Surveying the High Redshift University with Hyper-Suprime Cam, Spitzer, Euclid and WFIRST

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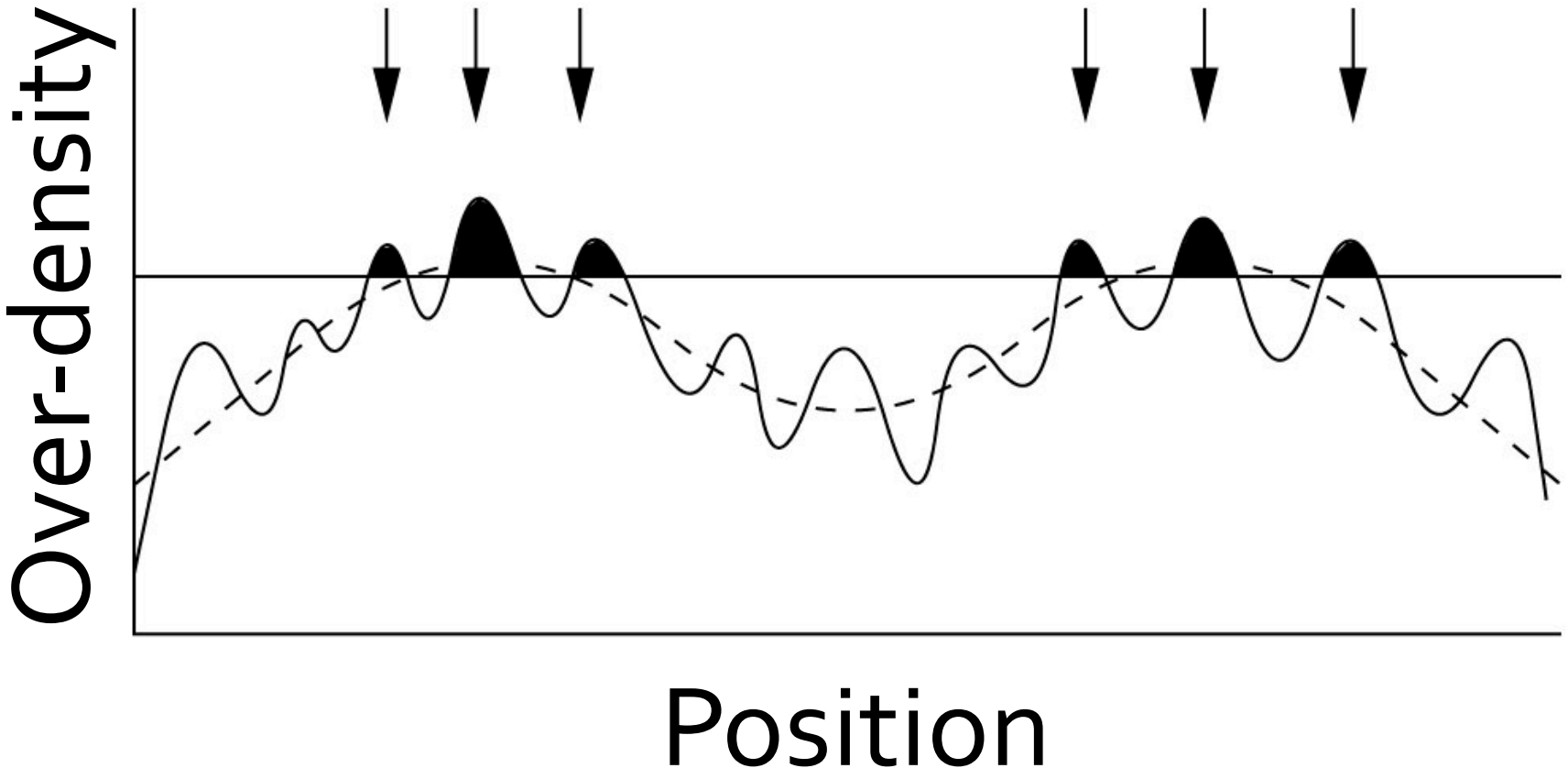
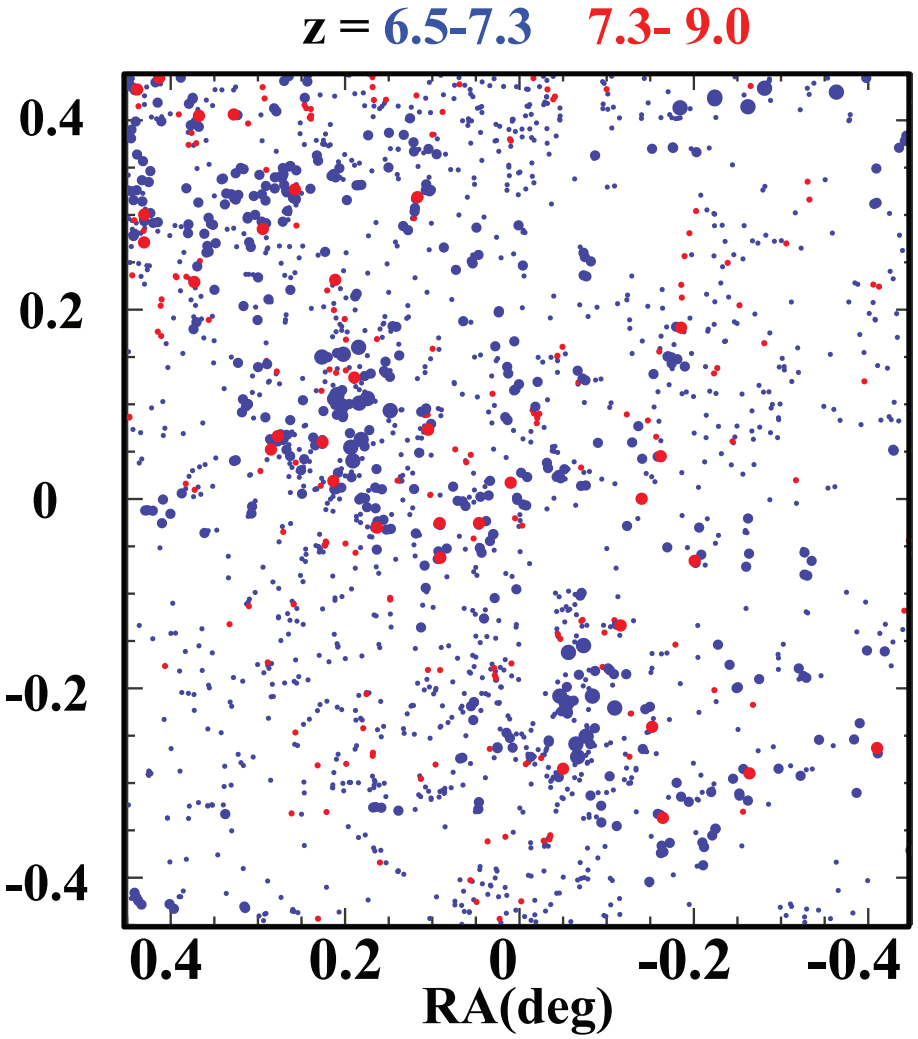
COSMOS

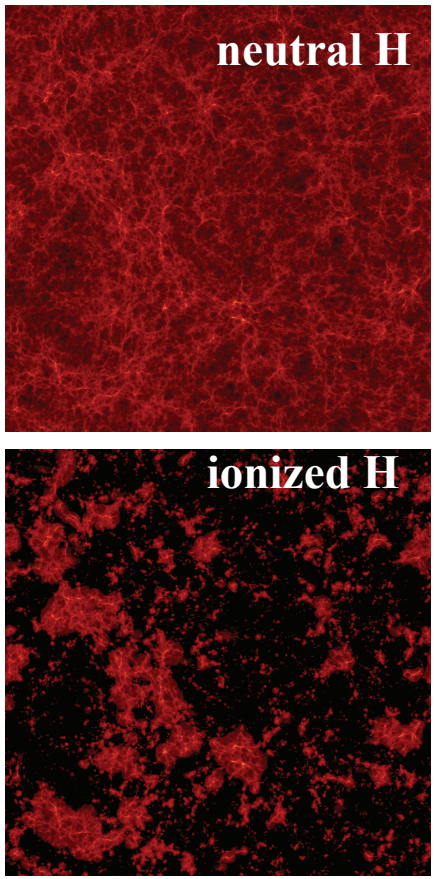
Galaxy Formation Is Bias



Re-Ionization Is Bias



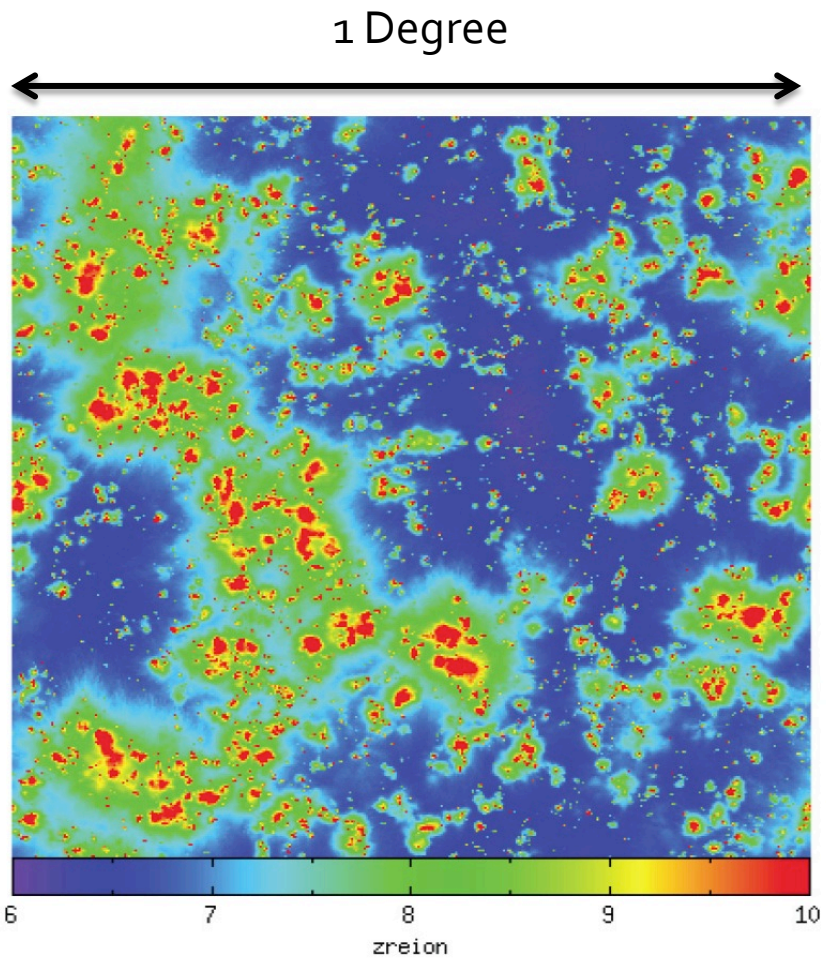
H band Magnitude
26
27
28
JWST NIRCAM FOV



Trac et al. 2008, Springel et al. 2006

Re-Ionization Is Bias

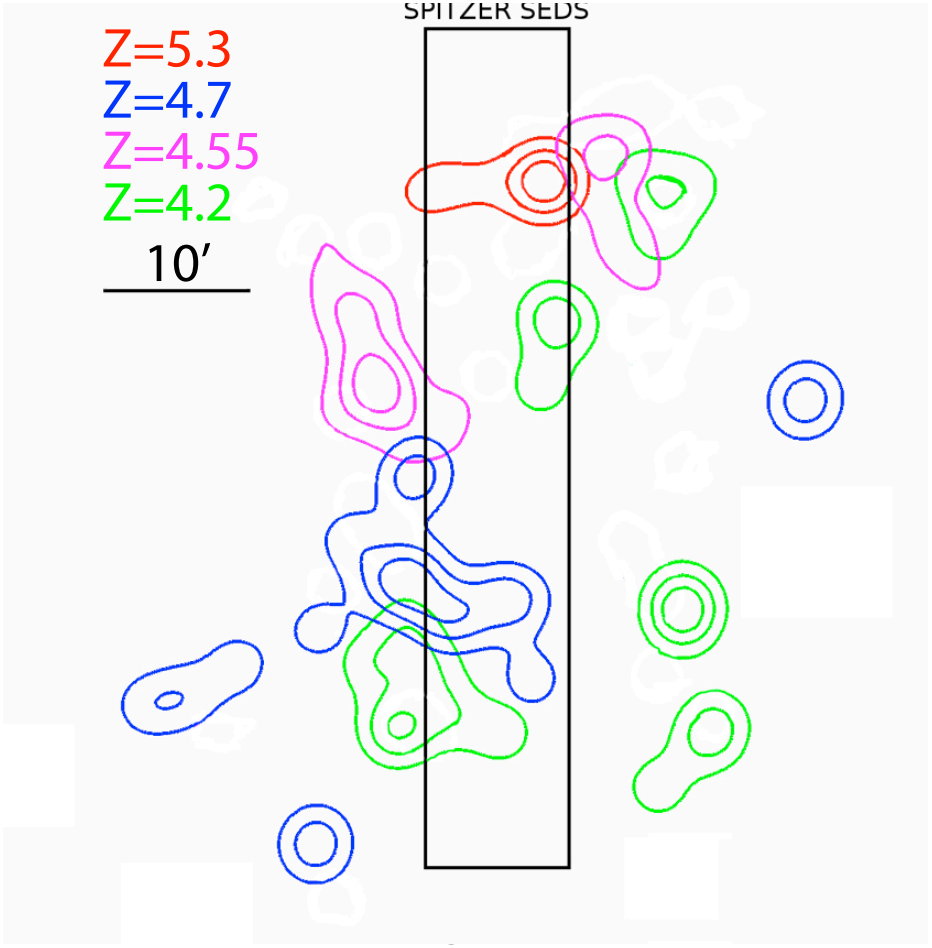
- Galaxies are strongly clustered at high-redshift
- Scales of ~10-30 arcmin
- Very large areas needed to probe the structure of re-ionization
- Ideally ~40 square degrees
  - Overzier et al. 2008



Trac et al. 2008, Springel et al. 2006

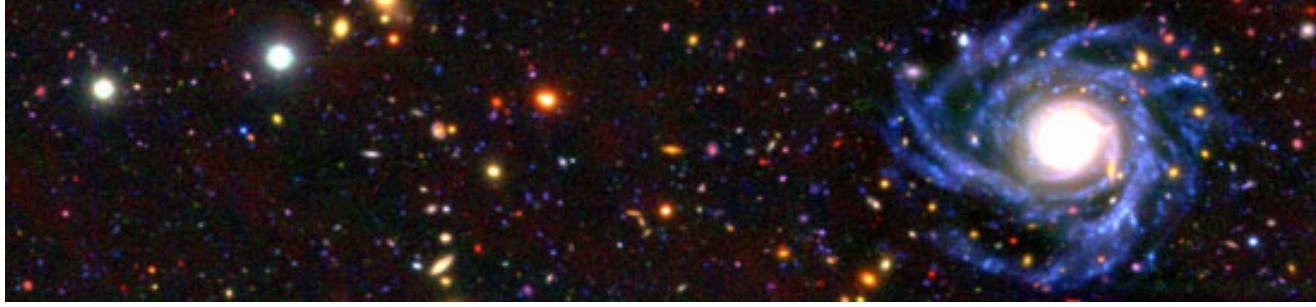
Massive Galaxies Strongly Clustered

- Massive Galaxies are even more clustered
- >M* galaxies should have ~40% variance field to field on 2 degree scales
  - Moster et al. 2011
  - Bowler et al. 2014
- Scale length of ~10-20′

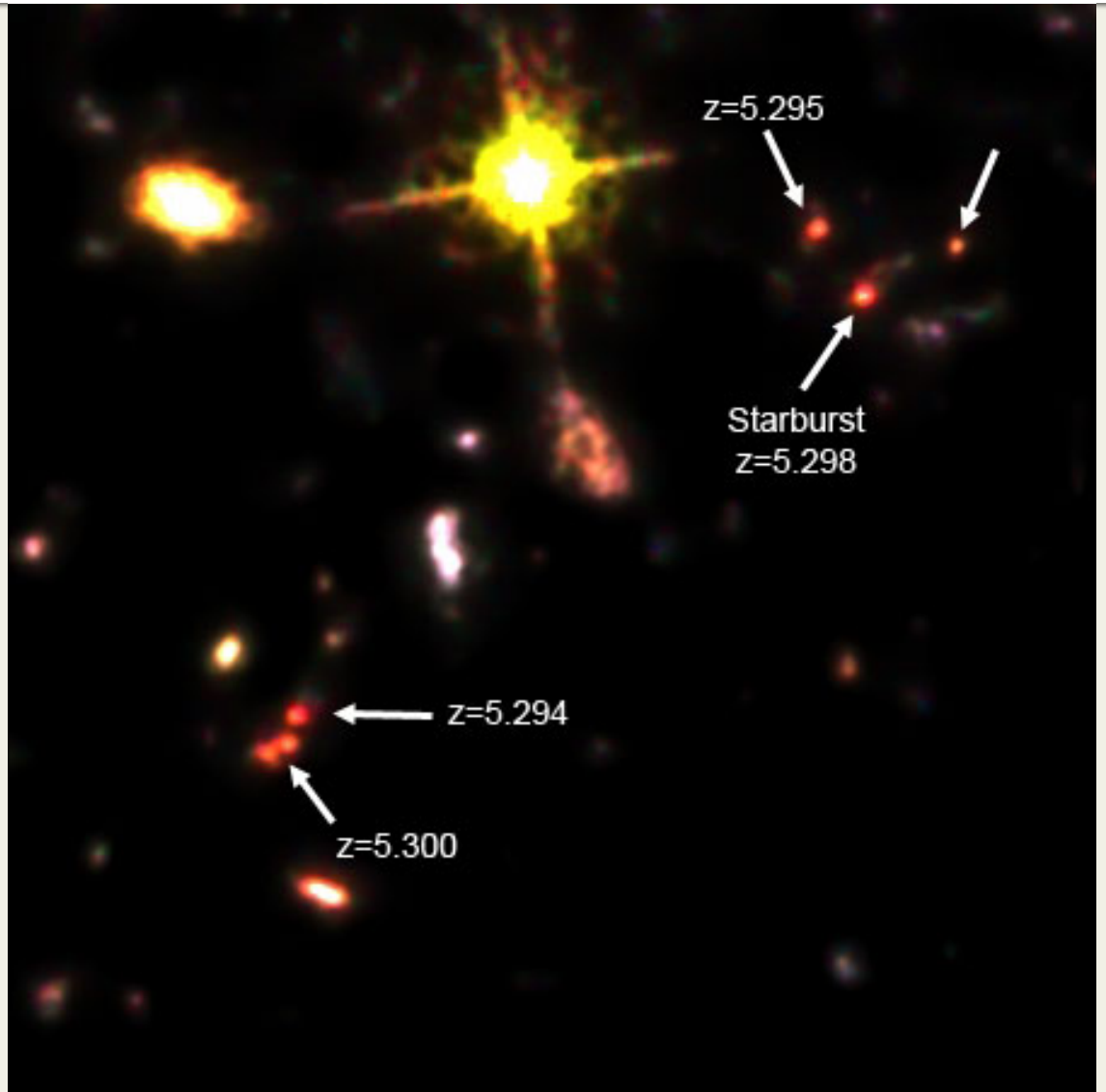


Millennium Simulation

Massive Galaxies Strongly Clustered



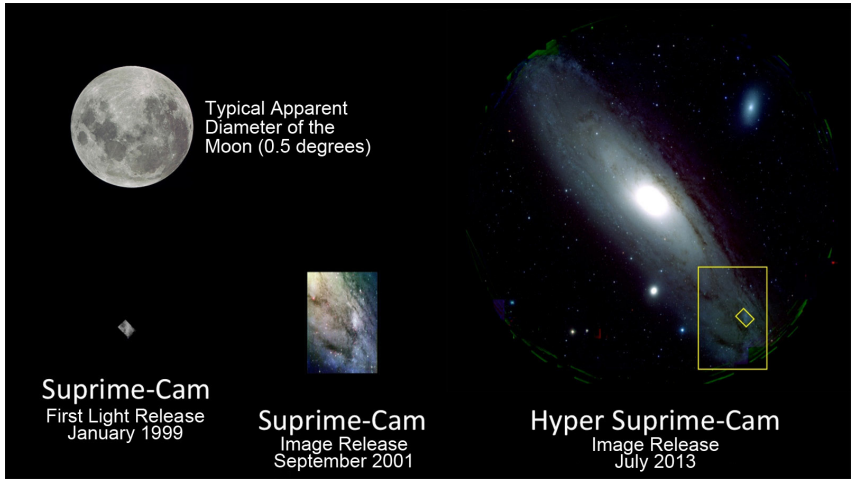
- Proto-cluster at z=5.3!
  - 24 times over dense
  - Gas>3.5x10^{10} solar masses
  - Stars > 3x10^{10} solar masses
- Core region >200 times over dense, likely to become cD galaxy

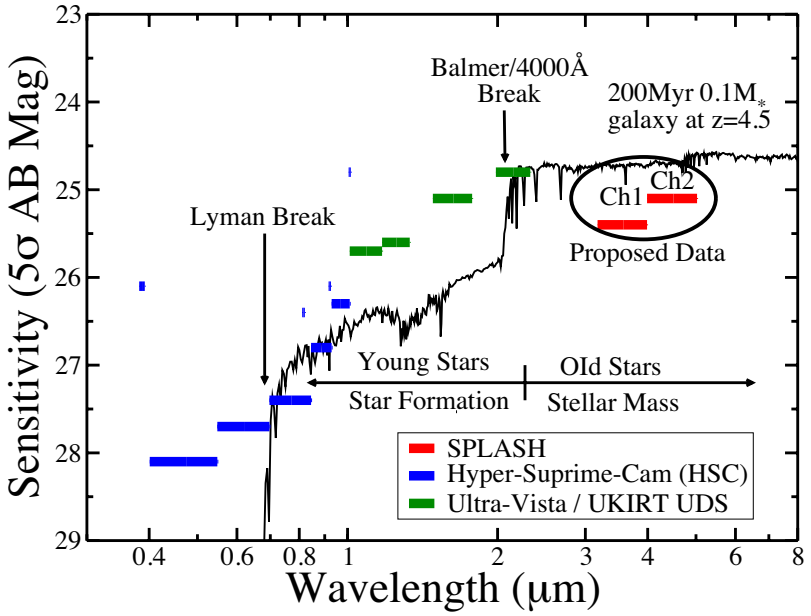


Capak et al. 2011

SPLASH

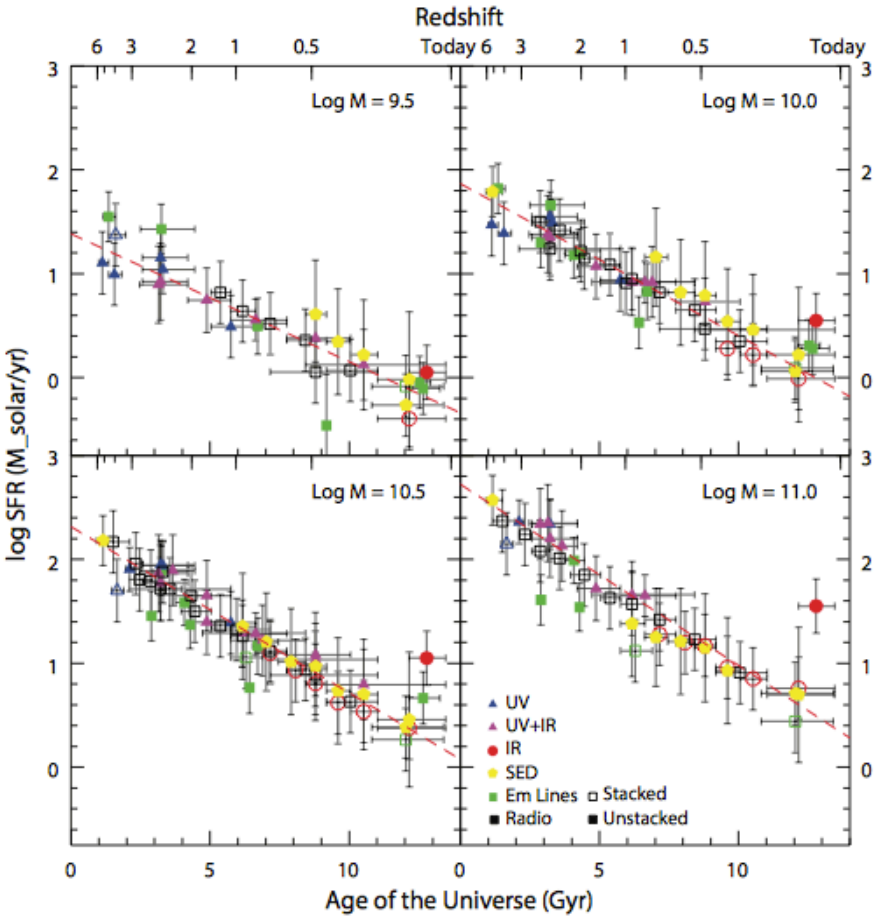
- Hyper-Suprime-Cam has 1/3 the survey speed of LSST
  - Operating now
- Will reach 27-28th mag over two 1.8 degree fields
  - COSMOS
  - SXDS/UDS
- SPLASH provides IRAC coverage over these two Ultra Deep Fields
  - Stellar mass and age estimates at z>4
- Started in March 2013, will finish in April 2015





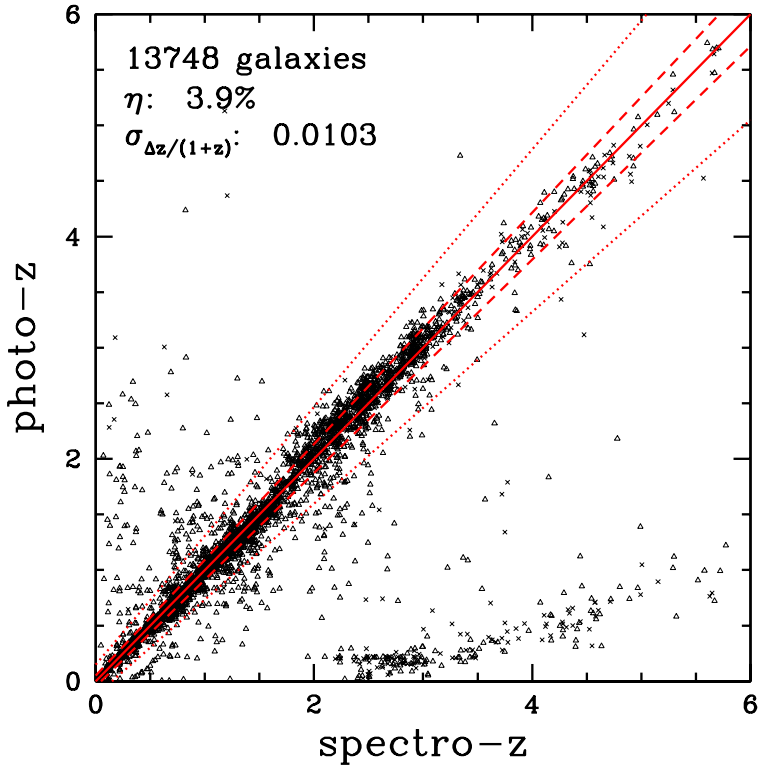
SPLASH

- First results use COSMOS photometry
- Main sequence at z>4
  - Steinhardt et al. 2014
- Continues to high-masses and redshifts
- Agrees with CANDELS results at lower masses
- Remarkably consistent evolution with redshift
  - Speagle et al. 2014



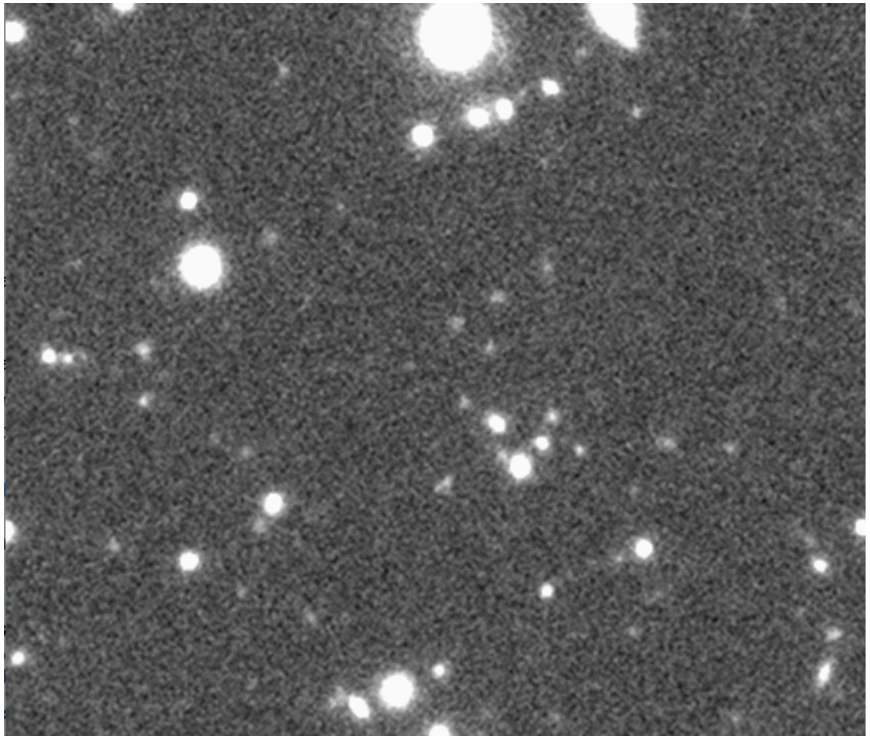
SPLASH

- The most massive galaxies have to appear at some point
- High-end of mass function should start to decrease at z>4
- Don't see it yet
- Need deeper optical data

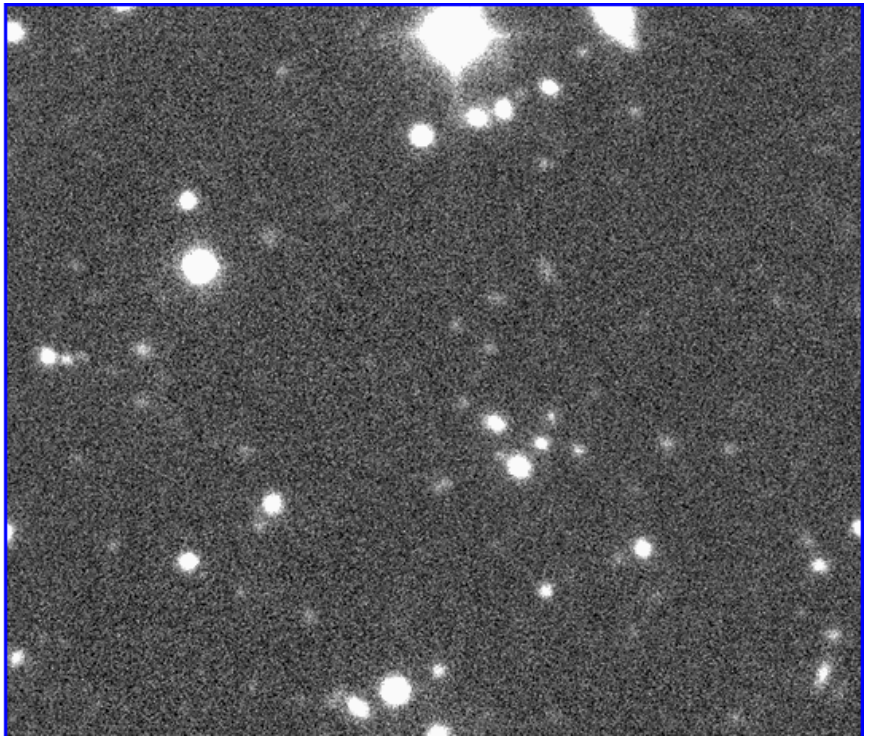


SPLASH

36h Ultra-Vista Y band

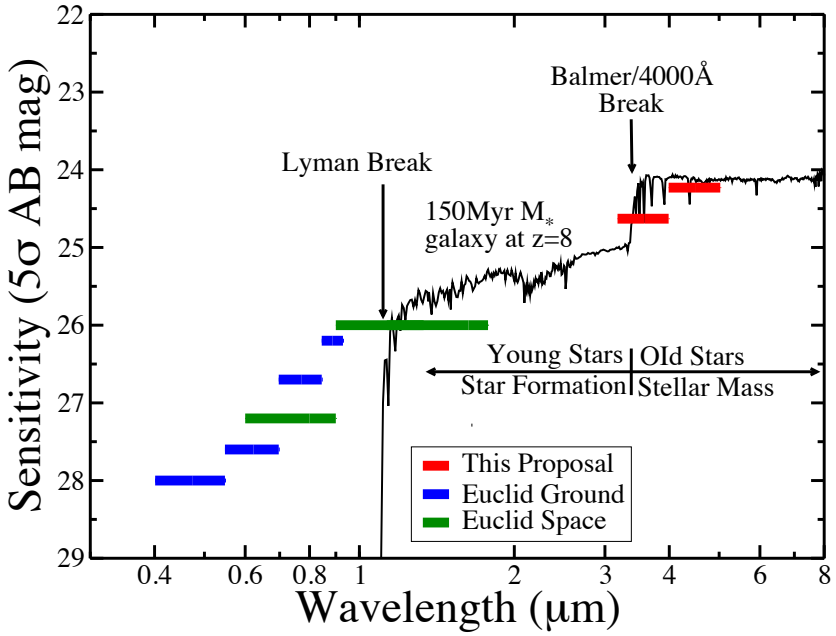


2h HSC y band



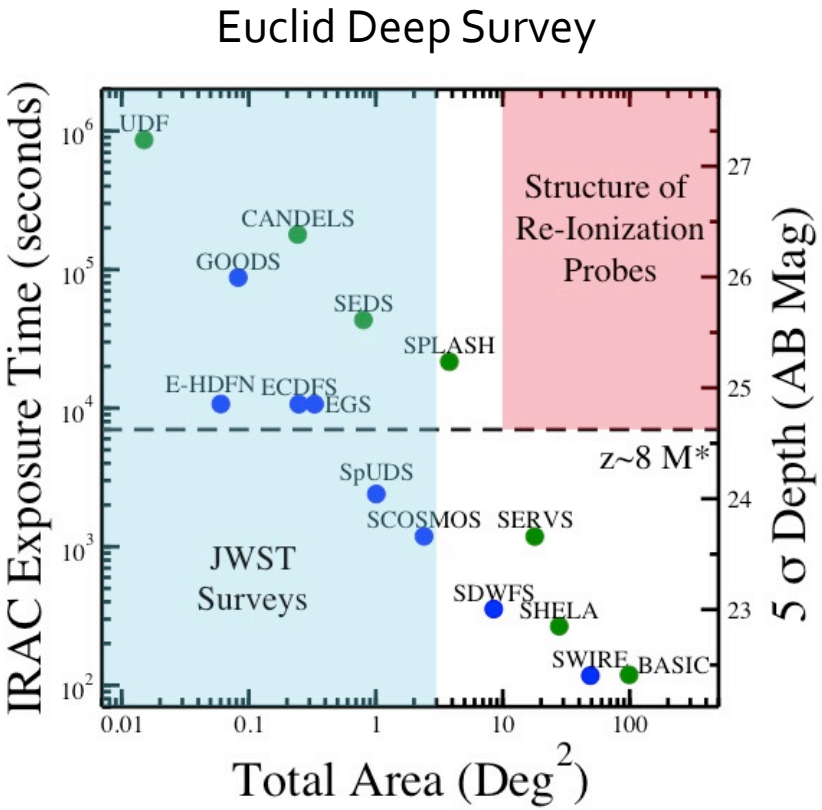
Euclid and WFIRST

- Can not measure stellar masses and ages at z>~3
- Only Spitzer and JWST can do this in the next decade
- Also needed to remove contamination
- Following up ~50 sources on JWST would cost less than operating Spitzer for a year



Euclid and WFIRST

- Probing the structure of re-ionization will require surveys of 10-40 square degrees
- JWST can not do this
  - Gardner et al. 2010
- To get the most out of JWST/WFIRST/Euclid we need to do a deep wide survey with Spitzer



Conclusions

- Galaxies are strongly clustered on degree scales at high redshift
- Need wide area surveys to identify the structures (Euclid, WFIRST)
- >3μm data is essential to probing the assembly of stellar mass at z>4
- Only Spitzer can cover complementary area's to Euclid/WFIRST