High redshift universe in the COSMOS field

how VISTA and Spitzer telescopes pave the way for JWST

Larry Davidzon (LAM —> Caltech)

How far is the high-z universe?

- \( z \sim 1-2 \)
- \( 3 < z < 6 \)
- \( z \sim 8 \)
- \( z > 10 \)
How far is the high-z universe?

“The K20 survey (Cimatti et al. 2002a) has been designed […] with the explicit aim of investigating the **high redshift** evolution of massive galaxies.”

Galaxy stellar mass function (SMF) by Fontana+04
~12 yr of explorations at $z<2$

$1.1 < z < 1.5$

$log(M^*)$ vs $\log(\phi(M^*)/dM_*/Mpc^{-3})$

- $z \sim 0.1$
- Santini12
- Ilbert13 (UVista)
- Tomczak14
- This Work

Moutard+16b
Recipe to go to higher z

- Deep exposure
  more distant galaxies, and intrinsically fainter
- Large area
  to have large-number statistics
- Coverage in near- and mid-IR (1-5 um)
  to constrain galaxy SED (>4000A r.f.) at z>2

Bowler+15
COSMOS: deep and large

F814W < 26.7 mag
(5sig pt-source)
COSMOS2015: going deeper in the IR...

- UltraDeep stripes: $K_s < 24.7$
- $zYJHKs$ stacking technique
- PSF homogenisation
- treasury spectroscopic catalog

Optical (0.3-0.9um): HSC (Myiazaaki+12)

near-IR (1-2.5um): UltraVISTA dr2 (McCracken+12)

mid-IR (3-8um): SPLASH (Capak+12)
COSMOS2018?: even deeper...

NEW: UltraVISTA DR3

Y sensitivity: 25.7 mag
H and Ks ~ 25 mag
in the `ultradeep’ stripes

+ SMUVS (PI: Caputi)
to get [3.6um] and [4.5um] ~ 26 mag
From COSMOS2015:

Largest spectroscopic sample wrt any other surveyed field

Most accurate photo-z covering the largest ever redshift range
SMF of star-forming vs quiescent galaxies

Classification with r.f. colors (NUV-r vs r-J)
First attempt to estimate the passive SMF at z~4 (cf. Tomczak+14, Spitler+14, Straatman+14)
SMF applications
SMF applications

Comparison with simulations
(eg Semi-analytical model of Henriques+15):

Curtesy of B. Henriques

Still many things to understand about physics of quenching mechanisms...
SMF applications

Example 1: abundance matching technique ← (eg Moster+2013)

Low-mass constraint
High-mass constraint

No need now to combine heterogeneous samples
SMF applications

Galaxy clustering:
Halo model (Coupon+15) vs COSMOS2015 at $3.1 \leq z \leq 3.7$

Coupon+ in prep
Comparison between SMF and the Halo Mass Function (cf. Steinhardt+16)
AGN feedback less effective at $z>3$:

- outflows escape in the direction of least resistance (preserving cold filamentary accretion)
- time-scale > 2 Gyr: they may cause starvation later
- Simu: Dubois+13, Costa+14, Curtis&Sijacki+16
- Obs: Maiolino+12, Cicone+14,+15, Padovani+15
SMF applications

specific SFR (sSFR):

• $= \frac{\text{SFR}}{M^*}$

• rate of $M^*$ build-up

• $\frac{1}{\text{sSFR}} = \text{timescale of in-situ galaxy formation}$

Faisst+16a
SMF applications

• Need to know:
  • the fraction of passive galaxies
  • mergers (to remove progenitor bias)
  • mass loss fraction

any bias (e.g. IMF) cancels out if it is \( \sim \) independent of \( z \)

cf Ilbert+13, Behroozi+13, Leja+13

ID+in prep
COSMOS2015: new independent sSFR estimate at z>3

![Graph showing the log(sSFR/yr⁻¹) vs redshift. The graph compares different datasets and models, including data from this work using Davidzon et al. 2017, data from this work using Grazian et al. 2015, data from Stark et al. 2013, data from Behroozi et al. 2013, the Henriques et al. 2013 model, and the Neistein & Dekel 2008 sMIR model.]}
What’s next? Galaxies at $z>6$

**PRELIMINARY**

$z \sim 7$ LF

Bowler+17

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$log(\Phi[Mpc^{-3}mag^{-1}])$

$M_{1500}$ [AB mag]

**Preliminary**

Bowler+15, $z=7$

Bouwens+15, $z=7$

Bouwens+15, $z=8$

COSMOS2015

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$log(M/M_\odot)$
What’s next?
First galaxies that halted SF

Passive locus in color-color diagrams, NUV-R vs R-J (Ilbert+13, Arnouts+13)

3<zphot<5
Advantage of NUVrJ
ZF-20115 is post-SB according to NUVrJ! see also Simpson+17
Synergy with JWST

- **COSMOS2015 helps JWST:**
  
  JWST will be slow doing surveys (momentum dump, filters change)
  
  better to have pre-selected candidates to follow up

- **JWST helps COSMOS2015:**
  
  substantial revision of SED fitting technique (parameter space)

  removal of interlopers, quantification of biases
Summary

• Latest results from COSMOS2015 (Laigle+16, Davidzon+17) which move the research frontier further

• 13 billion yr of SMF evolution in 10 coherent zbins

• Formation of the most massive galaxies at z>6

• M* build-up (sSFR) in galaxies at 3<z<8. Do quenching mechanisms (eg AGN feedback) become less efficient at higher z?

• Future (JWST) perspective: massive (passive?) galaxies at z>3, z>10 candidates…