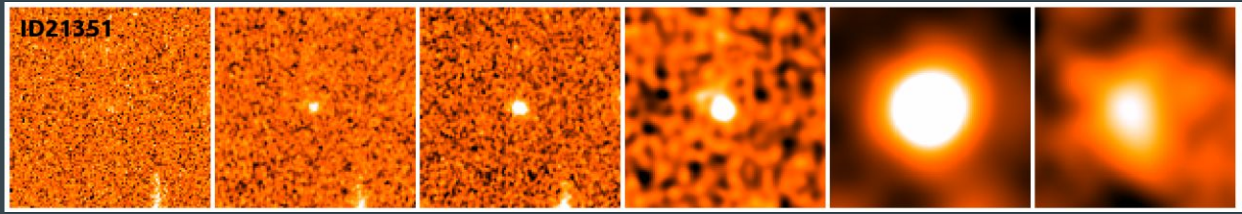
Properties of high-redshift passive galaxies

Number density and contribution to the cosmic star formation history



Emiliano Merlin

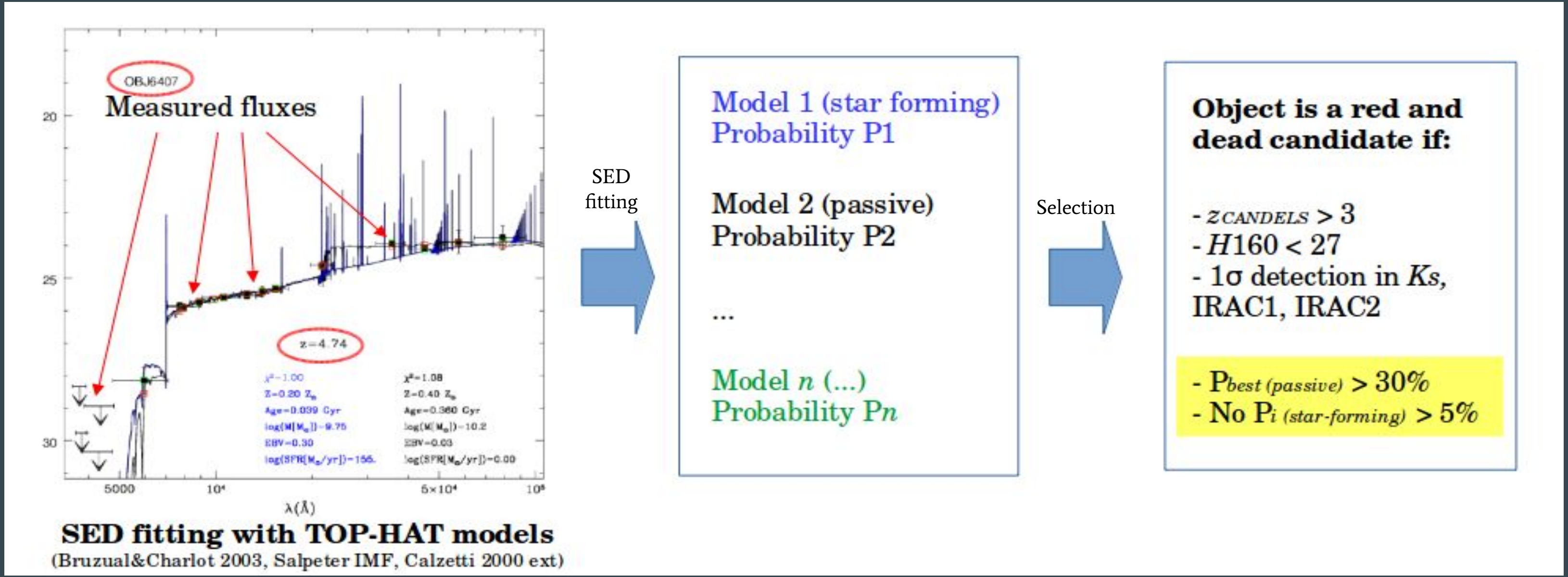
Paola Santini, Marco Castellano, Flaminia Fortuni, Adriano Fontana

INAF - OAR

Extremely Big Eyes On The Early Universe - Rome, Lincei 10/9/2019

How to identify early massive/passive (red&dead) galaxies?

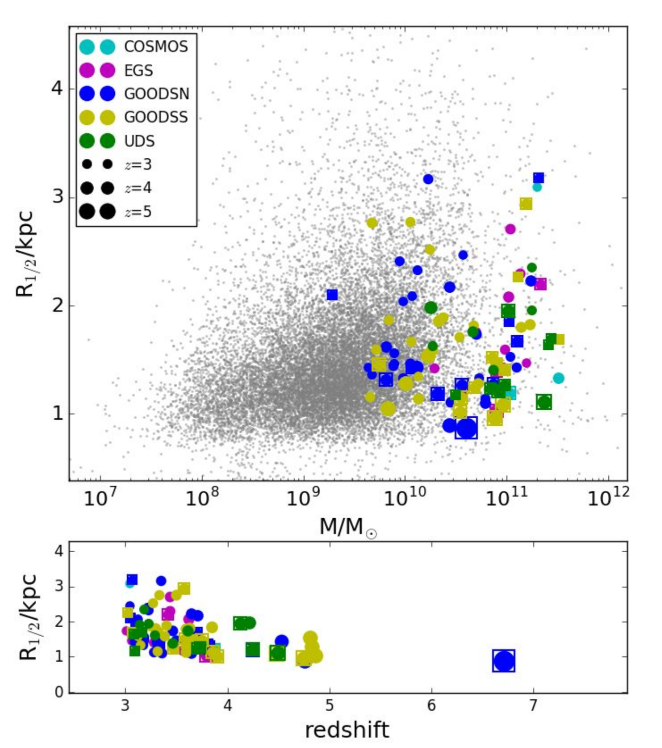
CANDELS photometric data on 5 deep fields (WFC3 *H*160 detections)

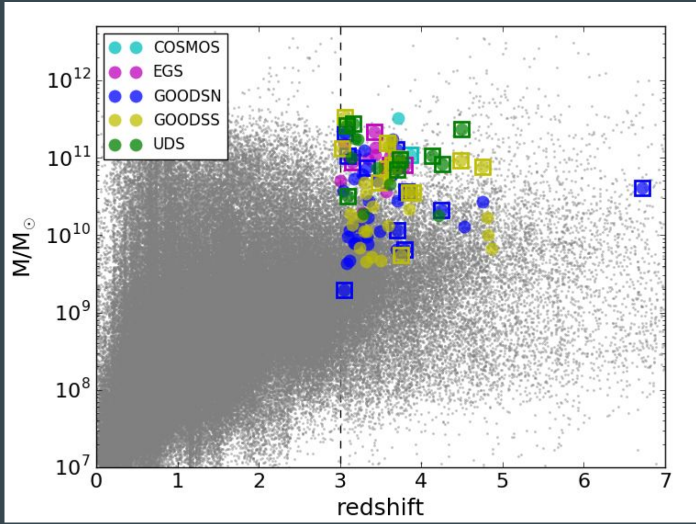


*2 selections: "**reference**" (no emission lines in the SED library) and "**lines**" (includes emission lines)*
Redshift fixed to CANDELS estimations

Properties of the candidates

Field/Sample	Total	$z > 3$	$S/N_{z>3} > 1$	Reference	Lines
COSMOS	38671	3778	1525	4	2
EGS	41457	4830	1775	13	5
GOODS-N	35445	3953	1793	36	11
GOODS-S	34930	5029	2884	33	13
UDS	35932	4018	2540	16	9
All fields	186435	21608	10517	102	40





Number density: comparison with models

Δz	Reference		Lines
	Observed	Corrected	
$3 < z \leq 5$	1.73×10^{-5}	2.30×10^{-5}	6.69×10^{-6}
$3 < z \leq 4$	2.90×10^{-5}	3.66×10^{-5}	1.08×10^{-5}
$4 < z \leq 5$	4.34×10^{-6}	7.94×10^{-6}	2.17×10^{-6}

We apply a corrective factor obtained from tailored simulations, to account for selection/incompleteness effects

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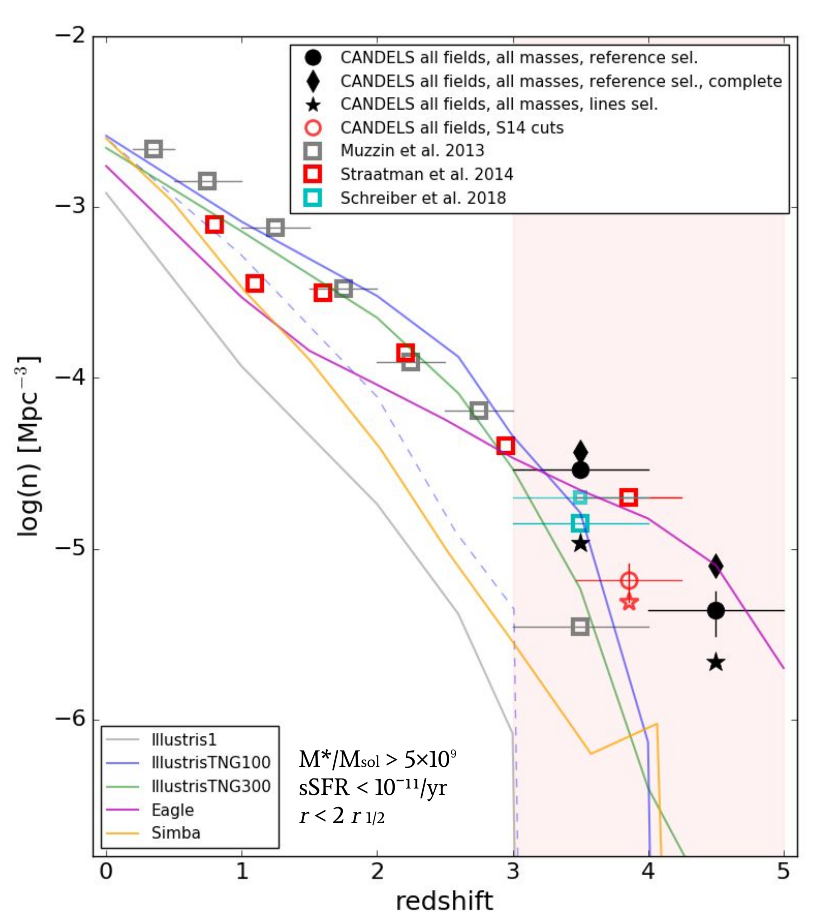
Caveats in Annalisa's talk!



Credits: F. Fortuni, A. Pillepich, C. Dalla Vecchia, R. Davé

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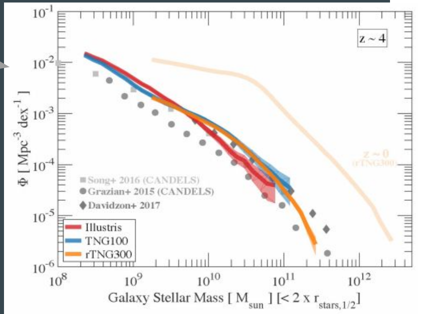
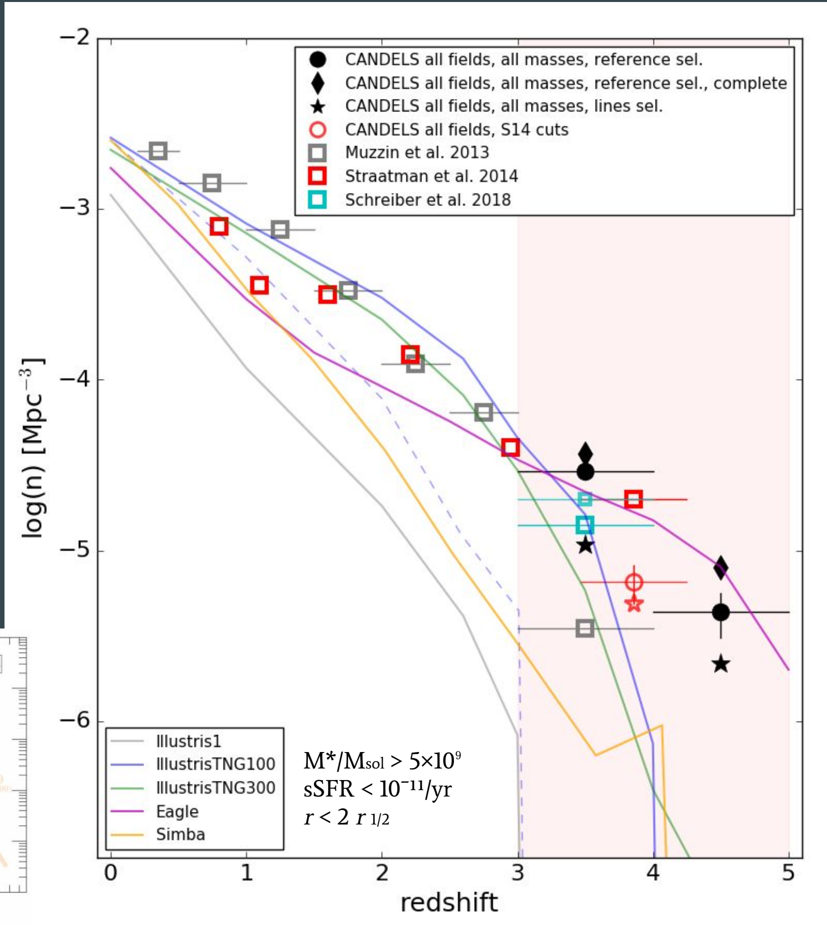
NOTE: Volumes are comparable ($\sim100^3$ Mpc^3), MF are ok up to $z\sim4$



BUT - Our estimates are lower limits:
(i) we only include very robust candidates
(ii) we do not consider possible
K or IRAC detections
(iii) incompleteness still plays a role



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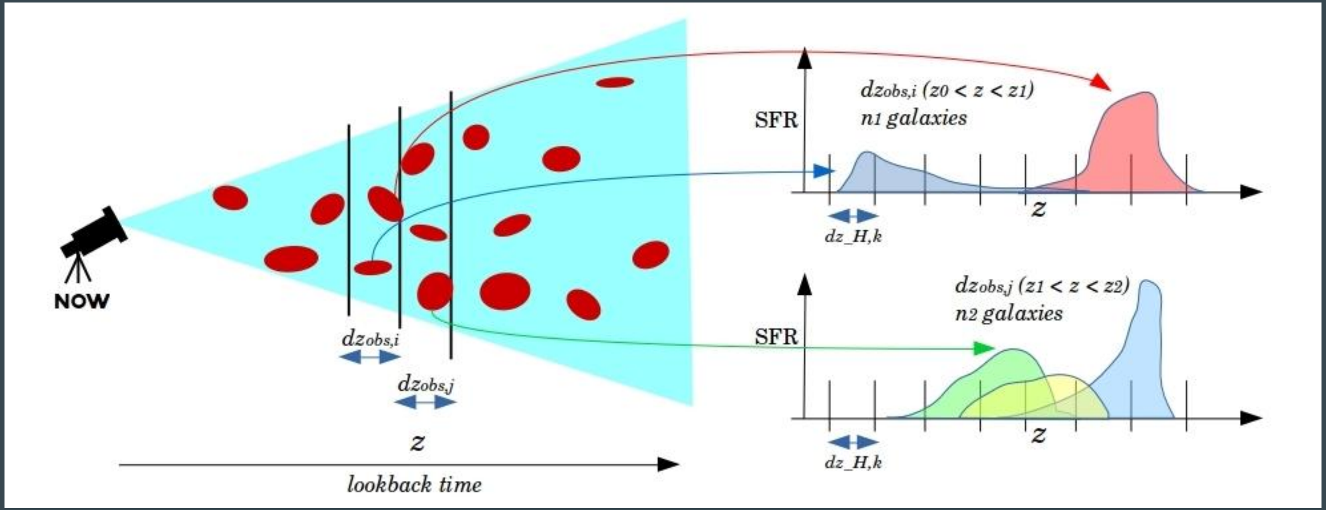
The contribution to the cosmic SFRD: method



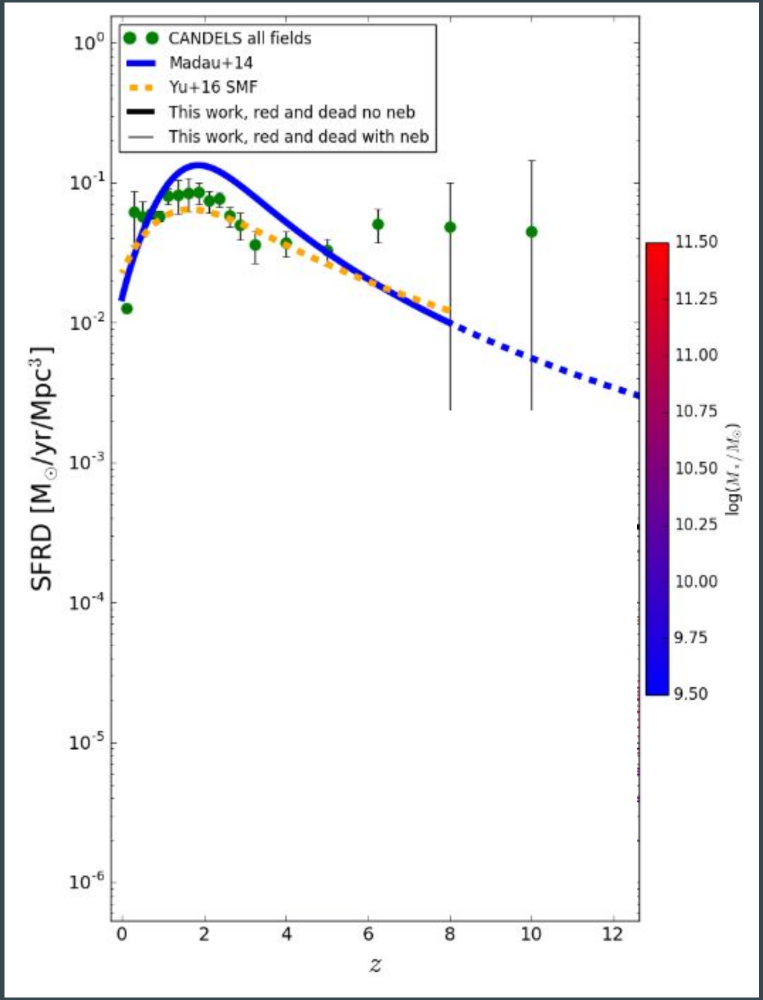
$$\forall dz_{\mathrm{obs}} \longrightarrow SFR_{dz_H} = \sum_{i=1}^{n} SFR_{dz_H,i}$$

$$\forall dz_{\mathrm{obs}} \longrightarrow SFRD_{dz_H} = SFR_{dz_H} / V_{dz_{\mathrm{obs}}}$$

$$\langle SFRD_{dz_H} \rangle = \frac{\sum_{j=1}^{N_{dz_{\mathrm{obs}}}} SFRD_{dz_H,j}}{N_{dz_{\mathrm{obs}}}}$$

The contribution to the cosmic SFRD: results

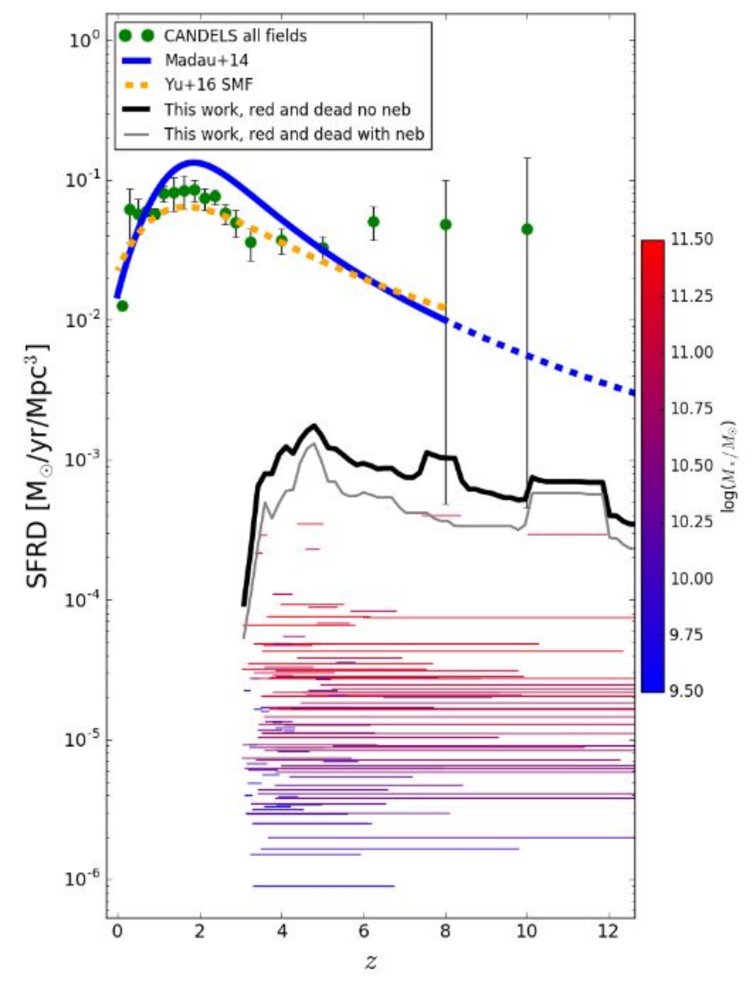
We are consistent with the observed SFRDs



The contribution to the cosmic SFRD: results

We are consistent with the observed SFRDs

Red&Dead are ~0.5% of all z>3 galaxies, but provide ~5-10% of cosmic SFRD at 3<z<8



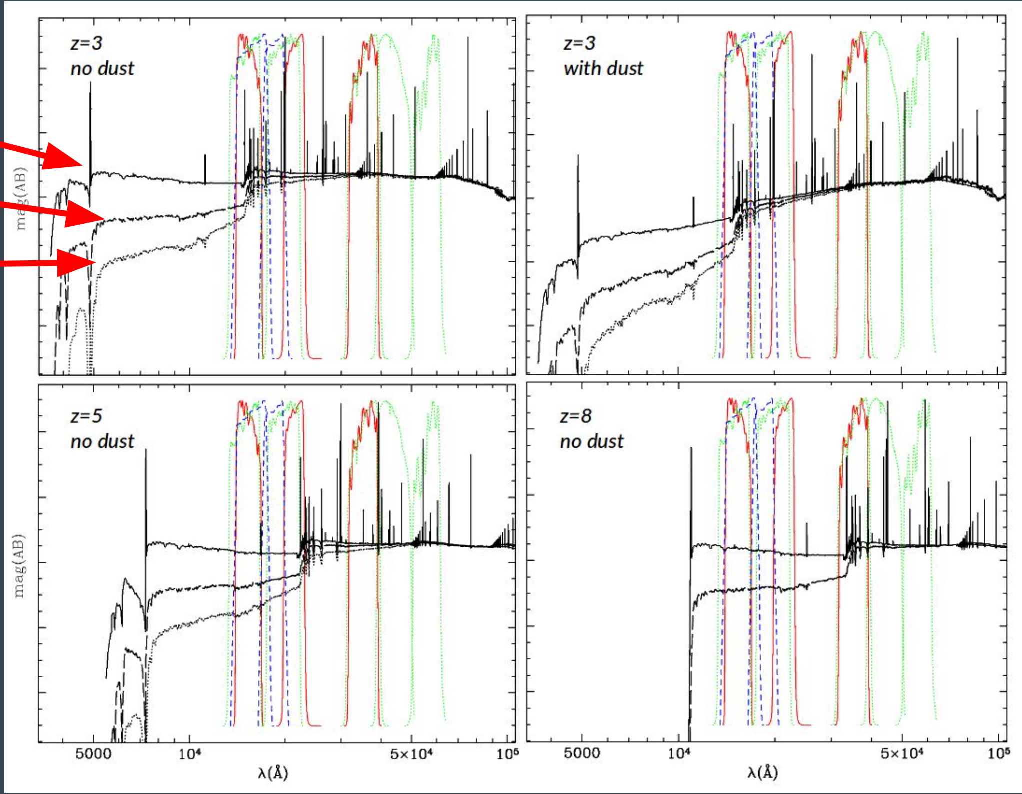
Looking forward

Superposed to the SEDs in arbitrary units are the the curves of some significant pass-band filters of CANDELS (solid red: left to right, F160, Ks and IRAC-CH1), WFIRST (dashed blue: left to right, H158 and F184), and JWST (dotted green: left to right, NIRCAM F150, F200, F356, F444, and MIRI F560).

t_{quench}

+50 Myr

+300 Myr

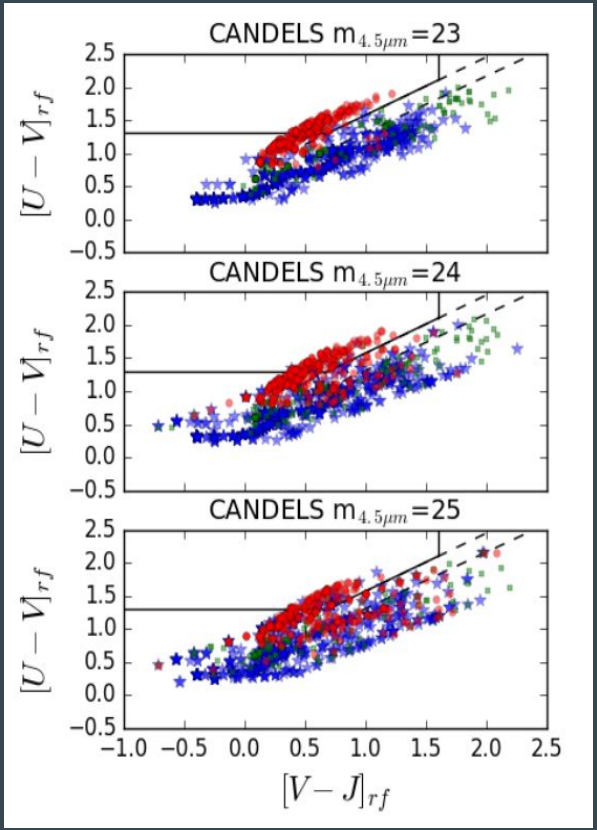


CANDELS

WFIRST

JWST

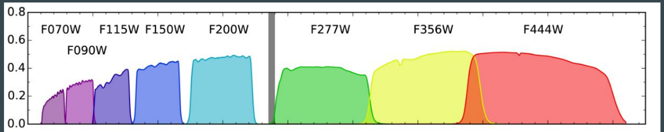
Looking forward



considering the three data sets with reference magnitudes $m_{4.5\,\mu m} = 23$, 24 and 25, the CANDELS simulation, respectively, yields ~3.6, 7.2 and 10.0 per cent star-forming galaxies erroneously falling within or above the green valley; conversely, the passive models falling within or below the green valley in the three cases are ~3.0, 16.7 and 31.4 per cent.

Looking forward

We then created observational catalogs corresponding to such models, reproducing both the filter sequence and depths of the CANDELS catalogue used in this work, as well as an idealized catalog reproducing a possible survey executed with *JWST*. To this purpose we have replaced all the CANDELS filters redward of Y (included) with a combination of twelve *JWST* bands ($F090W$, $F115W$, $F150W$, $F200W$, $F277W$, $F356W$, $F444W$, $F560W$, $F770W$, $F1000W$, $F1130W$, $F1280W$), as described in the MIRI and NIRCam documentation webpages. The resulting catalog mimicks a survey executed (redward of F090) with *JWST* on the GOODS-S field, building upon the existent ACS data.



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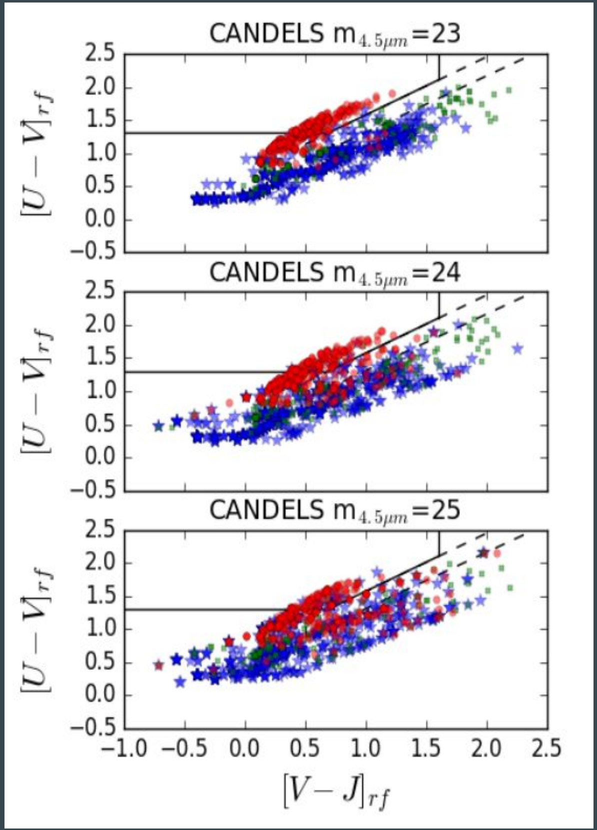

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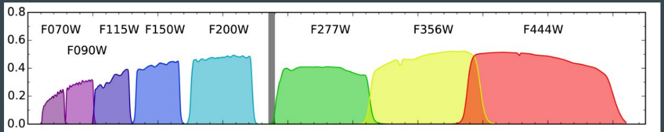

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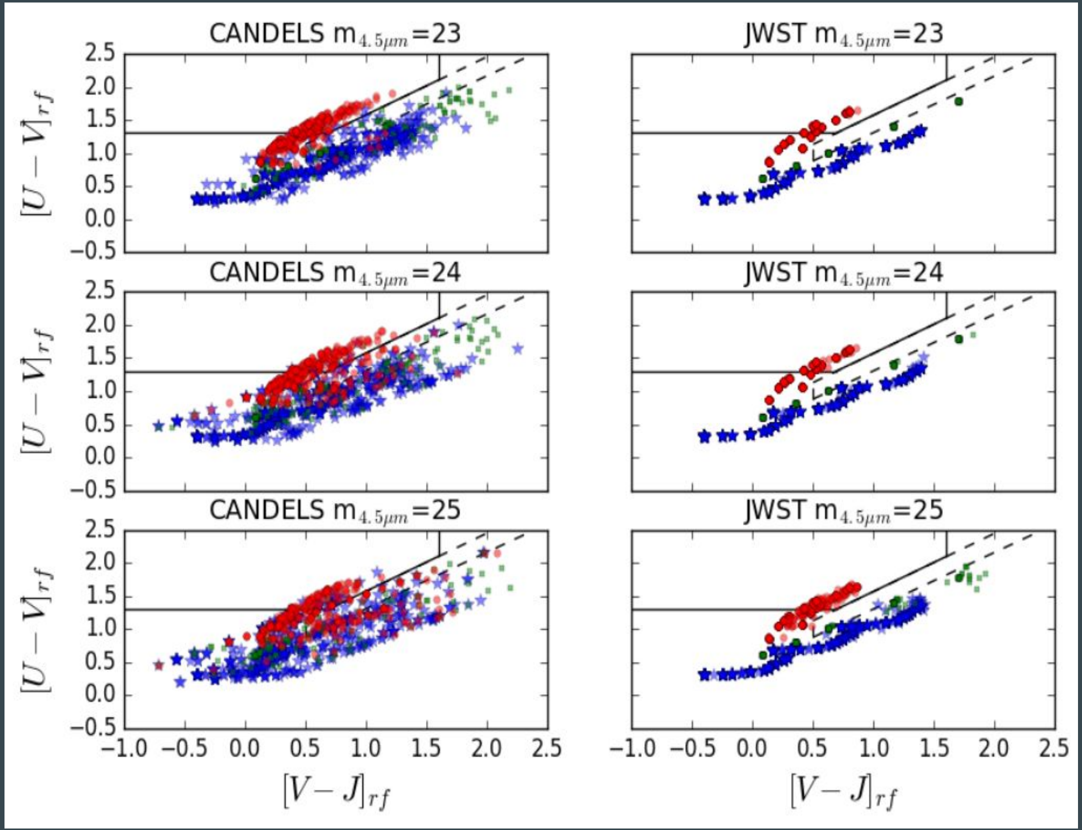

Simulating JWST observations

H band image of CANDELS field is used use to take the real position and morphology of the objects. Each object in the H detected catalog has then been re-scaled in intensity to match the F444 flux predicted by SED fitting models in the CANDELS catalogues. Fainter objects have been added using EGG (Schreiber+2017) down to the limit expected from the JWST observations. Depth and PSF are approximately close to the expected “strawman” proposal by Finkelstein et al. (2015), with exposure times of 2-3 hours.

CREDITS:
D. Paris, A. Fontana, EM
Animations available @
www.astrodeep.eu/movies-jwst1/

Summary and conclusions

- To single out robust red and dead candidates at $z>3$, we use a **SED fitting probabilistic technique** rather than standard color selections
- We find **102** (40) candidates in the 5 CANDELS fields
- This yields a number density of **$1.73 \pm 0.17 \times 10^{-5}$** ($6.69 \pm 1.08 \times 10^{-6}$) Mpc^{-3} for $3 < z < 5$; completeness correction yields $2.30 \pm 0.20 \times 10^{-5}$ Mpc^{-3}
- Reasonable agreement with models at $z<4$, tensions at $z>4$ (but likely still not OK)
- These objects are ~0.5% of all galaxies but provide **~5-10% of cosmic SFRD** at $3<z<8$
- Next generation large telescopes will largely improve the reliability of the results

For further information see: Merlin+2019 (submitted), Merlin+2018, Santini+2019