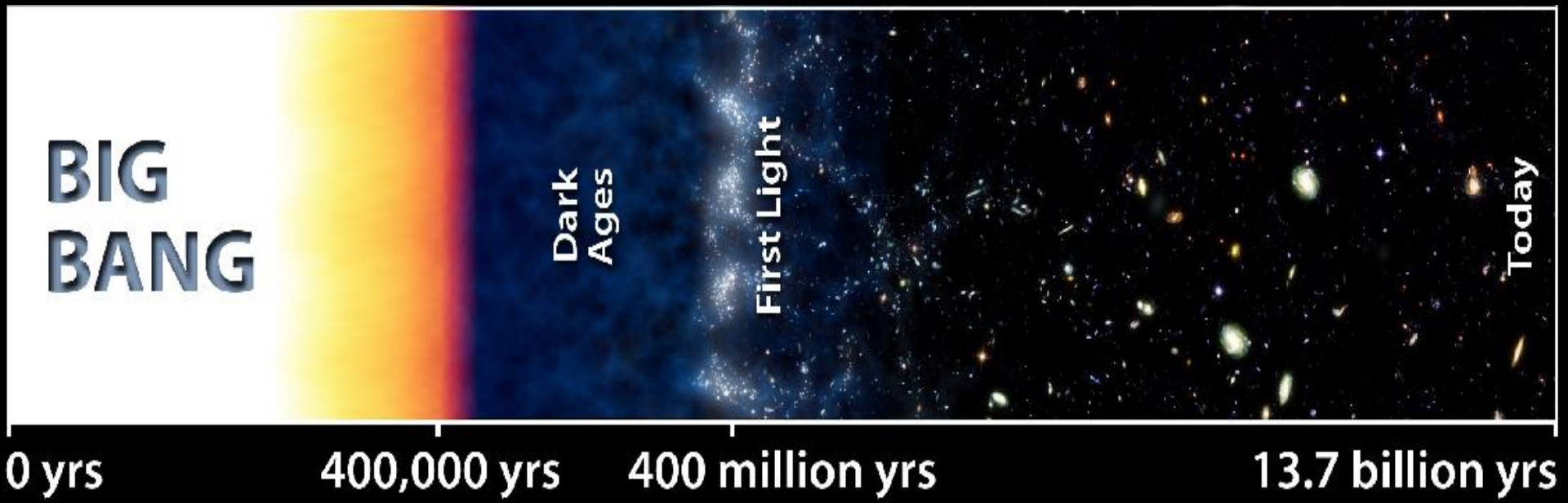
The Cosmic History of Star Formation



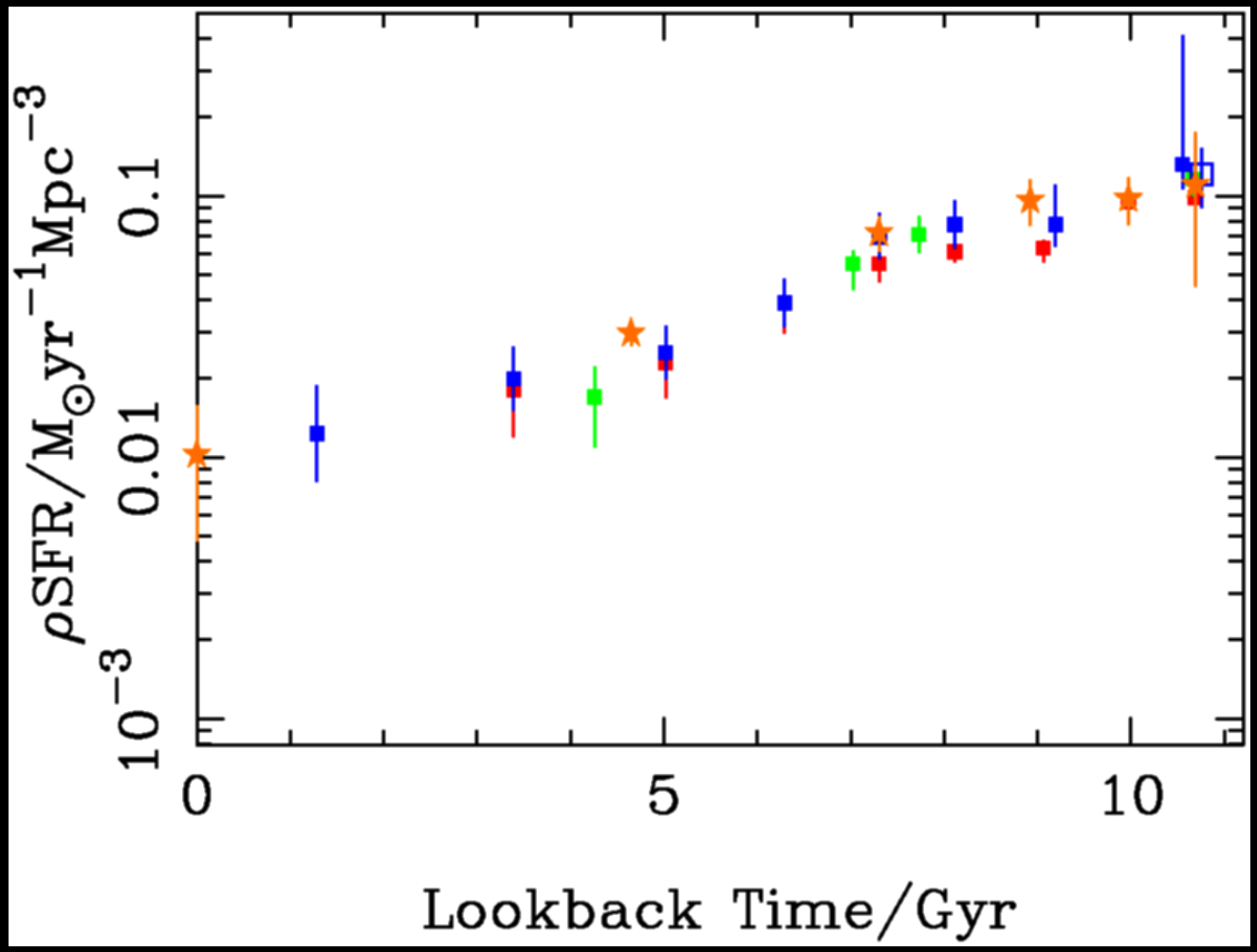
James Dunlop
Institute for Astronomy, University of Edinburgh

With Ross McLure, Derek McLeod, Rebecca Bowler, Shegy Parsa

+ Brant Robertson, Richard Ellis

The last ~11 billion years: 0 < z < 3

Good agreement



Reddy & Steidel 2009
dust corrected UV

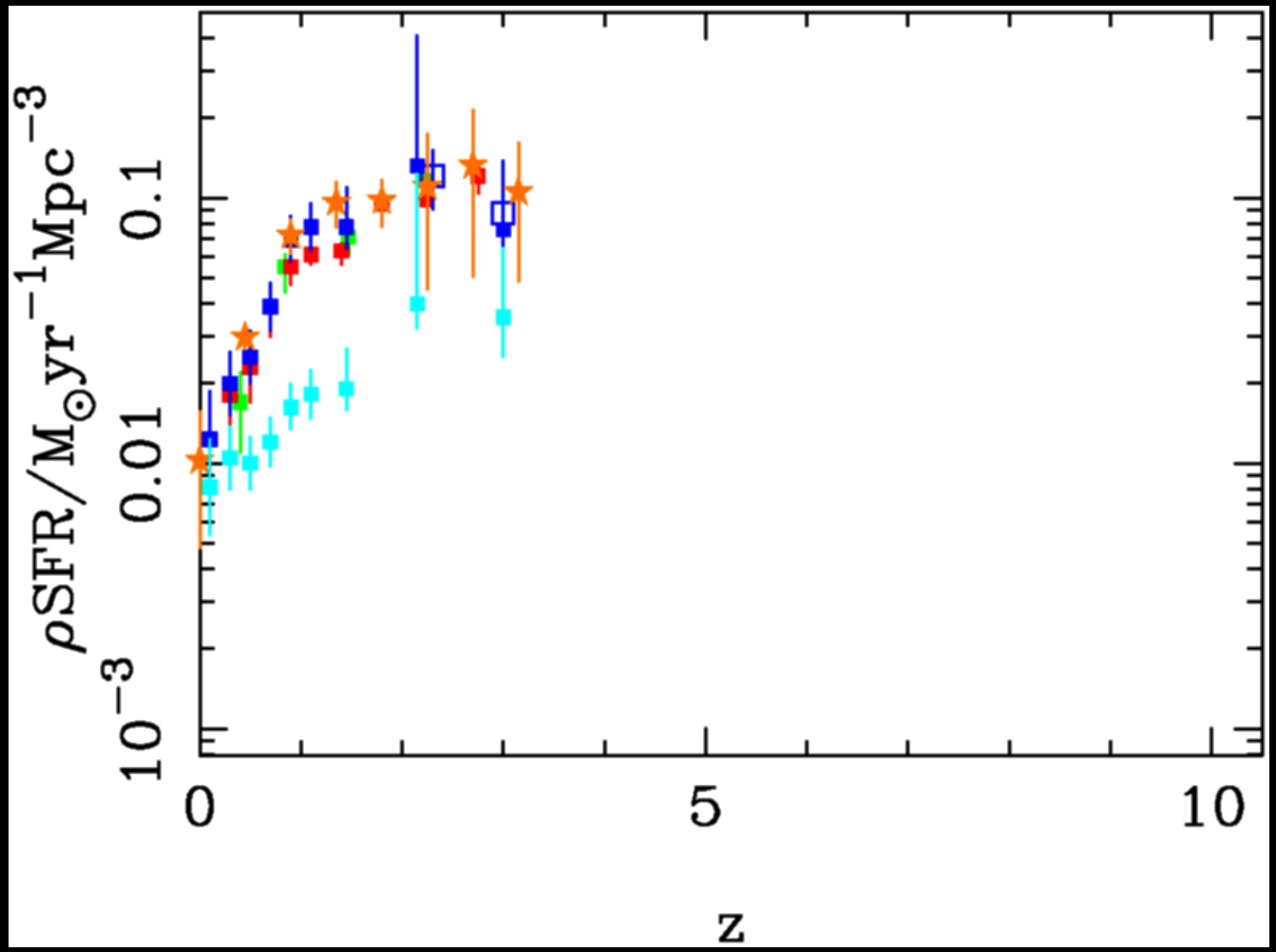
Cucciati et al. 2013
dust corrected UV

Sobral et al. 2013
dust corrected Hα

Karim et al. 2011
radio (1.4 GHz)

Burgarella et al. 2013
far-IR + raw UV

A complete cosmic history of SFR density?



Dunlop 2015

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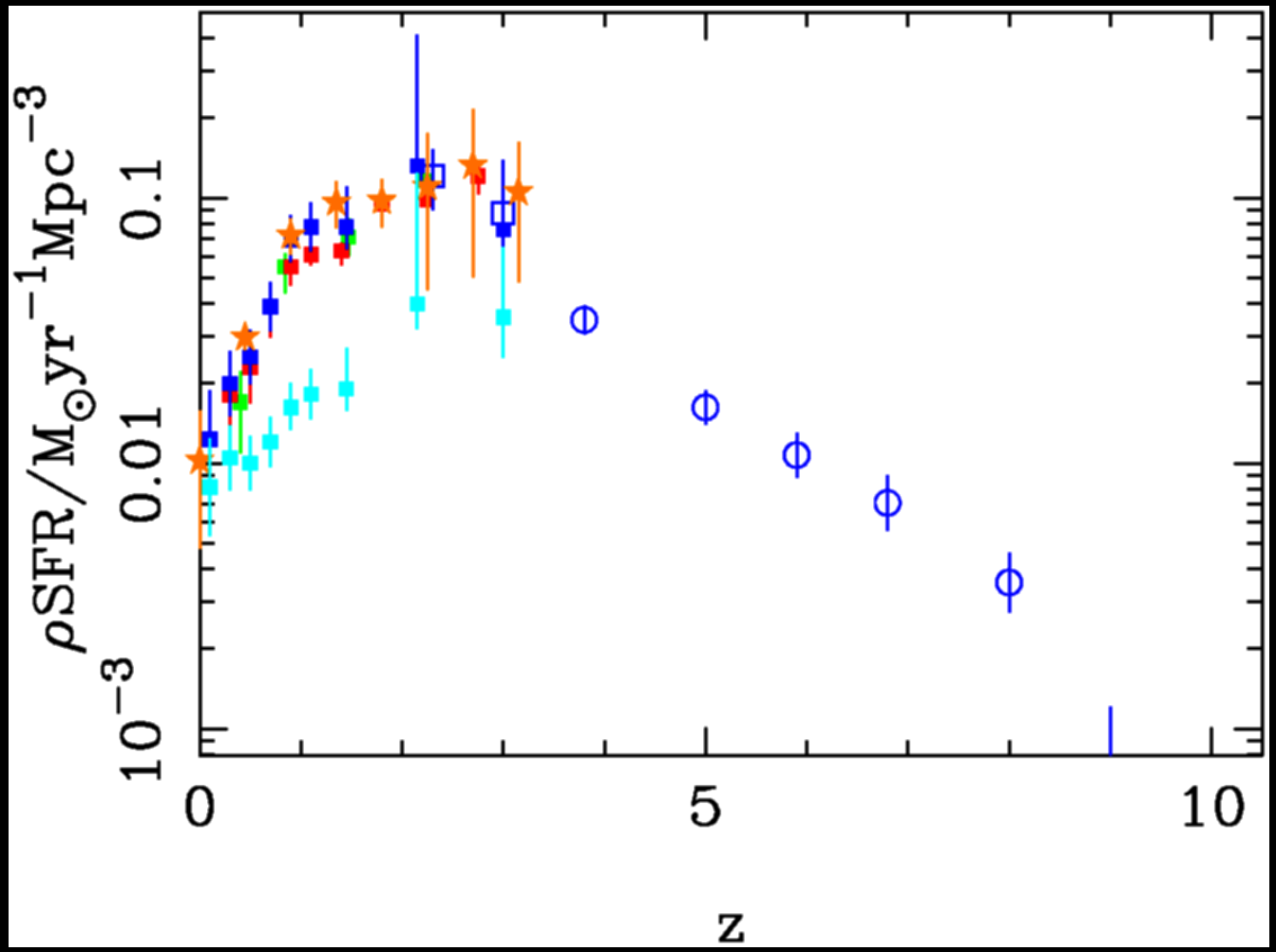

Bouwens et al. 2007
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Oesch et al. 2013
- Dust corrected
- Chabrier IMF

Dunlop 2015

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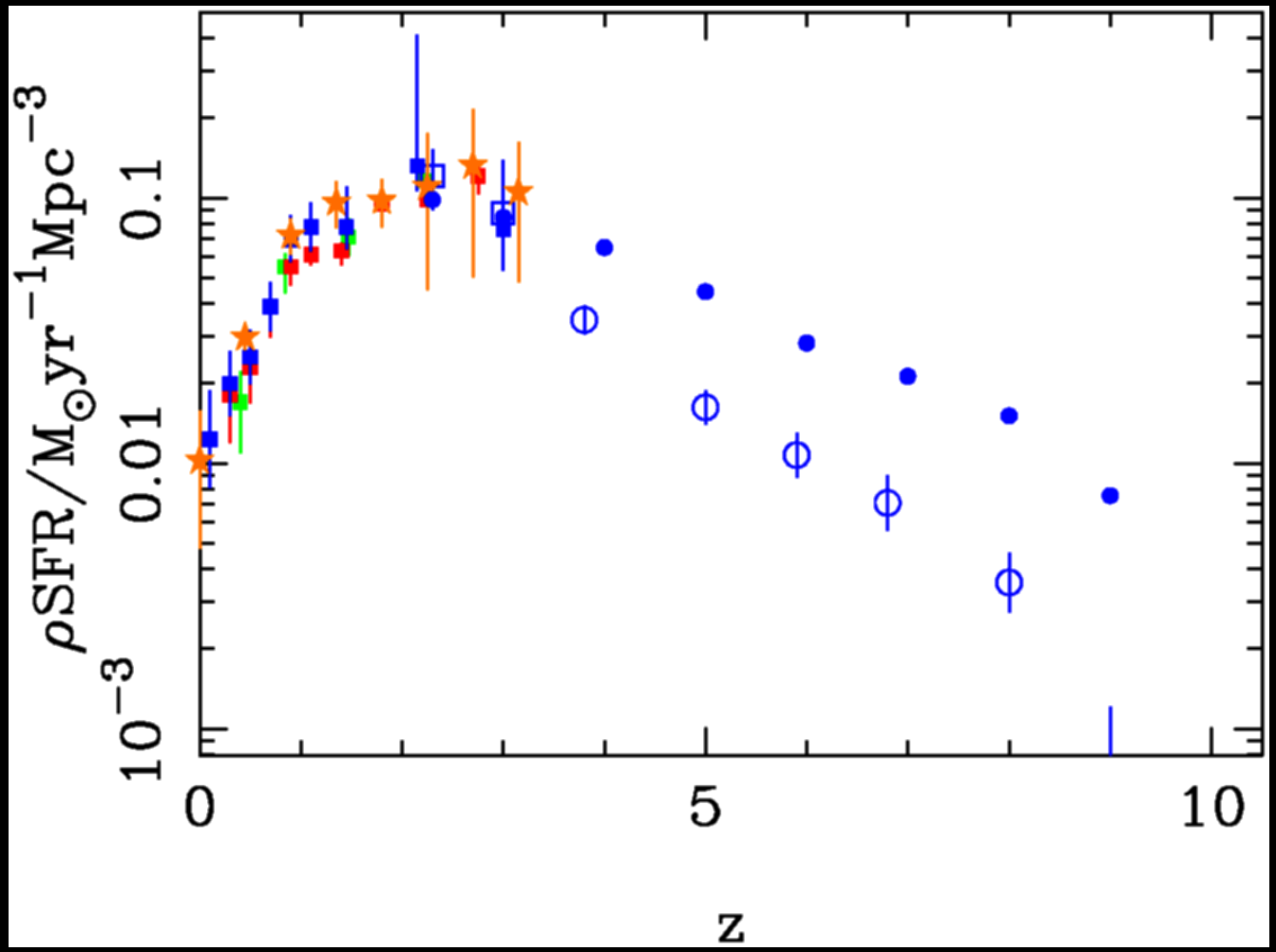

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to M = -13
Redshift indep dust

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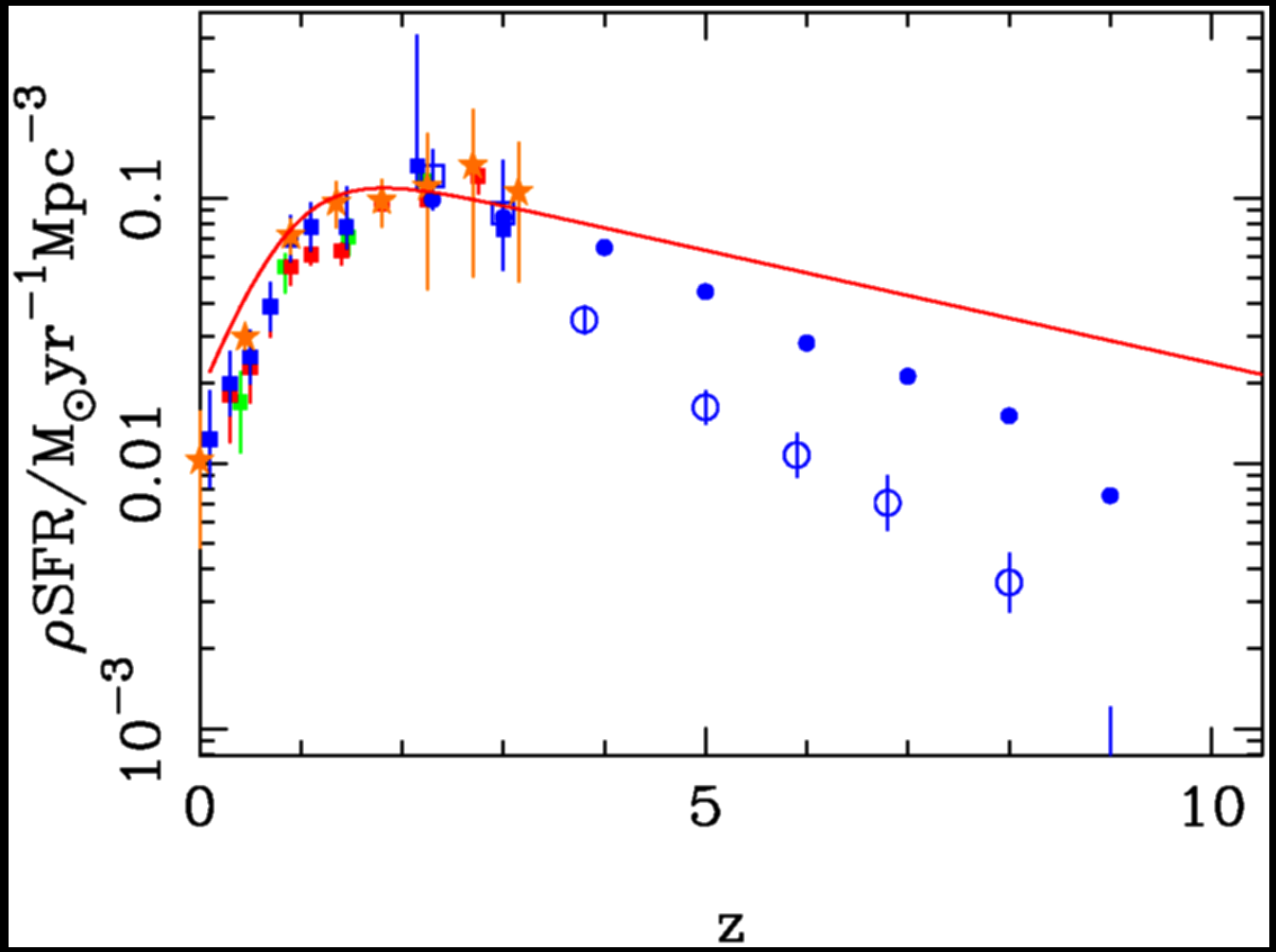

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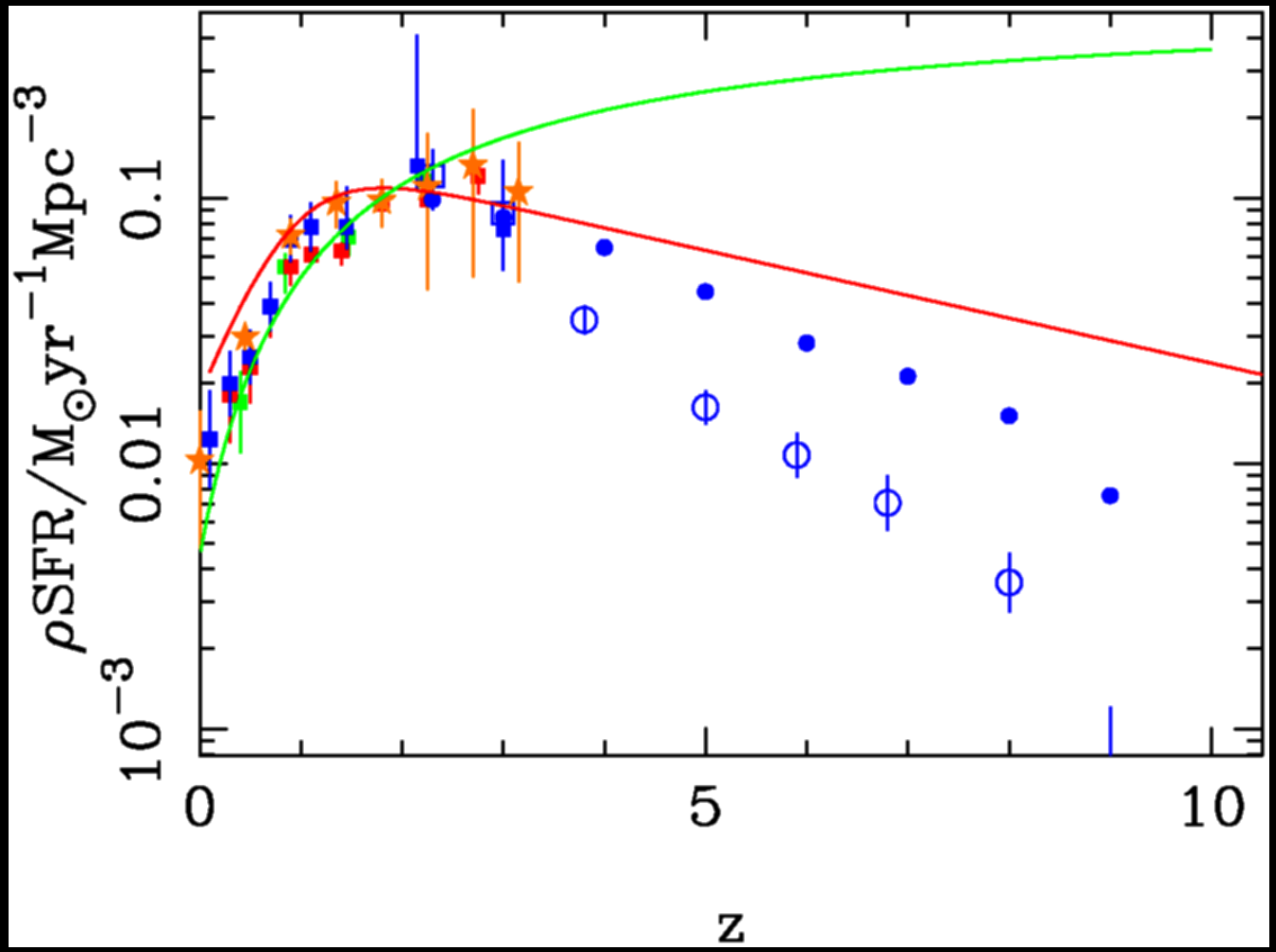

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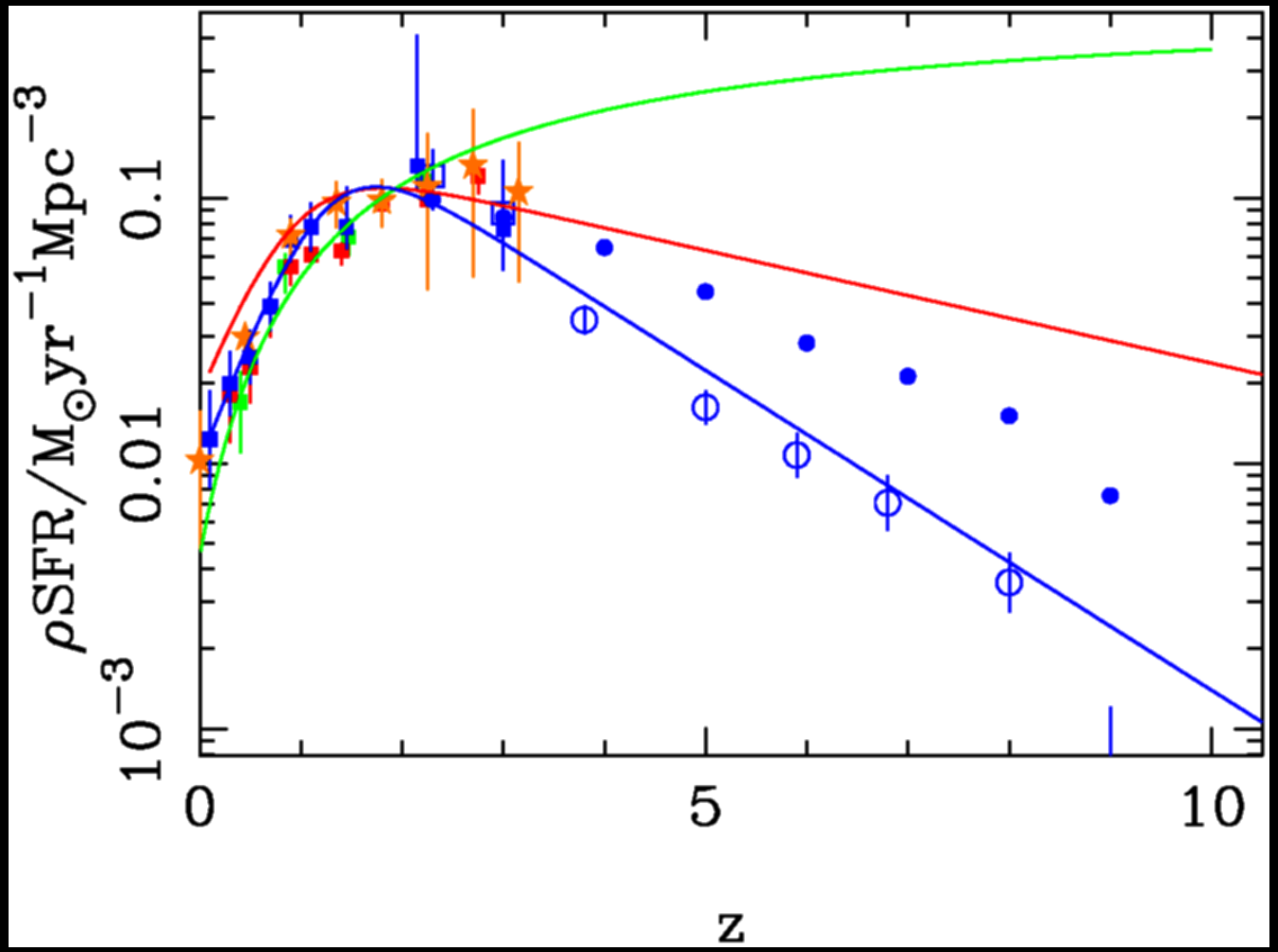

Dunlop 2015

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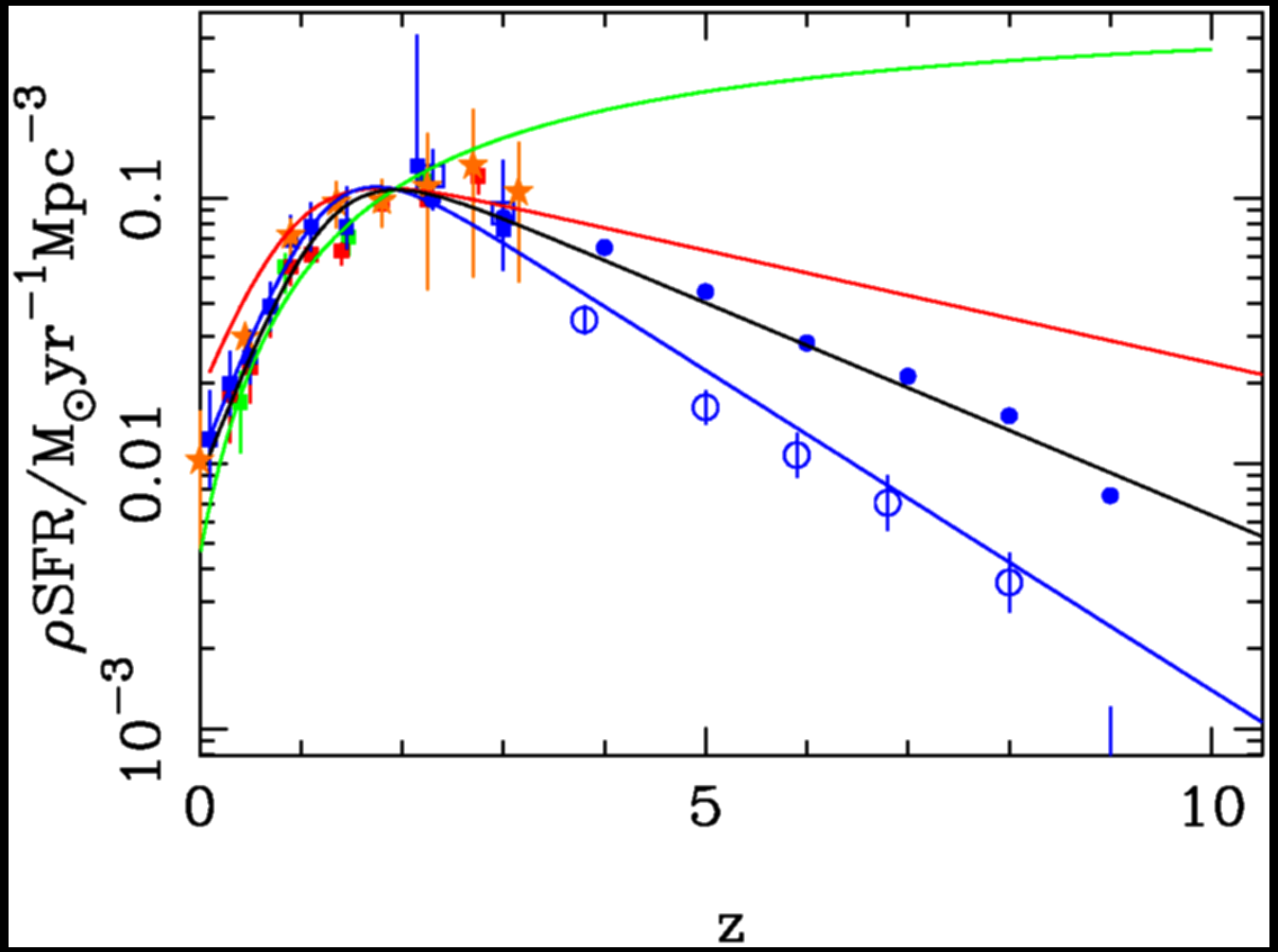

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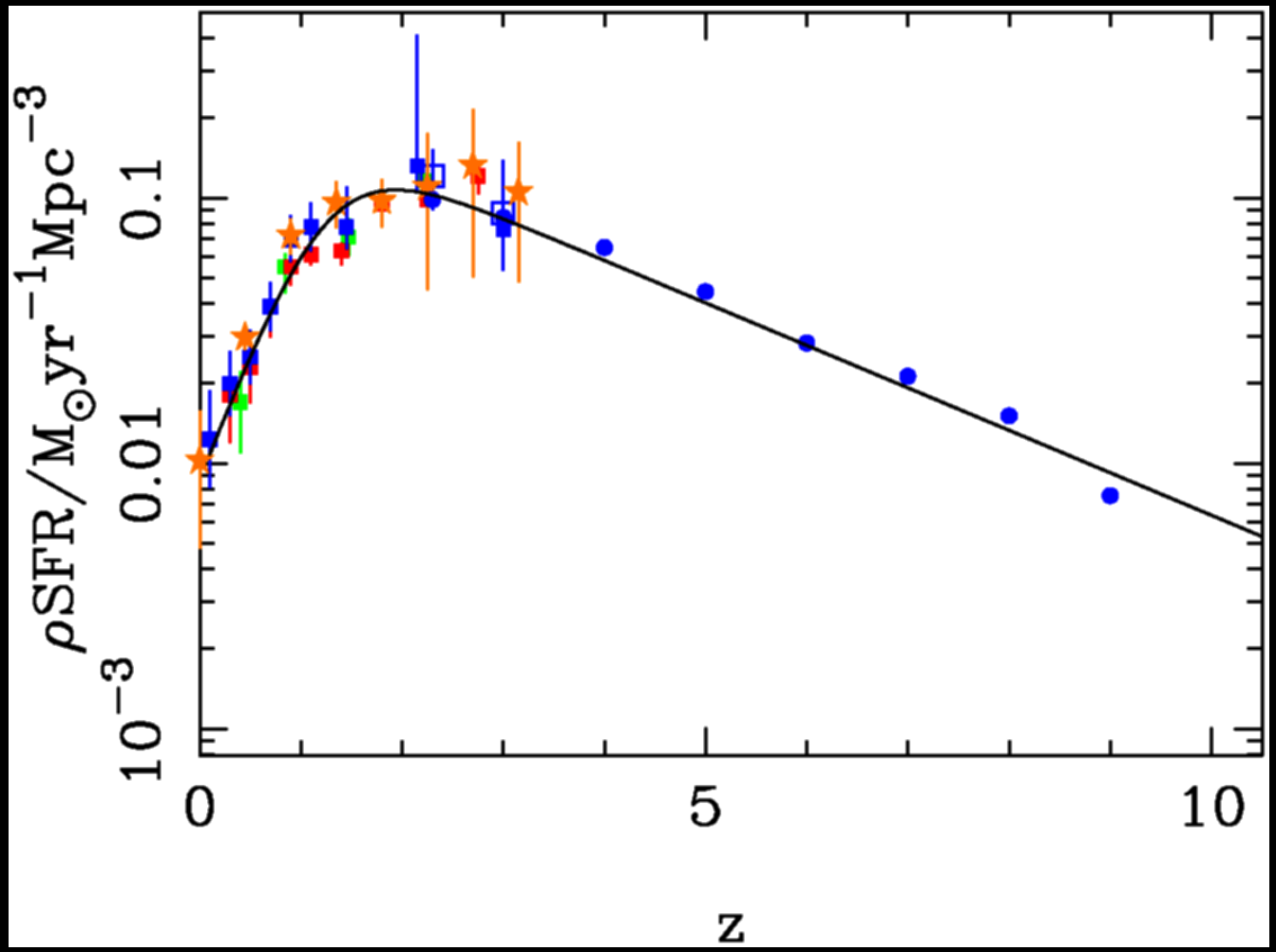
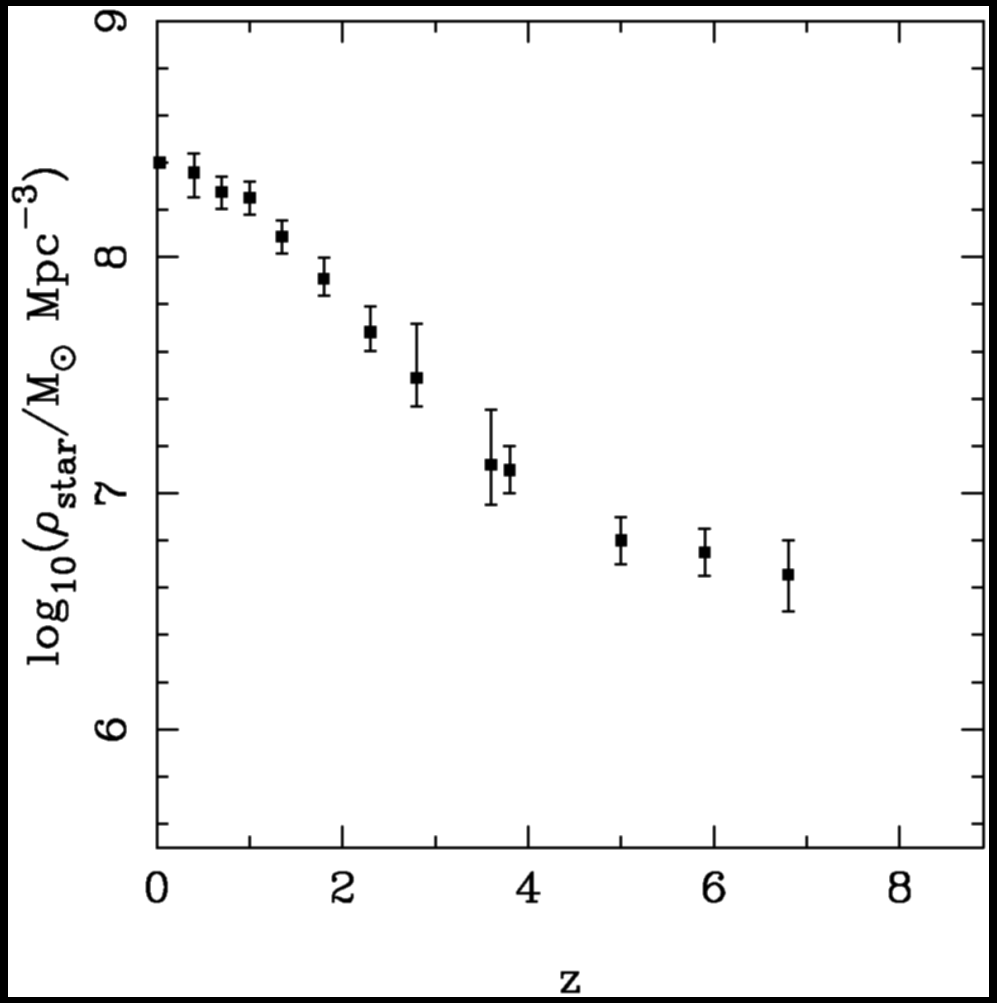


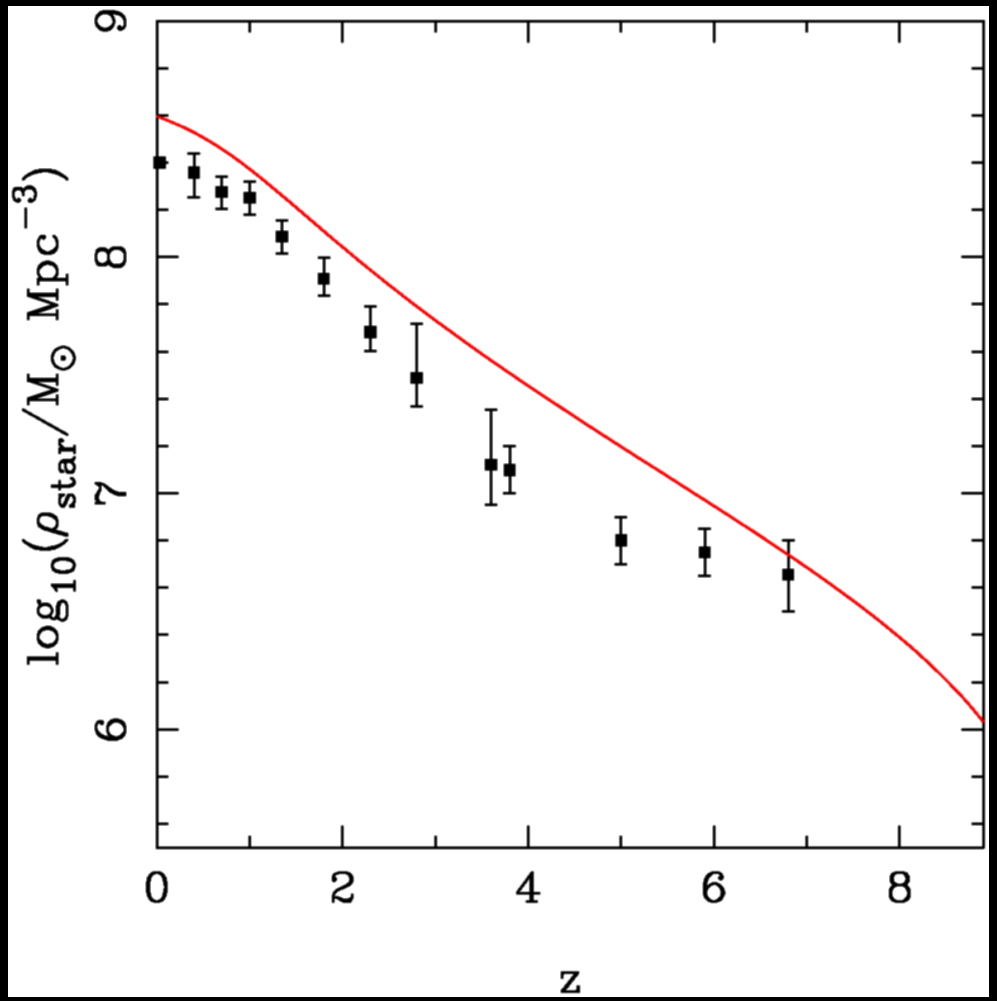
Dunlop 2015

The growth of stellar mass



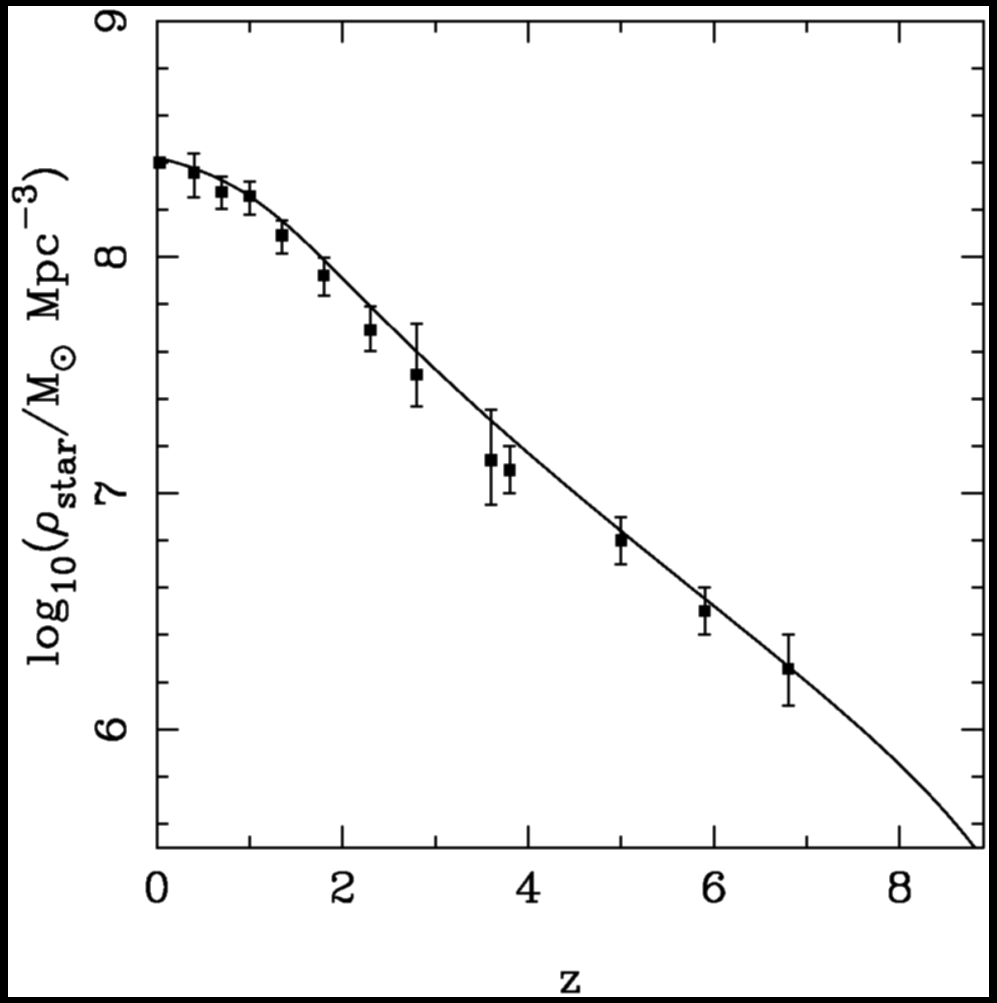
Data from Baldry et al. 2012, Ilbert et al. 2013, Gonzalez et al. 2011

The growth of stellar mass

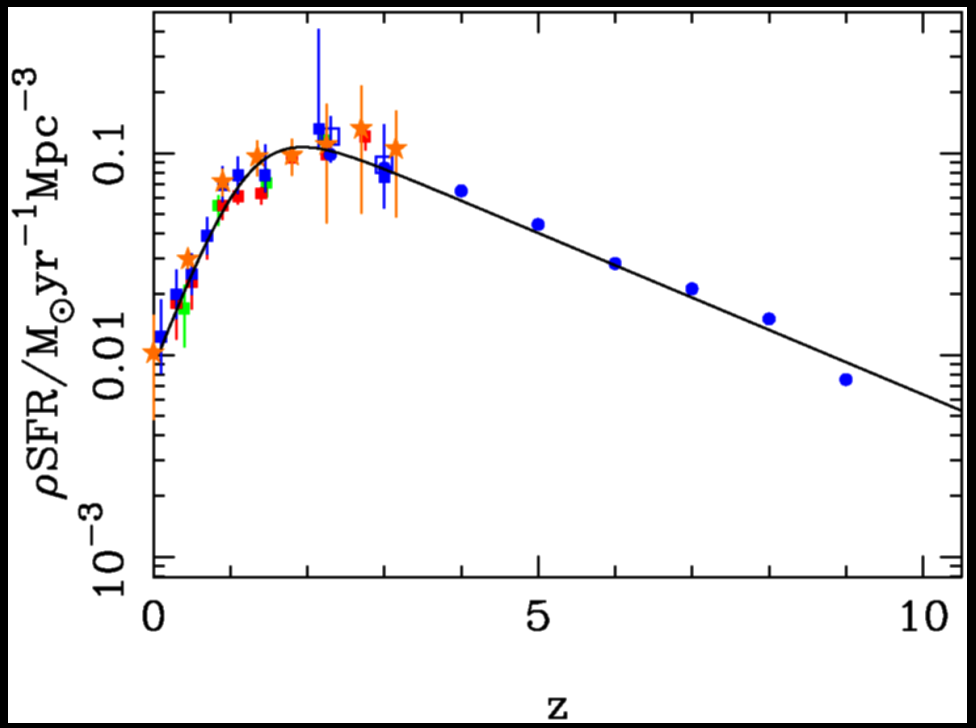


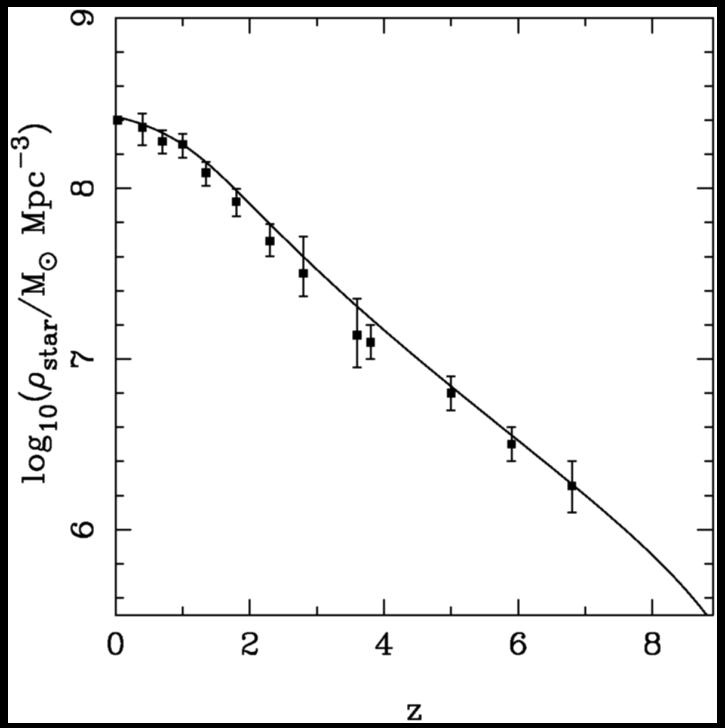
Data from Baldry et al. 2012, Ilbert et al. 2013, Gonzalez et al. 2011
+ Hopkins & Beacom 2006 prediction (converted to Chabrier IMF)

The growth of stellar mass



Data from Baldry et al. 2012, Ilbert et al. 2013 integrated to $M_* = 10^6\ M_{sun}$, Stark et al. 2013, and Dunlop 2015 prediction


ρSFR/M$_\odot$yr^{-1}Mpc^{-3}
10^{-3}
0.01
0.1
0
5
10
z

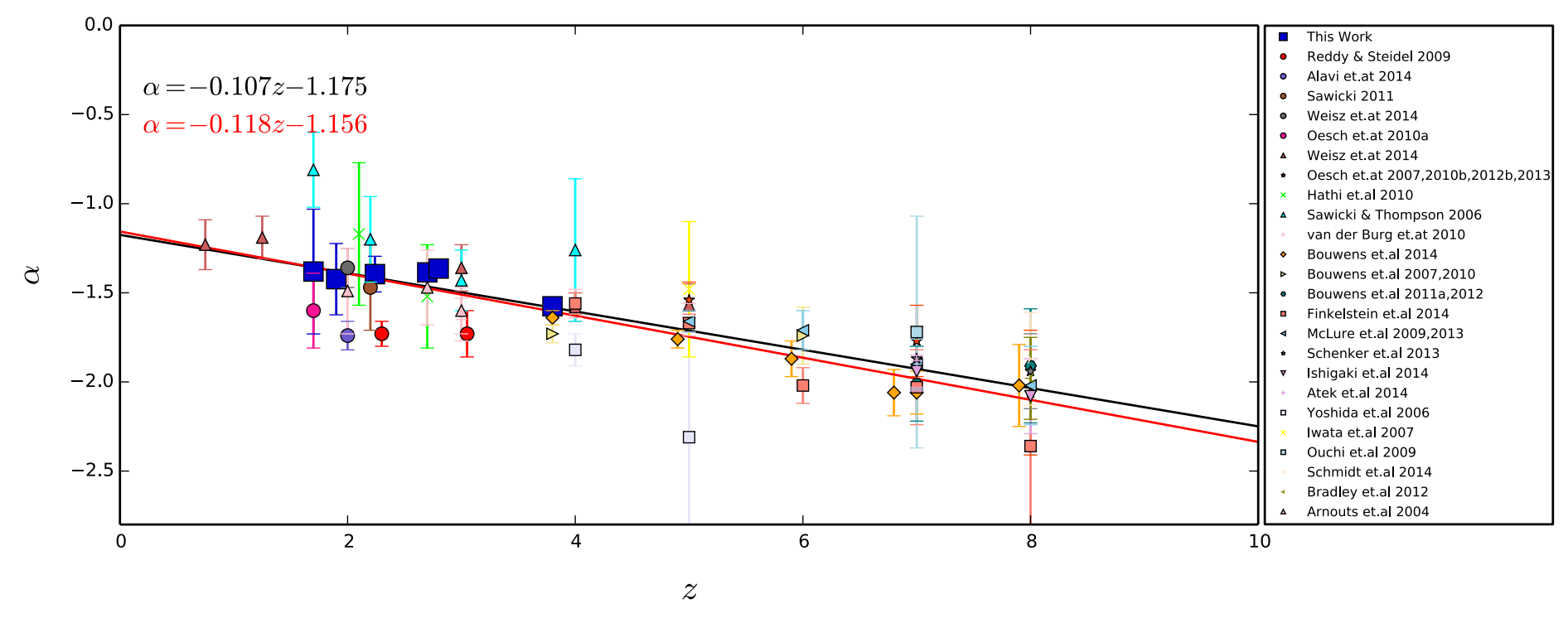

$\log_{10}(\rho_{star}/M_\odot$ Mpc$^{-3})$
6
7
8
9
0
2
4
6
8
z

Faint-end slope of the UV LF

The evolution of α - see Parsa, Dunlop, McLure et al. 2015

LF measured at z = 2 down to at least -14

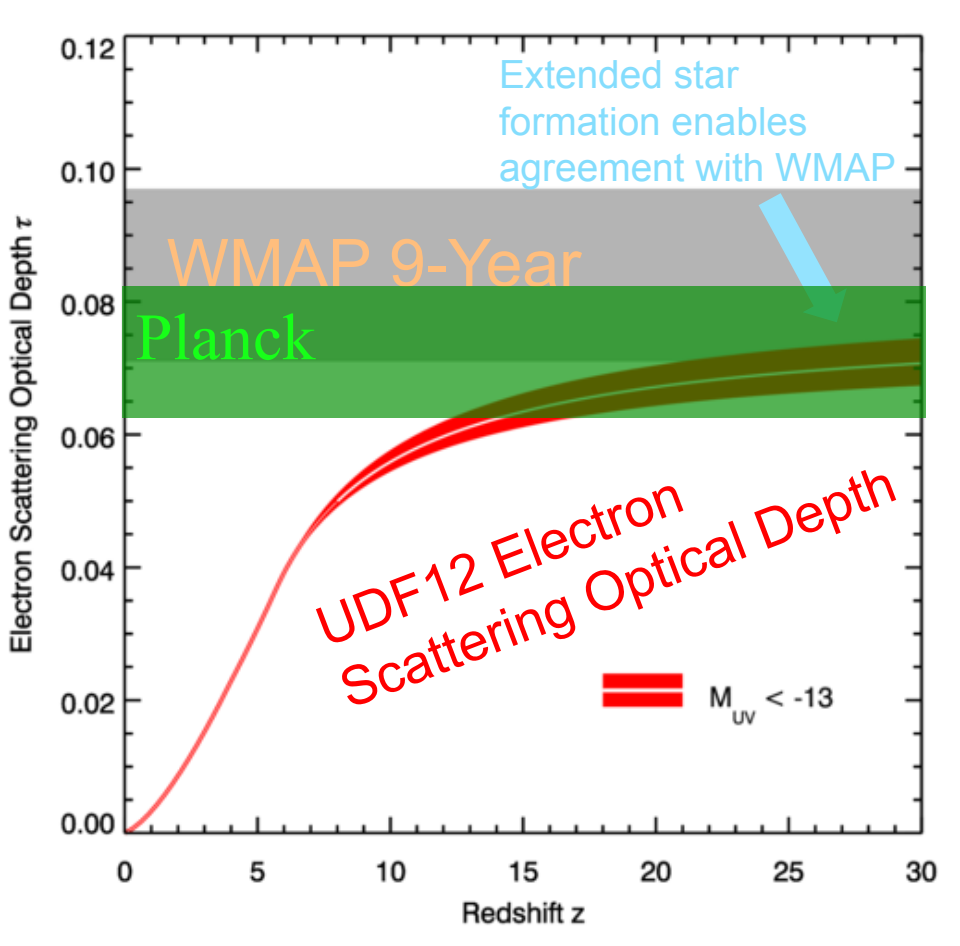
So, α = -1.4 at z = 2, steepening to α = -2 at z = 8.
Means luminosity density increasingly dominated by faint galaxies – implications for reionization.

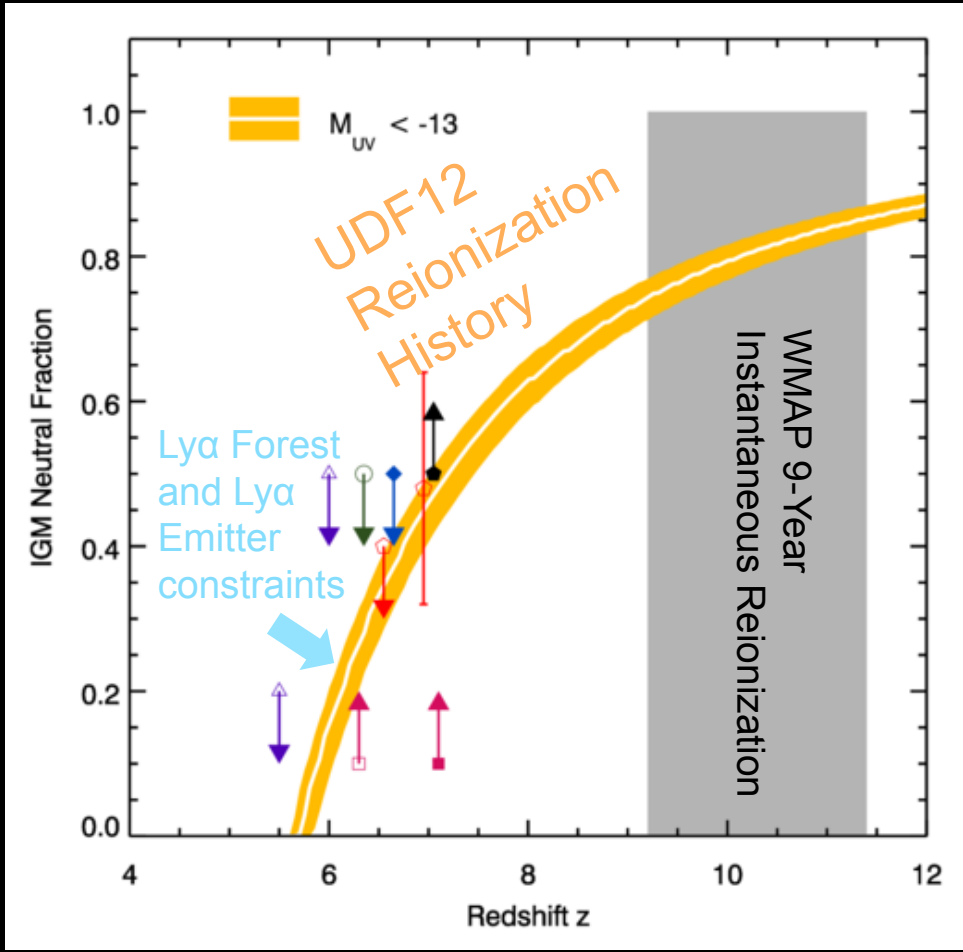


Link to Cosmic Reionization

Agrees (just!) with WMAP-9 and other probes if LF extended to $M_{uv} < -13$

Robertson et al. 2013, 2015





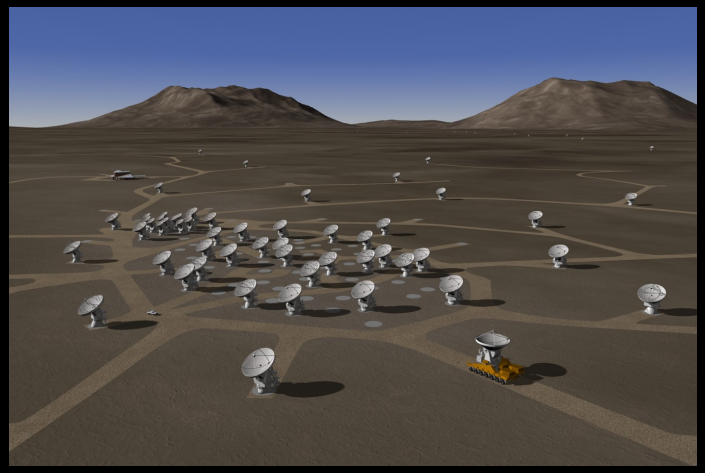
The Future: Atacama Large Millimeter Array

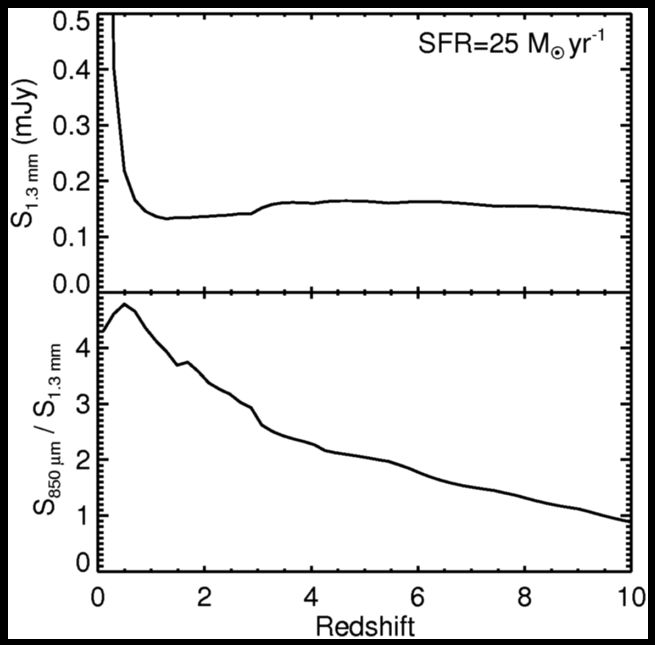
ALMA Deep Field

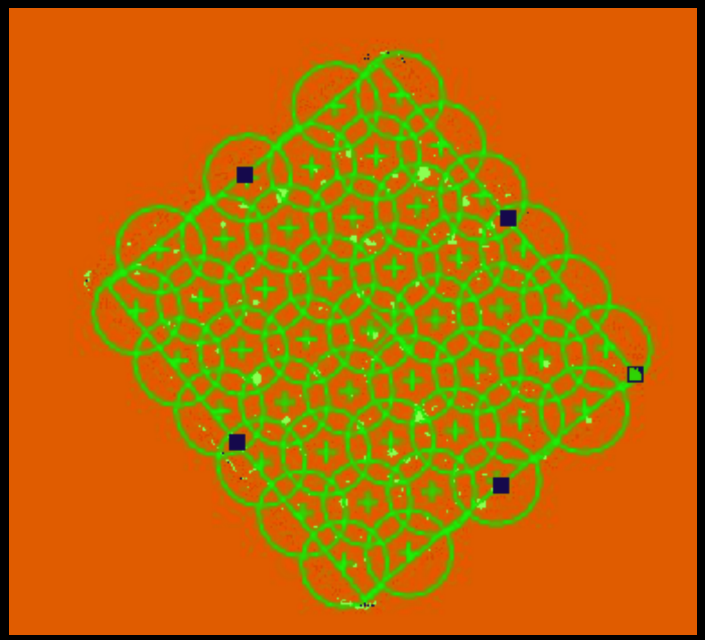
β measurements imply presence of dust
in even highest z galaxies seen to date

Need to observe dust emission to complete
Picture of cosmic star-formation history

ALMA 1.3mm image of HUDF
- awarded 20 hrs in Cycle 1
- Currently 59% complete – no data yet….





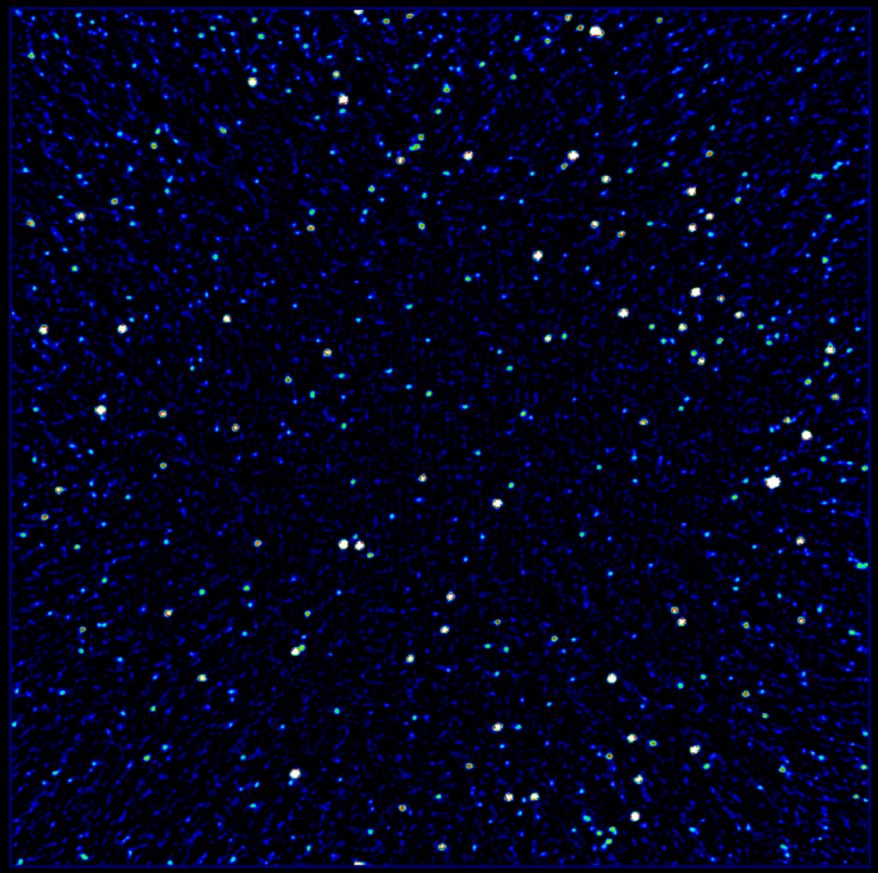


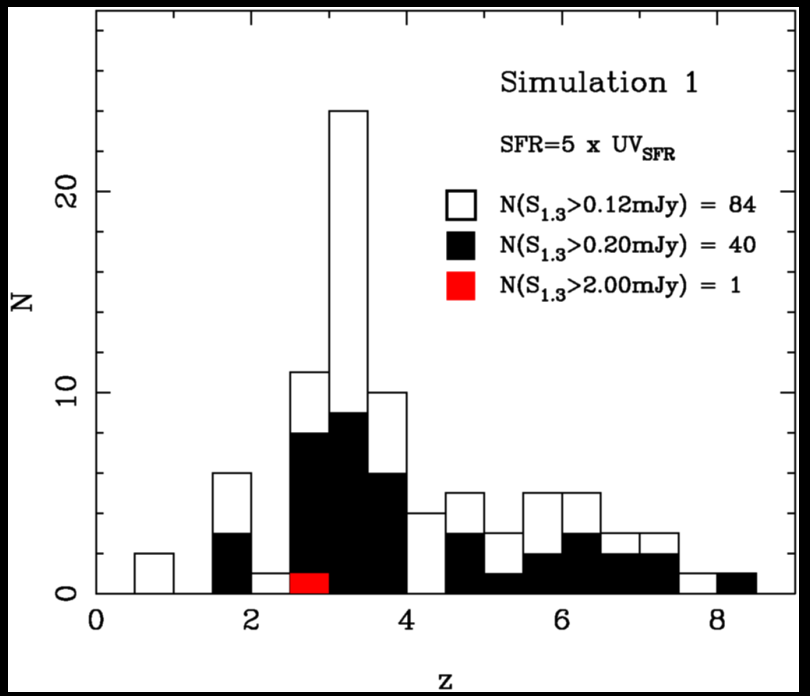
5-sigma detection limit is 0.15 mJy, spatial resolution of 0.7” FWHM

ALMA Deep Field

Alternative predictions based on > 2000 galaxies in the HST imaging

SFR = 5 x UV SFR

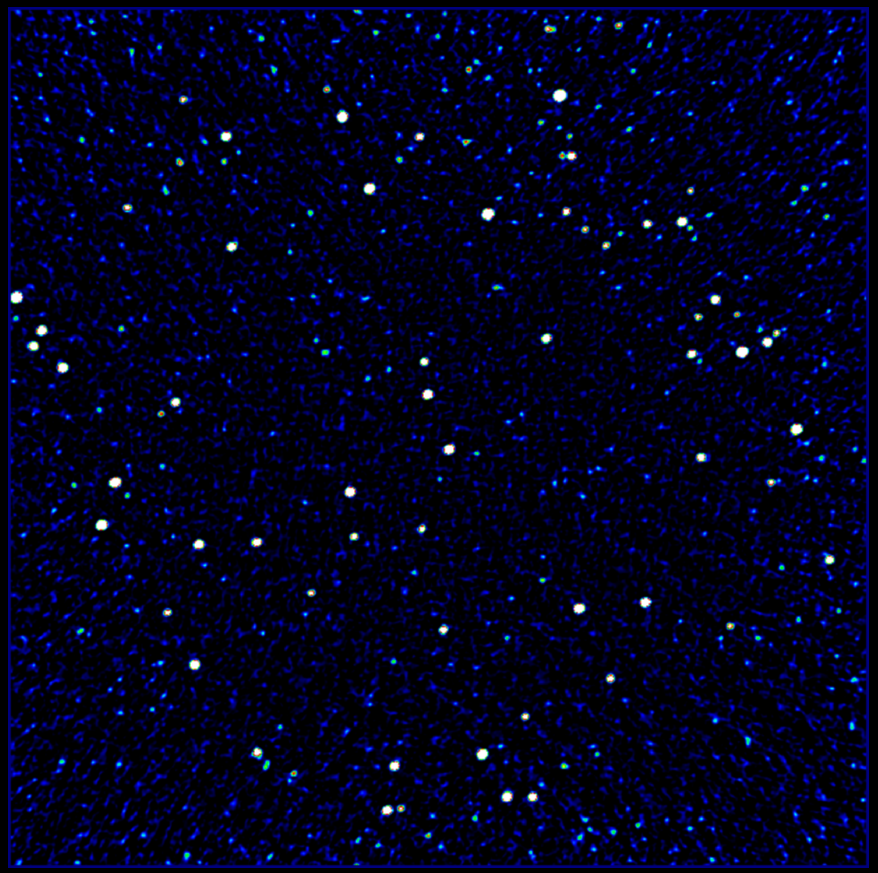


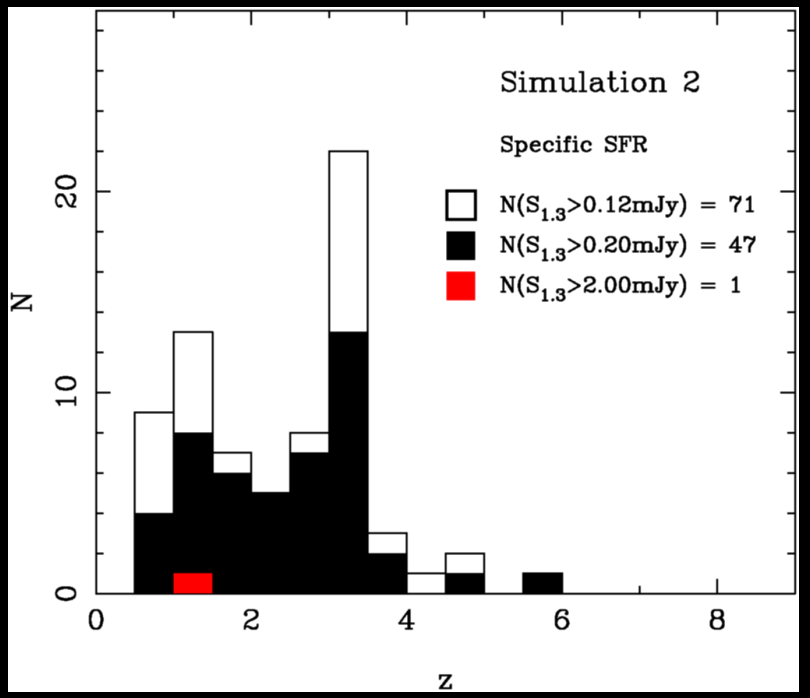


ALMA Deep Field

Alternative predictions based on > 2000 galaxies in the HST imaging

Specific SFR = 2/Gyr

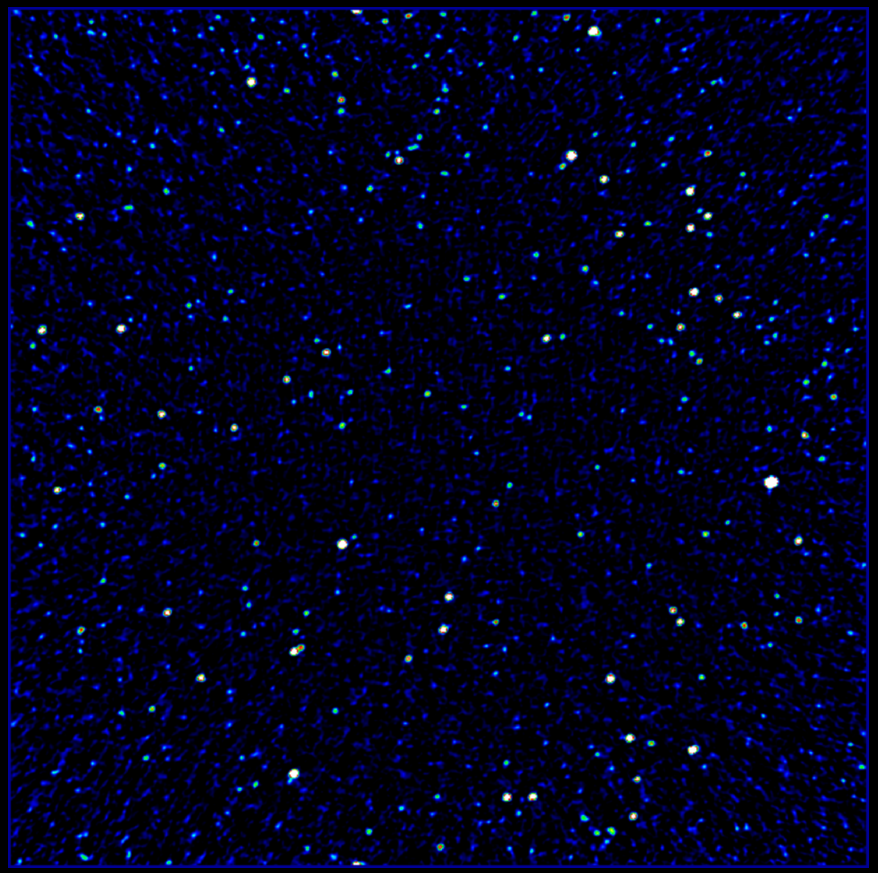


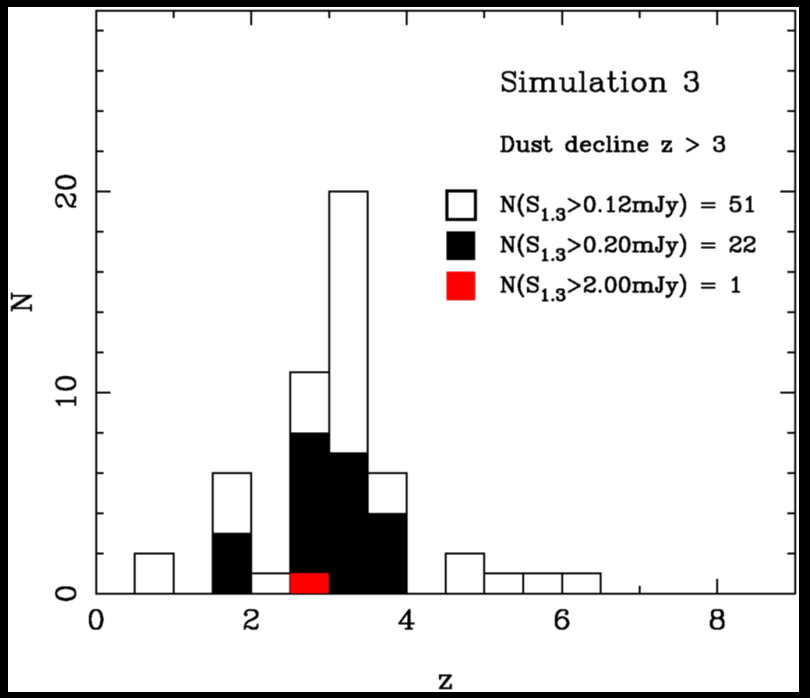


ALMA Deep Field

Alternative predictions based on > 2000 galaxies in the HST imaging

SFR = 5 x UV SFR plus $/(1+z)^2$ at $z > 3$





Answer in 2015 – I hope…