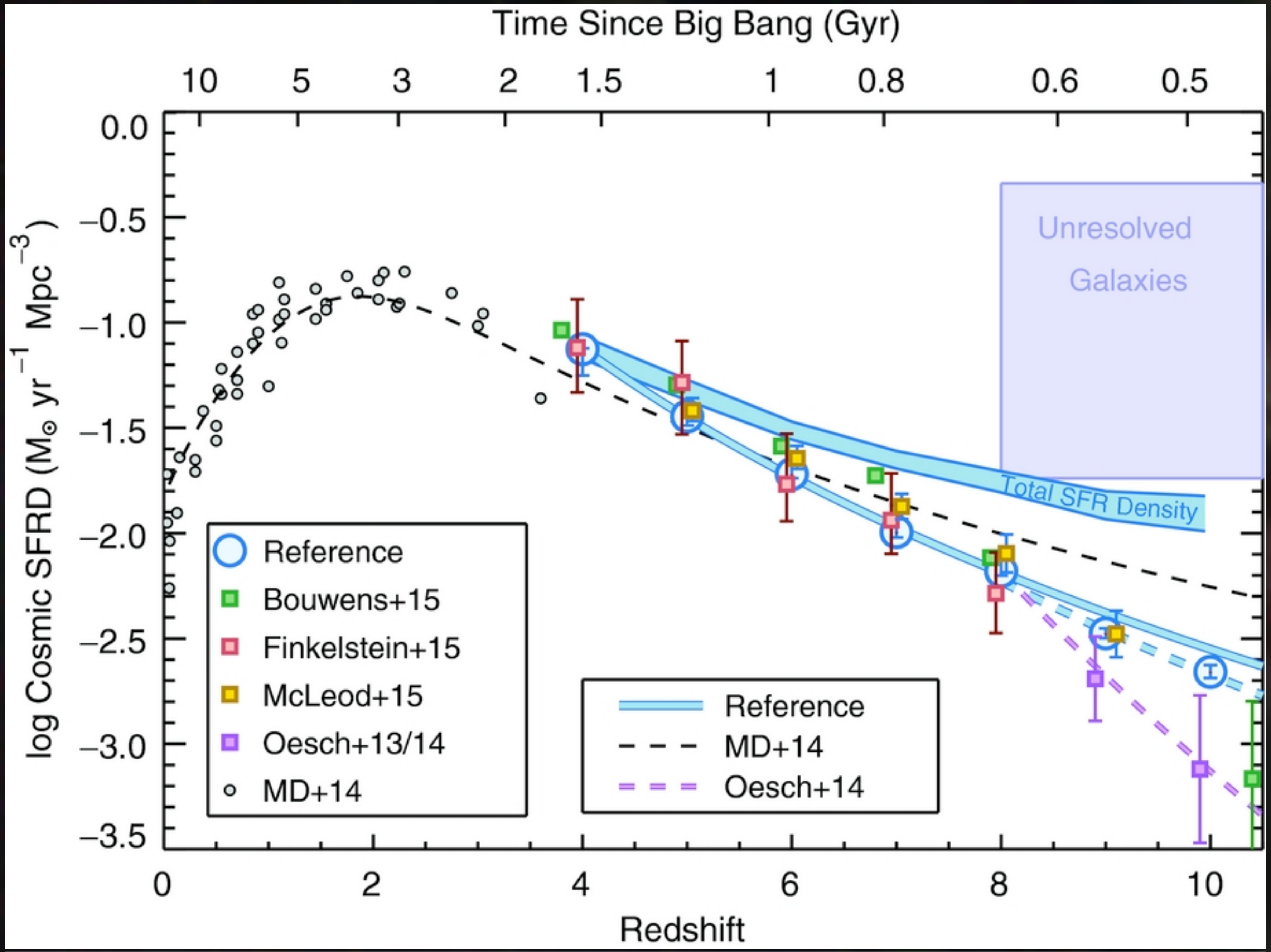
S.D. VERGANI

GRBs as tracers of cosmic SFR & first galaxies

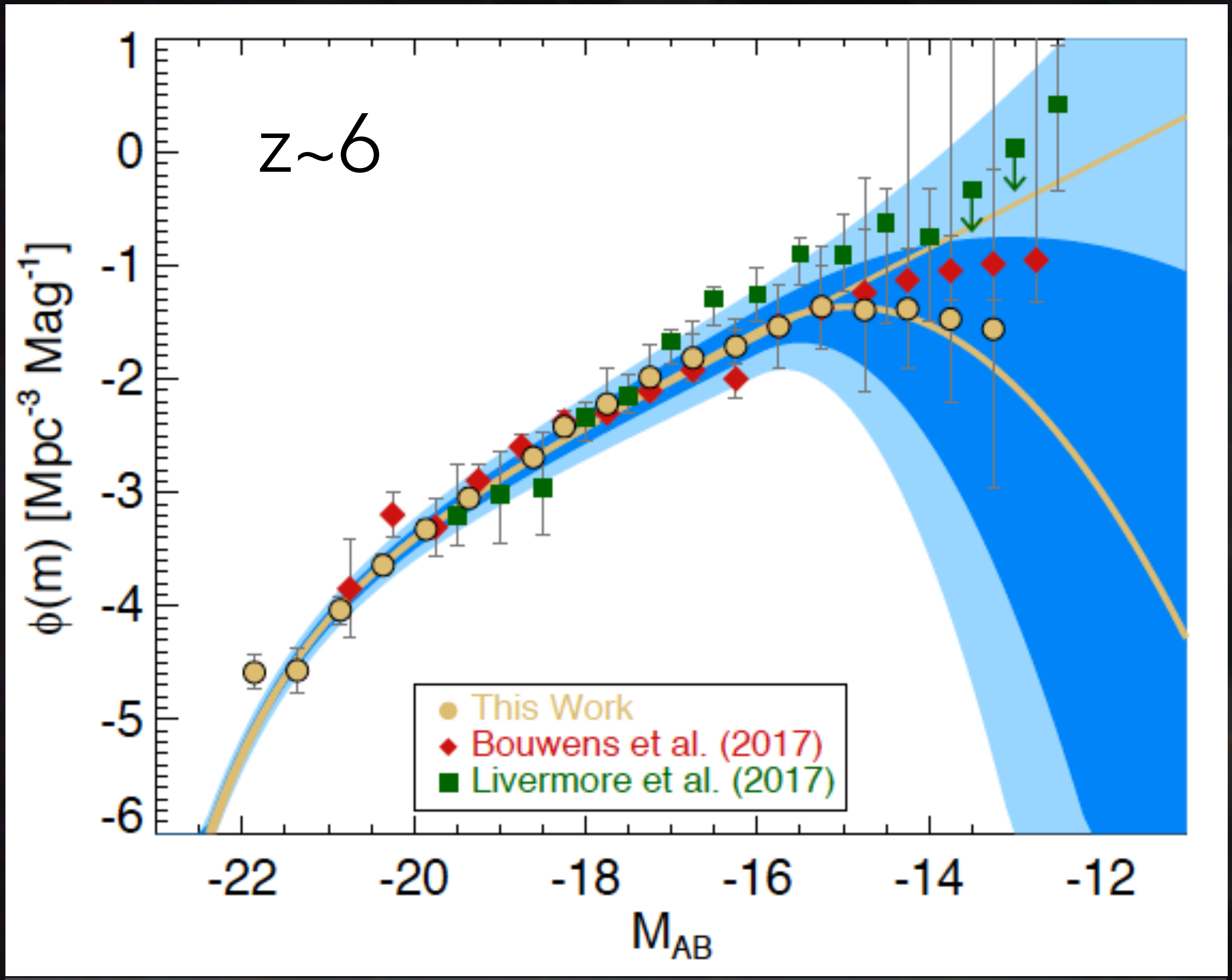
LGRBs AS SFR TRACERS

Finkelstein 2017



LGRBs AS SFR TRACERS

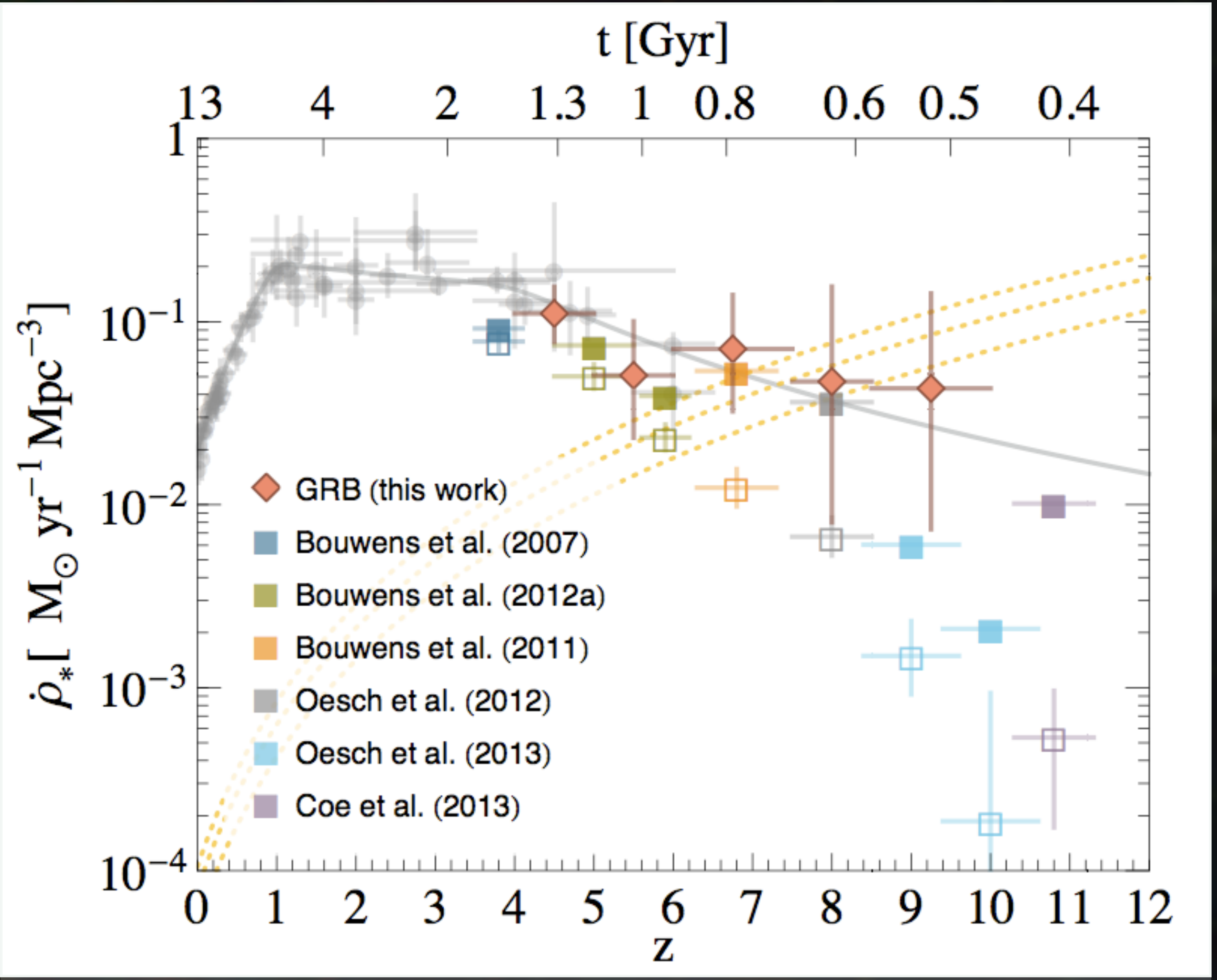
Atek+18



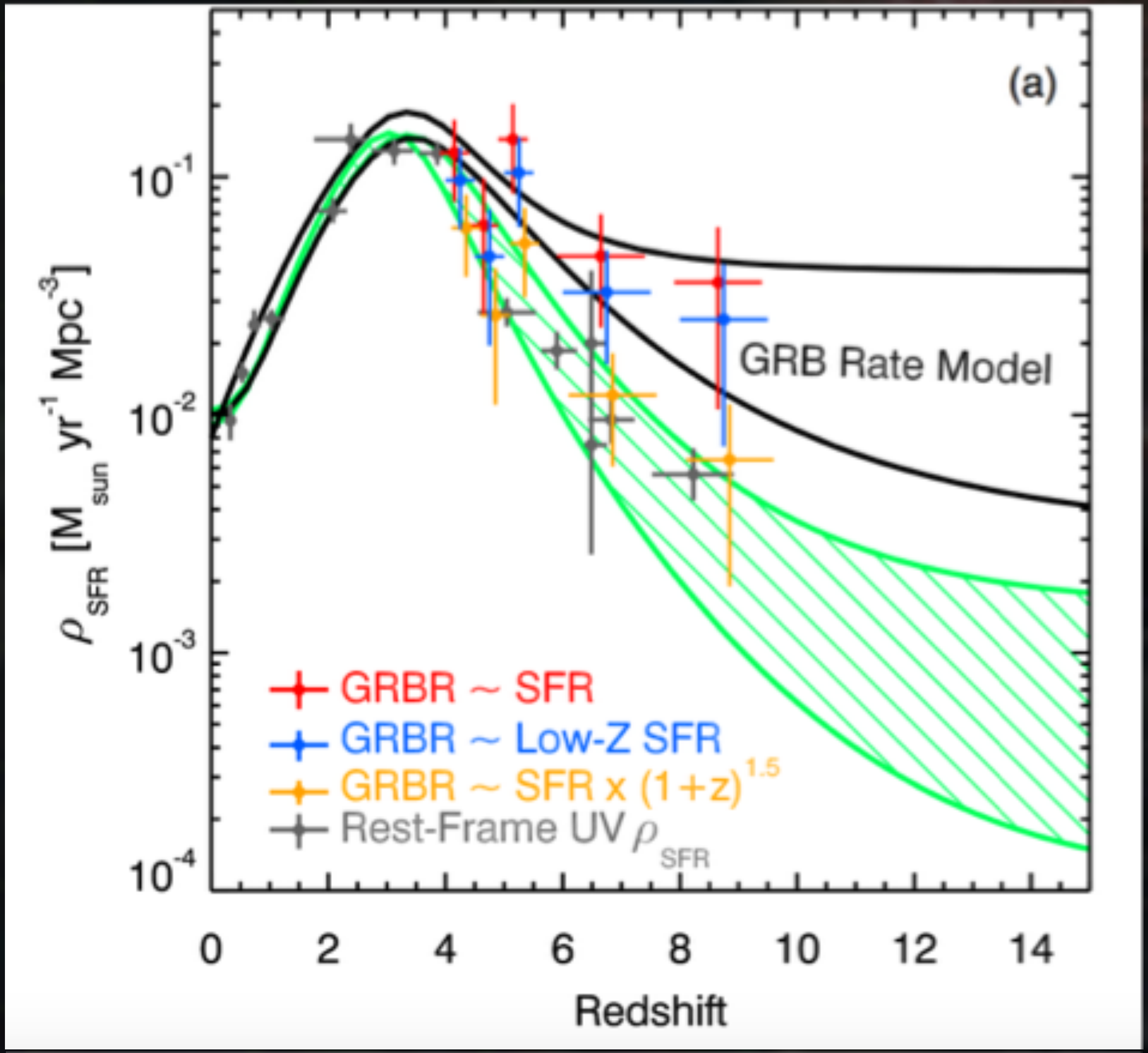
LGRBs AS SFR TRACERS

LGRBs produced by massive stars —> star formation

Kistler+13



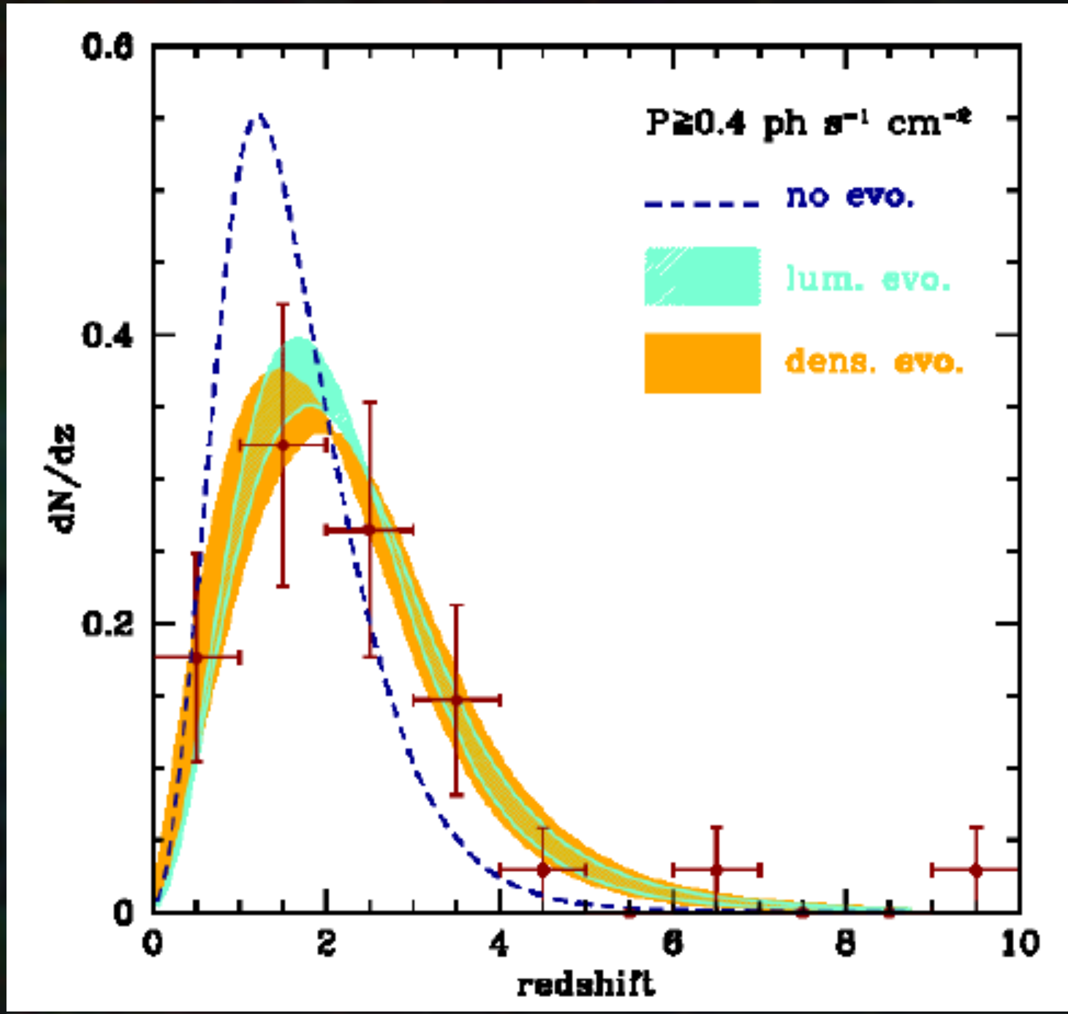
Robertson & Ellis 2012



LGRBs AS SFR TRACERS

? GRBrate = efficiency x SFR

? efficiency = eff.(z)



Salvaterra+12

Stellar evolution models predict that **metallicity** impacts the production of LGRB

Density evolution is expected

Progenitor star conditions needed to have a LGRB

LGRBs AS SFR TRACERS

Indirect information through host galaxy studies

- TOUGH: 69 galaxies, z completeness 85%, photometry
  Hjorth+12

- X-Shooter sample: 96 galaxies, complete up to z<1, spectroscopy
  Krühler+15

- *Swift*/BAT6: 58 galaxies, z completeness 97%, photometry (M_{star}) & spectroscopy (*SFR & Z*)
  Salvaterra+12

- SHOALS: 119 galaxies, z completeness 92%, photometry
  Perley+16

LGRBs AS SFR TRACERS

How: Comparison of the properties of LGRB host galaxies with those of star-forming galaxies (weighted by their SFR)

- TOUGH: 69 galaxies, z completeness 85%, photometry
  Hjorth+12

- X-Shooter sample: 96 galaxies, complete up to z<1, spectroscopy
  Krühler+15

- *Swift*/BAT6: 58 galaxies, z completeness 97%, photometry (M_{star}) & spectroscopy (*SFR & Z*)
  Salvaterra+12

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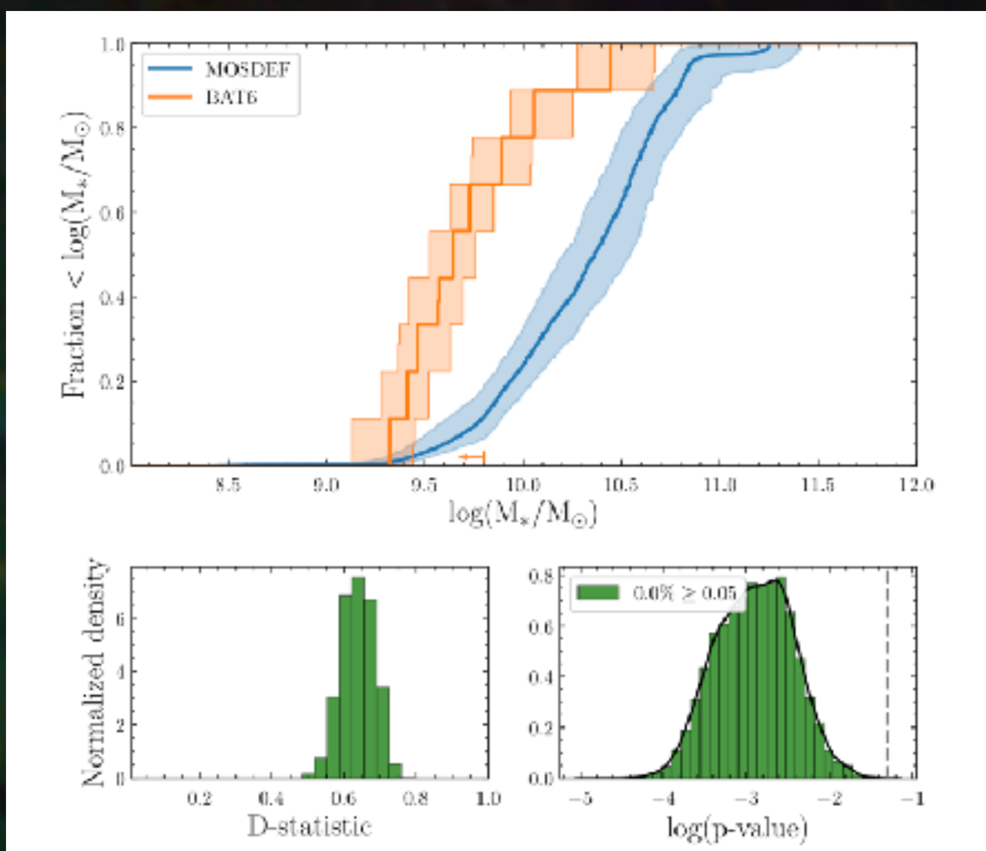
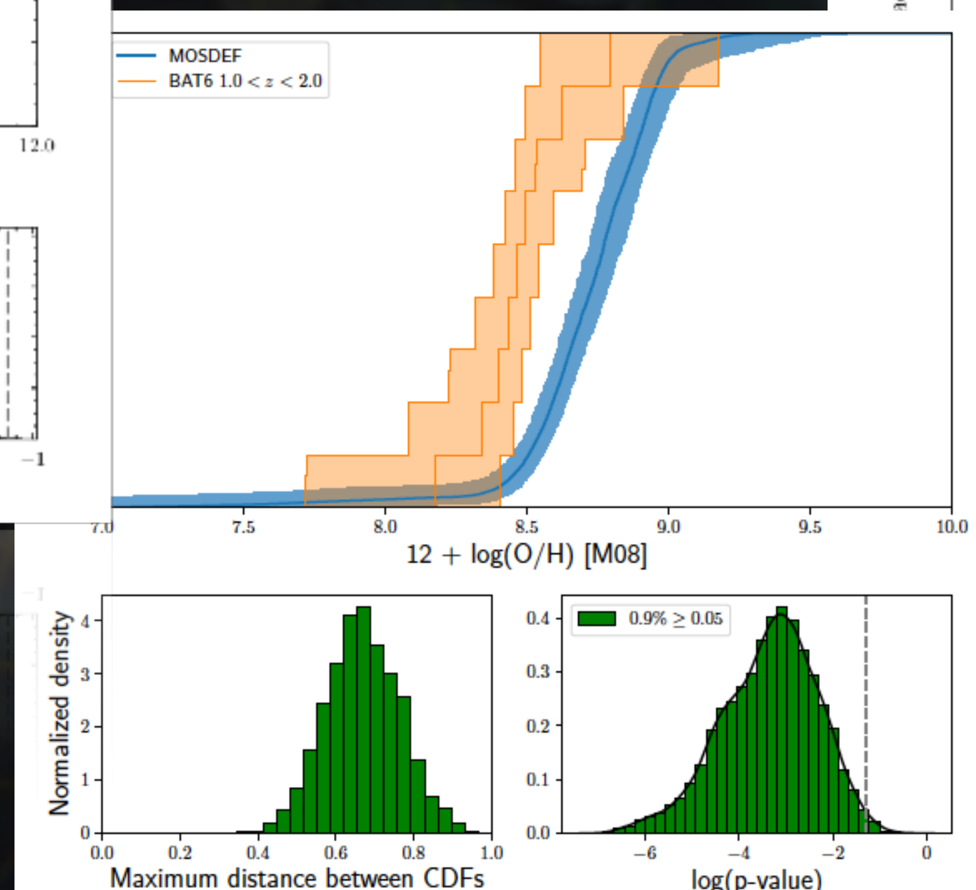
LGRBs AS SFR TRACERS

0.3<z<1 (Vergani+15; Japelj, Vergani+16) & **1<z<2** (Vergani+17; Palmerio, Vergani+19)

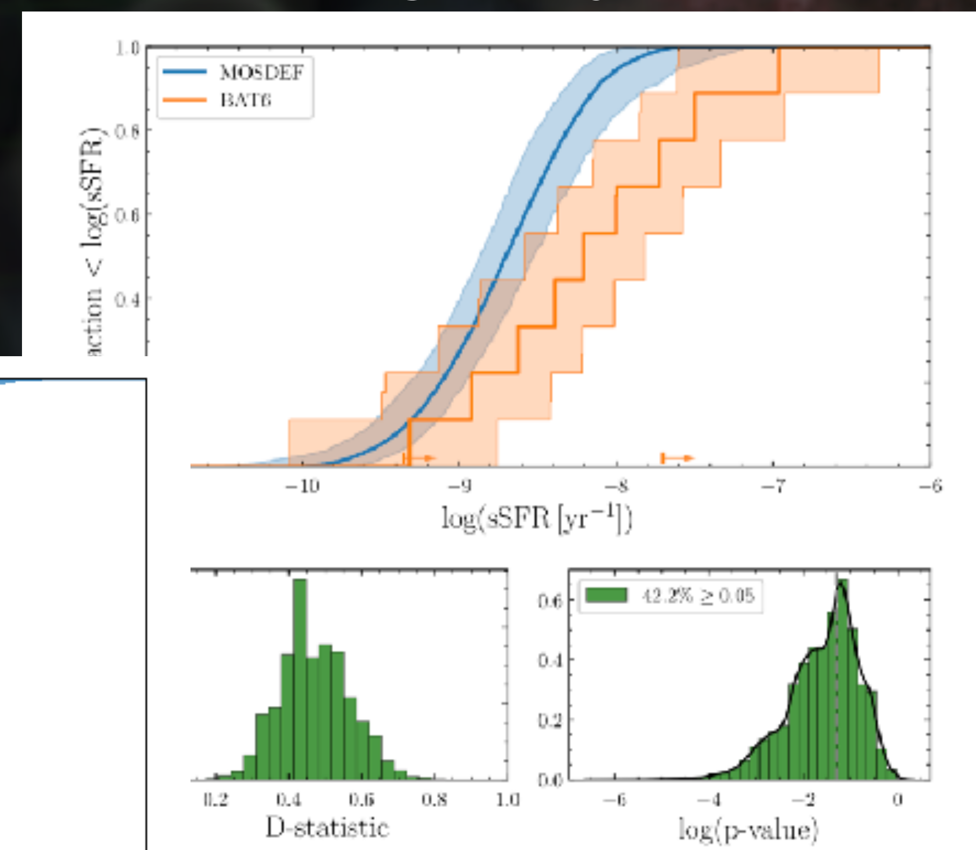
Host galaxy stellar mass



Host galaxy metallicity



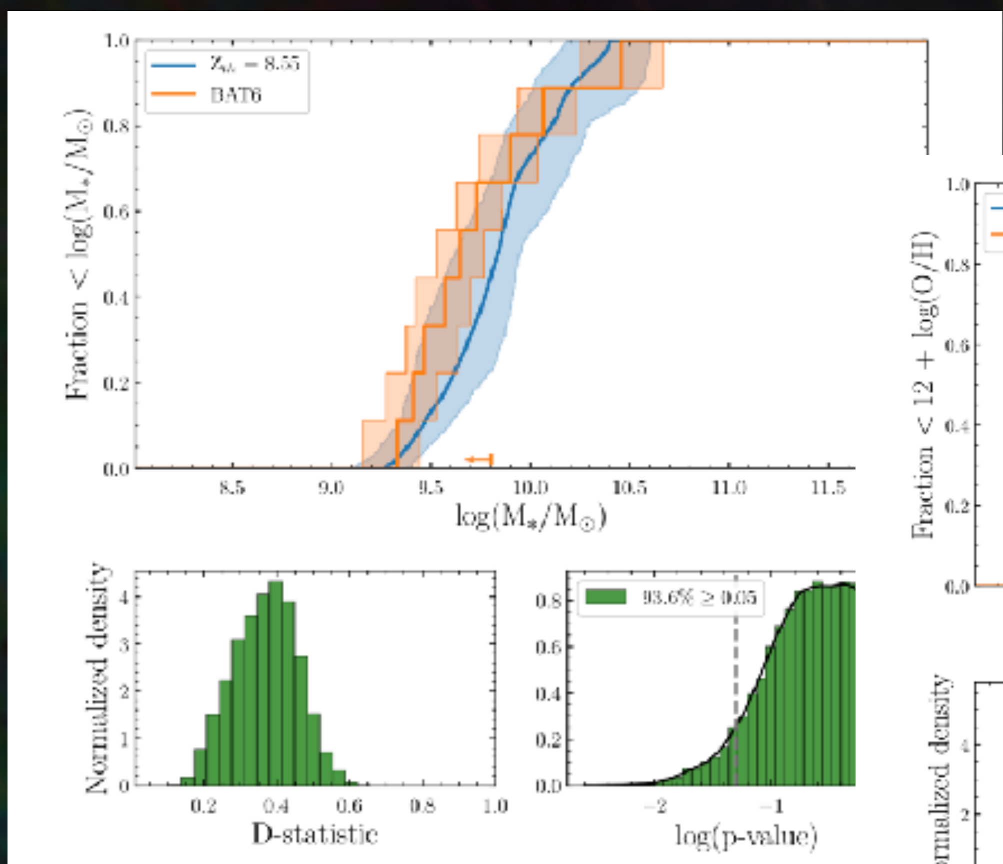
Host galaxy sSFR



GRBs AS SFR TRACERS

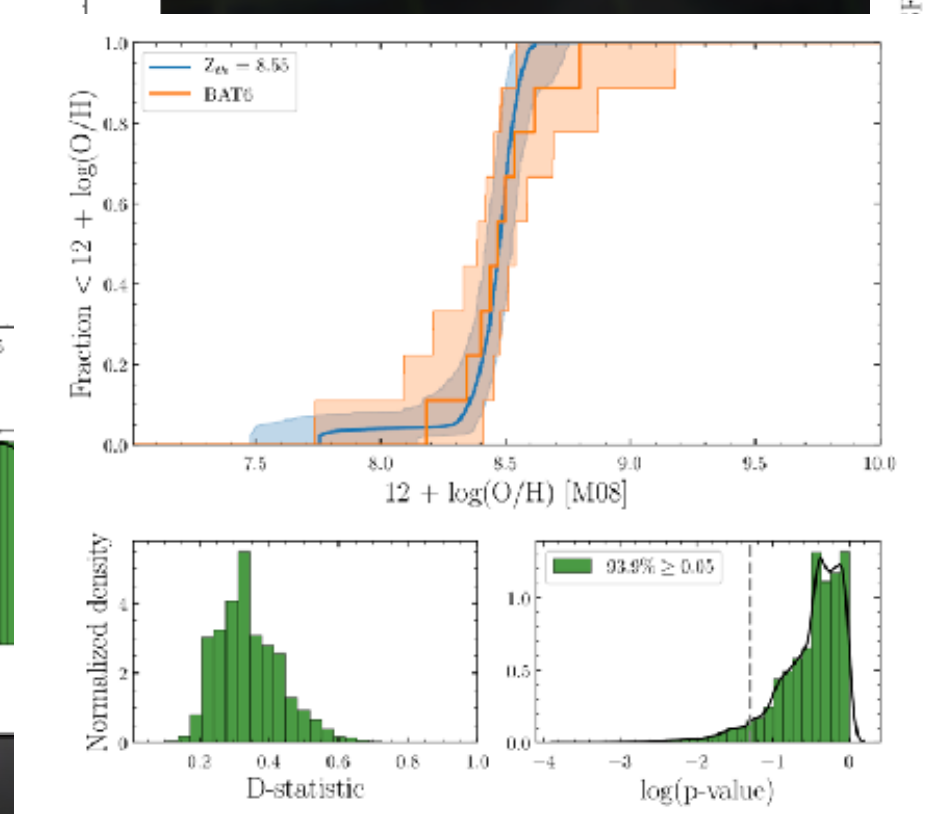
Z_{th}: $0.7Z_{sun}$

stellar mass

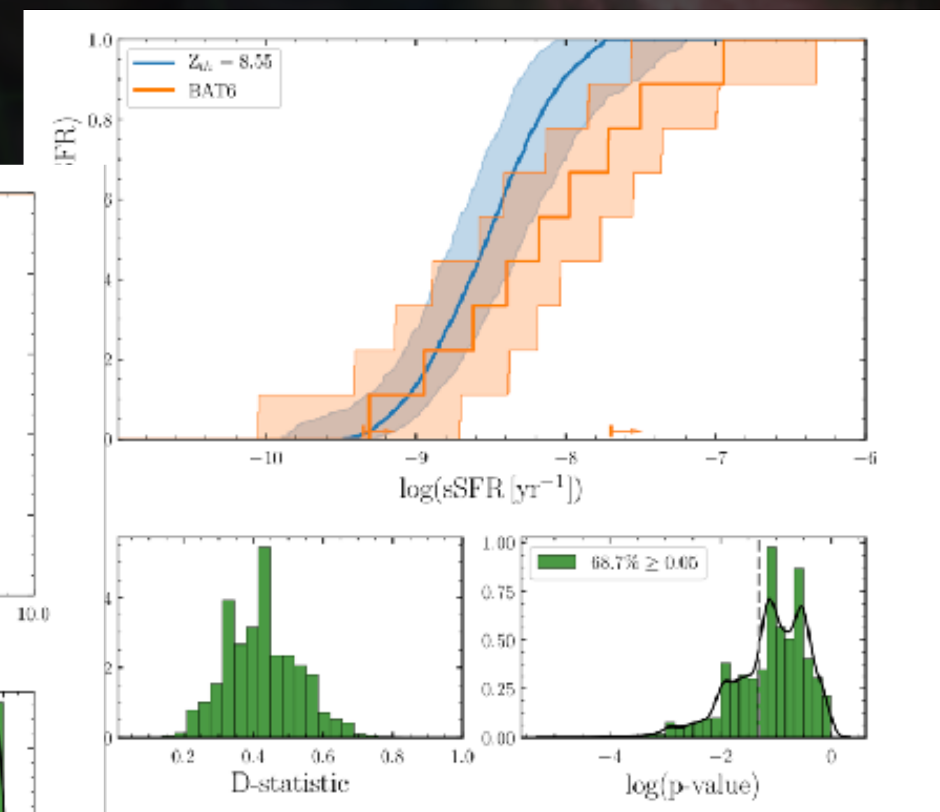


Palmerio+19

Metallicity

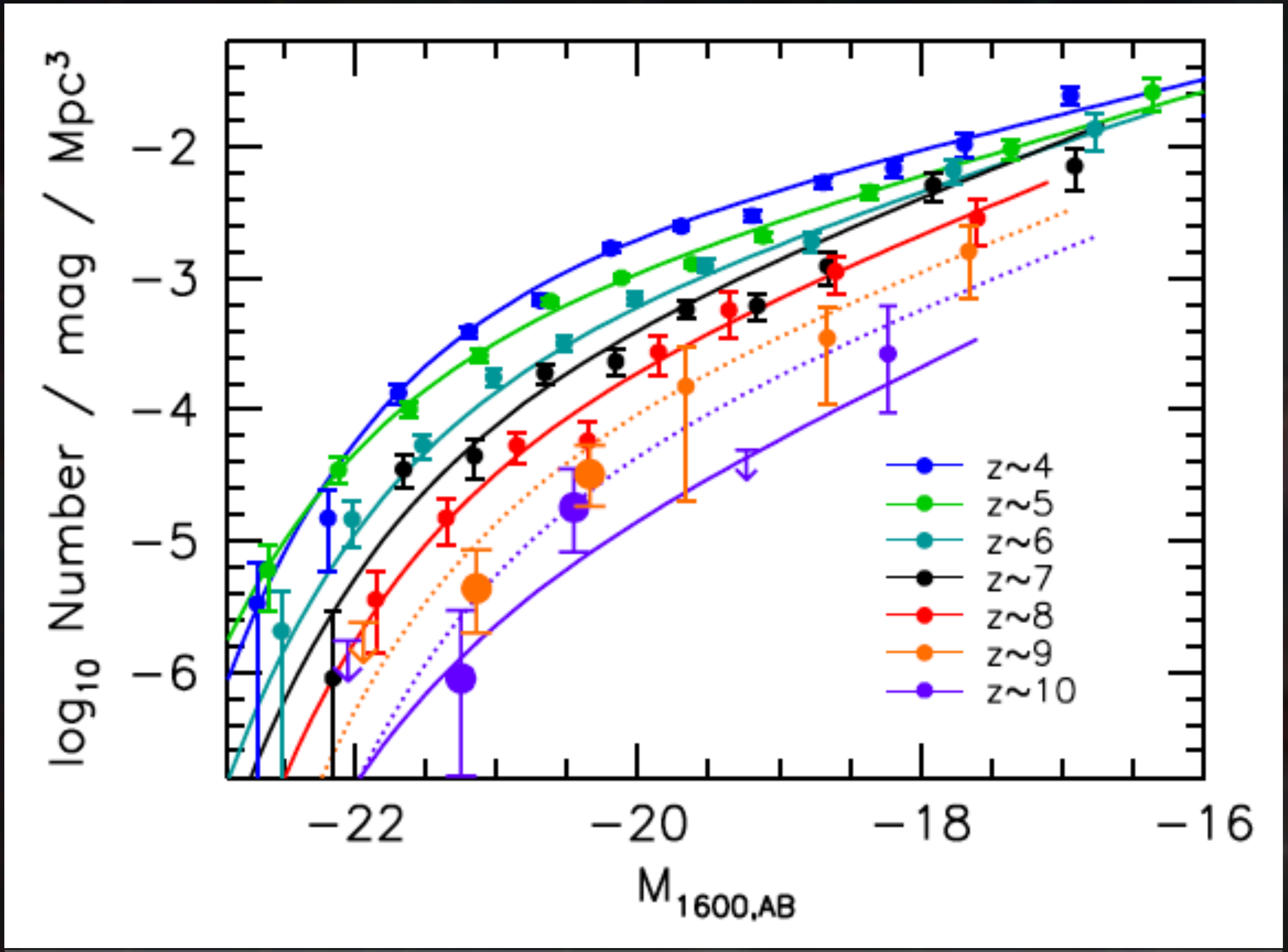


sSFR



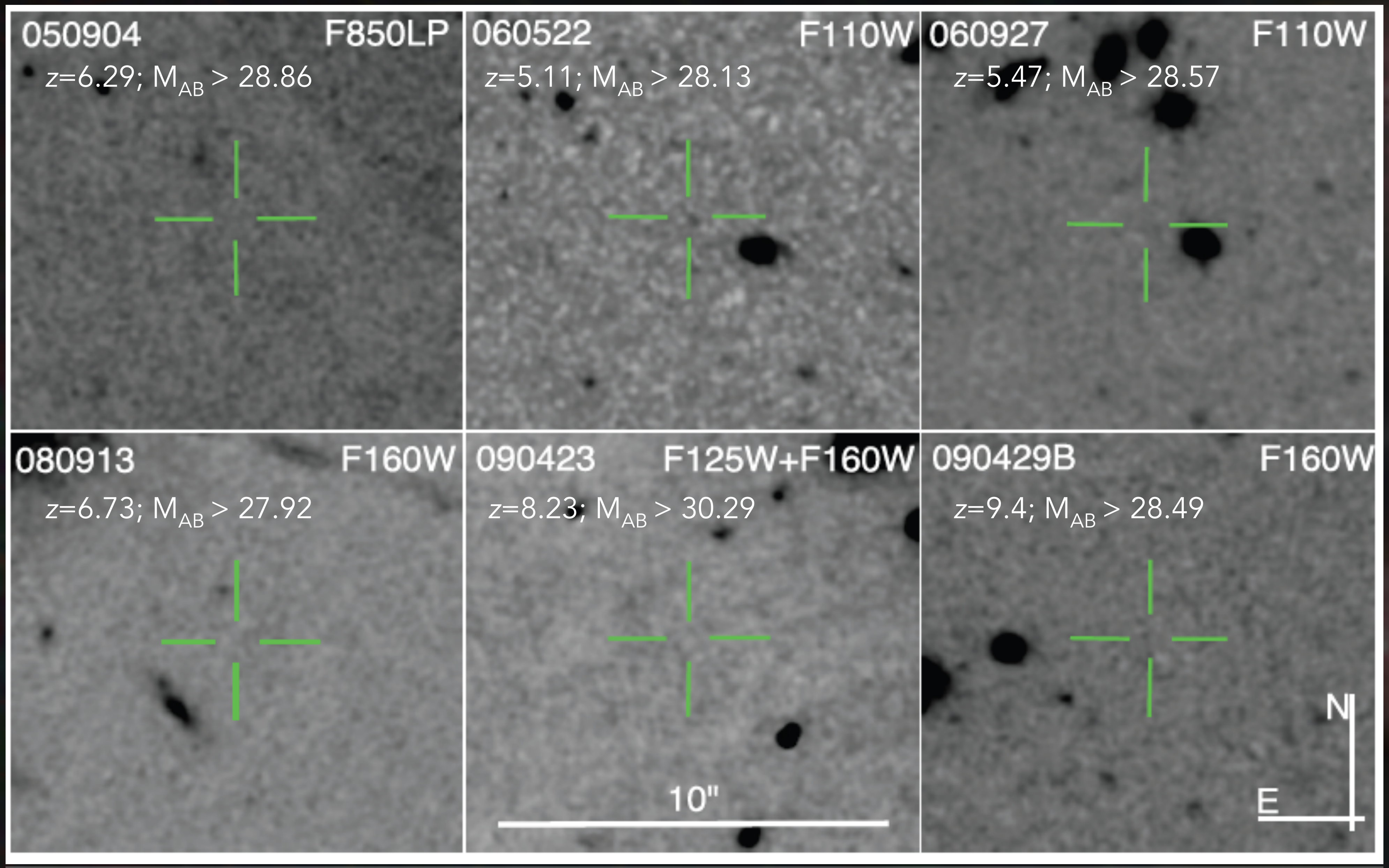
Metallicity is the driving factor,
LGRBs tracers of cosmic SF at z>3

LGRBs & THE FIRST GALAXIES



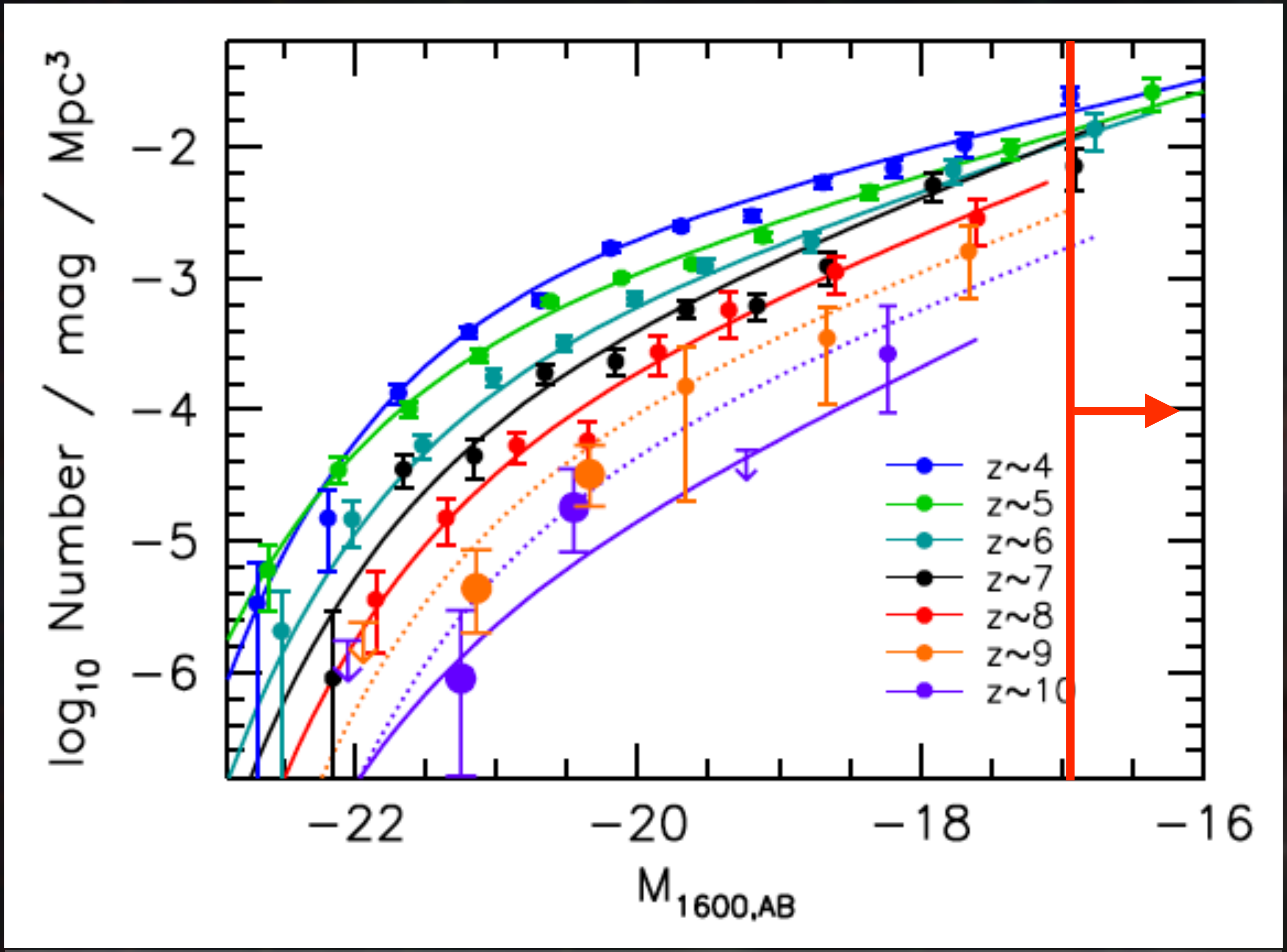
Bouwens+15

LGRBs & THE FIRST GALAXIES



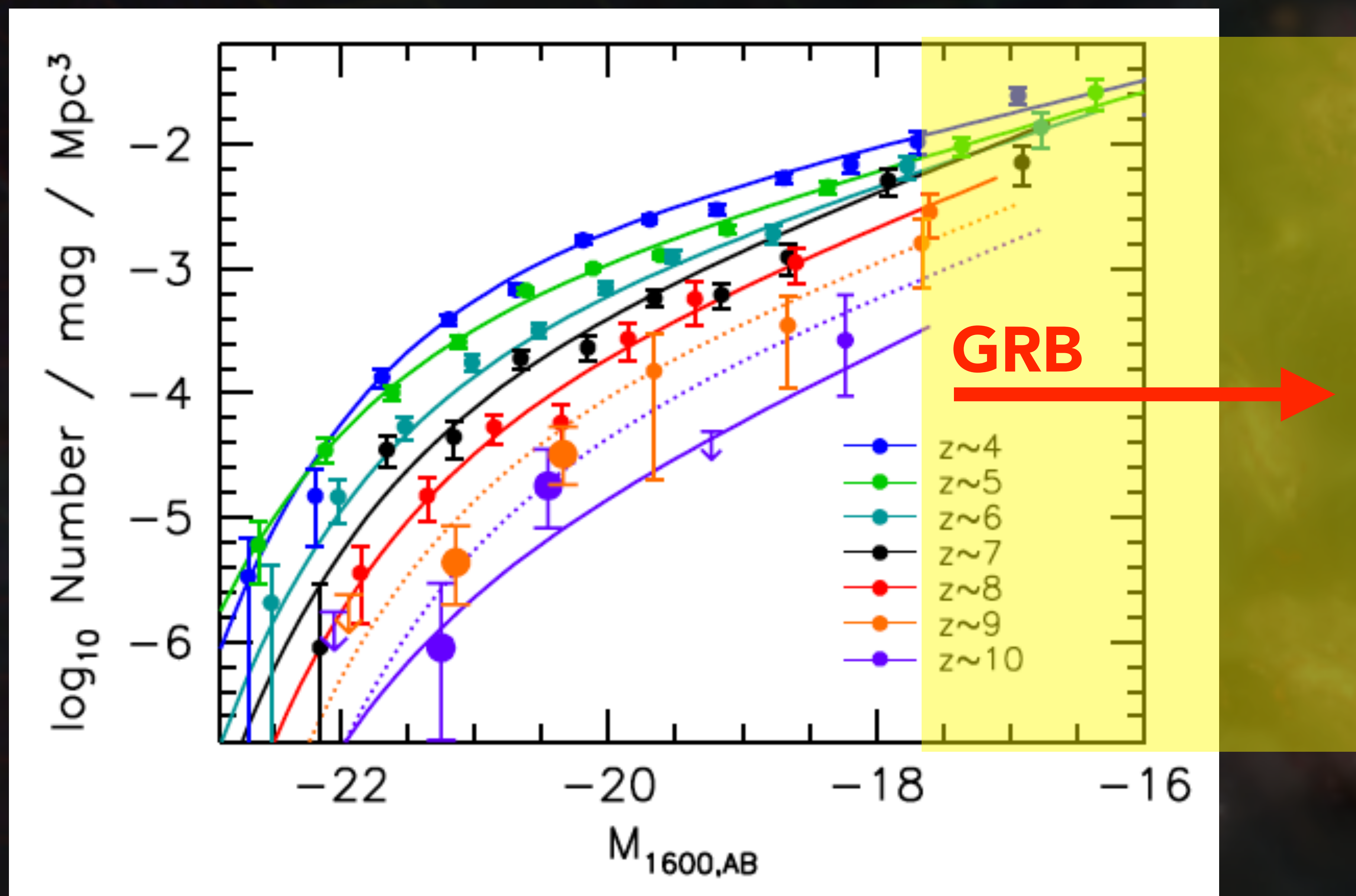
Tanvir+12

LGRBs & THE FIRST GALAXIES



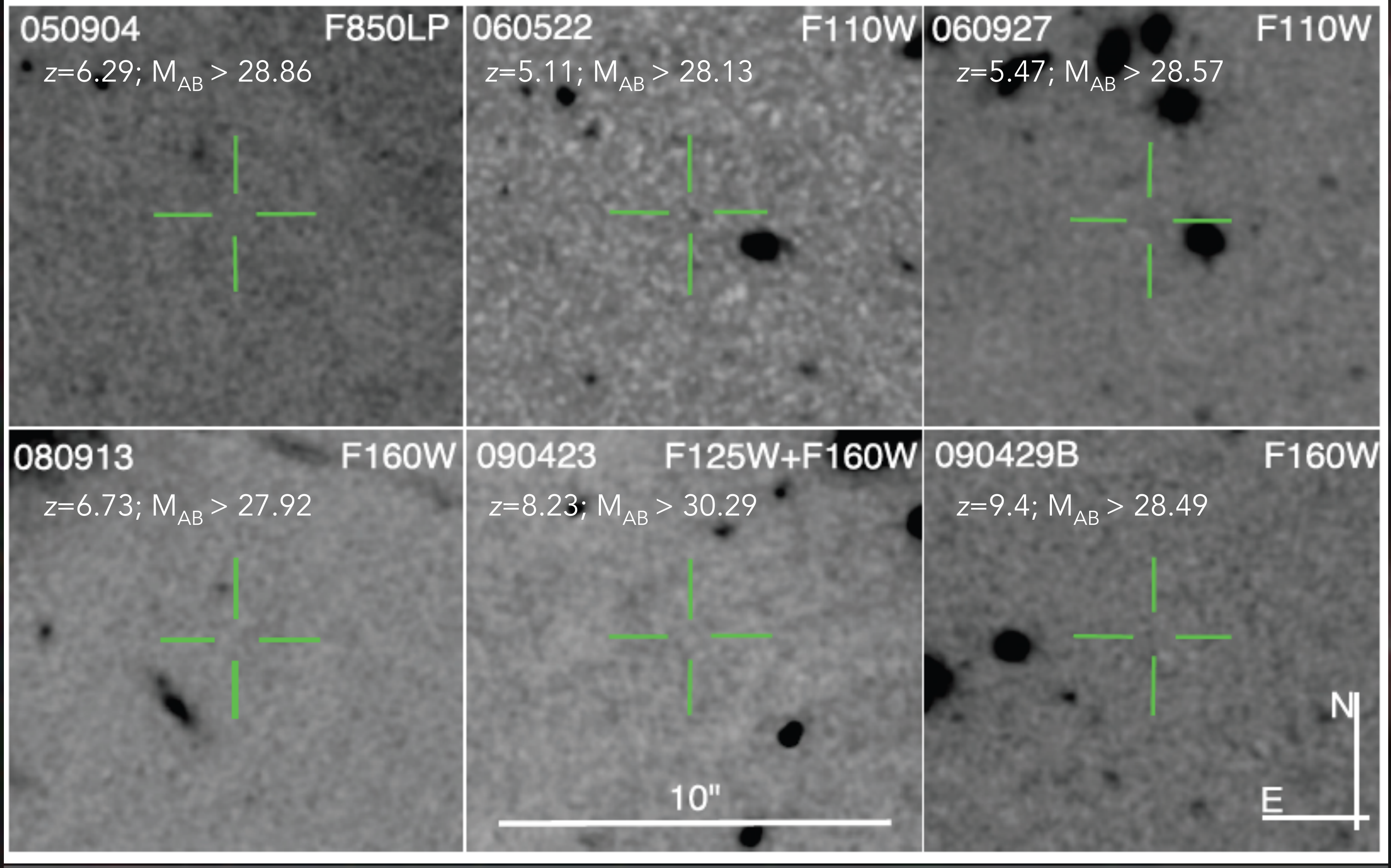
Bouwens+15

LGRBs & THE FIRST GALAXIES



Bouwens+15

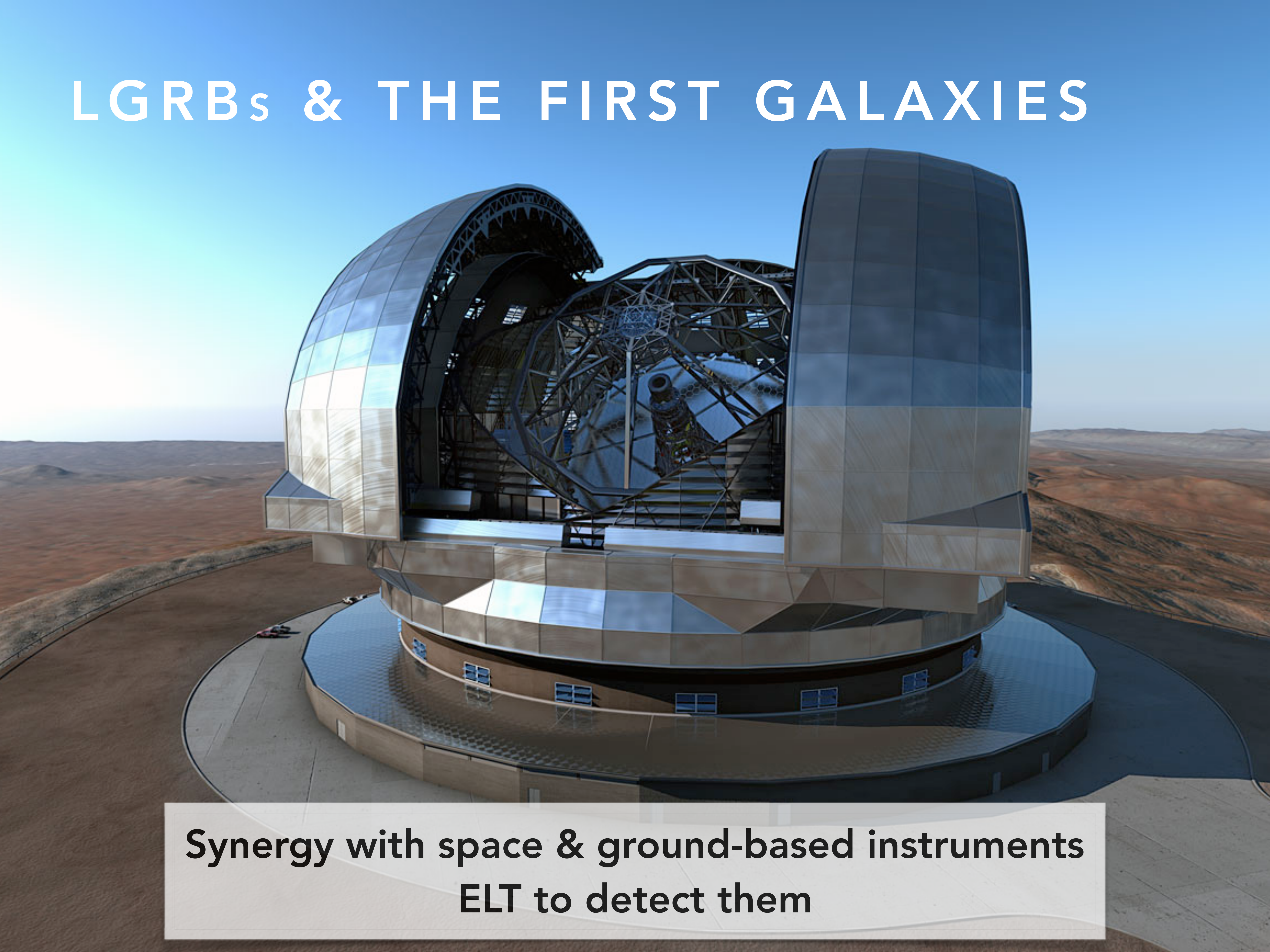
LGRBs & THE FIRST GALAXIES



Tanvir+12

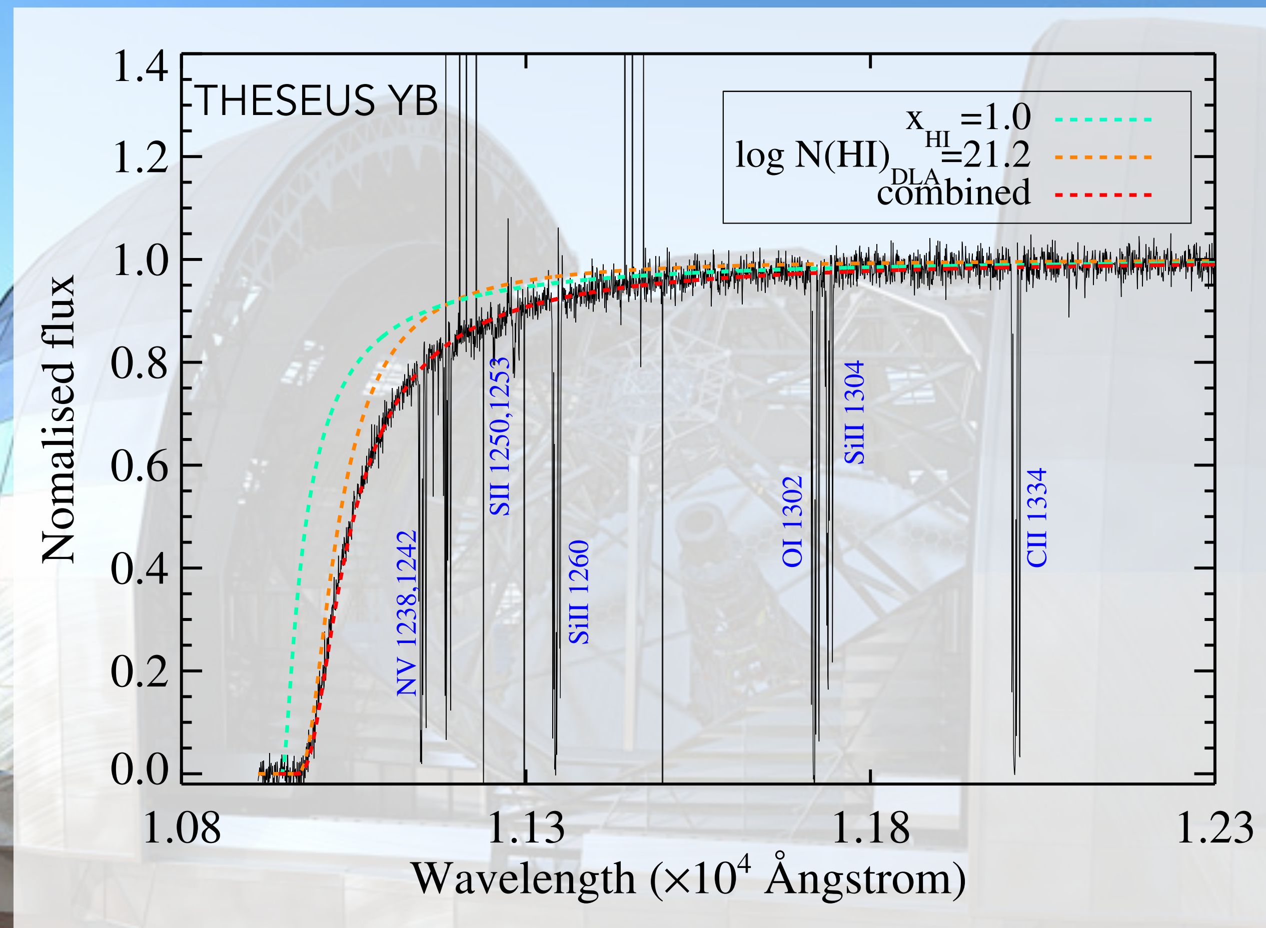
LGRB pinpoint very high-z galaxies belonging to bulk of the population

LGRBs & THE FIRST GALAXIES



Synergy with space & ground-based instruments
ELT to detect them

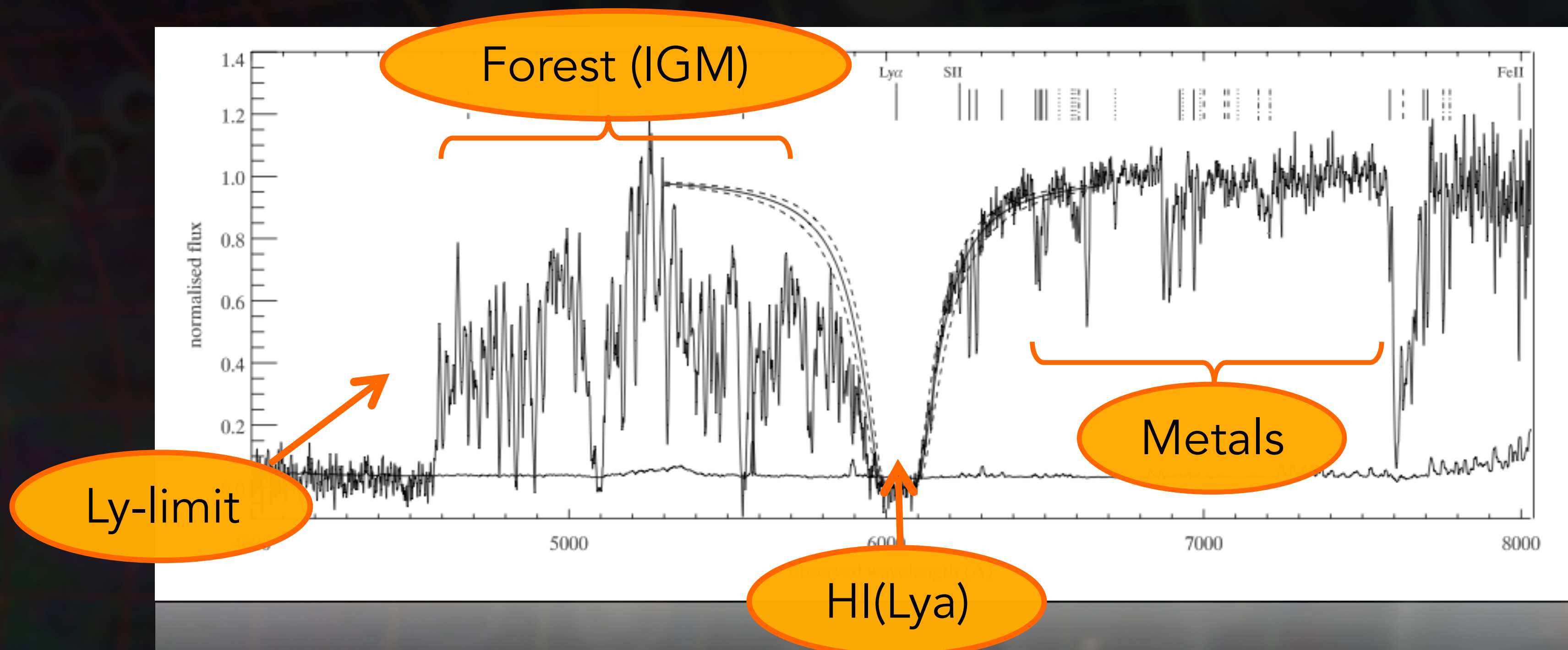
LGRBs & THE FIRST GALAXIES

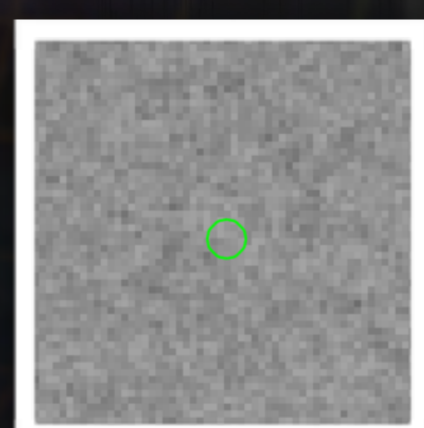


+ GRB afterglow: unique information!!!
for galaxies belonging to the bulk
of the very high-z population

Synergy with space & ground-based instruments
ELT to detect them

LGRBs & THE FIRST GALAXIES





z=3.97

[Fe/H]=-2

R>28.5

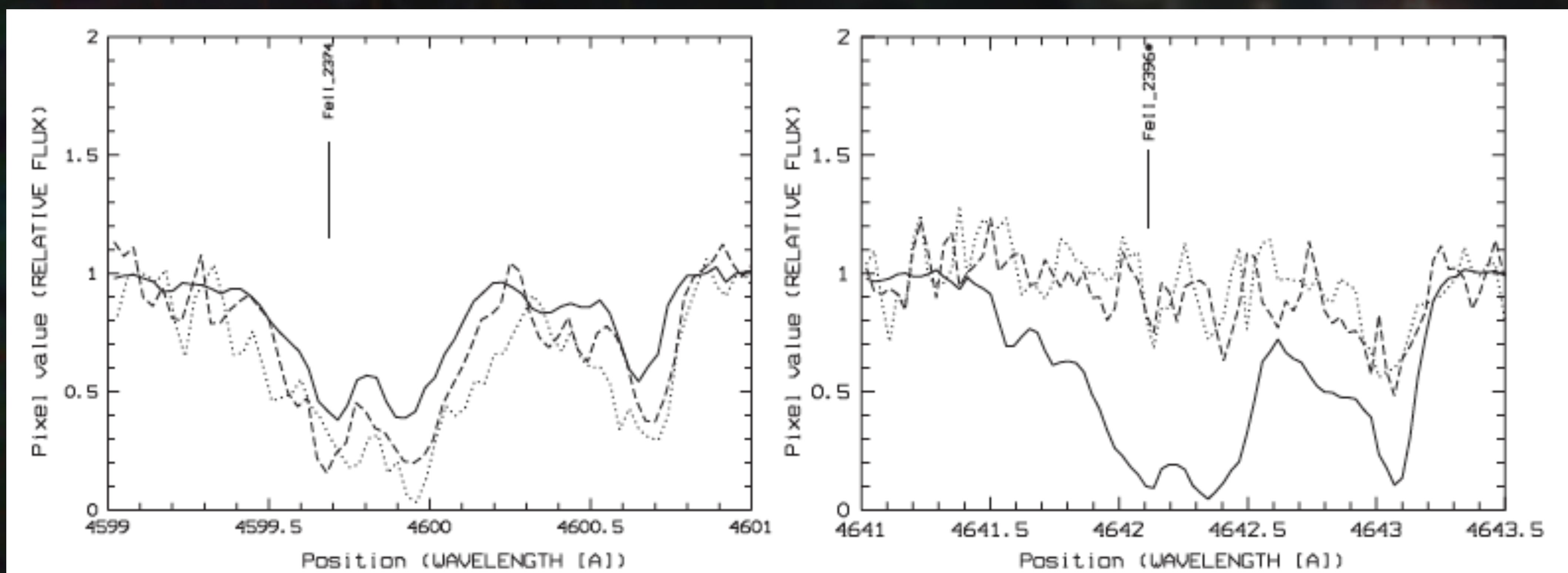
Chen+ 2005; Starling+2005

LGRBs & THE FIRST GALAXIES

Fine-structure and meta-stable lines due to UV-pumping caused by the radiation field

GRB afterglow + massive stars

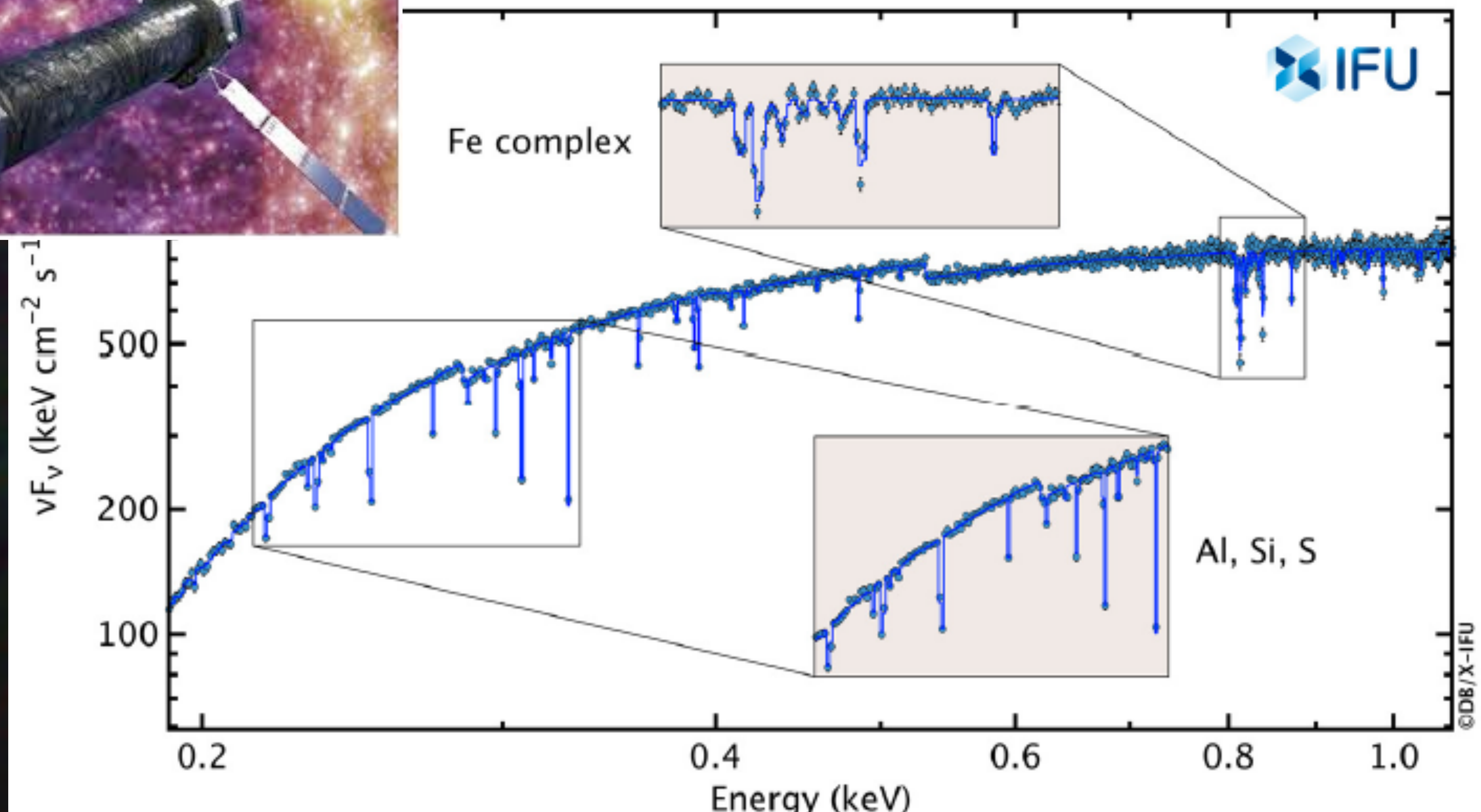
D'Elia+09



see also Vreeswijk+07,08,12,13

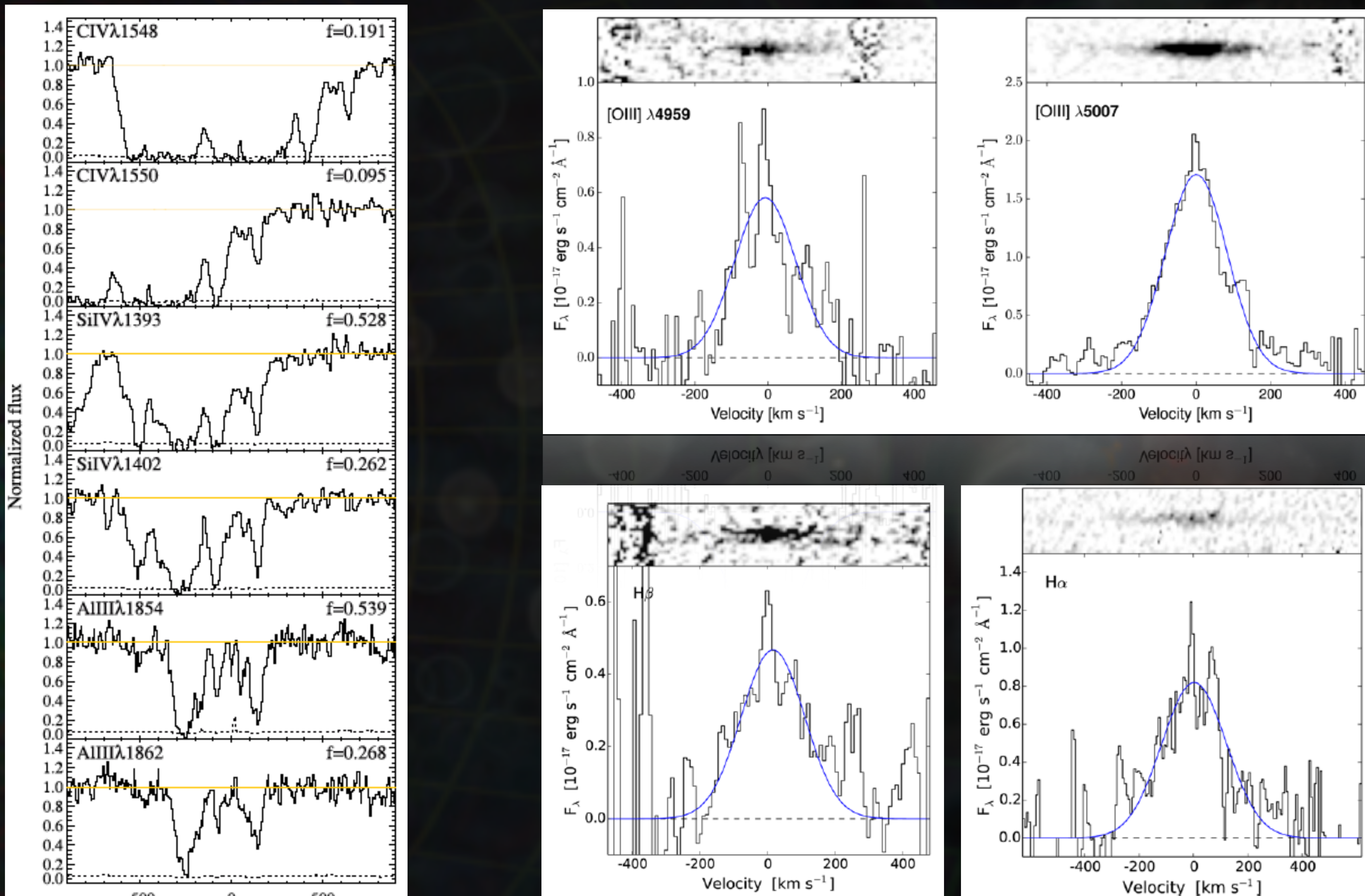
LGRBs & THE FIRST GALAXIES

GRB @ z~8



THESEUS YB

LGRBs & THE FIRST GALAXIES



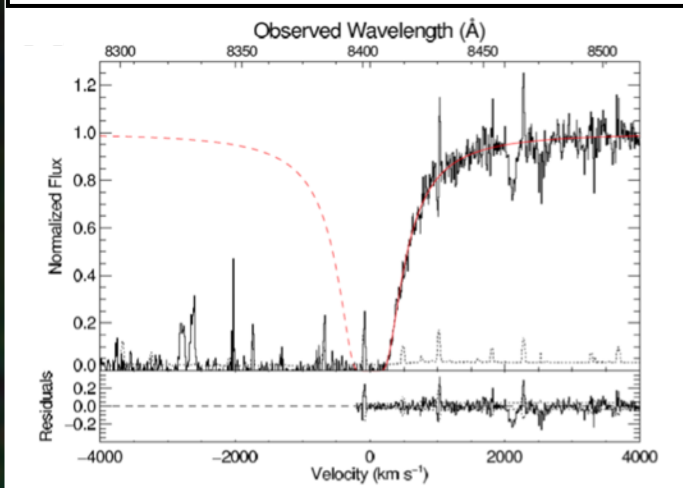
Friis+15

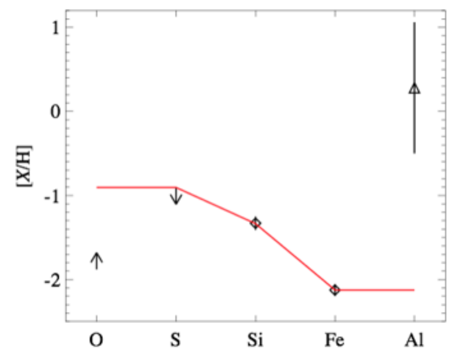
GRB 121024A @ z=2.3 Friis+15

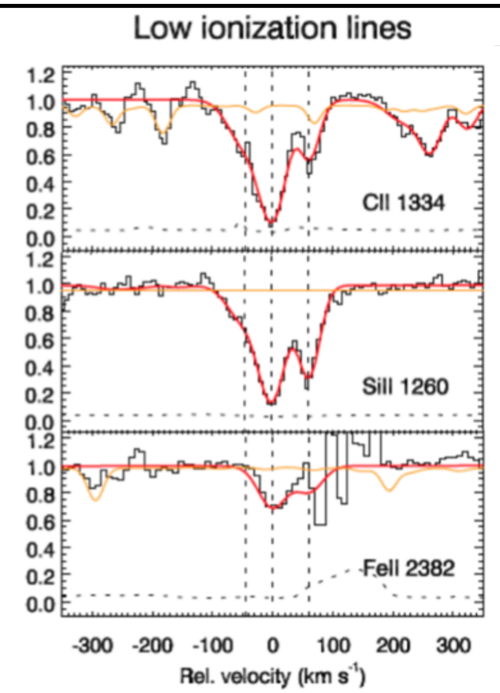
LGRBs & THE FIRST GALAXIES

z~6

X-shooter afterglow spectrum

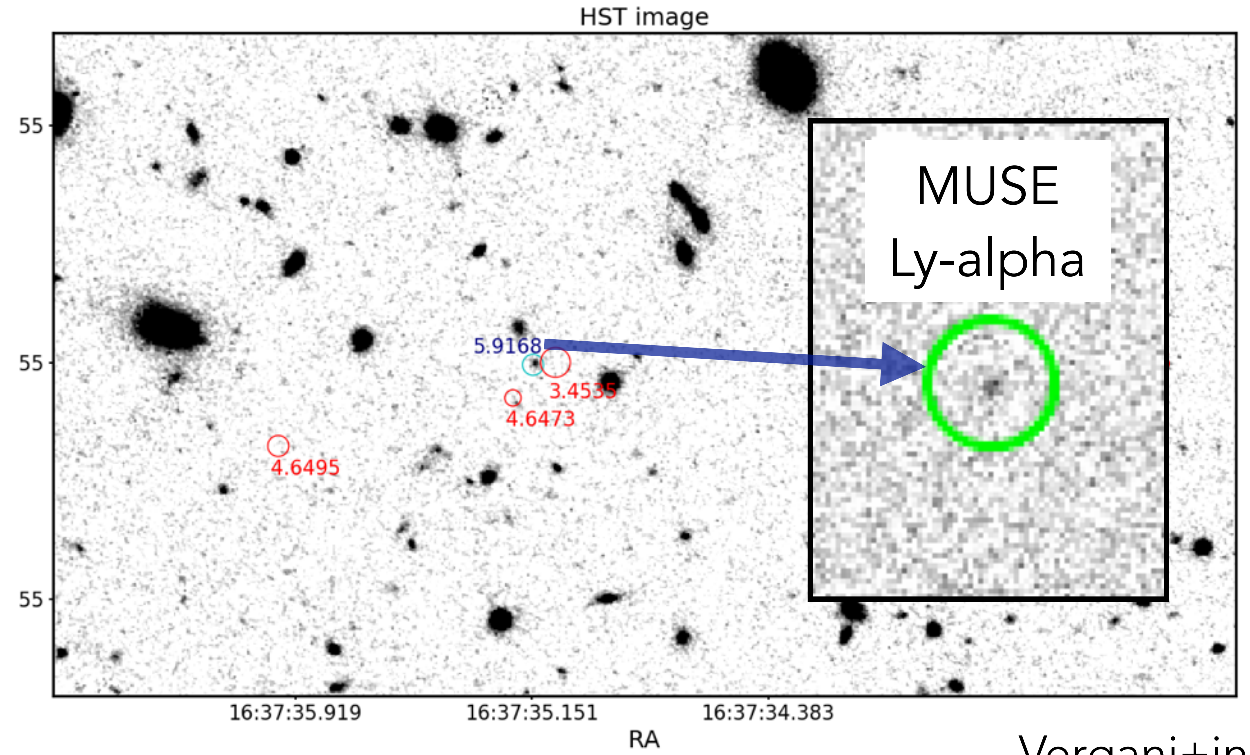






Hartoog+15

MUSE + HST campaign



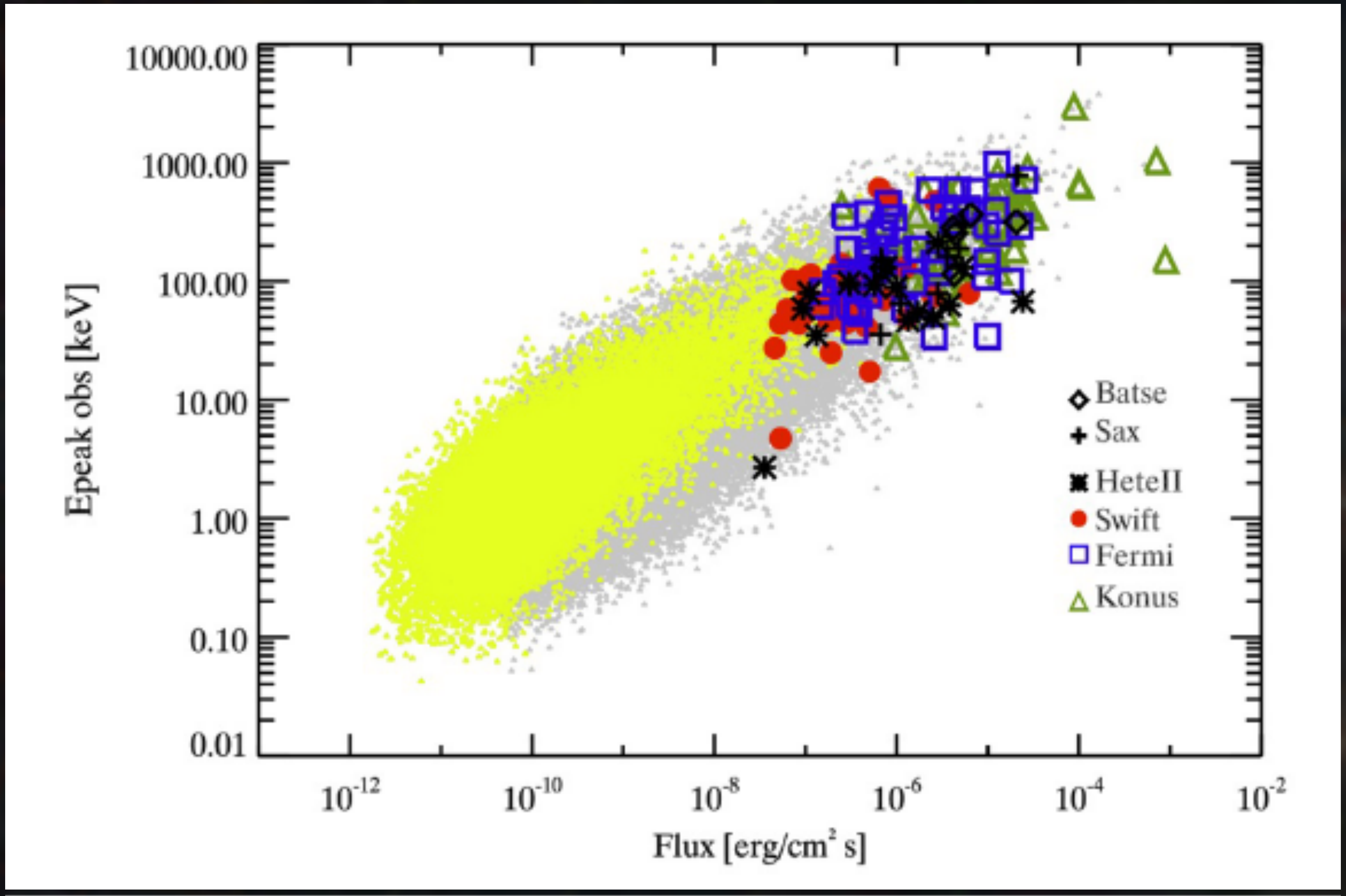
Vergani+in prep.

The only object at high redshift (z~6) having information on HI, ISM, continuum and emission lines

JWST to detect nebular lines

We need to increase the number of high-z GRBs detected by the satellites

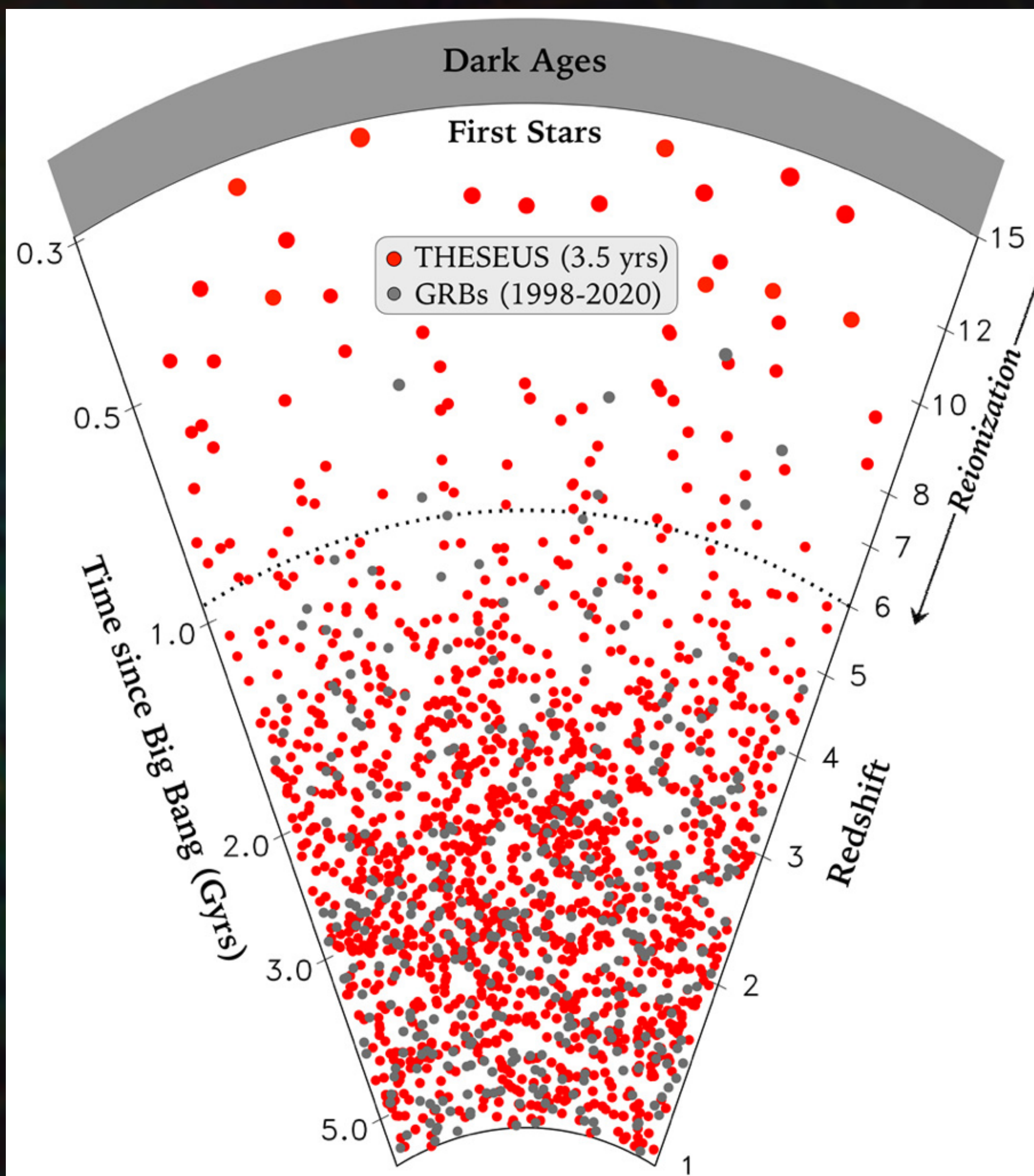
Ghirlanda+ 2015



z>5 population

theseus
TRANSIENT HIGH ENERGY SKY AND EARLY UNIVERSE SURVEYOR

THESEUS YB



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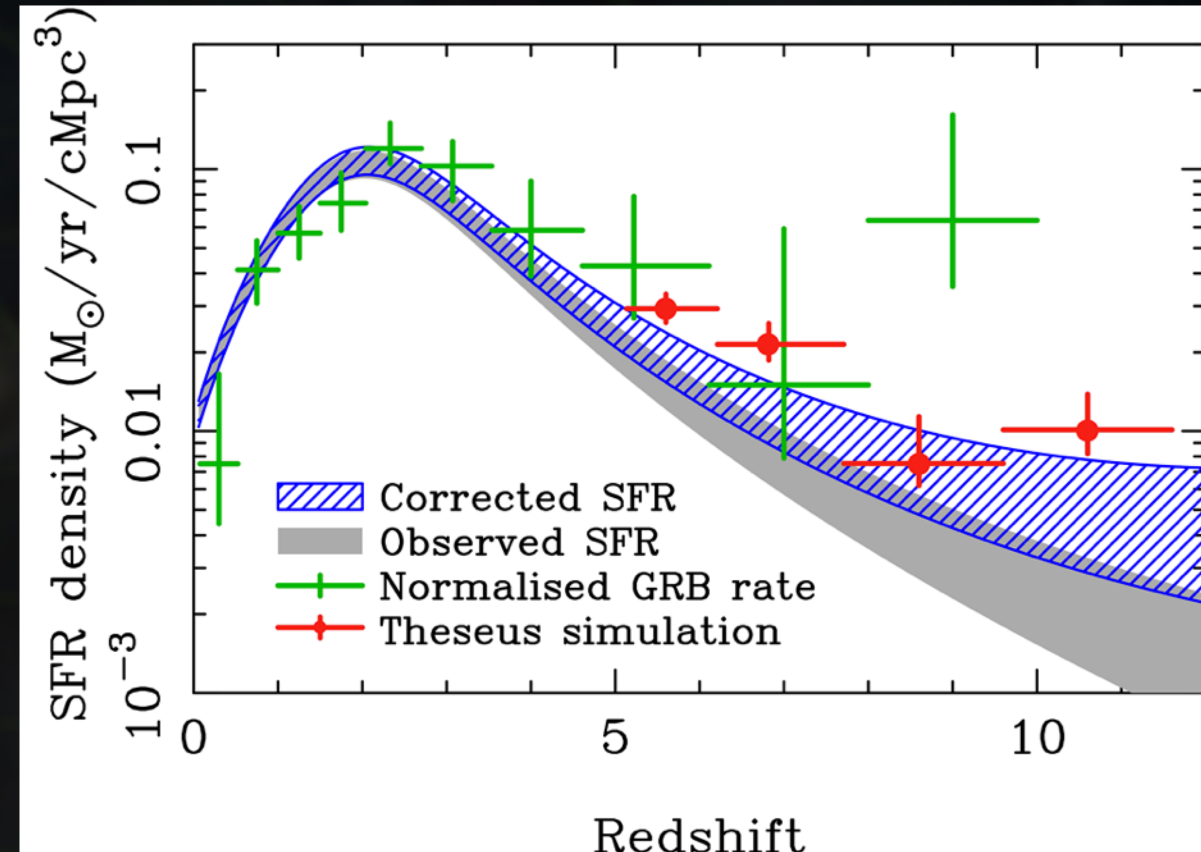

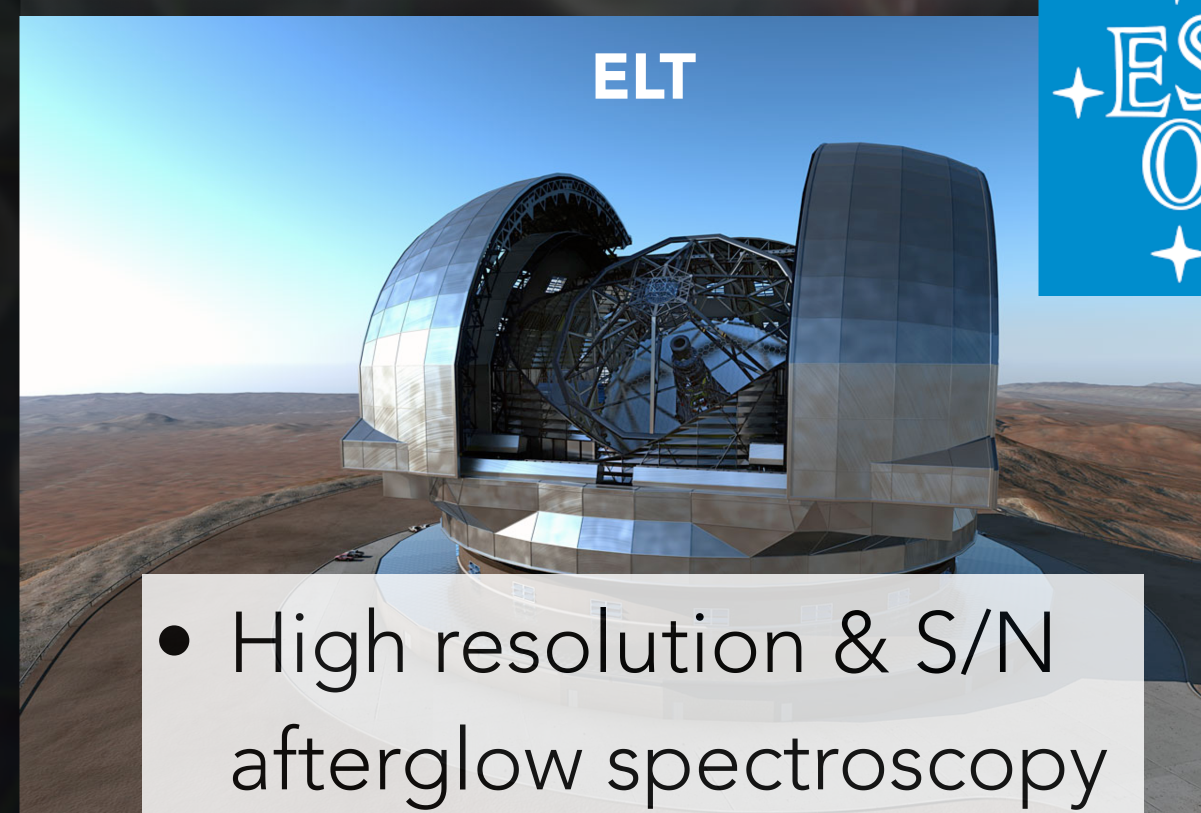

- High resolution & S/N afterglow spectroscopy
- Host galaxy detection

THANK YOU!