Self-consistent spatially resolved Star Formation Histories of 2 < z < 3 massive galaxies

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We present a spatially-resolved analysis of the stellar populations in Milky Way-like and Milky Way progenitors up to z~3. Our study is based on optical and near-infrared broad-band data from HST, in addition to mid-infrared observations from Spitzer, medium-band optical imaging from GTC/SHARDS, and ground-based near-infrared data. Our innovative method handles and benefits from the differences in spectral resolution and depth in order to obtain robust estimations of the spatial distributions of the stellar mass and Star Formation Histories taking into account degeneracies. Our work includes tests of the methodology on Illustris simulated data (including JWST imaging) for massive galaxies ($M_* > 10^{10} M_\odot$) at $2 < z < 3$, and the analysis of the data for $0 < z < 3$ massive galaxies provided by the deepest HST, Spitzer and GTC observations in the CANDELS and Frontier fields.

Key words: galaxies, high-redshift, formation, photometry, Illustris

Context of the research

Formation and evolution of **MW-like** & **more massive** galaxies

Can give us very important clues to understand:

- Evolution of the Universe
- Star formation
- Quenching

Galaxies until z ~ 2 - 3

Red Quiescent Galaxies

Old stellar populations

Spheroids, concentrated light profiles

↓

at **z ~ 2**

Compact Quiescent Galaxies (cQG)

Blue Star-Forming Galaxies

Young

Bigger sizes, disk-like

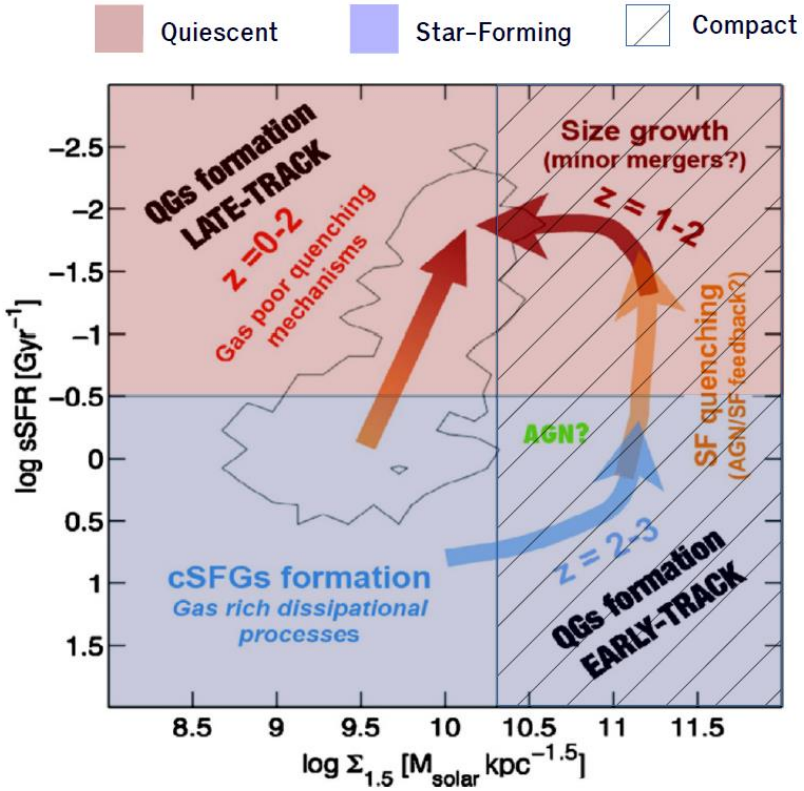
Extense disks at **z ≥ 2**

↓

at **z ~ 2 - 3**

Compact Star-Forming Galaxies (cSFG)

(Barro et al. 2013)



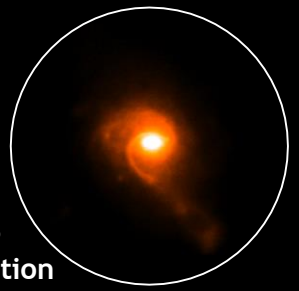
Modified figure from Barro et al. 2013

Objective | Select progenitors of these galaxies in the early Universe and establish evolutionary connection between them **via** | Analysis of the spatial distribution of stellar populations of massive galaxies at different evolutionary stages

We propose an innovative approach which combines photometric data with different depth and resolution in order to obtain robust estimations of the spatial distributions of the stellar mass and SFHs

Description of the work

1) Illustris simulation: photometry on synthetic images



Stellar particle distribution

ACS/F435W synthetic image

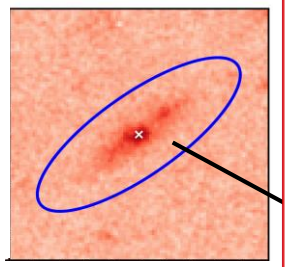
*Photometry image**

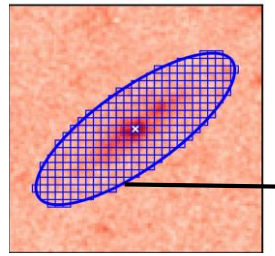
(2x2 binning + + PSF matched + + noise)

(*) Images with the same characteristics as CANDELS concerning noise, PSF and pixel size

2) Photometry

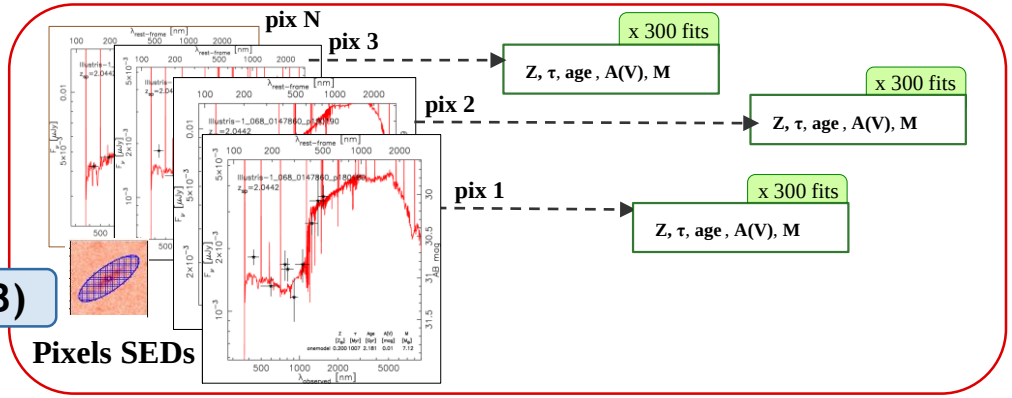
9 ACS and WFC3 filters in visible/NIR + 2 NIRCAM filters





9 ACS and WFC3 filters in visible/NIR

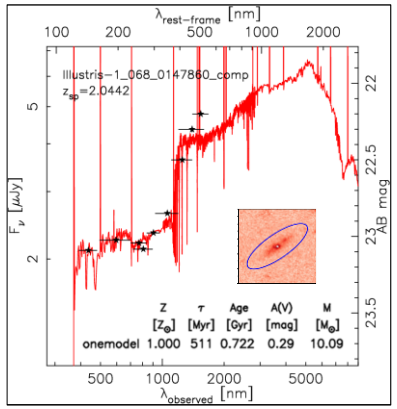
3)



Methodology

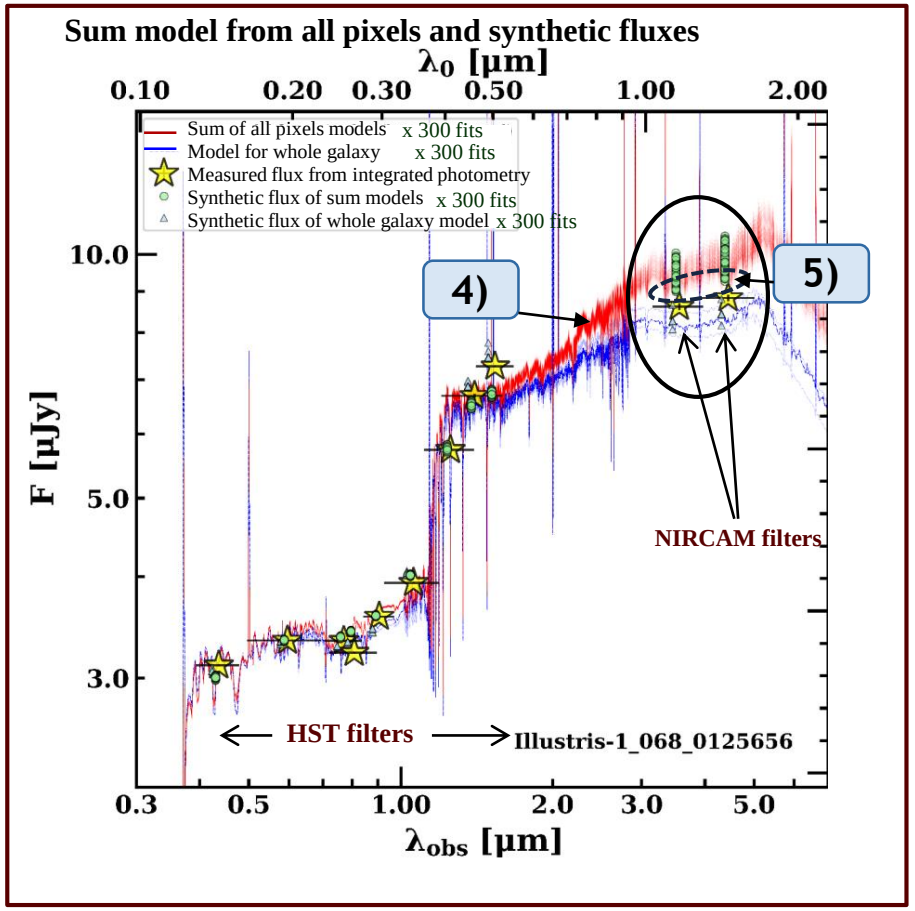
1) Photometry images derived from Illustris-1 original mock images, from optical/NIR ACS and WFC3 (HST), and from NIR NIRCAM (JWST) broad-band images.
2) Multi-wavelength photometry on these images: for a) complete galaxy (ACS, WFC and NIRCAM images), and b) for individual pixels (ACS and WFC bands).
3) Multiple MonteCarlo SED-fits for complete galaxy and pixels.
4) Sum of pixels SED-fits to create sum model for whole galaxy (red lines).
5) Selection of best sum models of all pixels (green circles) that best reproduce integrated photometry (stars).
6) Stellar properties derivation (in 2D) from pixels fits responsible for these better sum models and comparison to Illustris-1 stellar particles information (next slide).

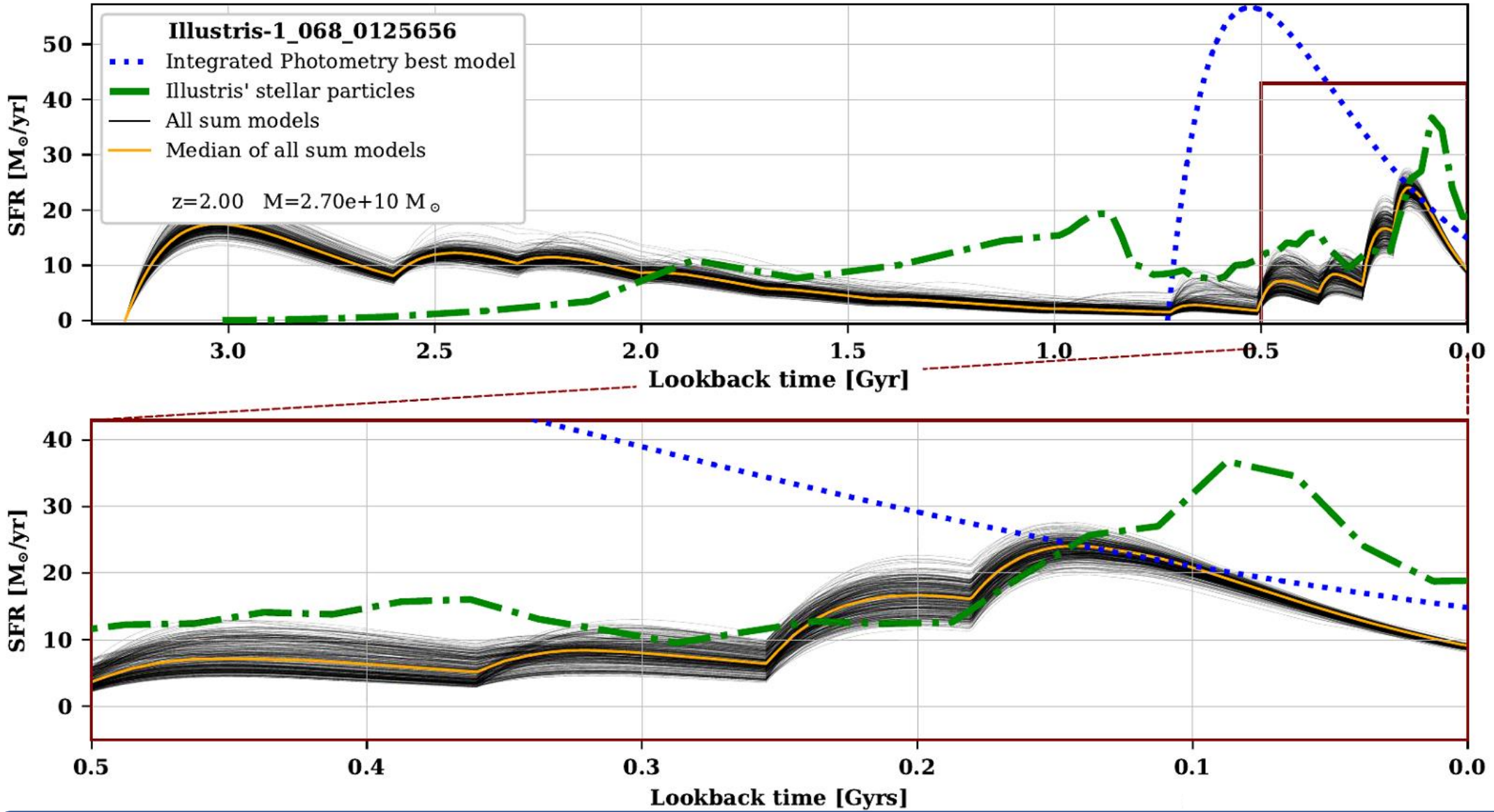
3) Integrated SED



300 sets of solutions:

Z, τ, age , A(V), M





SFHs obtained for simulated galaxy Illustris-1_068_0125656. Comparison between Illustris stellar particles' SFH (green line) and the one derived from our sum models of all pixels (black lines), and for integrated photometry (dotted blue line).

The SFHs derived from our pixel sum models are better at reproducing the SFH from Illustris particles than the integrated SFH

Impact and Prospects for the future

- Our method using 2D photometry succeeds at recovering the SFH given by Illustris stellar particles. This is a significant improvement over the results obtained taking into account only integrated photometry measurements (even though these include JWST NIRCAM data).

- Different treatments of dust attenuation and optimization of datasets to fit are underway.

- Once the method is statistically tested on Illustris simulated galaxies, the plan is to apply it to $0 < z < 3$ massive galaxies provided by the deepest HST, Spitzer and GTC observations in the CANDELS and Frontier fields, including to the analysis medium-band optical imaging from GTC/SHARDS, and ground-based near-infrared data.