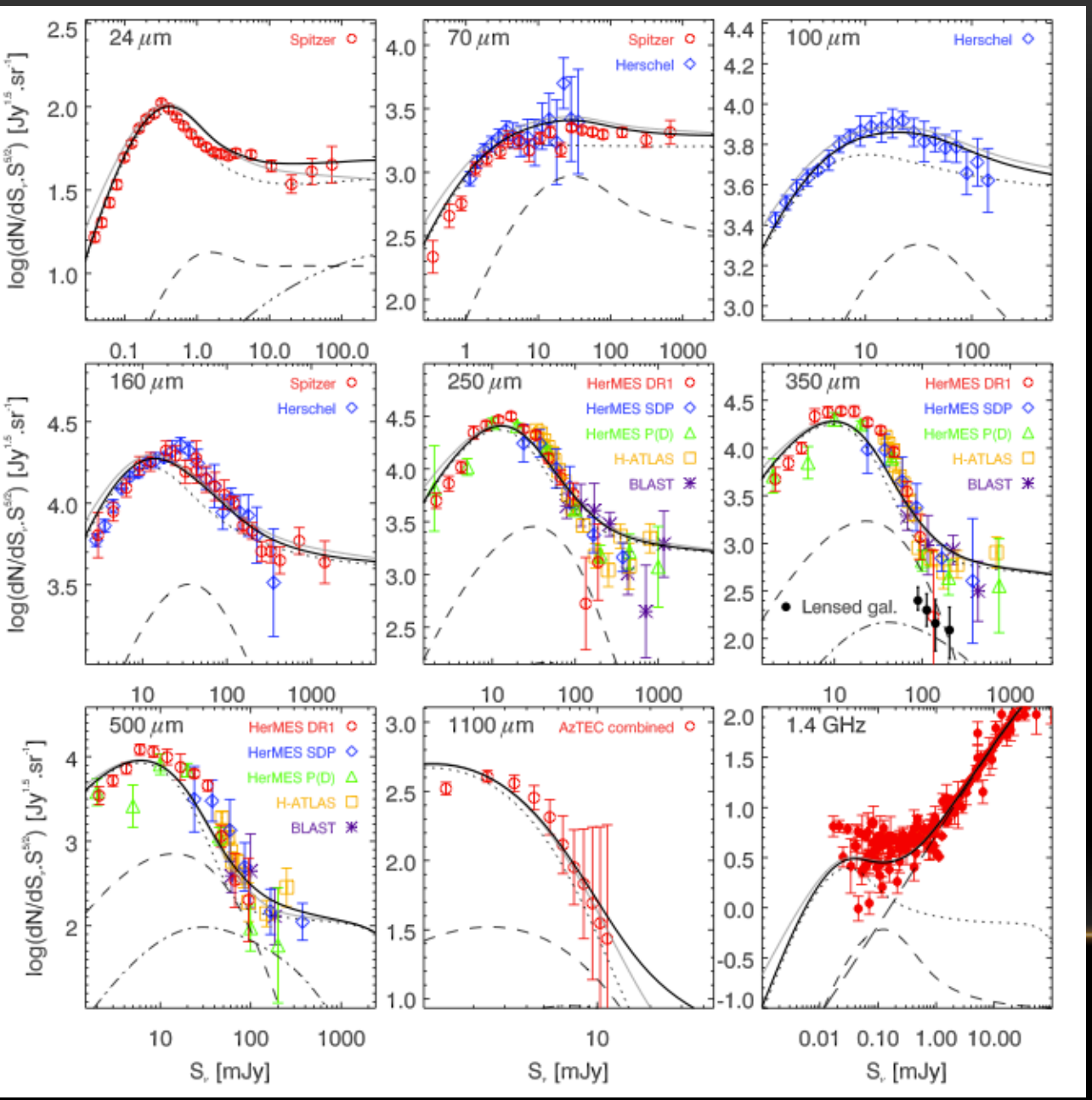
Béthermin+12c, Magdis+12b

A NEW MODEL FOR STATISTICAL PROPERTIES OF IR GALAXIES



Béthermin+12c, Sargent+12

MID-IR T RADIO COUNTS FROM OUR FIDUCIAL MODEL

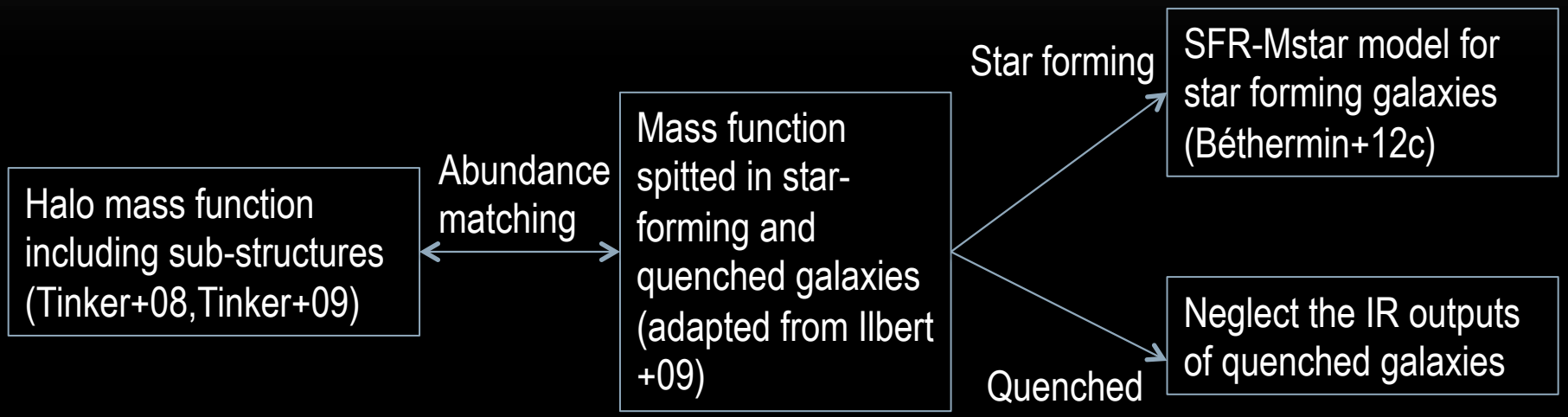


Number counts are globally well reproduced using fiducial parameters based on mean values from literature.

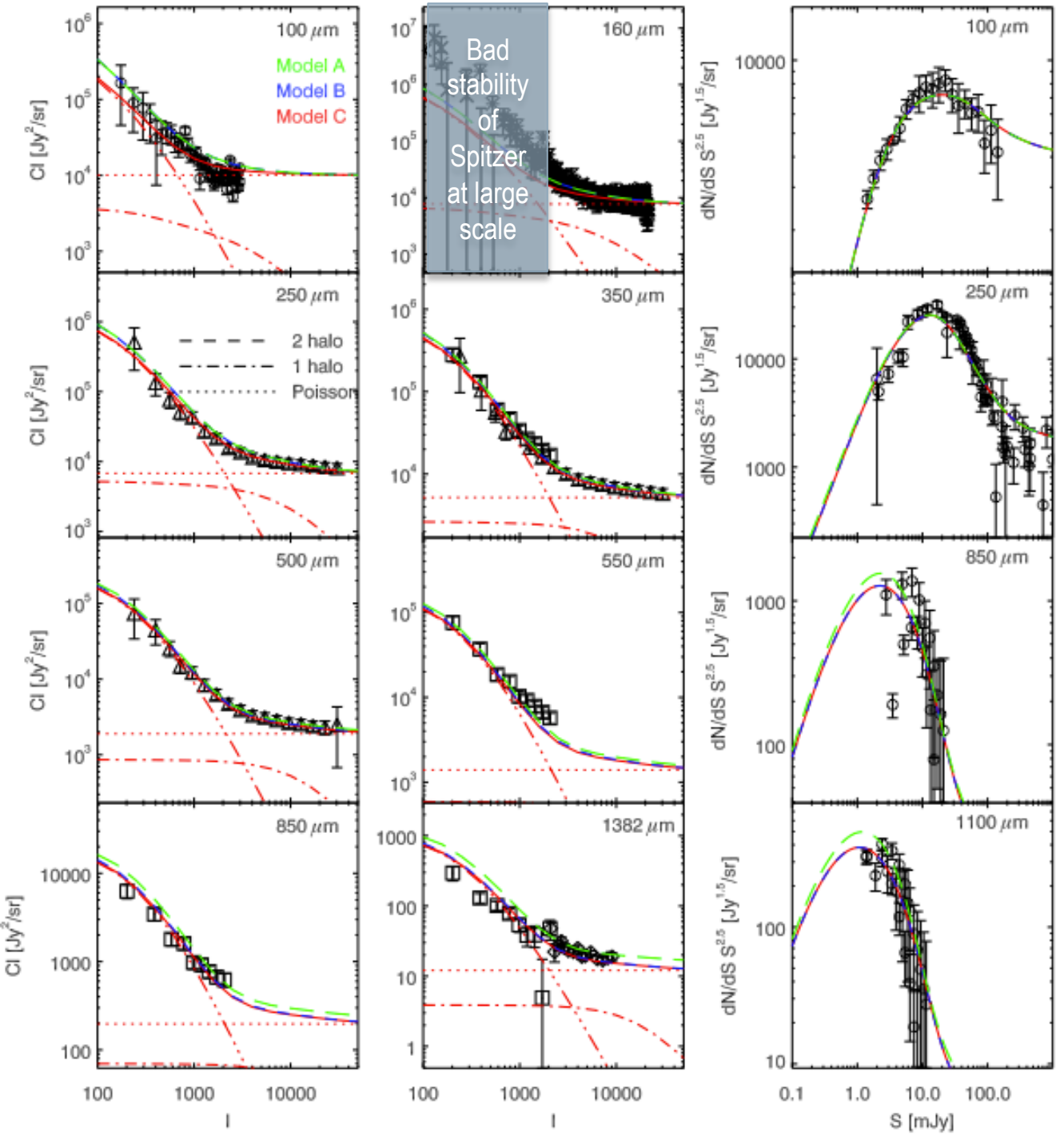
The starburst (dashed line) have a very variable contribution depending on the flux regime and the wavelength.

Comparison between the model and the observations (Béthermin +12c)

CONNECTING STAR FORMATION AND HALO MASS BY ABUNDANCE MATCHING



Main hypotheses:
- same Mstar-Mhalo relation in main and sub-structures
- same Mstar-Mhalo relation for SF and quenched galaxies
- the probability to be quenched depends only on the halo mass
- starburst and main-sequence lies in the same halos



RESULTS

Model A:
Fiducial model

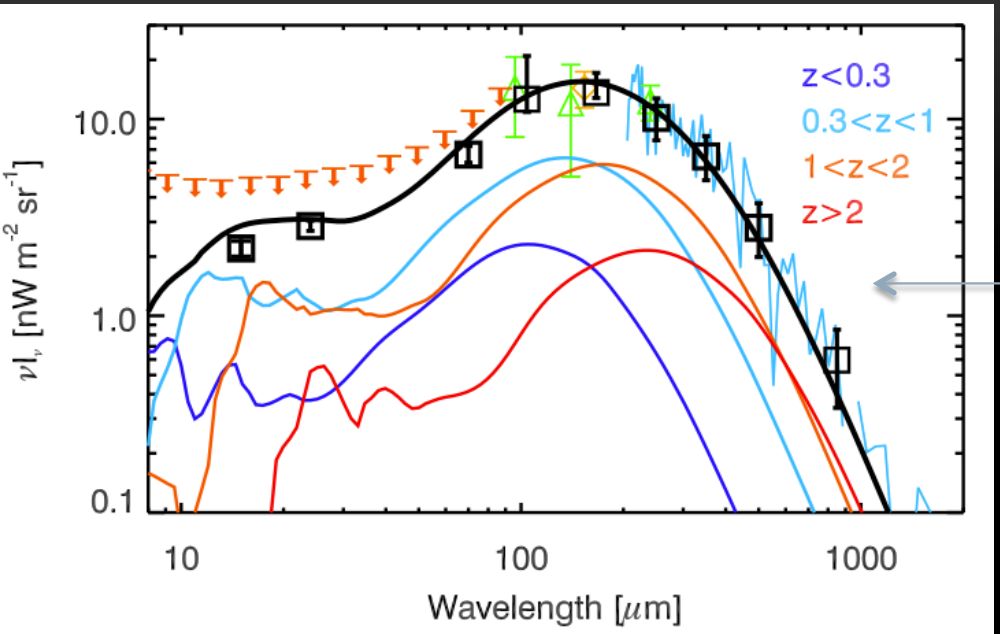
Model B:
Lowest density, high sSFR

Model C:
Lowest density, high, sSFR
+no star-formation around passive central galaxies

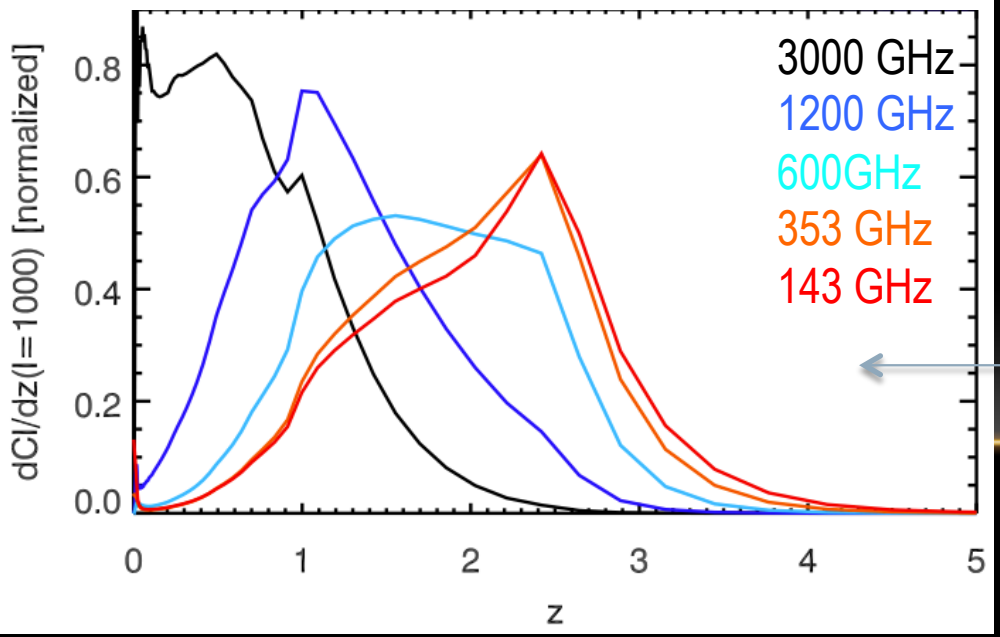
Check also with SPIRE cross power spectra, ACTxSPIRE, Planck CIBxlensing, angular correlation function of bright PACS sources

CIB power spectrum and galaxy counts

REDSHIFT DISTRIBUTION OF THE CIB



CIB spectral energy distribution spitted by redshift slices

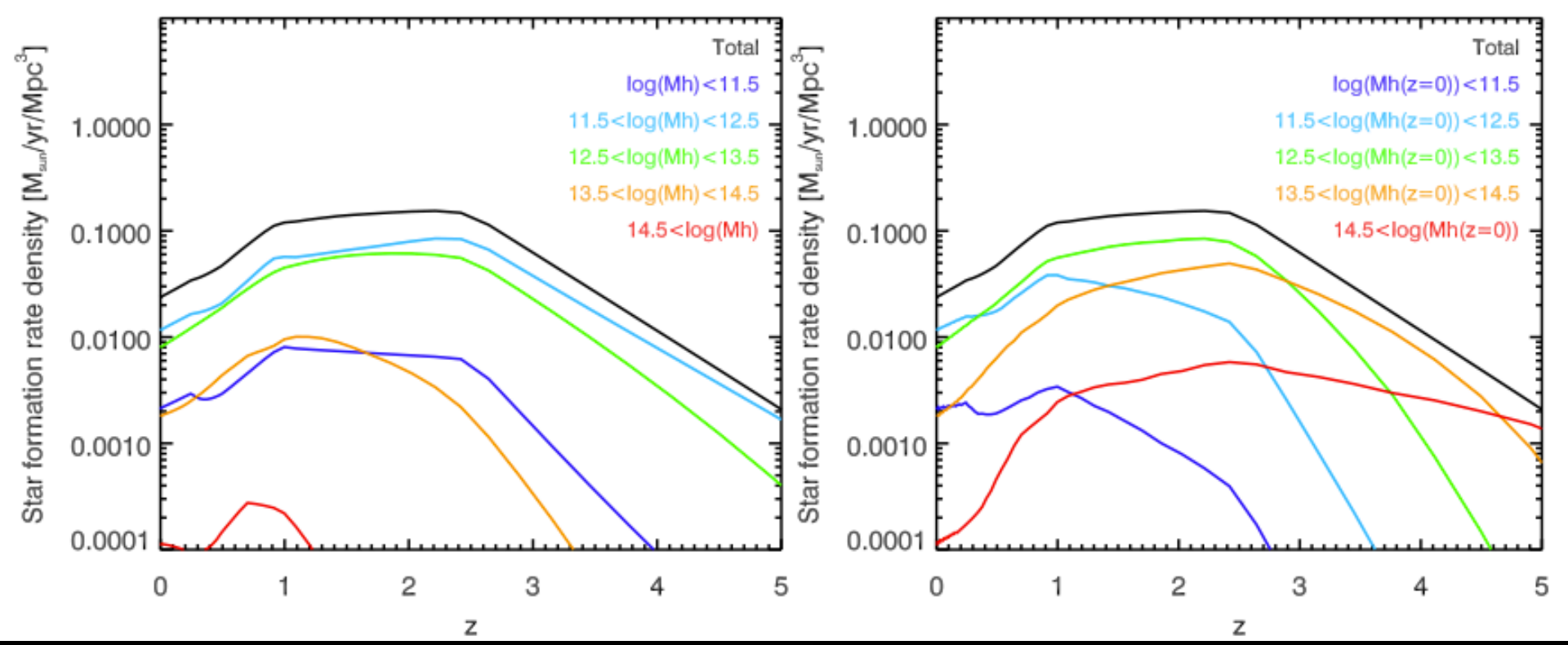


Redshift distribution of CIB fluctuation at l=1000

STAR FORMATION HISTORY AND HOST HALOS

Instantaneous halo mass

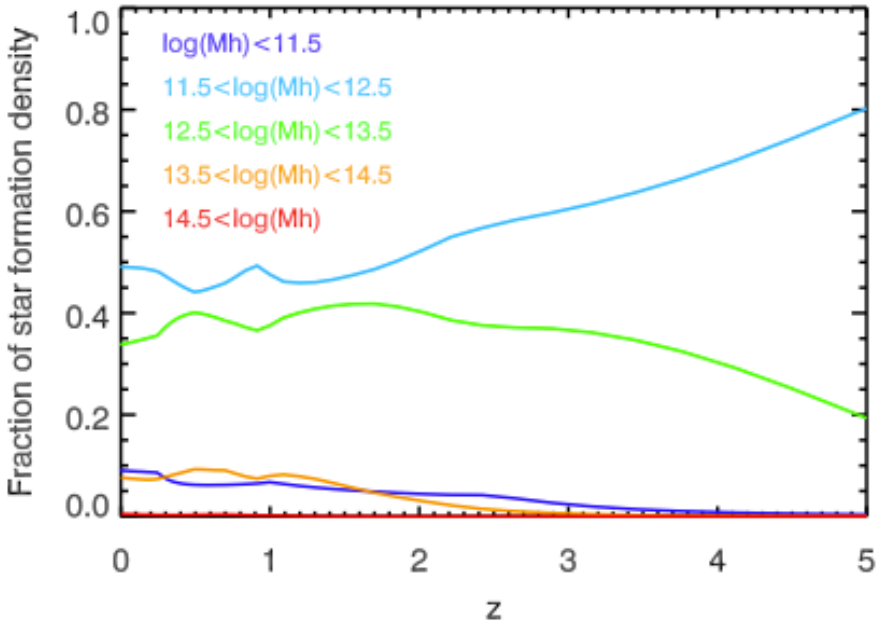
mass at z=0



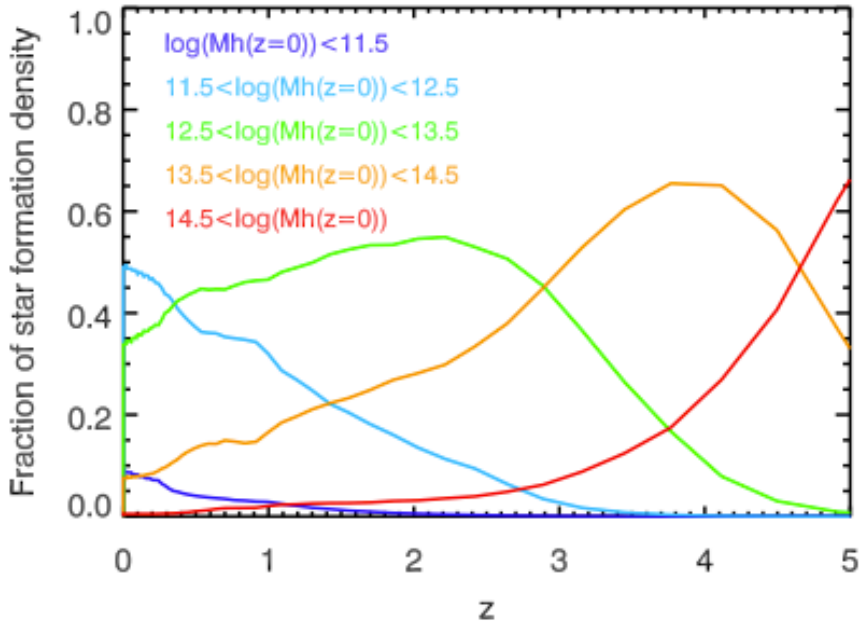
Contribution of various halo mass to the star formation history

STAR FORMATION HISTORY AND HOST HALOS

Instantaneous halo mass



mass at z=0

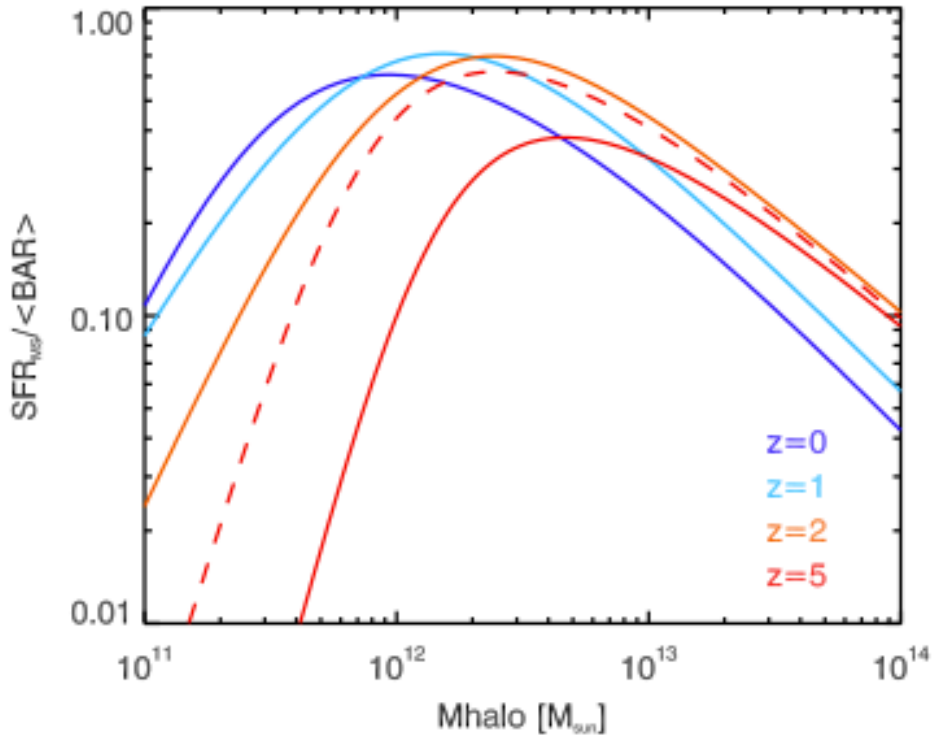


Relative contribution of various halo masses as a function of redshift

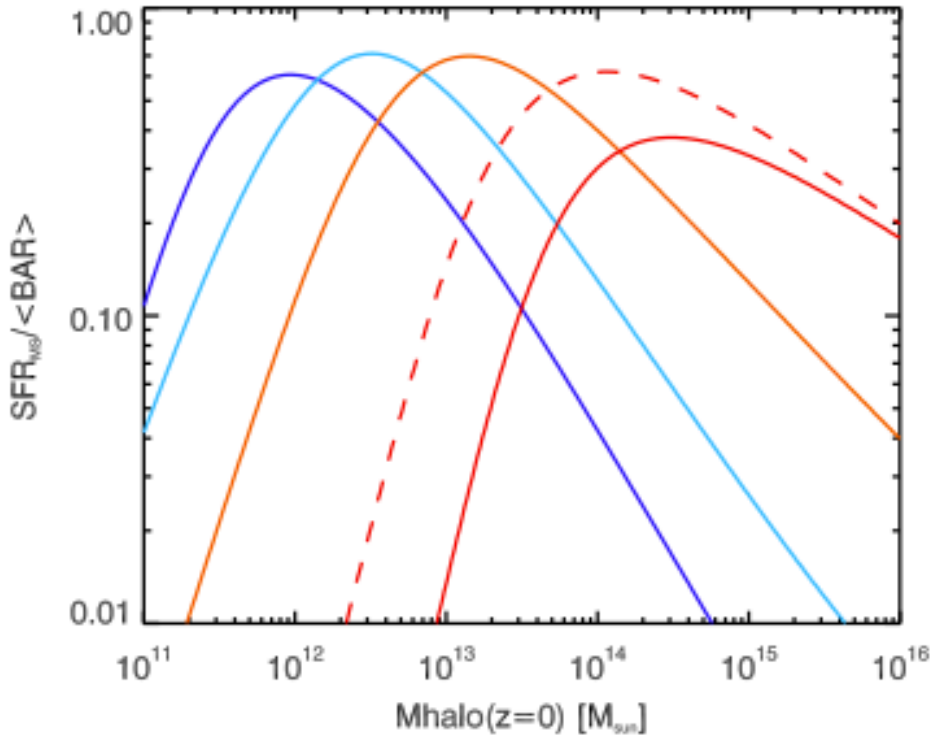
STAR FORMATION EFFICIENCY

in a main-sequence galaxy

Instantaneous halo mass



mass at z=0



Mean ratio between star formation rate and baryonic accretion rate as a function of halo mass and redshift

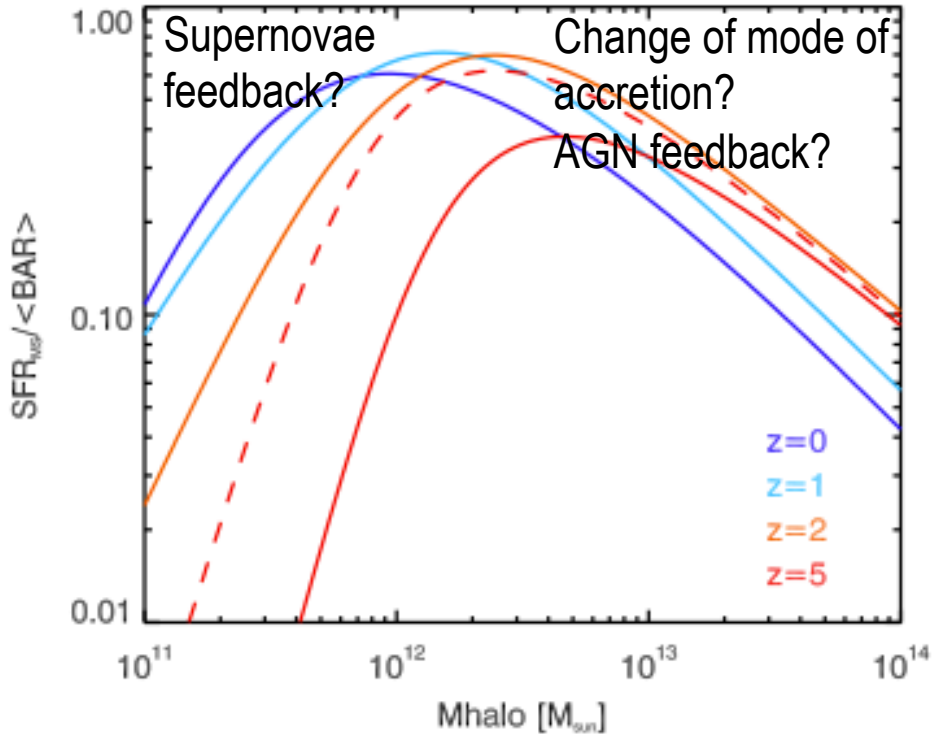
Mean baryon accretion rate (BAR) = Mean accretion rate (Fakhouri+10) × Ωb / Ωm

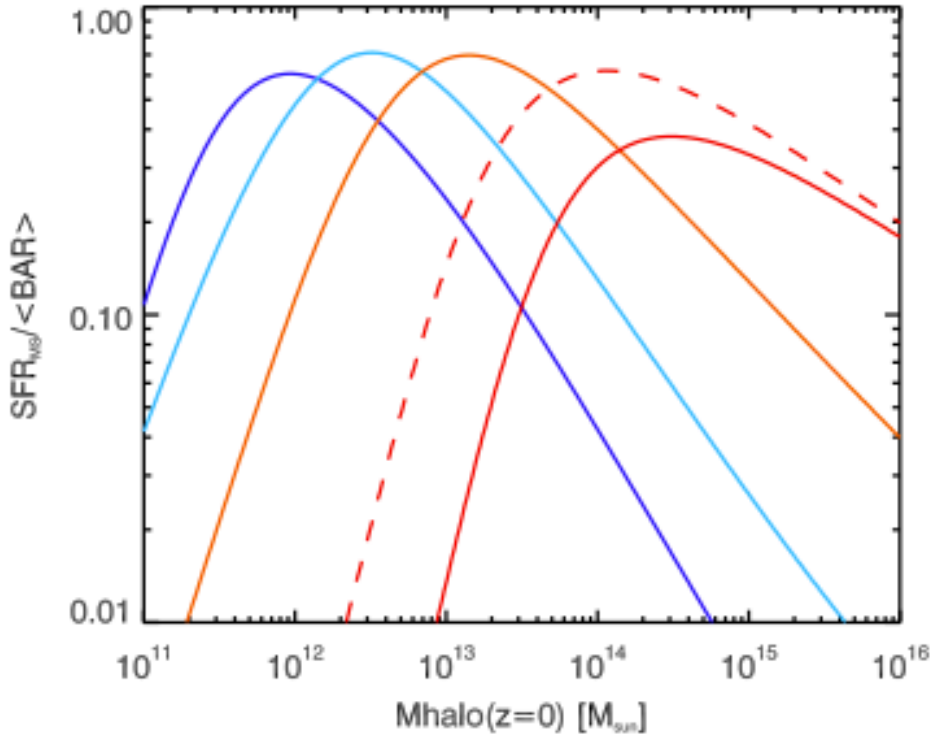
STAR FORMATION EFFICIENCY

in a main-sequence galaxy

Instantaneous halo mass

mass at z=0





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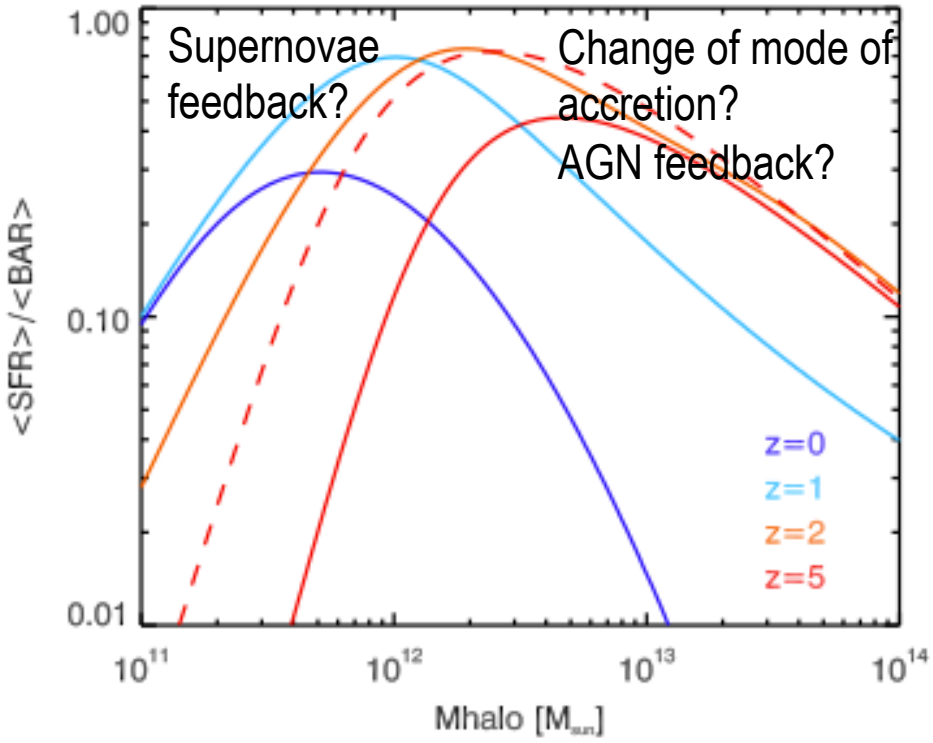
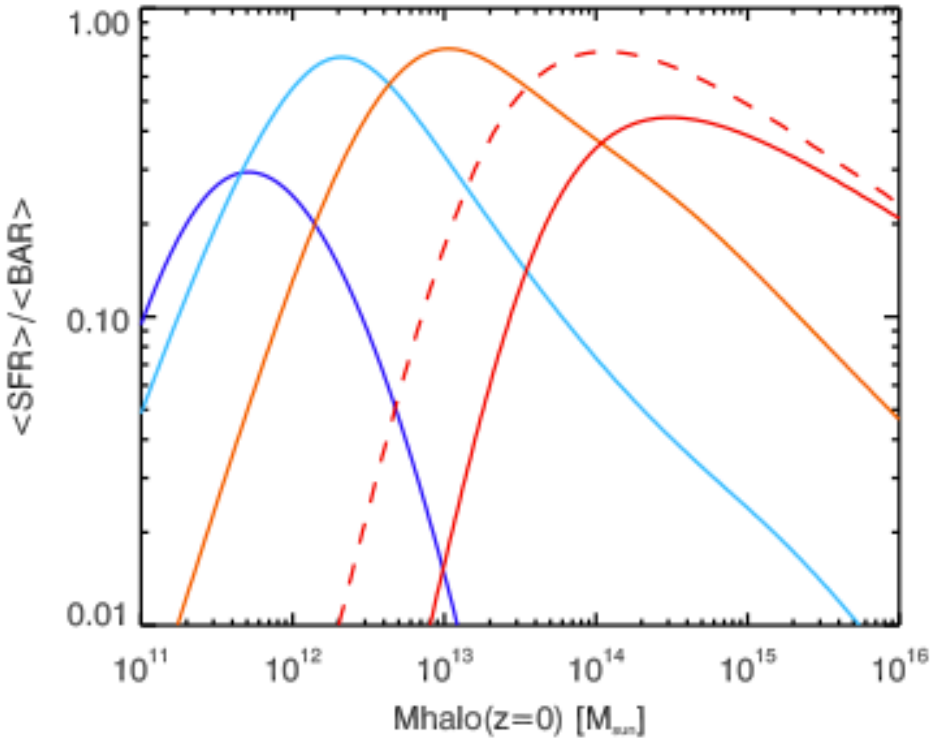
STAR FORMATION EFFICIENCY

mean star formation efficiency (including passive galaxies)

Instantaneous halo mass

mass at z=0





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CONSLUSION AND PERSPECTIVES

- We propose a new modeling approach to model the evolution of the infrared galaxies and the CIB model based on the observed correlation between stellar mass and star formation rate, called “main-sequence”.
- Infrared galaxy counts, CIB anisotropies and clustering of bright IR sources can be well reproduced with this simple approach.
- This model suggests that galaxies hosted by ~10^{12} M_{sun} halos are the most efficient to form stars and emits the bulk of the CIB. The strong downsizing of infrared galaxies would be caused by an higher baryonic accretion in 10^{12}-ish halos at high redshift.

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