ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Euclid's Legacy in *Imaging the Universe*

Marcella Carollo

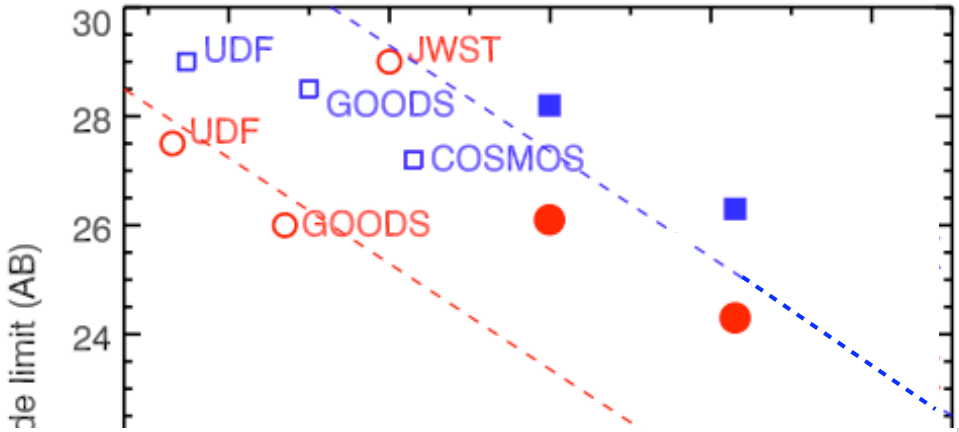
also on behalf of the EIC

Euclid's Imaging Surveys

Wide Survey: 20,000 deg^2 = 2π sr

Visible: $RIZ_{AB} \leq 24.5$ (AB, 10σ) at 0.18 arcsec FWHM
35 resolved galaxies/arcmin^2
median redshift $\langle z \rangle \sim 0.9$

NIR: Y, J, H ≤ 24 (AB, 5σ PS)
photometric redshifts accuracy: 0.05(1+z)



Unique combination of:
✓ Area
✓ Resolution + Depth in Optical
✓ Depth in NIR
✓ PSF Stability

Deep Survey: ~30 deg^2 at ecliptic poles

+2 magnitude in depth
for both visible and NIR

Euclid's Wide Imaging Survey

Science Opportunities

Free-floating super-Jupiters in Young star-clusters:

SED peak at 1-2 mm

- Born as planets, and became unbound, or directly from cloud fragmentation
- About 1 billion free-floating super-Jupiters in the Milky Way
  - ➡ All ~10 Myr systems present within ~1kpc from the Sun
  - ➡ Crucial for understanding the efficiency of (retained) planet formation

Milky Way satellites:

- Major discrepancy between CDM simulations and observed universe
- 12 objects detected over 8000 deg^2 of SDSS down to a r ~ 22.5
  - ➡ Faintest-end of dwarf galaxy luminosity function; Radial distribution
  - ➡ Nature of dark matter, physics of reionization

Euclid's Wide Imaging Survey

>2 billion galaxies with:

- ➡ **Morphological information**
- ➡ **Photometric redshift accuracy: 0.05(1+z)**

➡ 10^3 SDSS

➡ SDSS AT 10^3 REDSHIFTS

➡ Rest-frame optical luminosities and stellar masses for the bulk of the galaxy population out to z~3 (down to 0.1 M* at z=1)

➡ Bulk of the unobscured star formation out to z=6 through rest UV

➡ With morphological information!


MORPHOLOGY
MATTERS!
Created by Zsolt Frei and James E. Gunn
Copyright © 1999 Princeton University Press

Euclid's Wide Imaging Survey

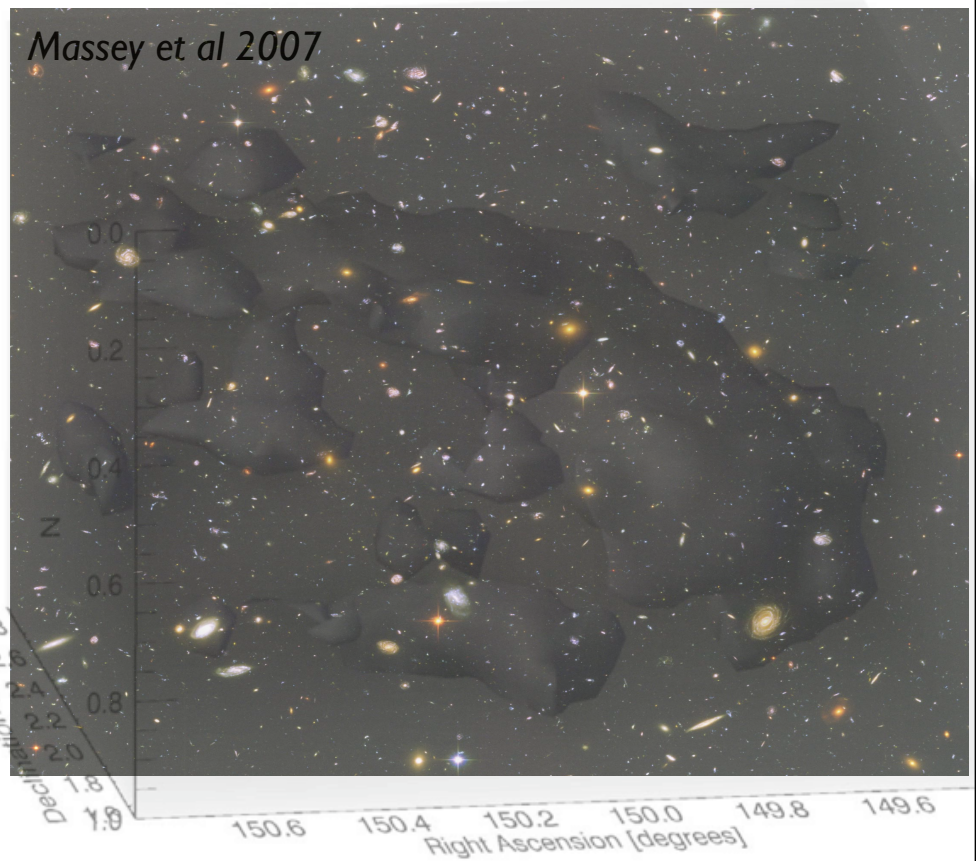
To Establish the Connection between Matter & Light

Strong-lensing systems: ~10^5 galaxy-galaxy lenses,
~10^3 galaxy-quasar lenses,
5000 strong lensing arcs in clusters

Euclid's Wide Imaging Survey

To Establish the Connection between Matter & Light

Comparison of the distribution of light/stellar mass with underlying total matter density derived from weak lensing maps



➡Establish how the *bias*
- evolves with redshift, and
- depends on galaxy properties

➡Discover *naked* dark matter peaks and quantify abundance

Euclid's Wide Imaging Survey

Finding the largest scale signposts of structure formation

How the environment controls galaxy *structural* & *photometric* evolution

Mass-detection
(weak lensing maps)
of
40,000 galaxy clusters
at $0.3 < z < 0.7$

Euclid's Wide Imaging Survey

Finding the largest scale signposts of structure formation

- Only a few massive clusters at z > 1 are currently known

NIR-detected clusters at z > 2:

$10^{2\text{-}3}$ $M = 10^{14}\ M_\odot$

$10^{3\text{-}4}$ $M = 1\text{-}2 \cdot 10^{13}\ M_\odot$

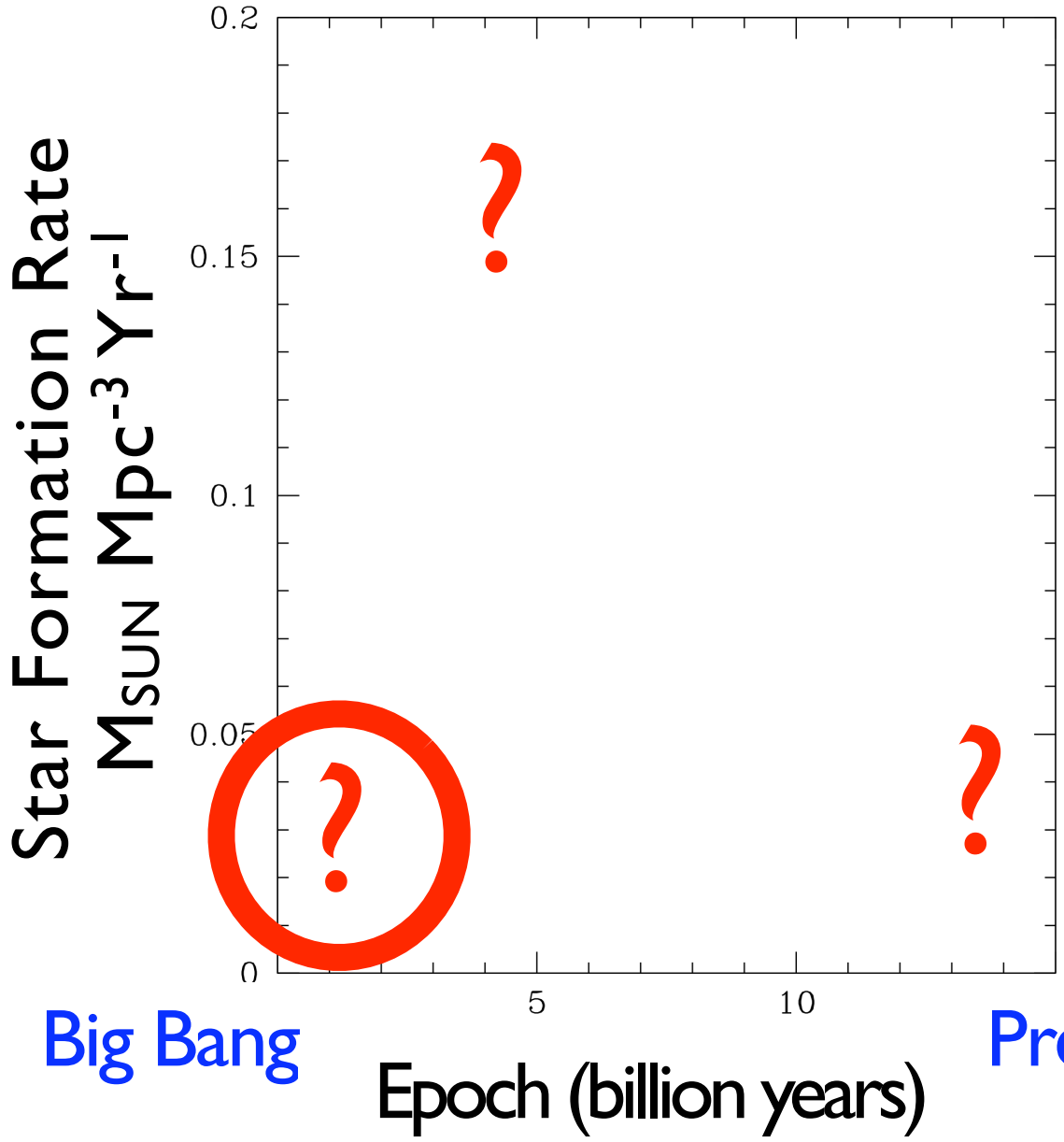
Compare with:

- SZ surveys (e.g., SPT): $\approx 0.7 \times 10^{14}\ M_\odot$
- X-RAY surveys (eROSITA): $\approx 10^{14}\ M_\odot$ only up to z≈2

Capitalizing on large area with NIR AB≈24: Unique niche to detect **massive groups***

* The typical environments of QSOs at z ~ 2, i.e. the empirical key to understand QSO activity

What are the Physical Drivers of Galaxy Evolution?



Masses
+
Morphologies

Euclid's Deep Imaging Survey

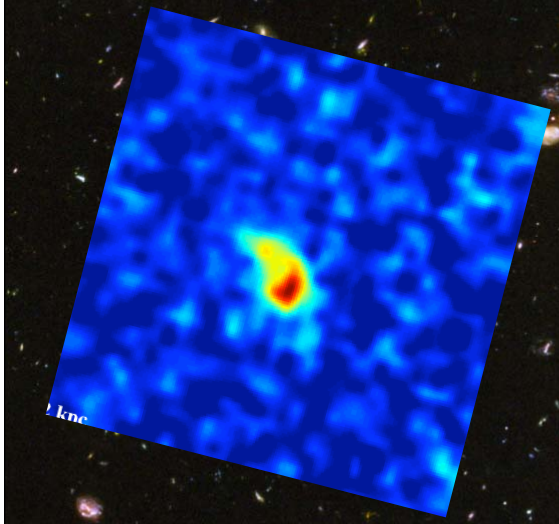
2mag fainter limits (H_{AB}~26) + Large area (~30deg^2)

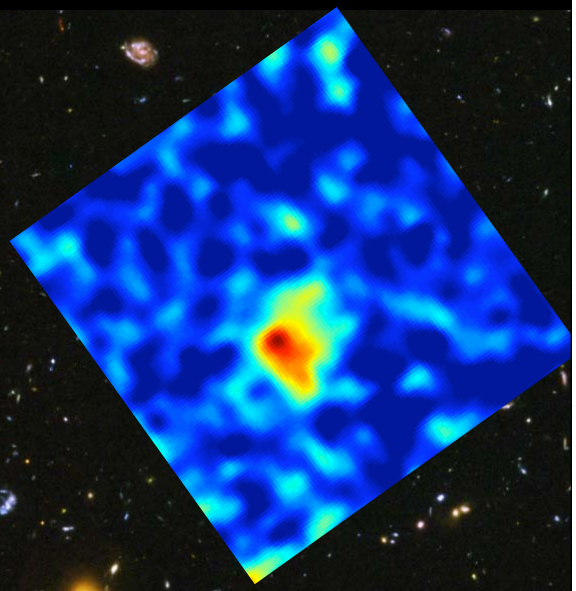
(1. Small building blocks at "low" redshifts)

2. Galaxies and QSOs well into the reionization epoch (Lyman Break Technique)

UDF09: ~200 WFC3 Orbits

Illingworth (PI), Bouwens, Carollo, Franx, Labbe', Oesch, Stiavelli, Trenti, vanDokkum

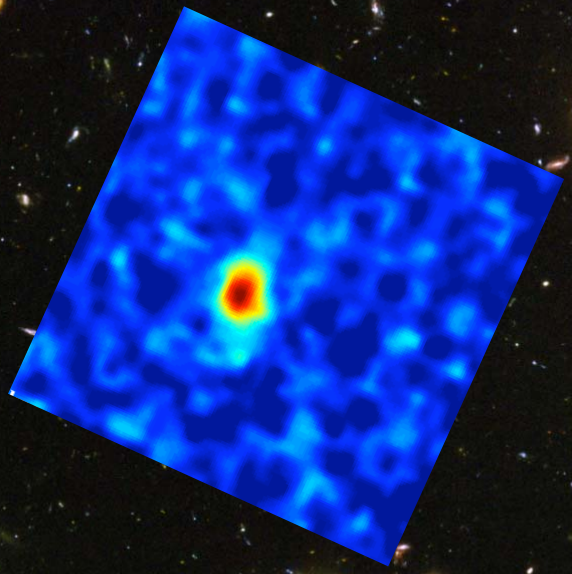


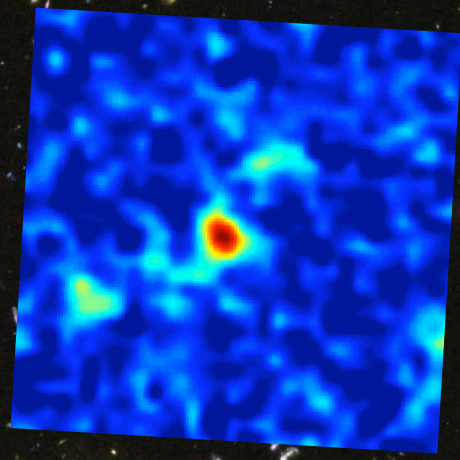


16 LymanBreak Galaxies at z~7

+

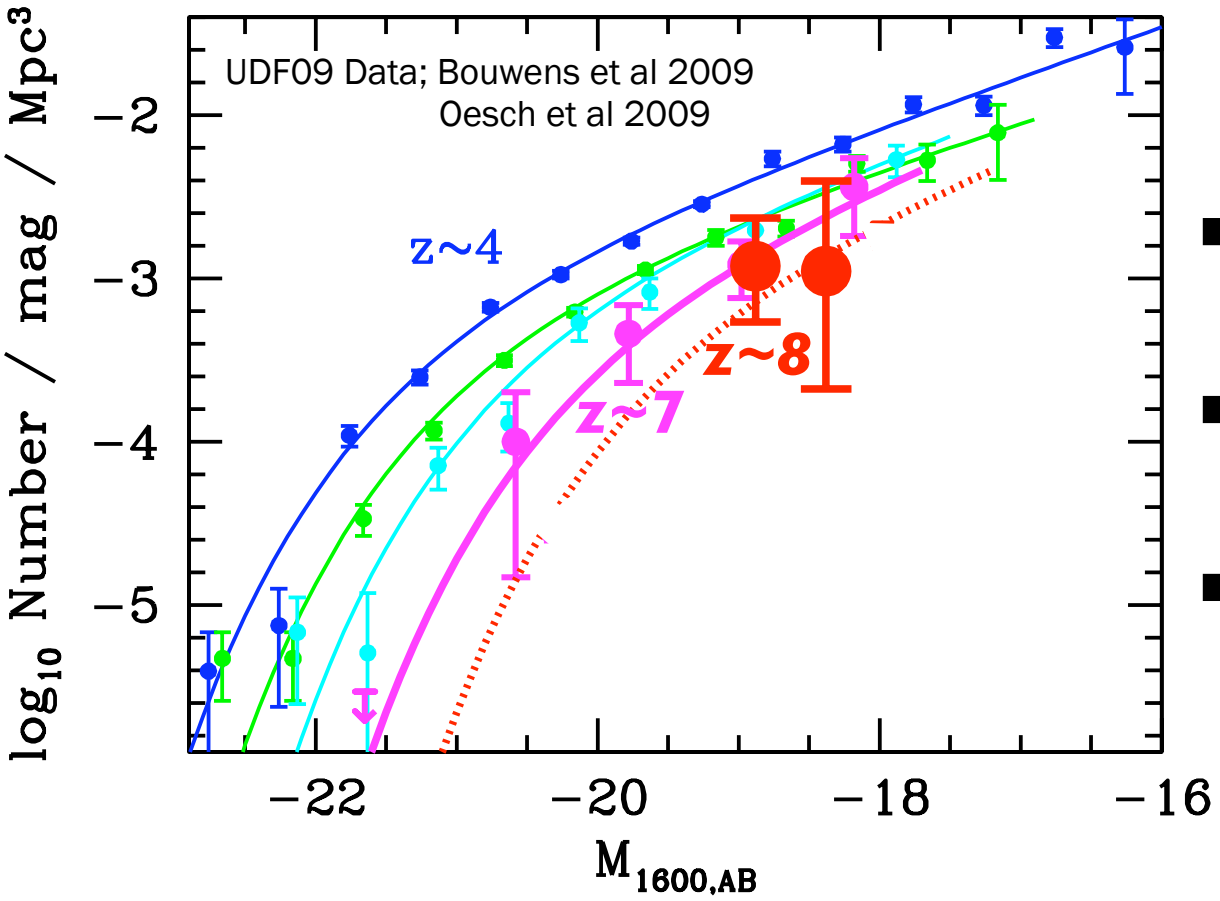
5 LBGs at z=8 (600 Million Years after recombination)





Bouwens et al arXiv:0909.1803
Bouwens et al arXiv:0910.0001
Labbe' et al arXiv:0910.0338
Labbe' et al arXiv:0911.1356
Oesch et al arXiv:0909.1806
Oesch et al arXiv:0909.5183

Constraints on the Luminosity Function at z>6.5

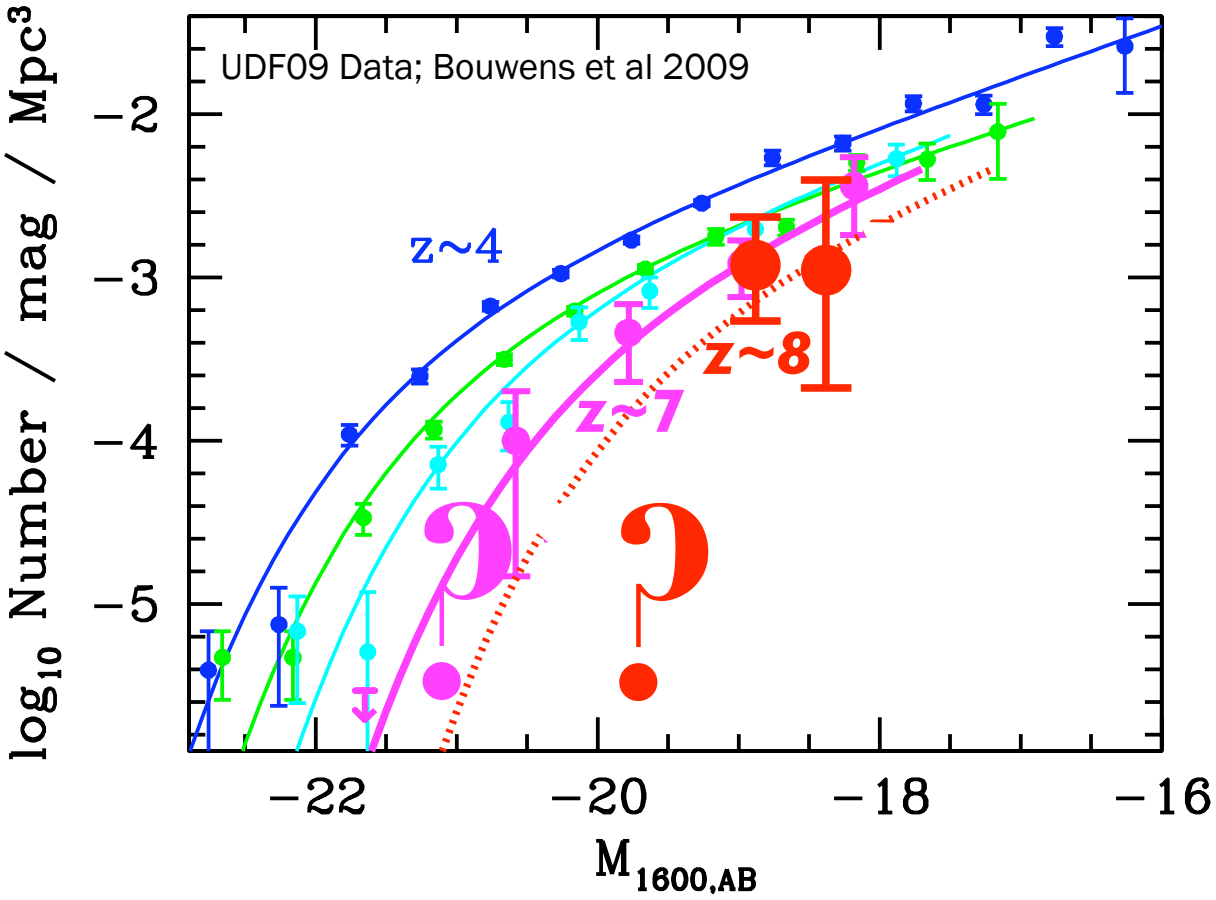


➡Compact, R_{eff}<1kpc

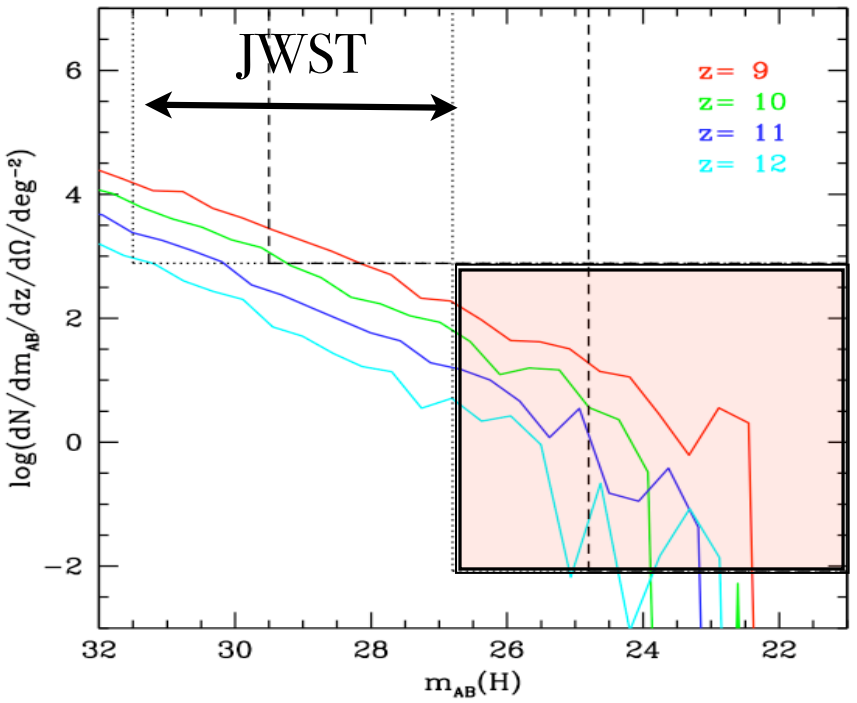
➡Faint-end slope ~-1.8

➡UV-continuum slope ~-3

Uncharted Terrain at z>6.5



SemiAnalytic Predictions based on z~7 data
(courtesy: C. Lacey)



Euclid's Deep Imaging Survey

The most luminous galaxies and AGNs at z≈7-10

☞ rare but fundamental

SFRs > 30 – 100$M_\odot$/yr :
- ❑ ≈10^4 LymanBreak Galaxies at z ~ 8
- ❑ ≈10^3 at z ~ 10

High-z quasars:
- ❑ ≈10^4 at z ~ 7
- ❑ ≈10^3 at z ~ 9

➲ Characterize luminosity functions, SFR, and spatial correlations

Unique niche in area and depth, complementary to JWST and Ground.
E.g., **1000xArea** of *UltraVista* in **0.1 x TIME**

Simulating ~~the~~ Physics of Galaxy Evolution

which?

Hahn, Carollo & Teyssier 2009
Hahn, Teyssier & Carollo 2009

BOX: 25 Mpc
~1M CPUh @ XT3