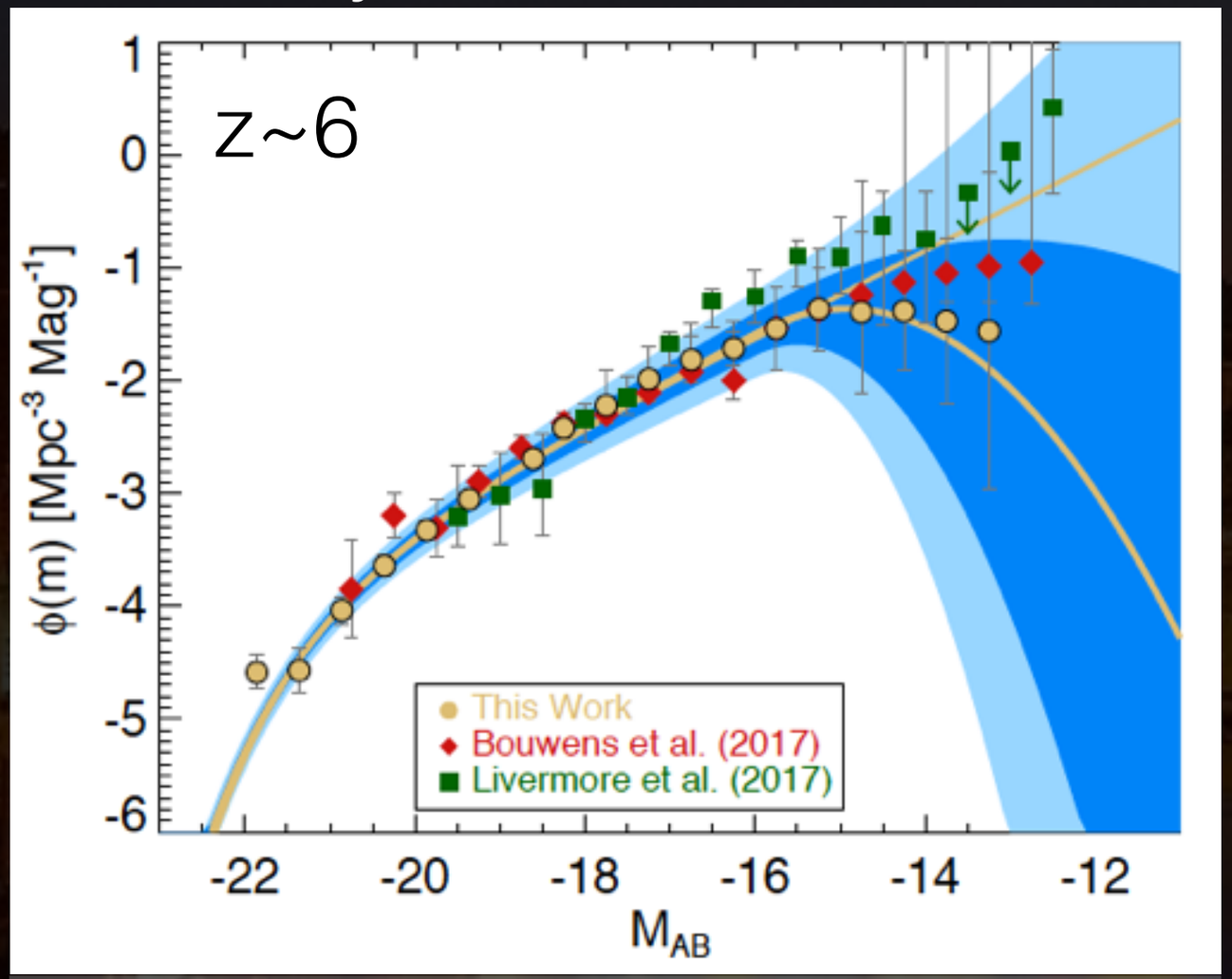
Gamma-ray bursts as tools to probe the early Universe

S.D.Vergani

Observations of the bulk of the population of very high-redshift galaxies

Photometry



Atek+18

A deep JWST survey with a time investment similar to the HUDF, will reach UV absolute magnitudes − 16 (− 15.5) at z = 10 (z = 7), two magnitudes fainter than the current HST observations

Observations of the bulk of the population of very high-redshift galaxies

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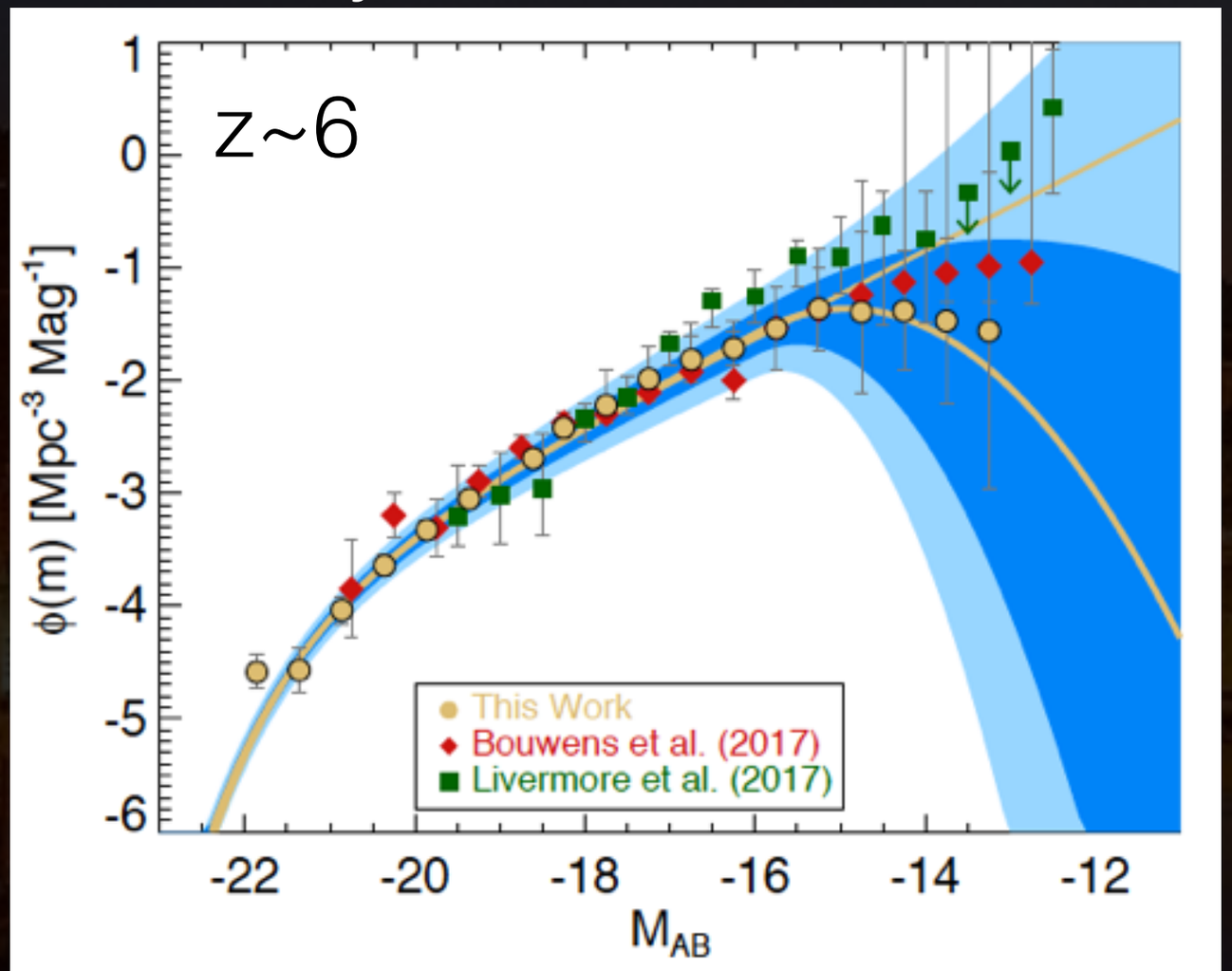
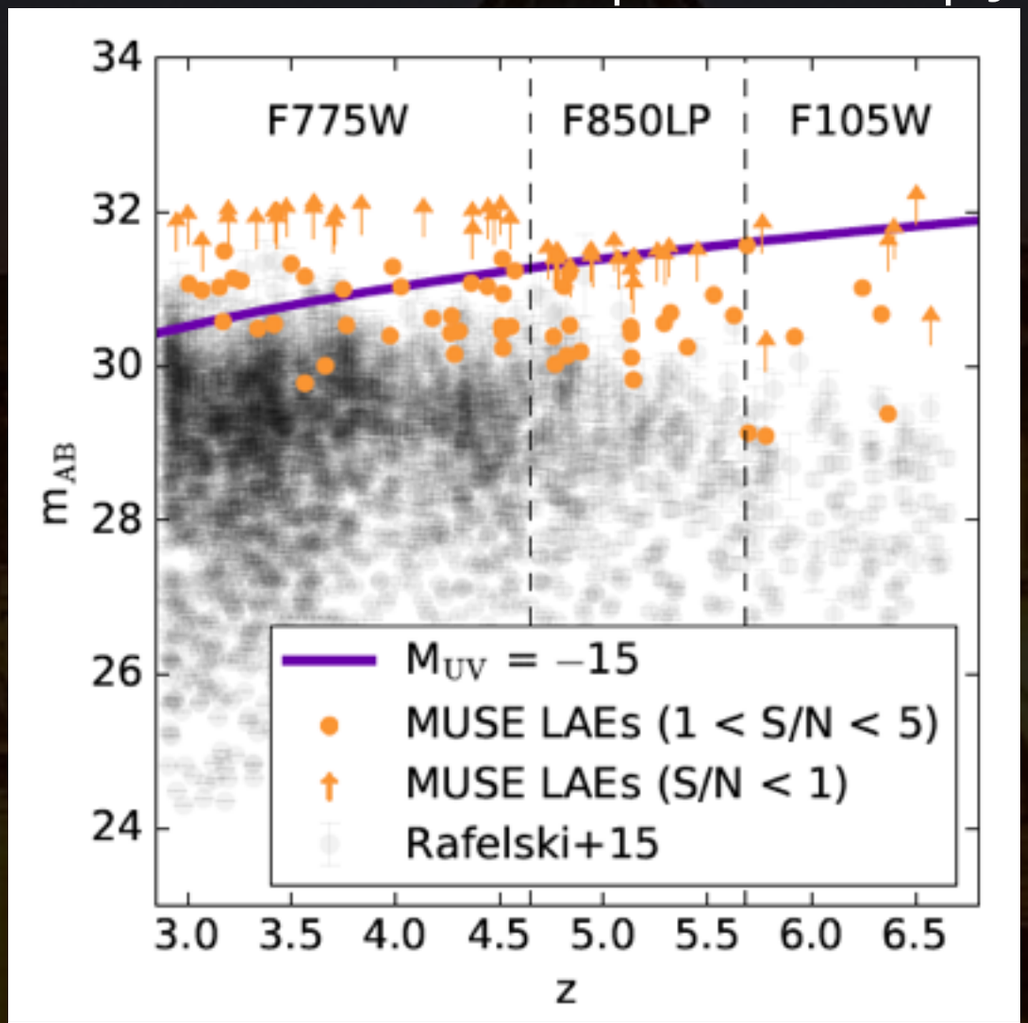


Atek+18

Spectroscopy



Maseda+18

Observations of the bulk of the population of very high-redshift galaxies

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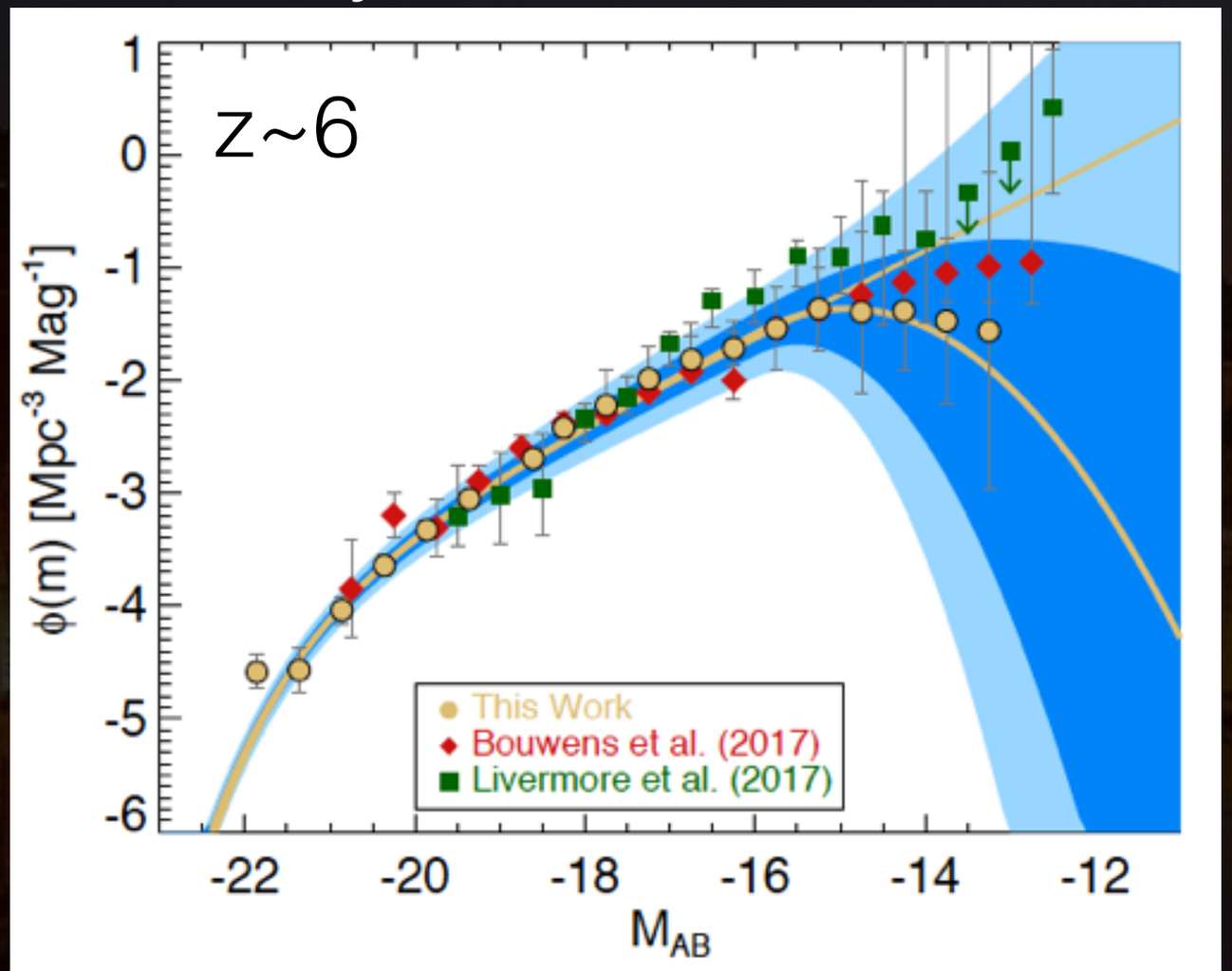
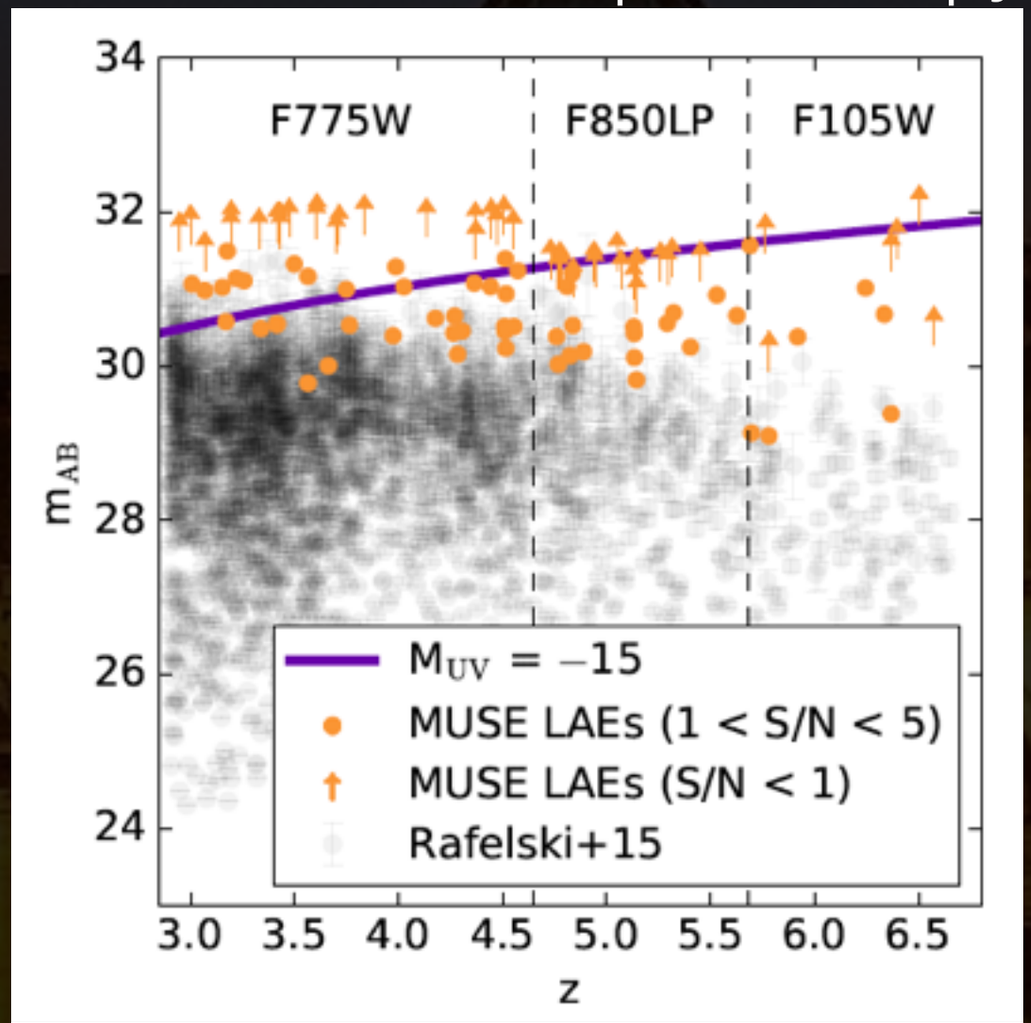


Atek+18

Spectroscopy



Maseda+18

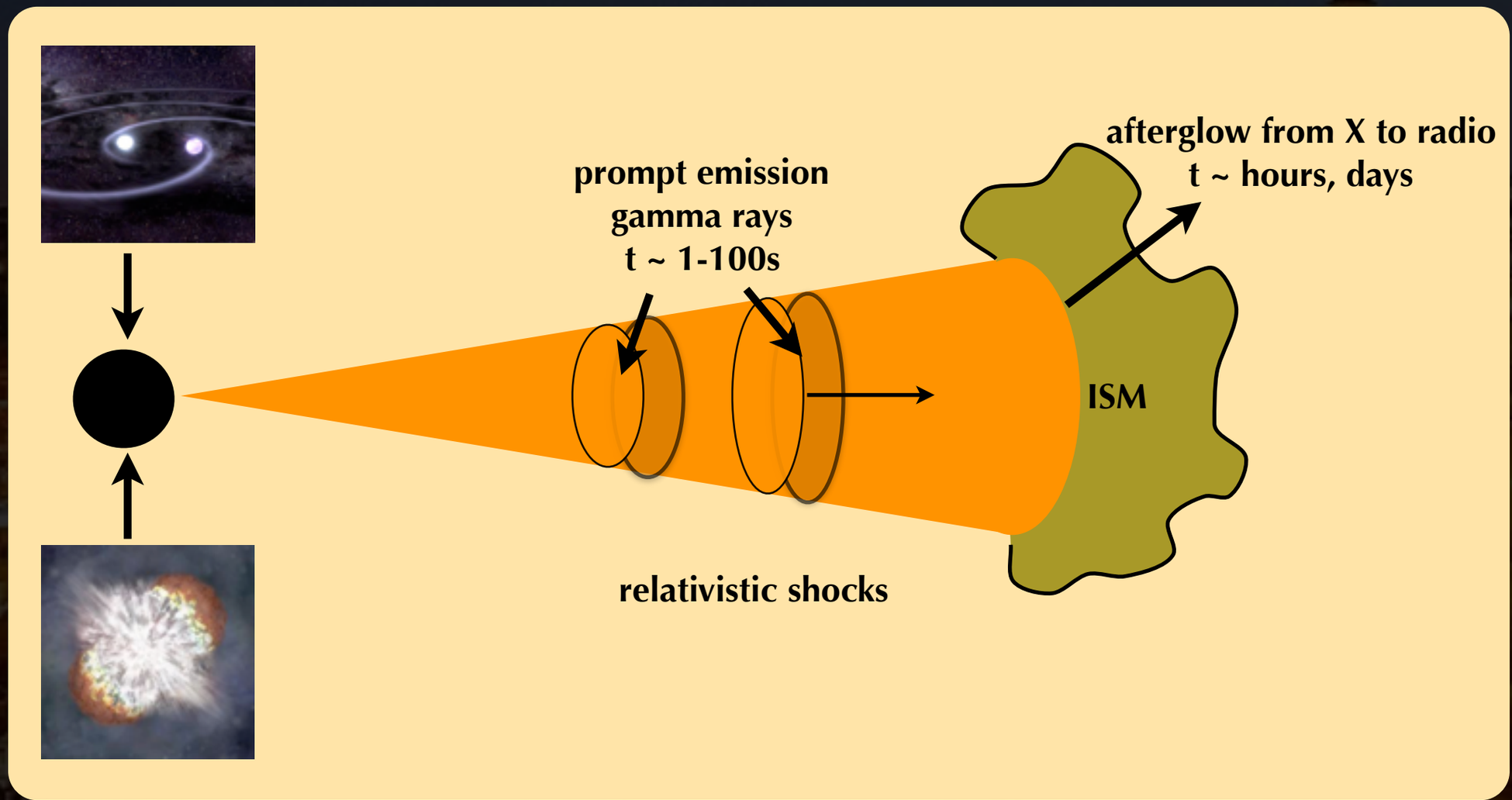
No information on the ISM: bright continuum needed

Gamma-ray bursts (GRBs)

Ultra-relativistic jets associated with black holes formation

merging of compact objects massive star explosion

Short



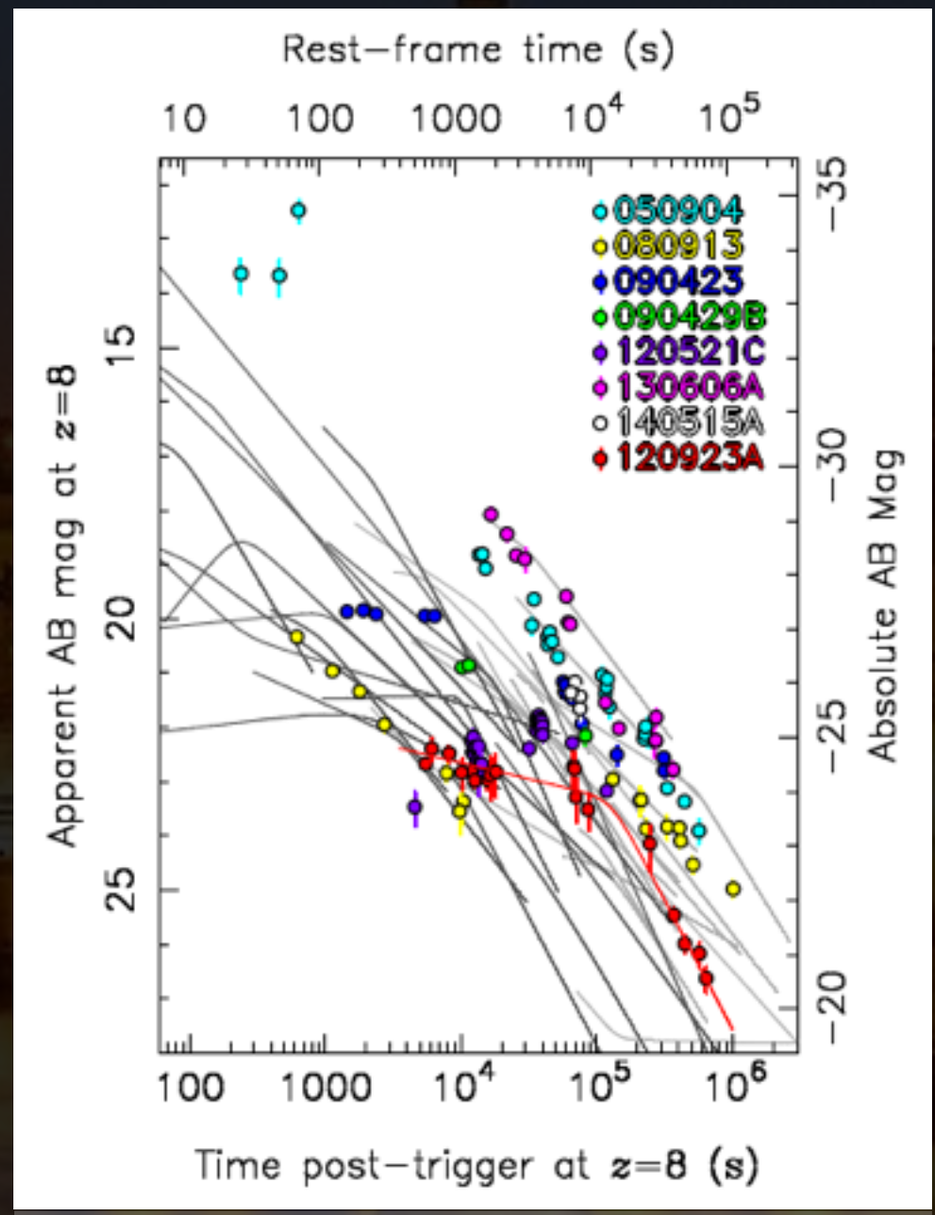
Long

Long GRBs associated with massive stars

Afterglows localized at arcsec precision

Enlightening the first galaxies with gamma-ray bursts

Adapted from ESO PR0813a



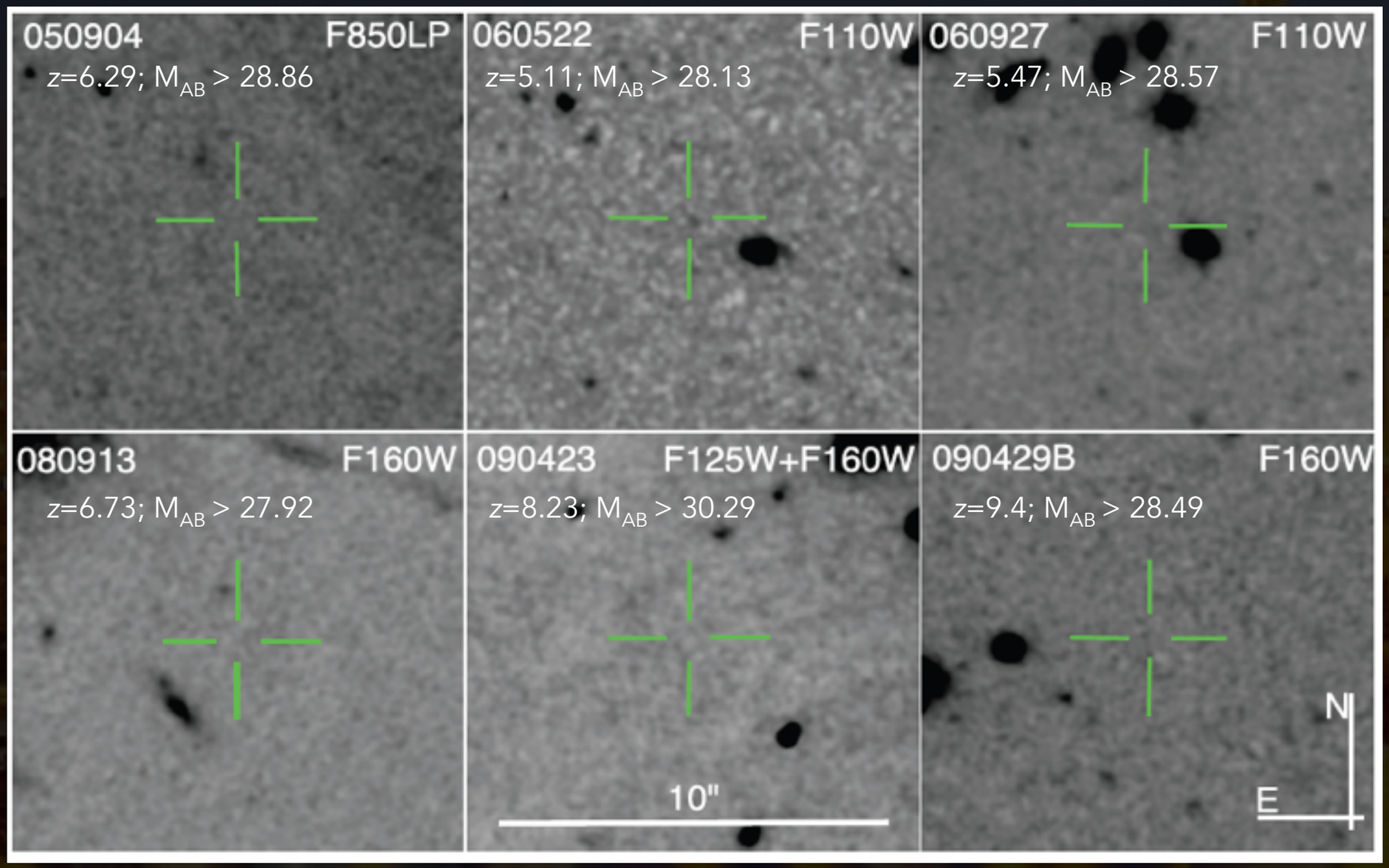
Tanvir+18

Detection: gamma rays

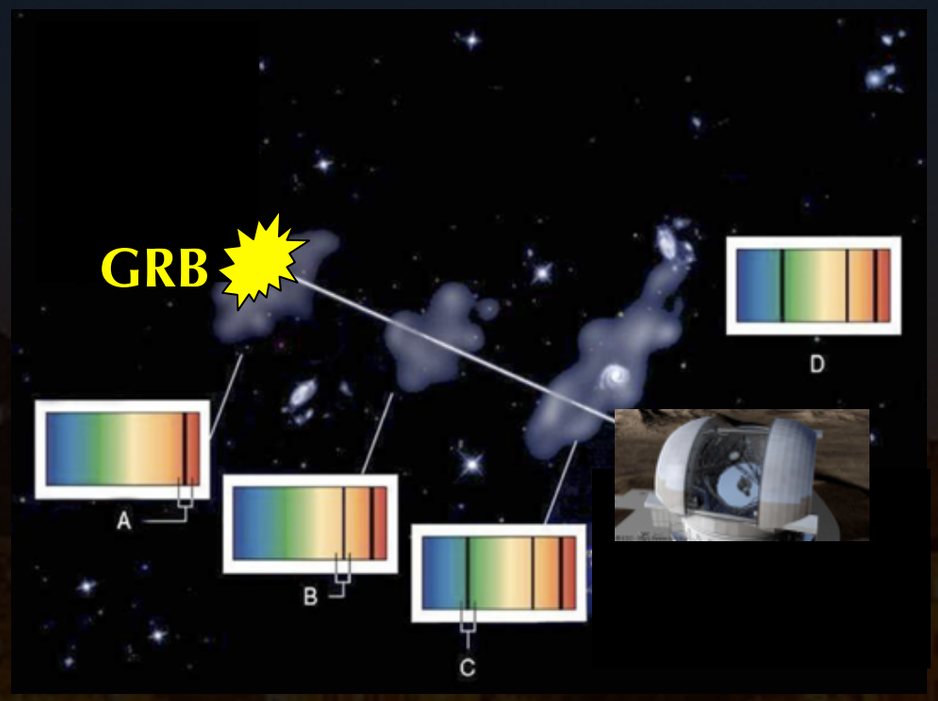
Pinpoint to SF galaxies at any redshift

Bright optical/near-infrared afterglows

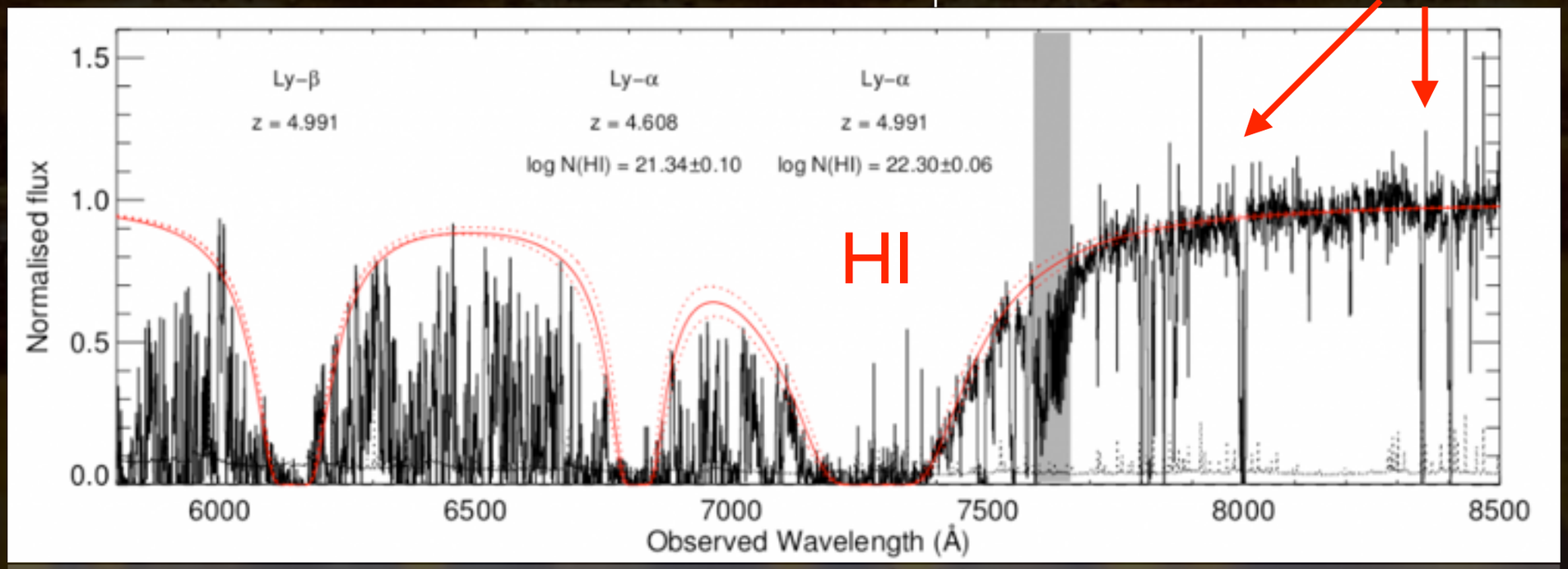
Enlightening the first galaxies with gamma-ray bursts

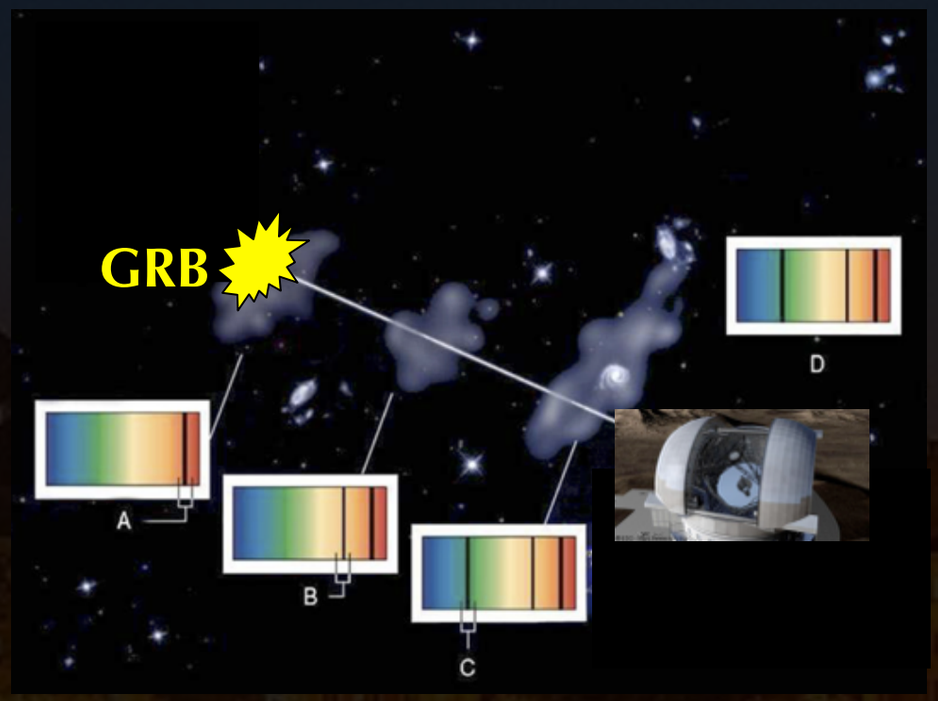


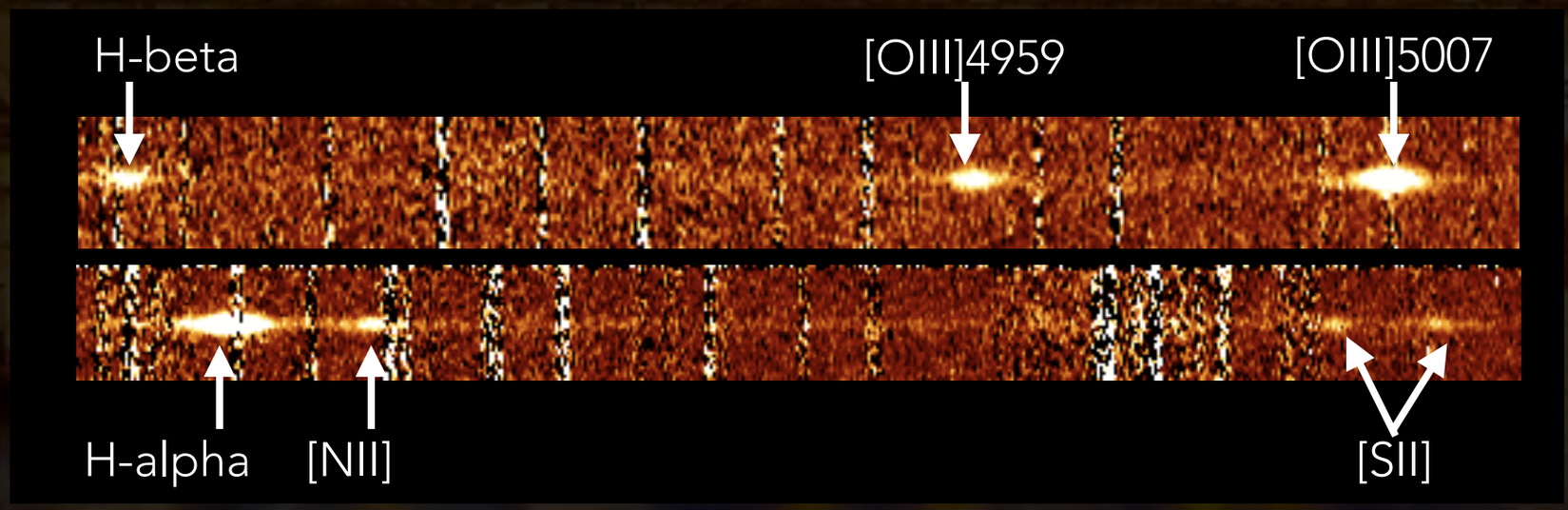
Tanvir+12; see also Salvaterra+13; McGuire+16



GRB111008A z=4.991 - Sparre+14



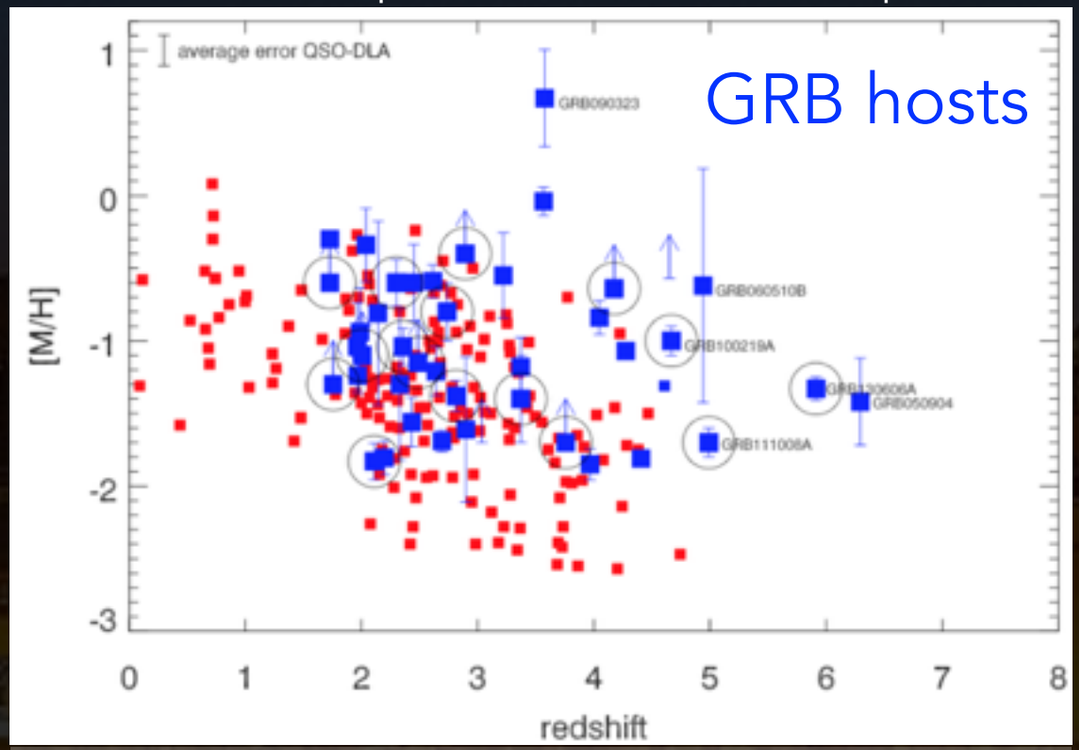


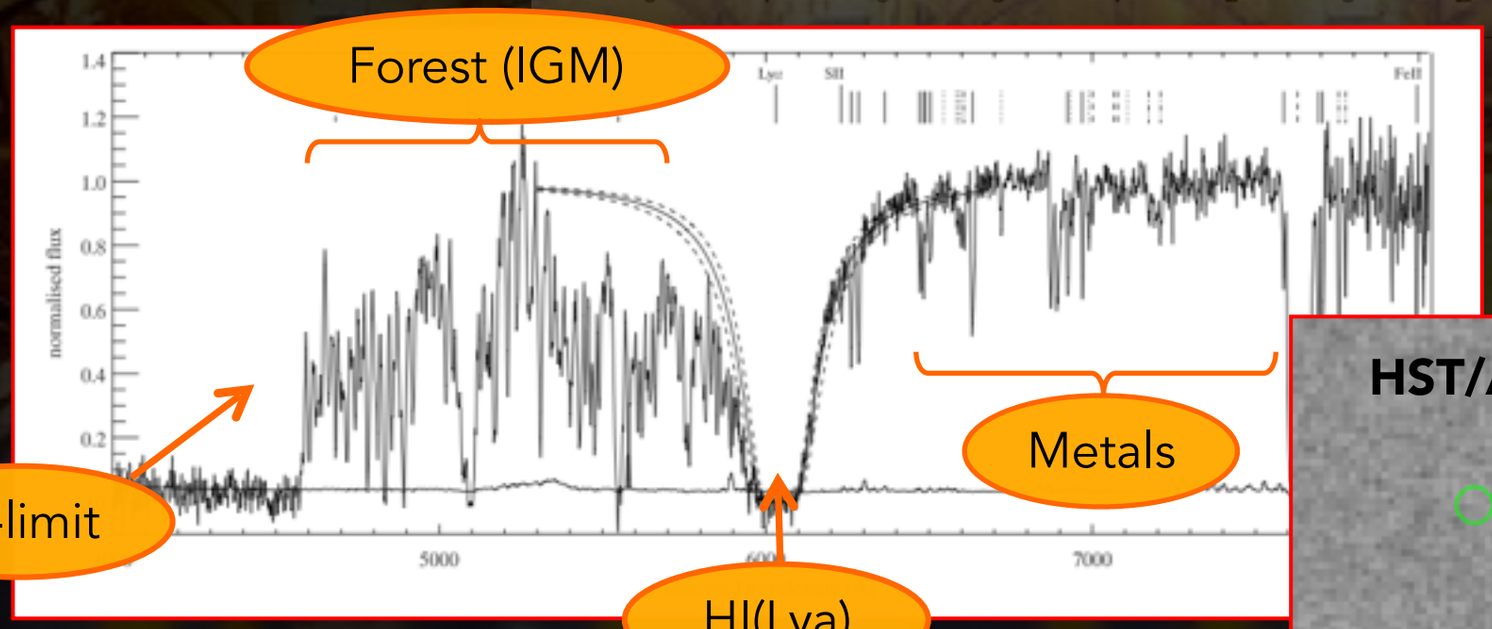


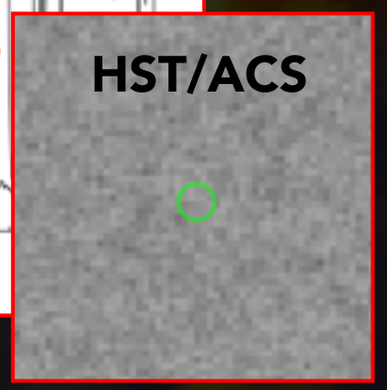
GRB070306 z=1.49

Enlightening the first galaxies with gamma-ray bursts

Adapted from Thöne+13 & Sparre+14







z=3.97

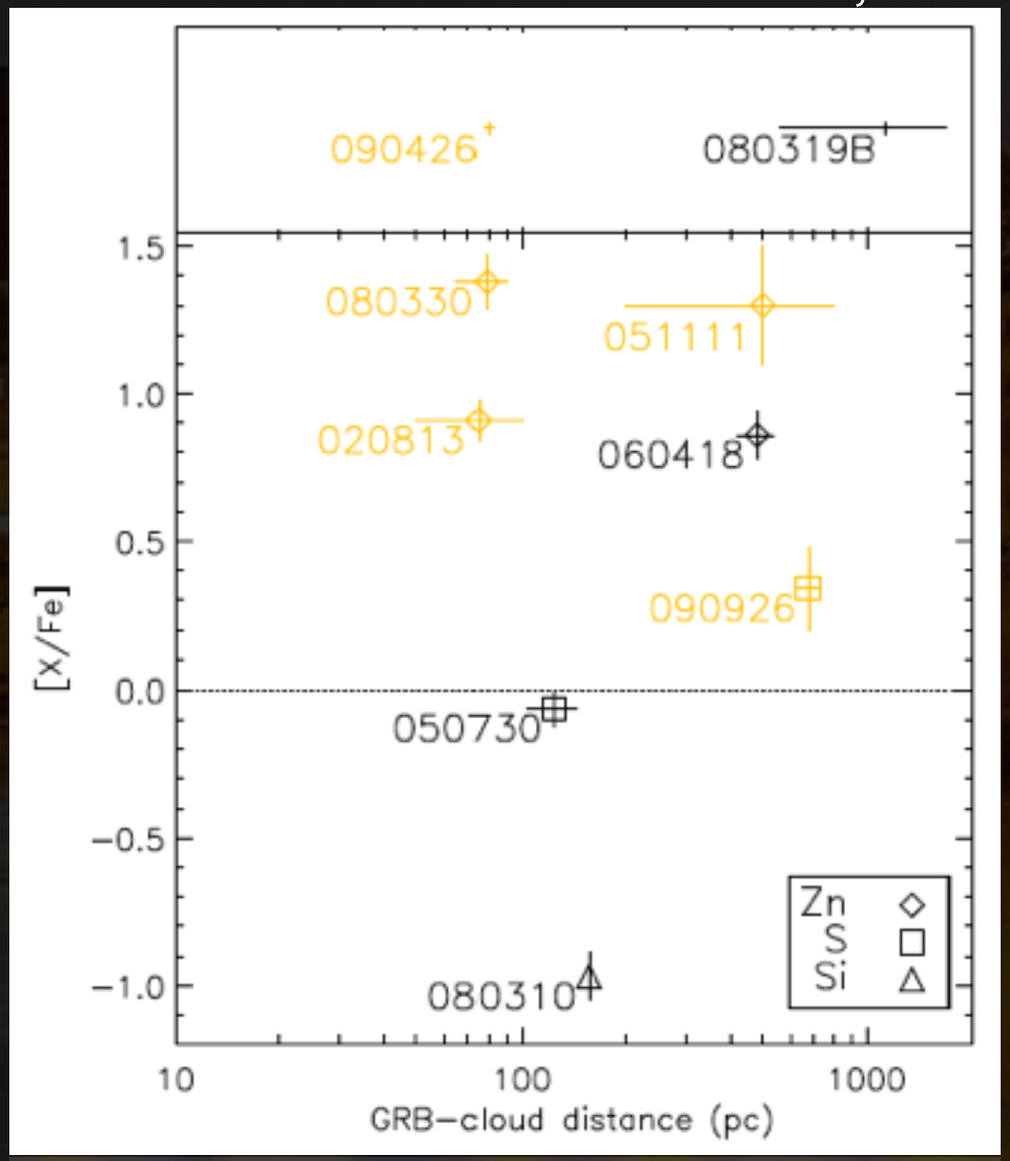
[Fe/H]=-2

R>28.5

Chen+ 2005; Starling+2005

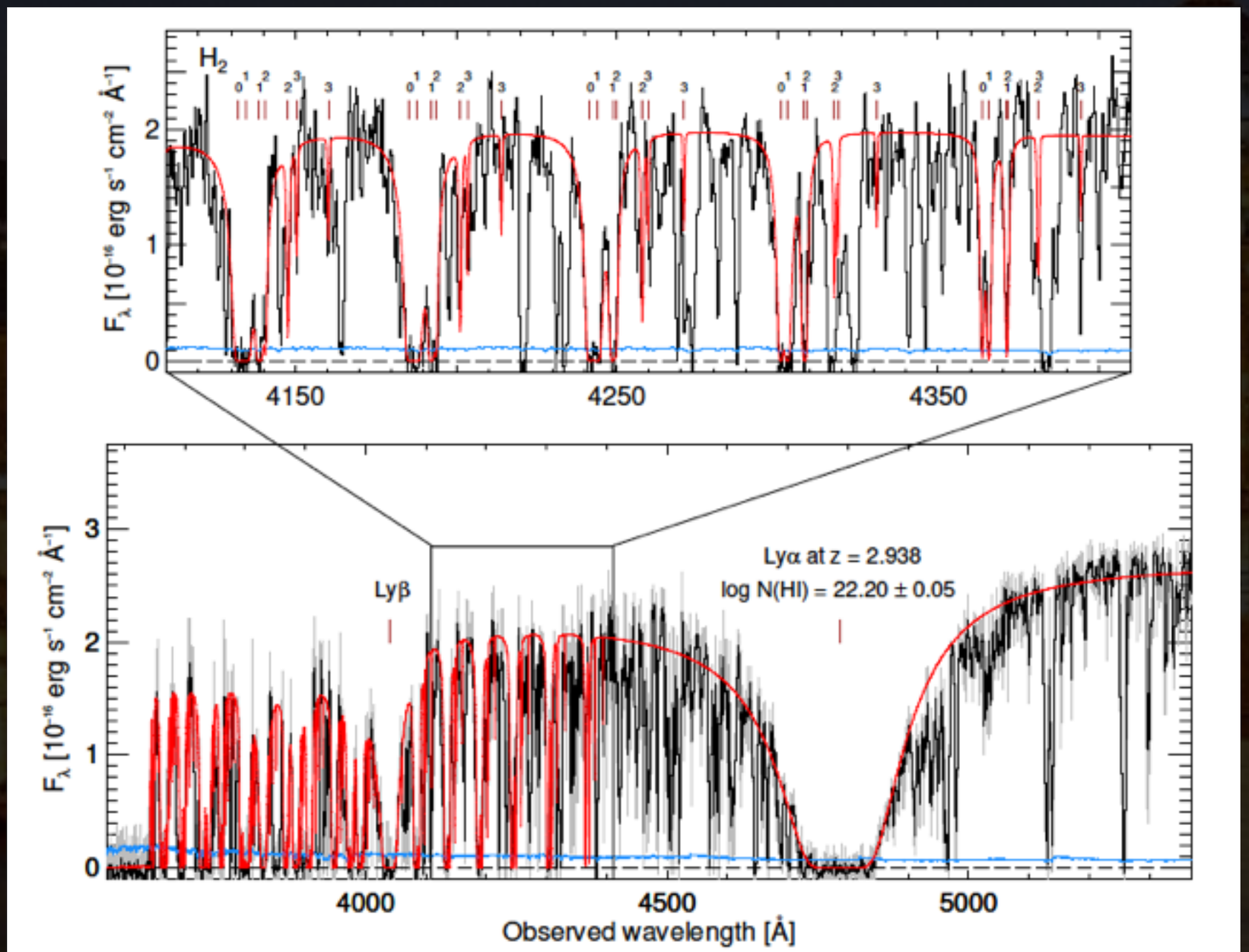
GRBs probe the ISM of star-forming regions and the inner parts of the hosts

Vreeswijk+12

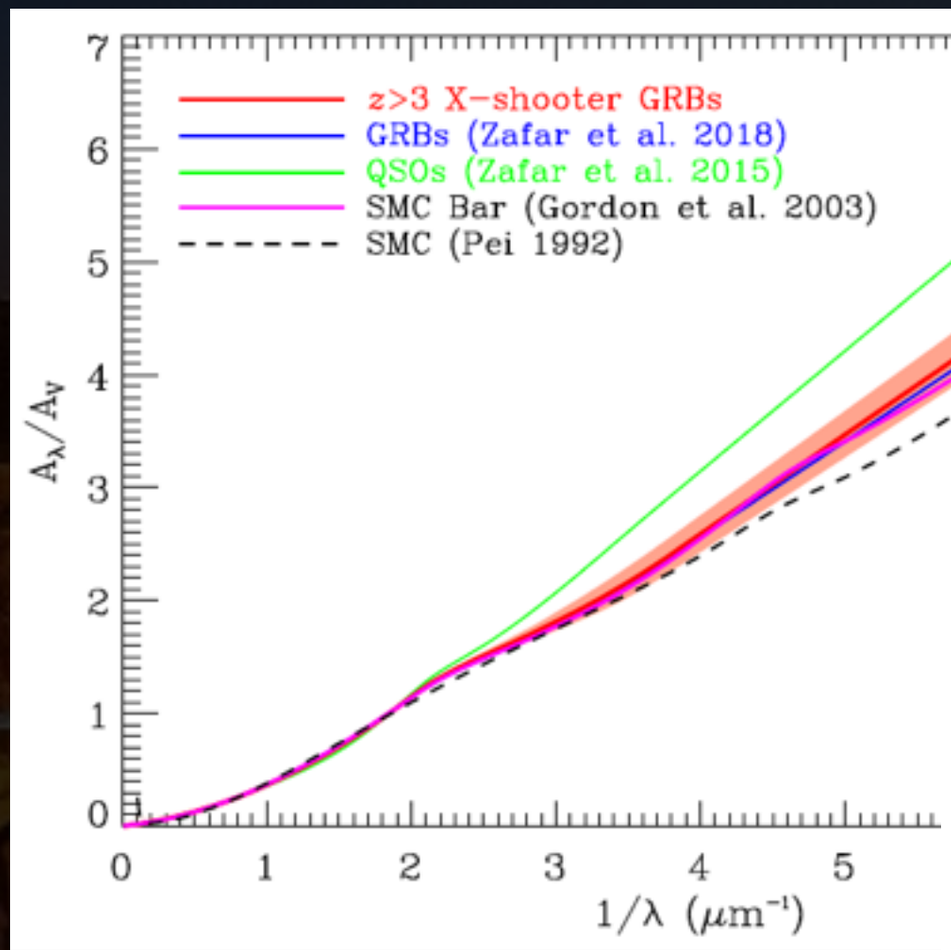


Direct H2 detection

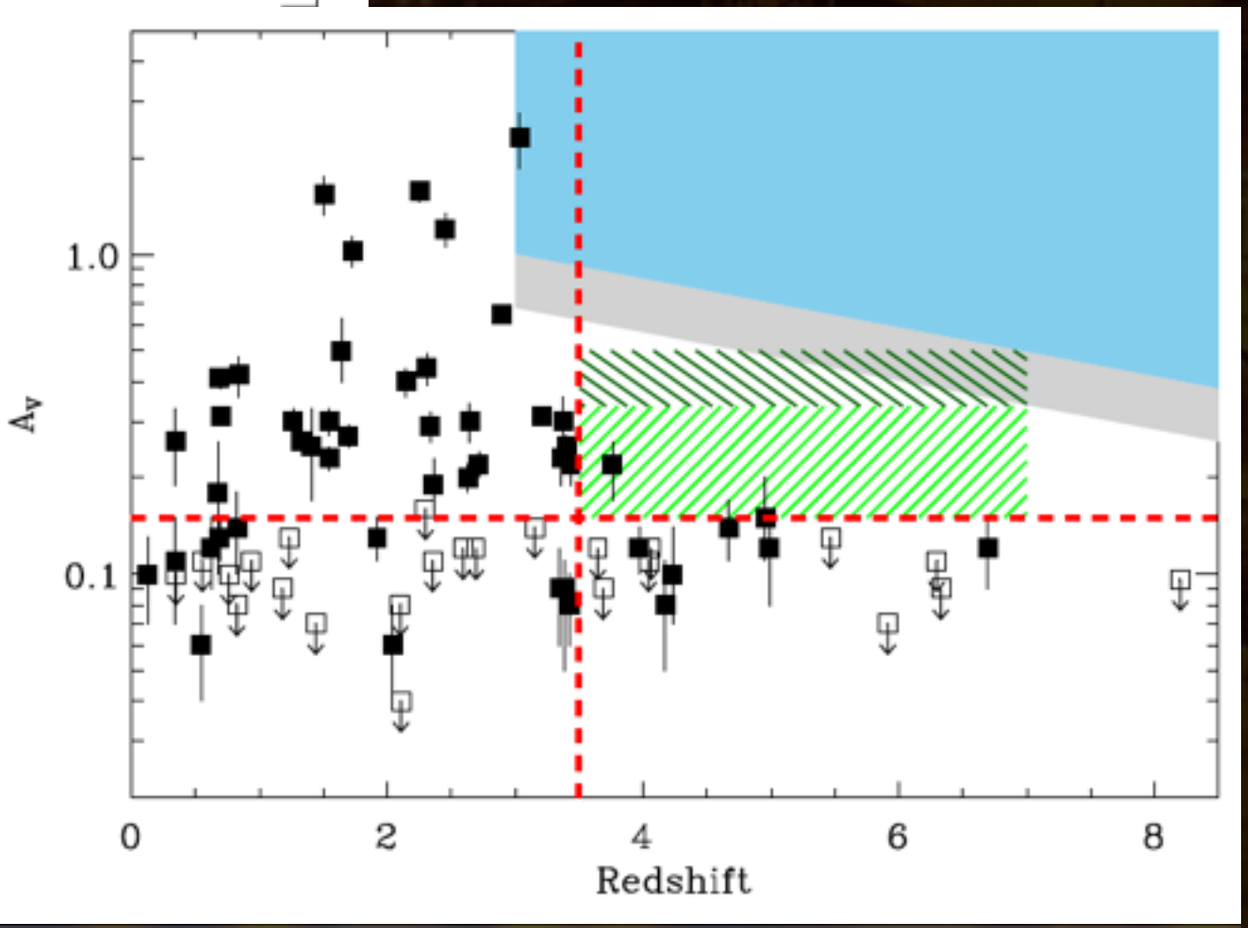
Bolmer+19



Dust content and extinction

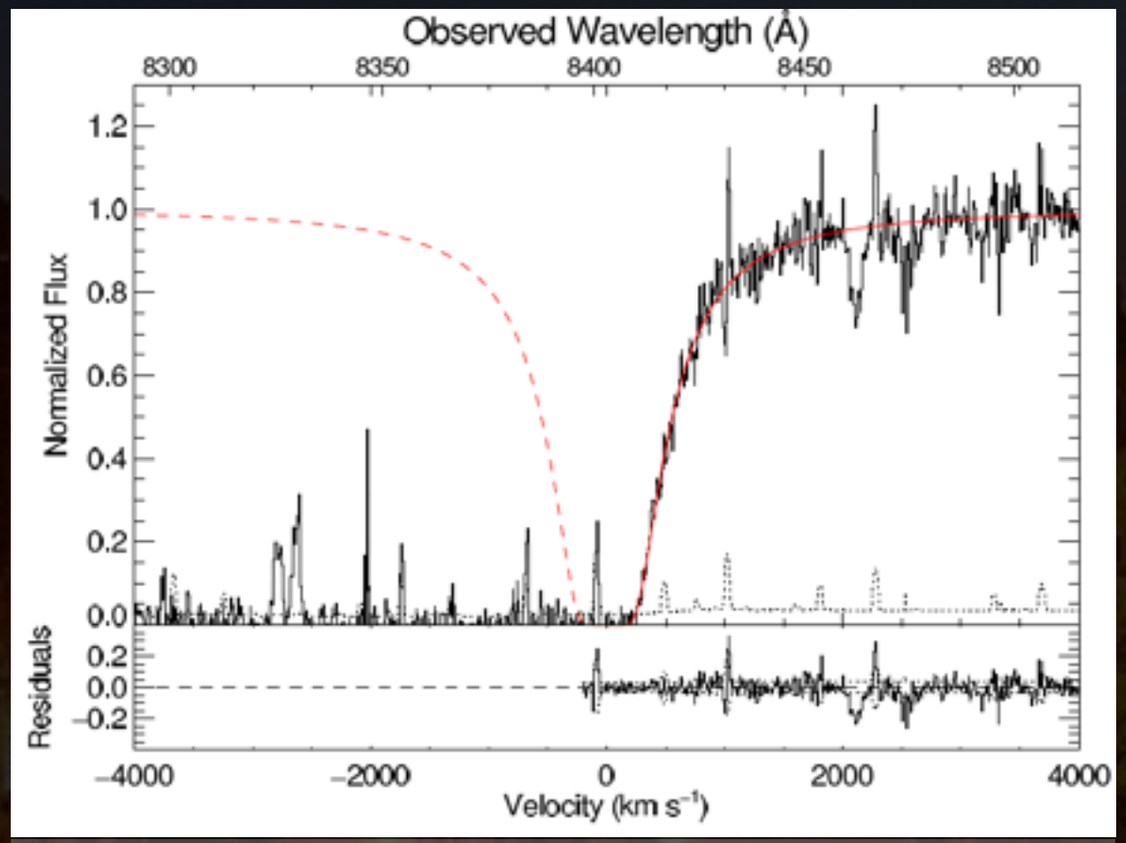


Zafar+2018

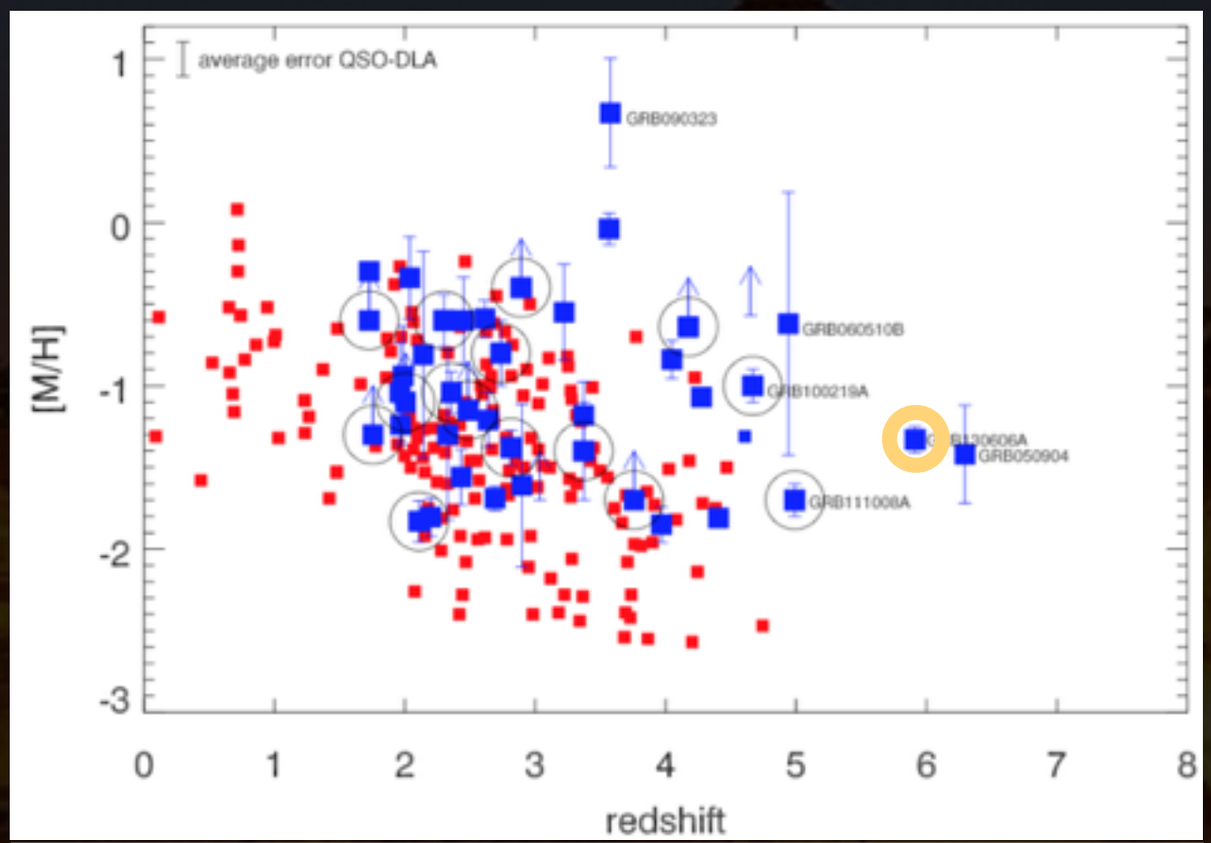


- Star-forming galaxies
- not luminosity selected
- extend to faint galaxies & high z
- cold/warm gas ISM + ionized gas
- HI, metallicity, dust, SFR...
- kinematics
- inflow/outflow
- systematically & at any z!

GRB130606A z~6

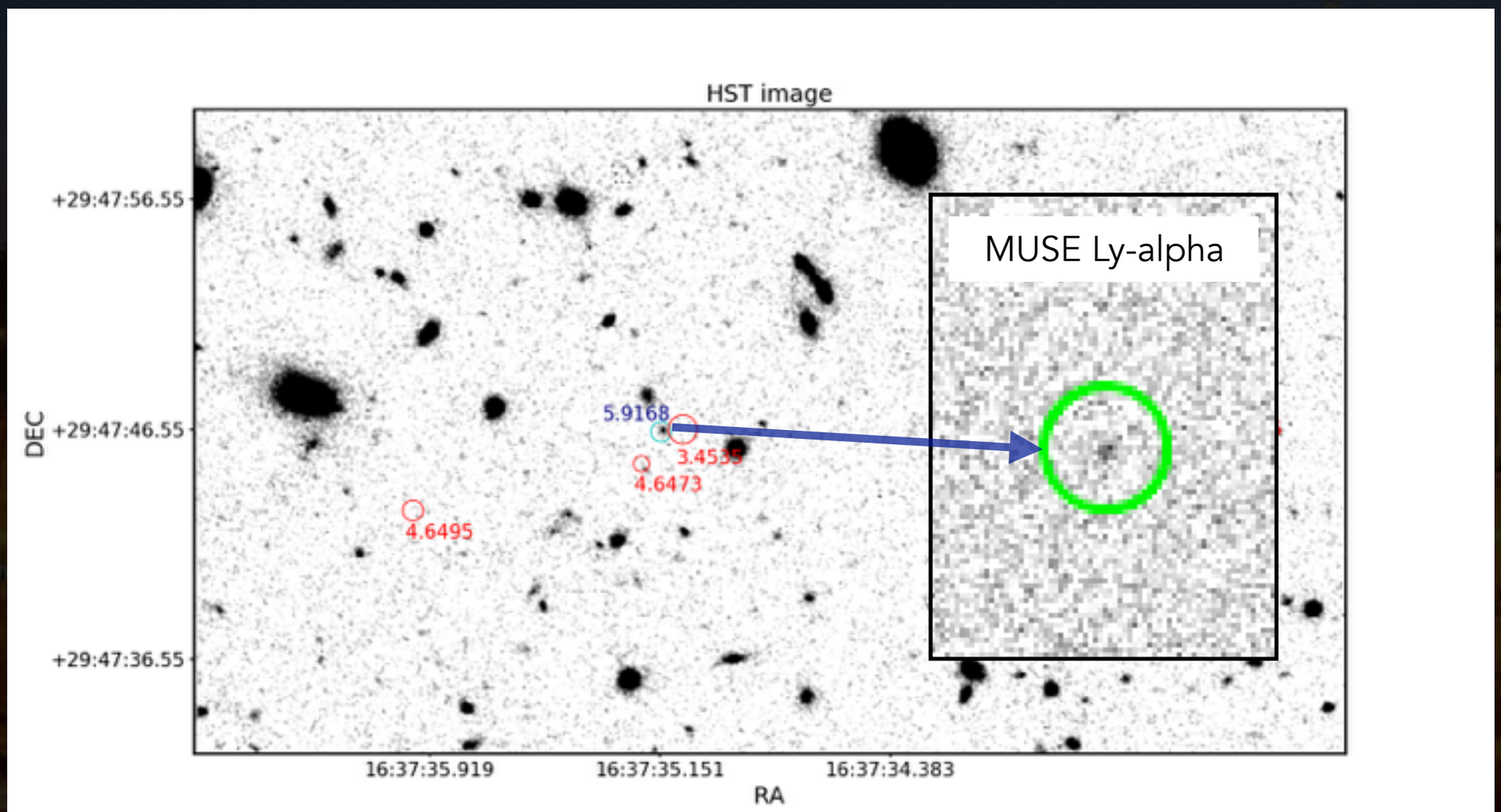


Haartog+15



NHI + Abundances

GRB z~6, MUSE (16hr)

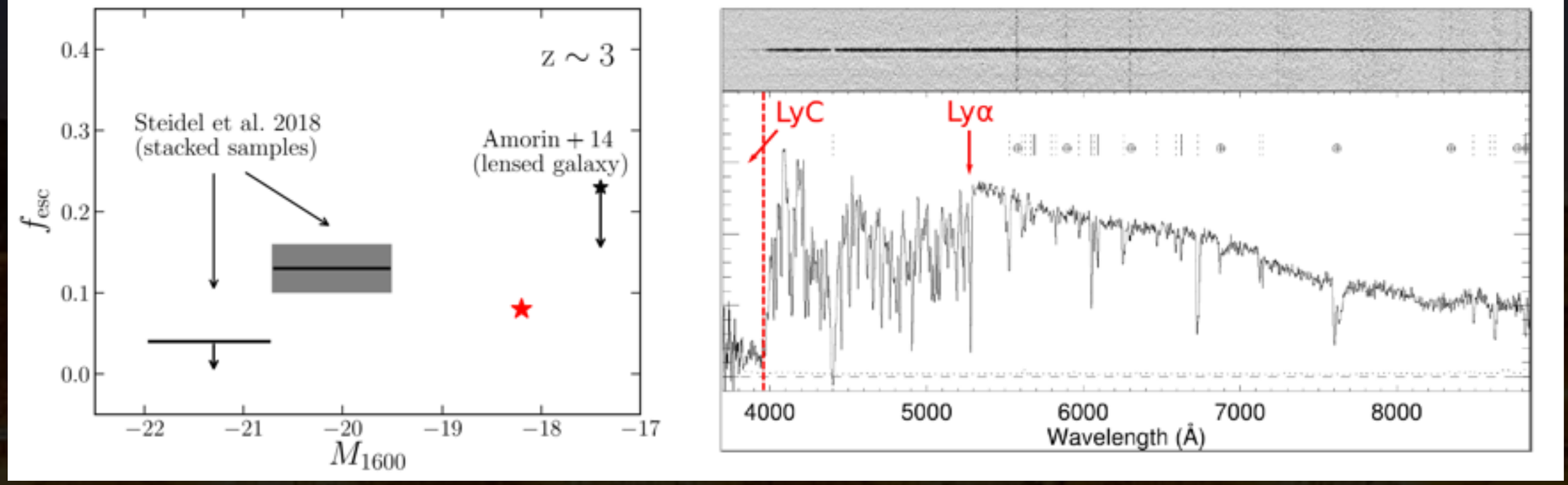


The only object at high redshift having information on HI, ISM, continuum and emission lines

JWST to detect nebular lines

LyC leakers: faint galaxies

z=3.3



Fynbo+09

LAE (Milvang-Jensen+2012)

Information on ISM available

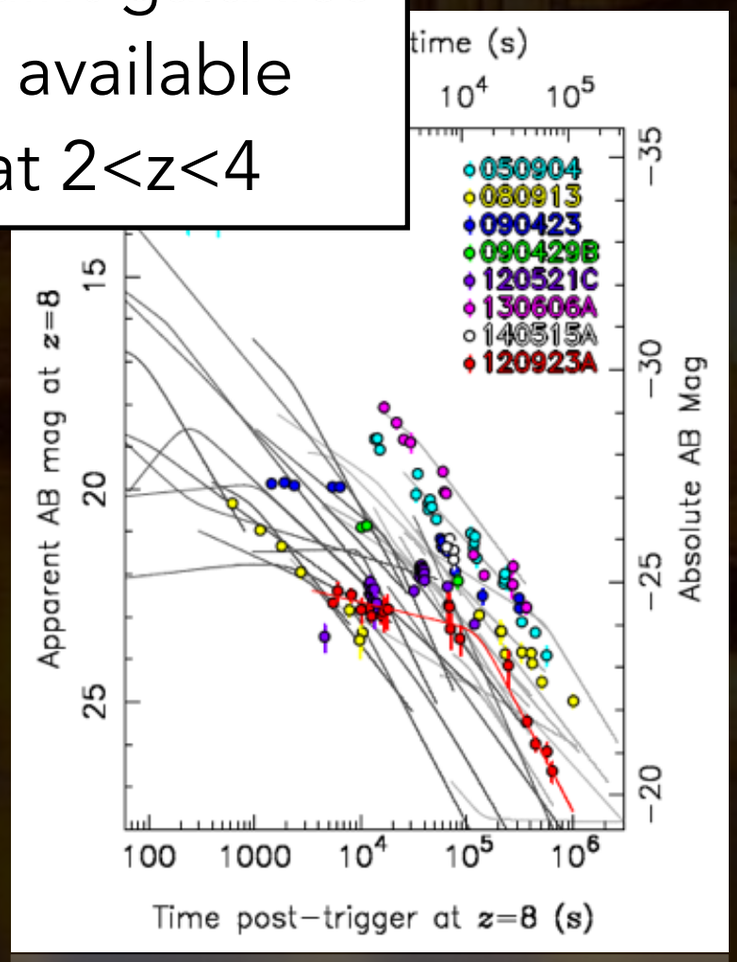
X-shooter spectrum to characterize the emission properties of this galaxy, possibly similar to very hig-redshift leakers

- High-z GRBs pinpoint to galaxies that belongs to the bulk of the high-z population
- Information on properties very difficult to access in other ways

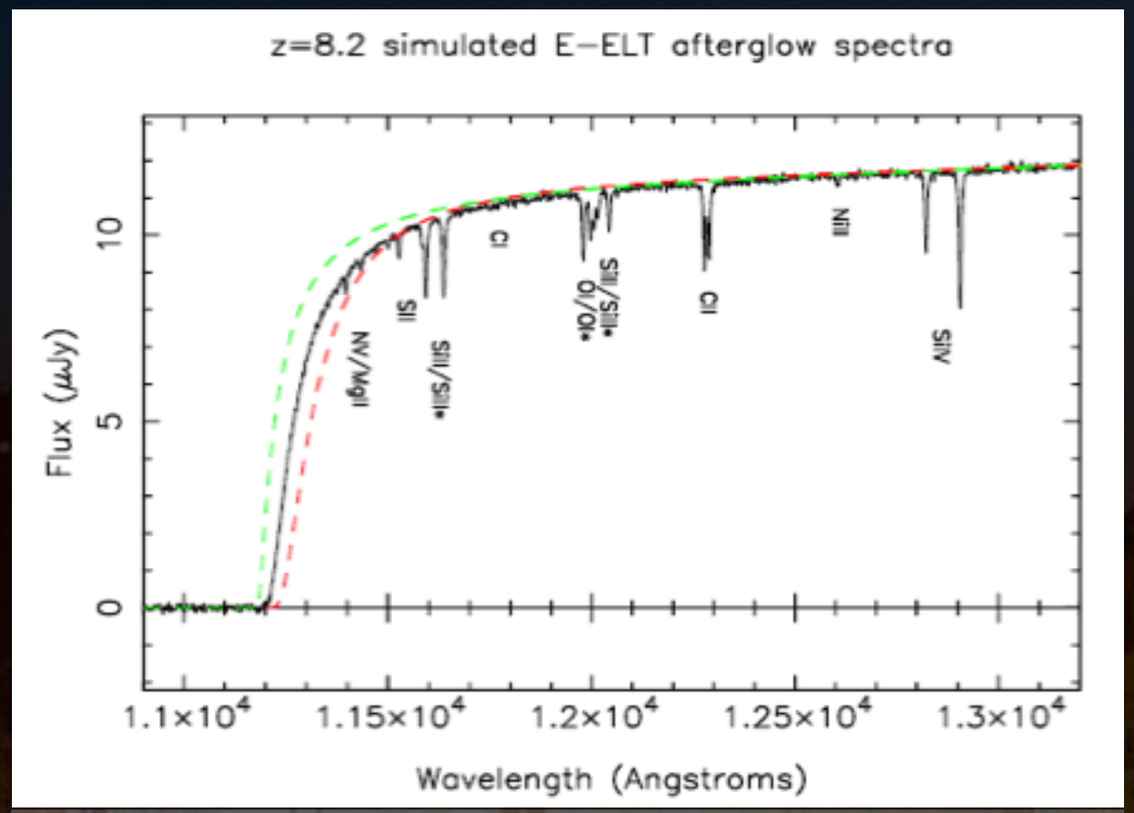
ELTs spectroscopy fundamental
- to have high S/N spectra of the ISM of high-z very faint galaxies
- to solve the problem of telescopes not immediately available
- to extend to very high-z the studies currently done at 2<z<4

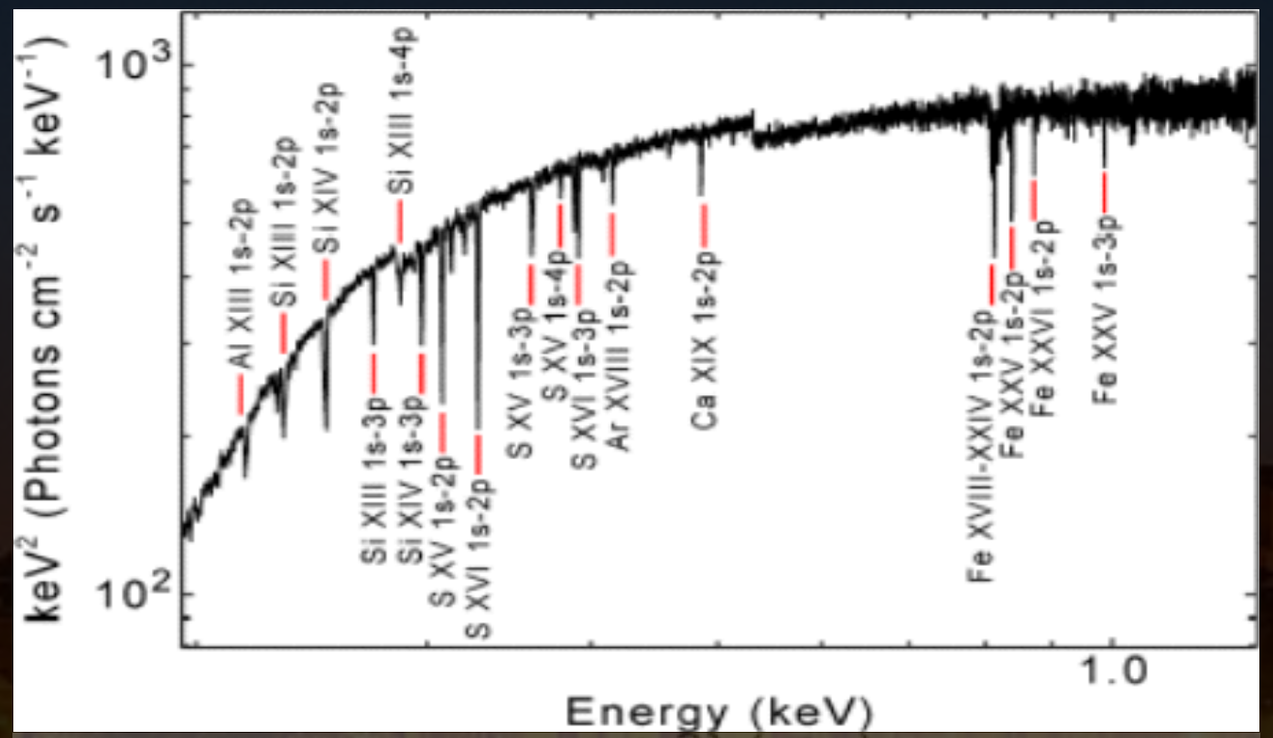
ELTs photometry
- detection of the very high-z host galaxies

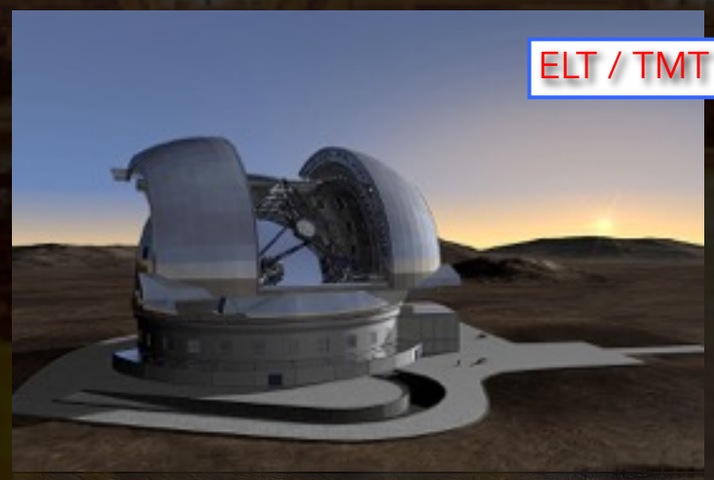
Resolved properties at z~2

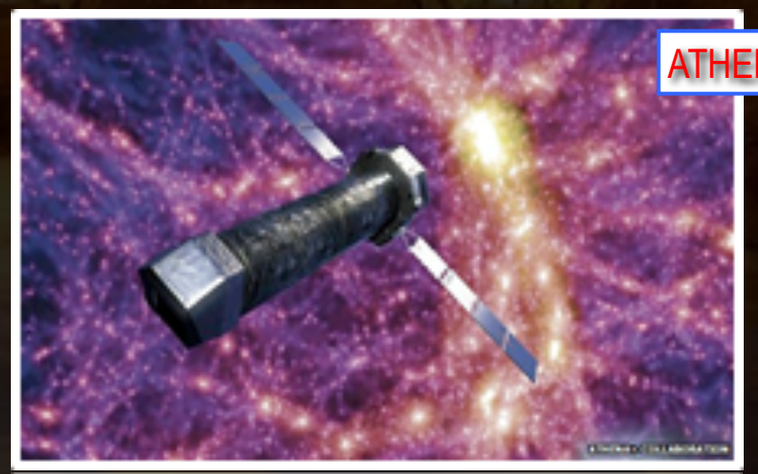


ELT & ATHENA SYNERGY





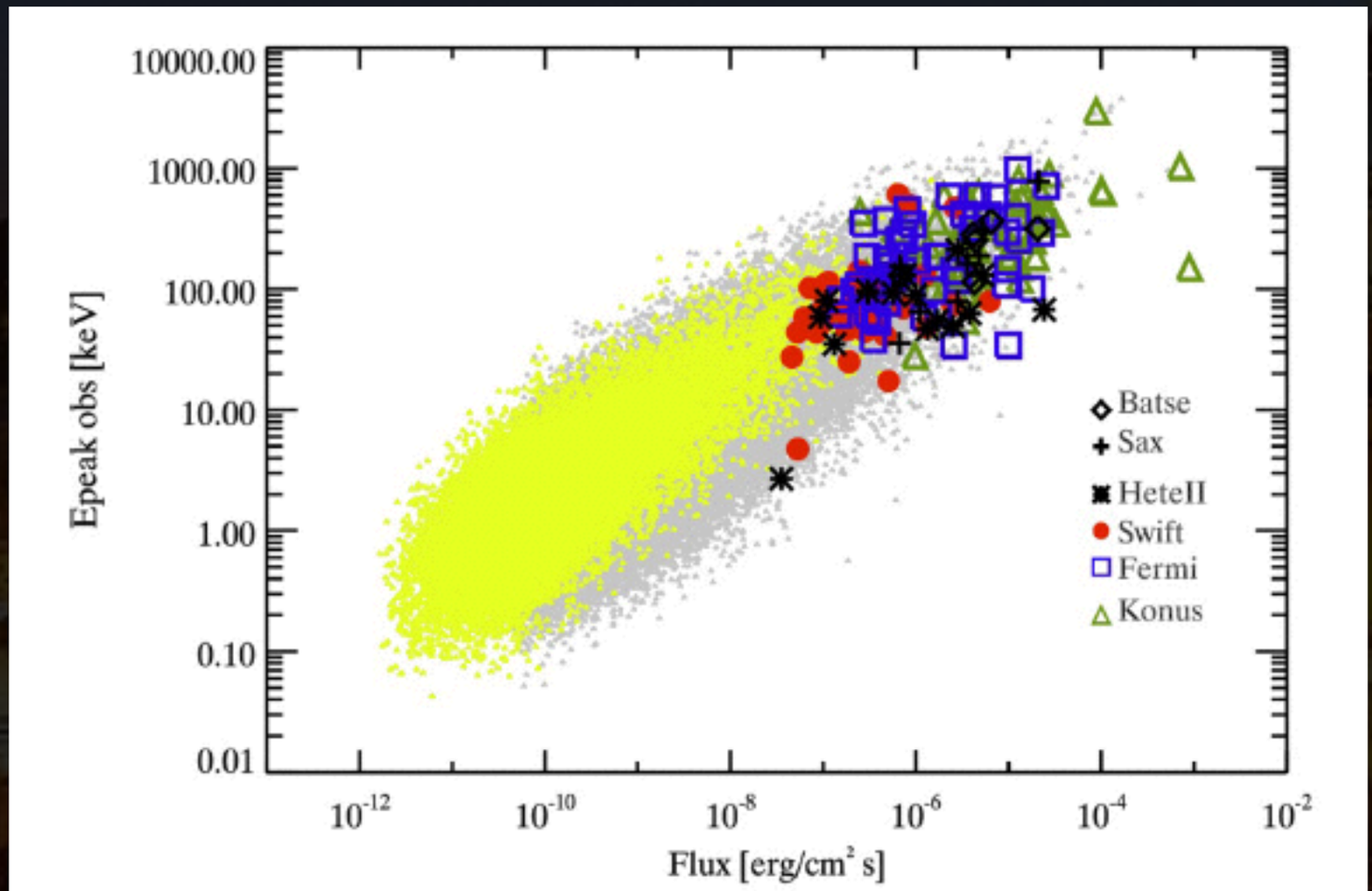




Courtesy of the THESEUS & ATHENA collaborations

High-z GRB population

Ghirlanda+ 2015



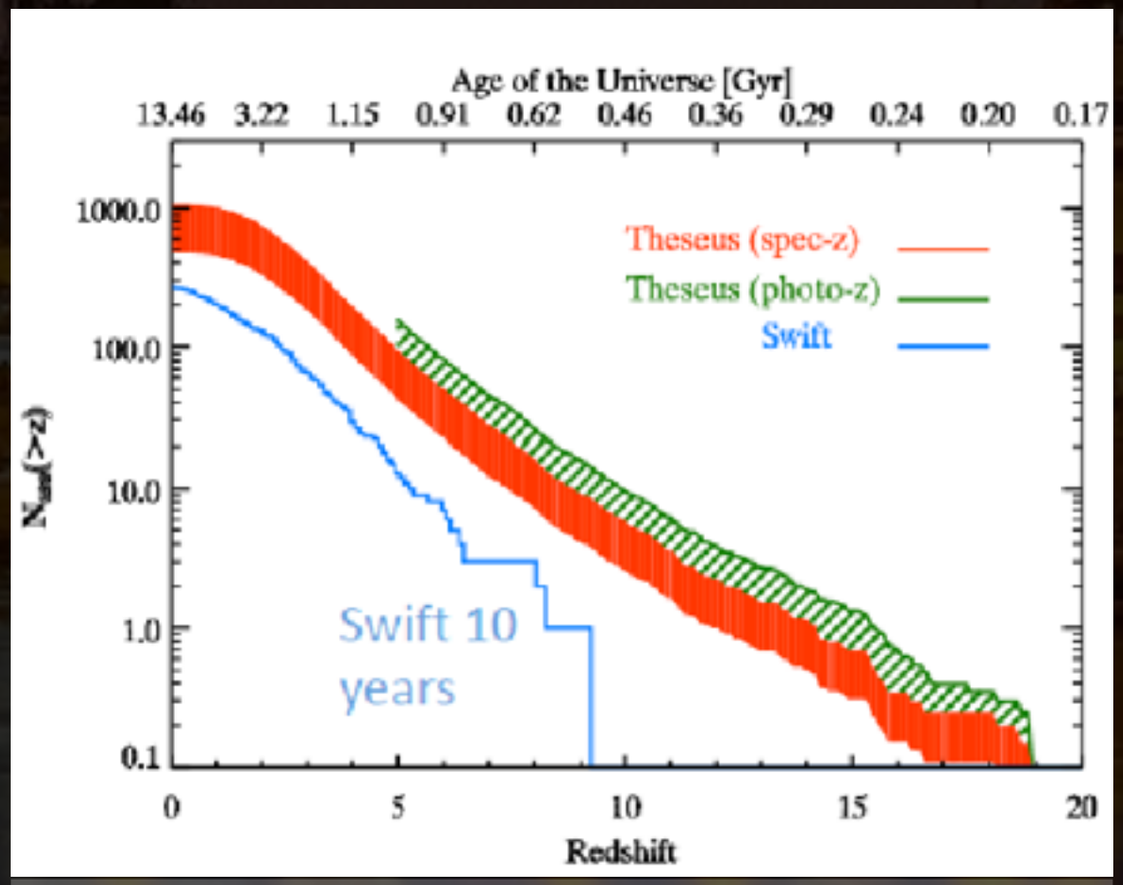
z>5 population

theseus

TRANSIENT HIGH ENERGY SKY AND EARLY UNIVERSE SURVEYOR

http://www.isdc.unige.ch/theseus

Pre-selected by ESA for M5



Amati+18

Low-resolution NIR telescope on board to pre-select very high-z GRB so as to trigger efficiently ELTs

Grazie