Scaling relations for absorption-selected galaxies

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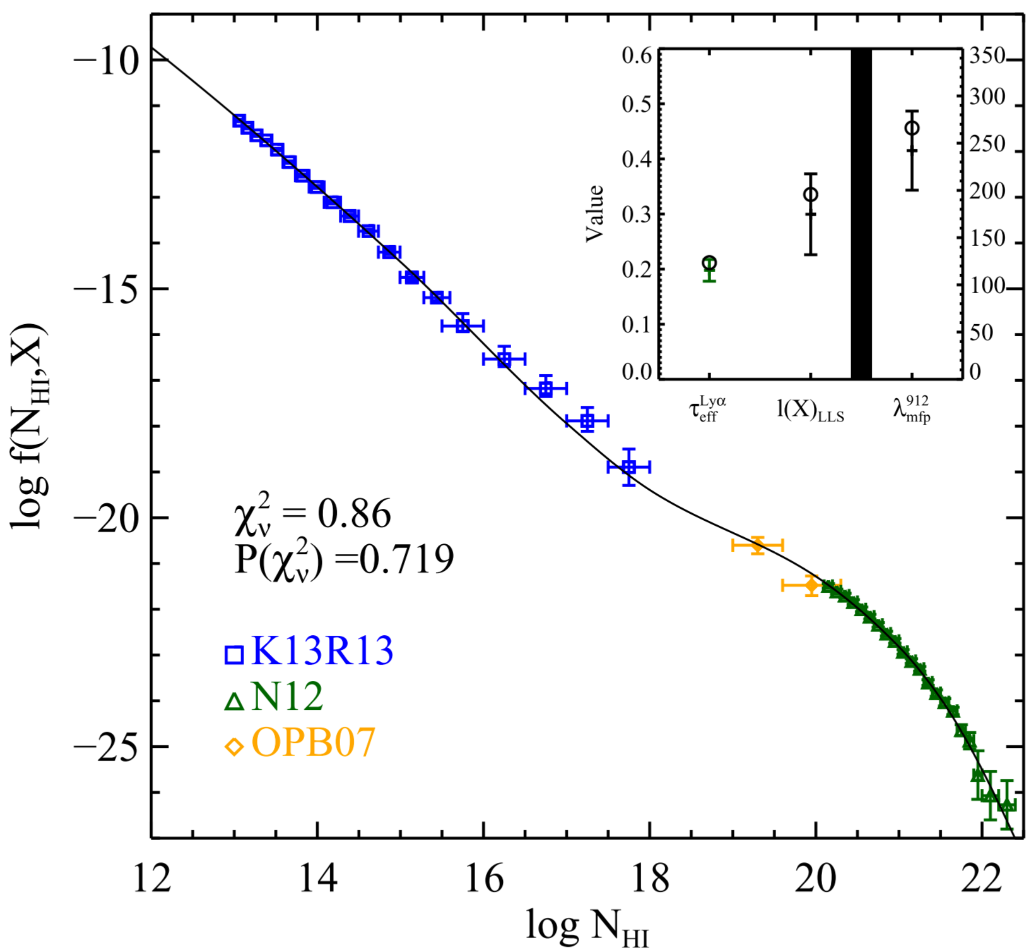
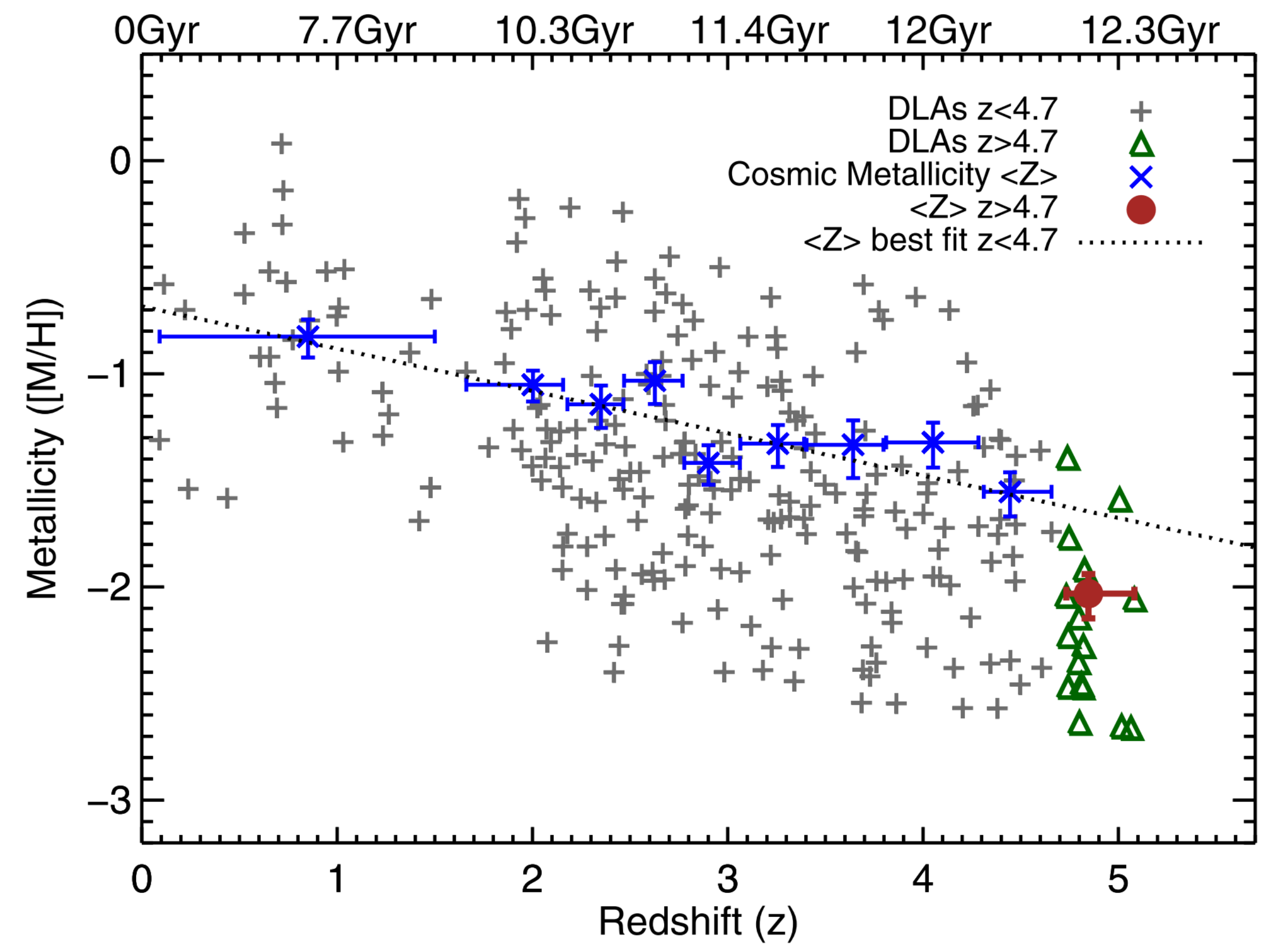
DLA characteristics



DLAs hold bulk of neutral gas (Prochaska et al. 2014)



DLA metallicity evolution with redshift (Rafelski et al. 2014)

DLAs are reservoirs feeding star-formation

This works' academic birth, in perspective

Møller et al. 2013
Predicts stellar mass of host-galaxy in functional form, based on absorption metallicity, redshift, and a free parameter, C[M/H].

↓

Christensen et al. 2014
Inverts Møller(2013)'s functional form assuming SED stellar masses. Solves for C[M/H], interpreted as mean metallicity gradient between emission and absorption.

↓

Rhodin et al. 2017, in prep.
Expands analysis to low redshift and to sub-DLAs. Explores parameter distributions, and populates the M-Z relation and SFR sequence for absorption-selected galaxies.

This study

Objectives

- Increase statistics of confirmed absorber-galaxy pairs
- Explore scaling relations for absorption-selected galaxies and compare to a luminosity-selection

Sample selection

- High column density absorbers: $\log_{10}N(HI) > 19.5$ cm^{-2} (Rao et al. 2006, Mg II systems)
- Low redshift, $z_{abs} < 1$ (Rao et al. 2006)
- Metal-rich absorbers: > 10% solar (Lehner 2013; Nestor 2008)
- Photometric host-galaxy candidates (Rao et al. 2011)

Programme

- 10 systems along 9 quasar sight-lines
- FORS2 long-slit spectra (spectral range: 5100 - 8300 Å; R~900) with 1.3 arcsec slit-width, non-photometric conditions
- Target [O II]3727,3729, Hb4861, and [O III]4959,5007 to confirm host, determine SFR, extinction, and R23 metallicity diagnostics. Combine with photometry do determine stellar mass.

Avoiding the glare…

Figure Credit: Krogager et al. (2013)

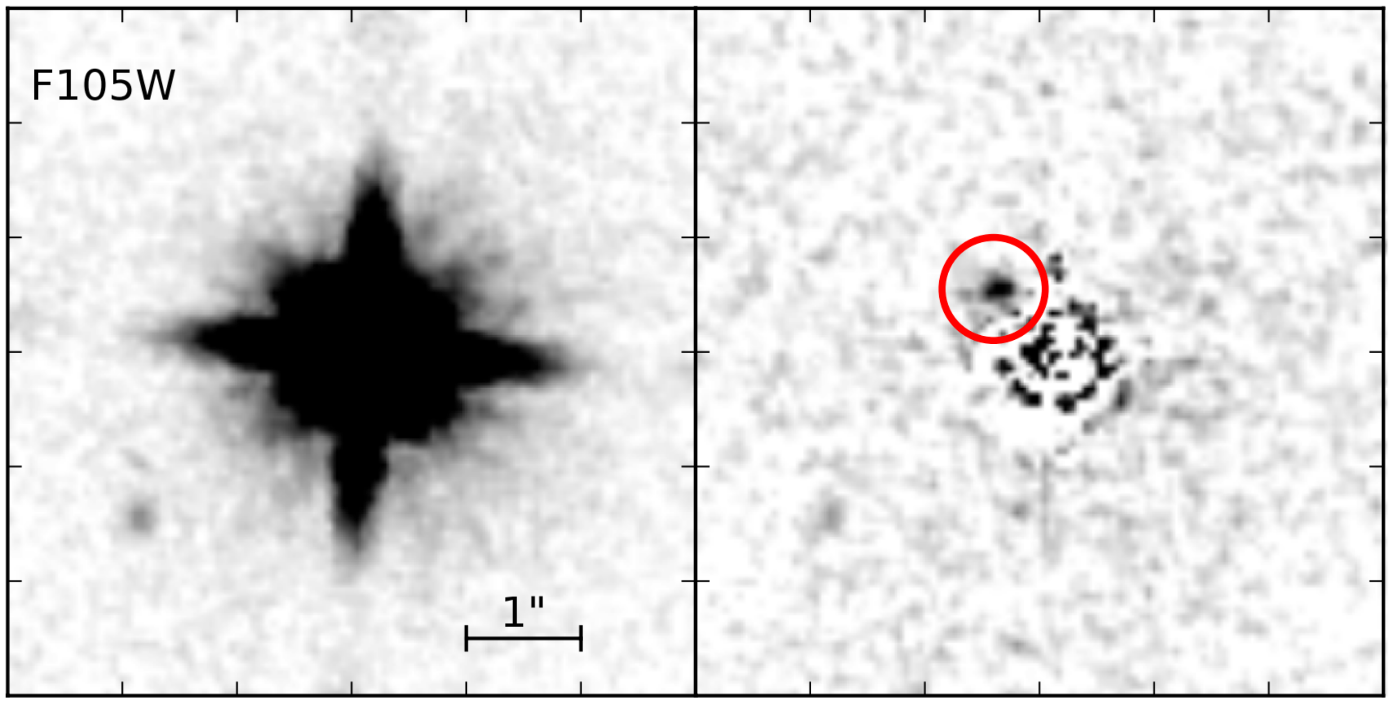
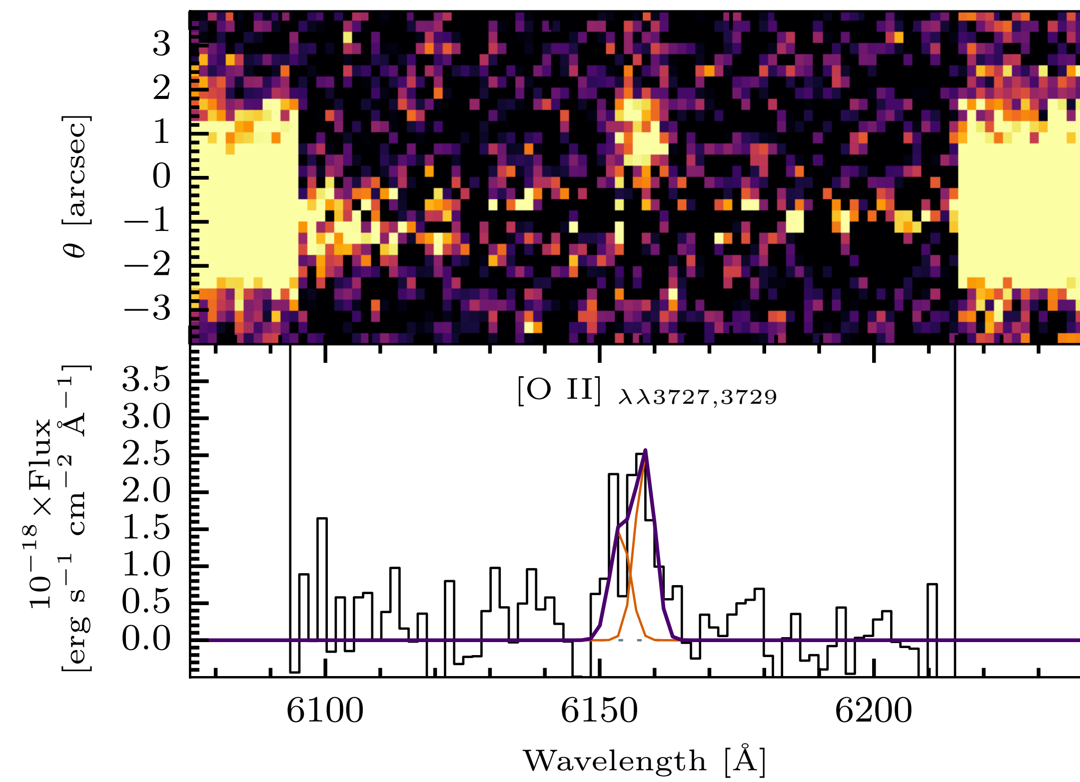
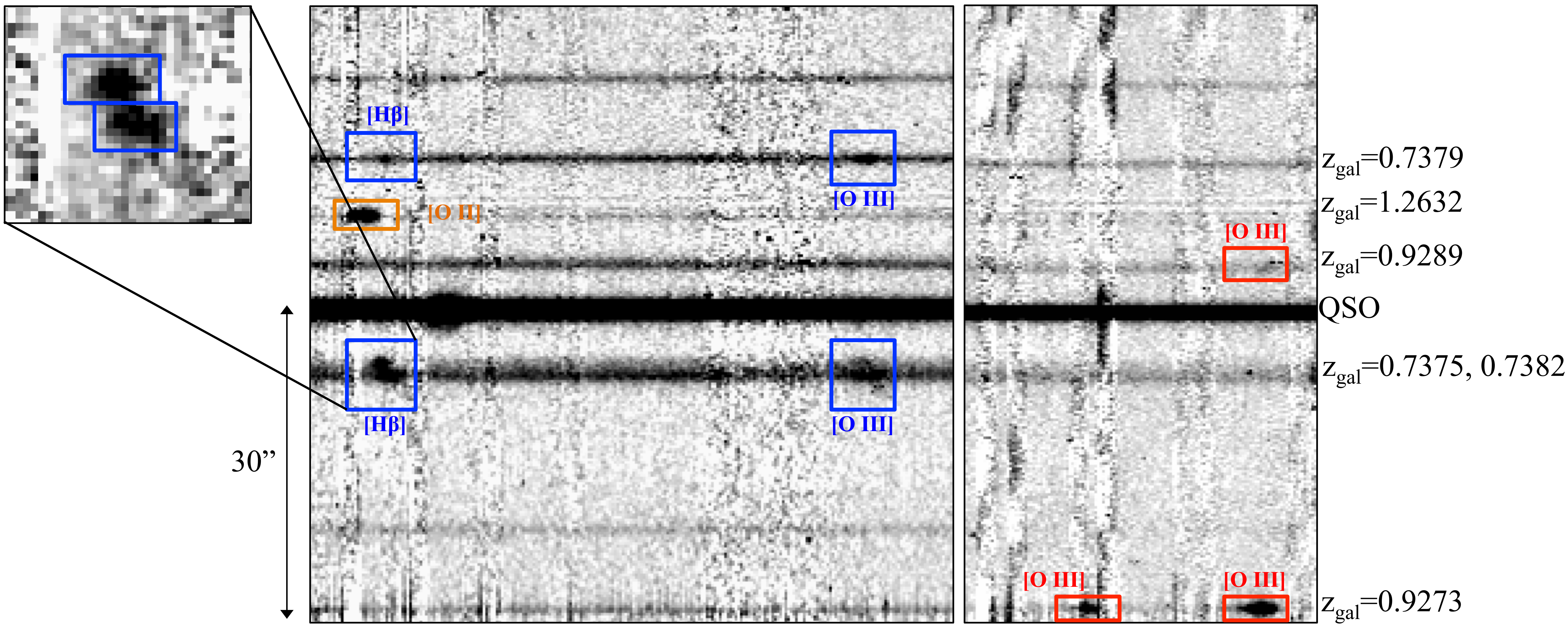


Figure: Rhodin et al. (2017, in prep.)



- Bright background quasar vs. faint foreground galaxy
- Remove quasar PSF to search proximity for host
- Interpret excess flux in residual image and/or 2D spsf-subtracted spectrum as host emission

Remarkable group alignments in a single long-slit spectrum?



Absorber 1

- zabs = 0.7377
- logN(HI) = 20.08 ± 0.10

Absorber 2

- zabs = 0.928
- logN(HI) = 18.4 ± 0.98

Stellar masses from SED-fitting

Figure Credit: Rao et al. (2011)

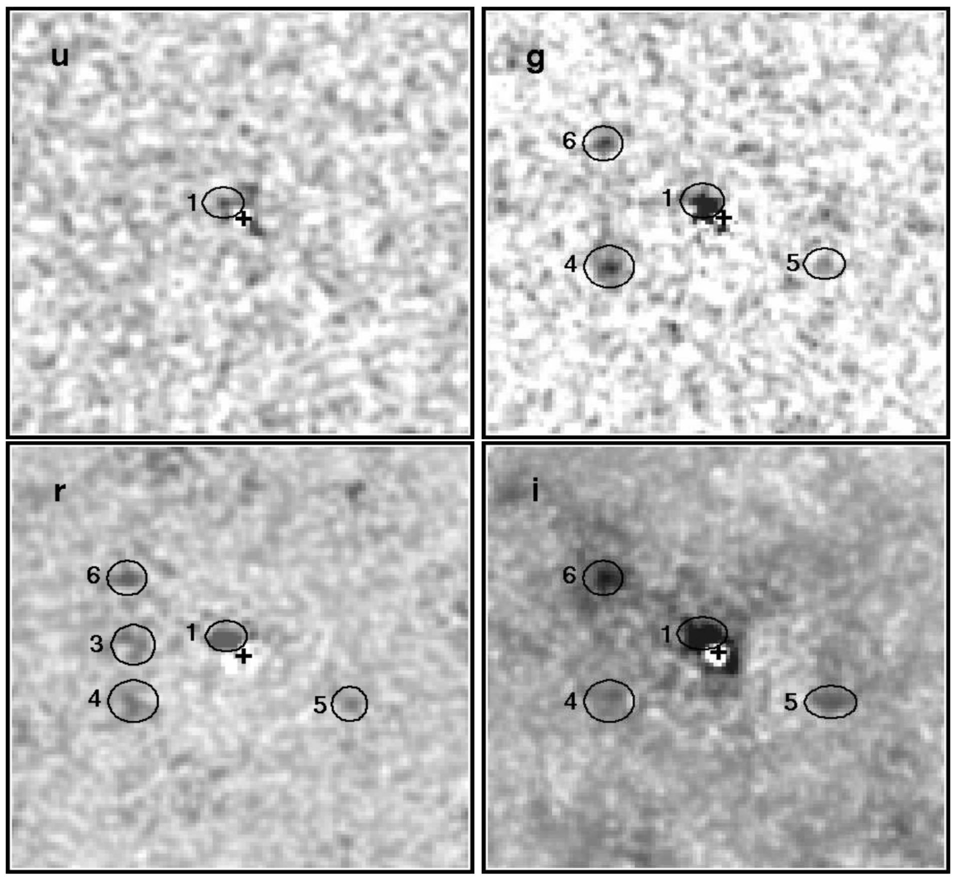
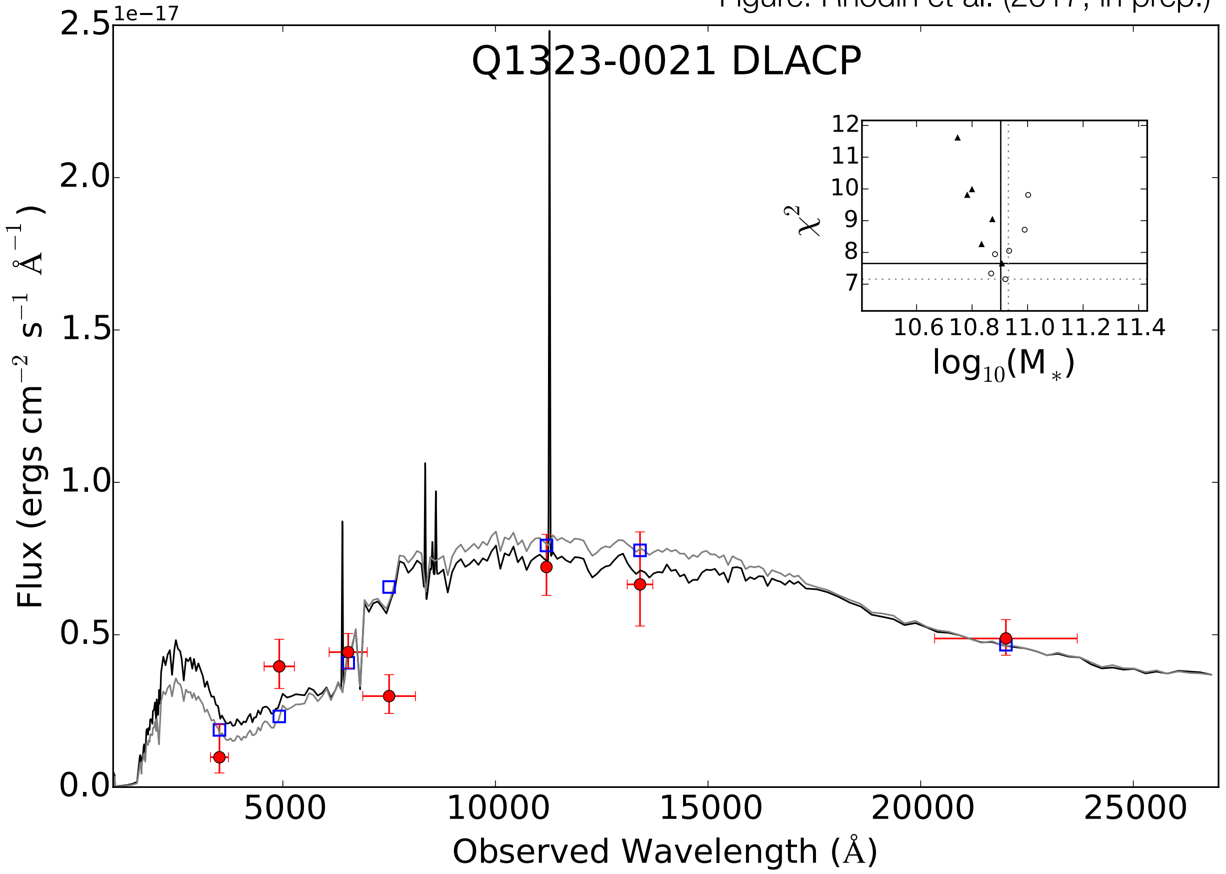


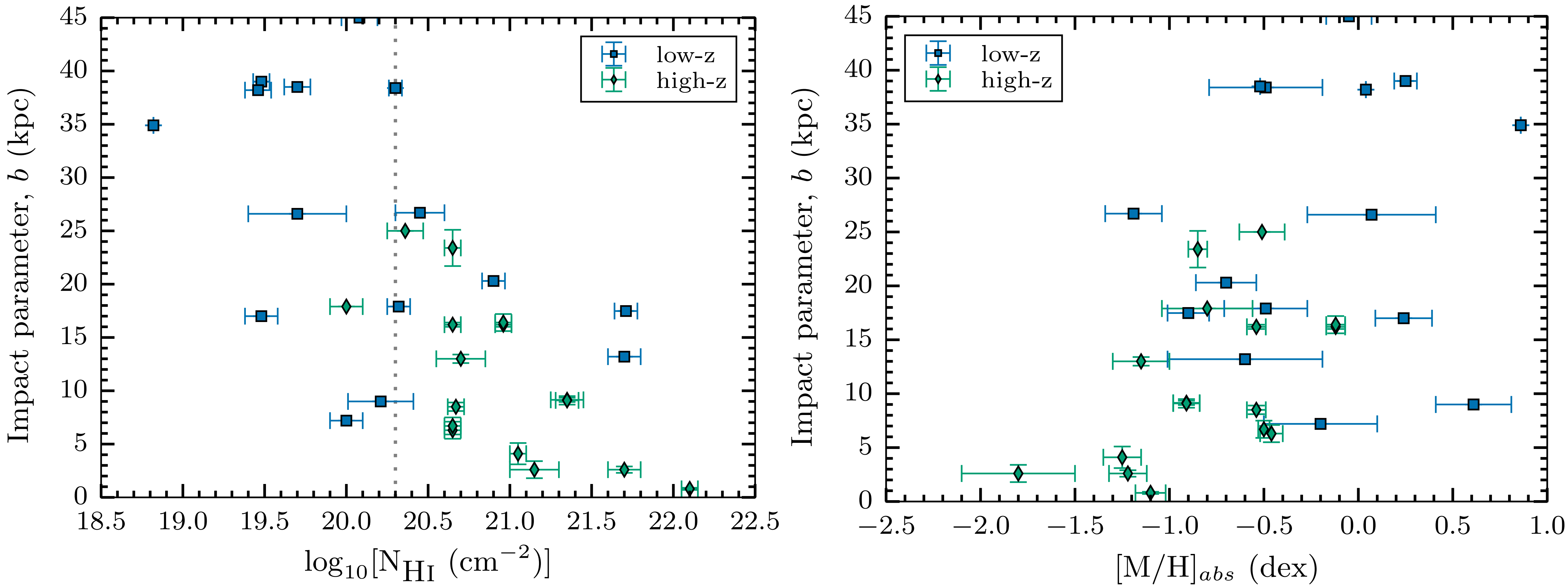
Figure: Rhodin et al. (2017, in prep.)



LePhare (Arnouts et al. 1999; Ilbert et al. 2006)

- BC03 templates/SED-libraries (Bruzual & Charlot 2003)
- Spectroscopic redshift of confirmed host (Rhodin et al. 2017, in prep.)
- Multi-band photometry (Rao et al. 2011; Chen & Lanzetta 2003)

Characterising the absorber-galaxy connection



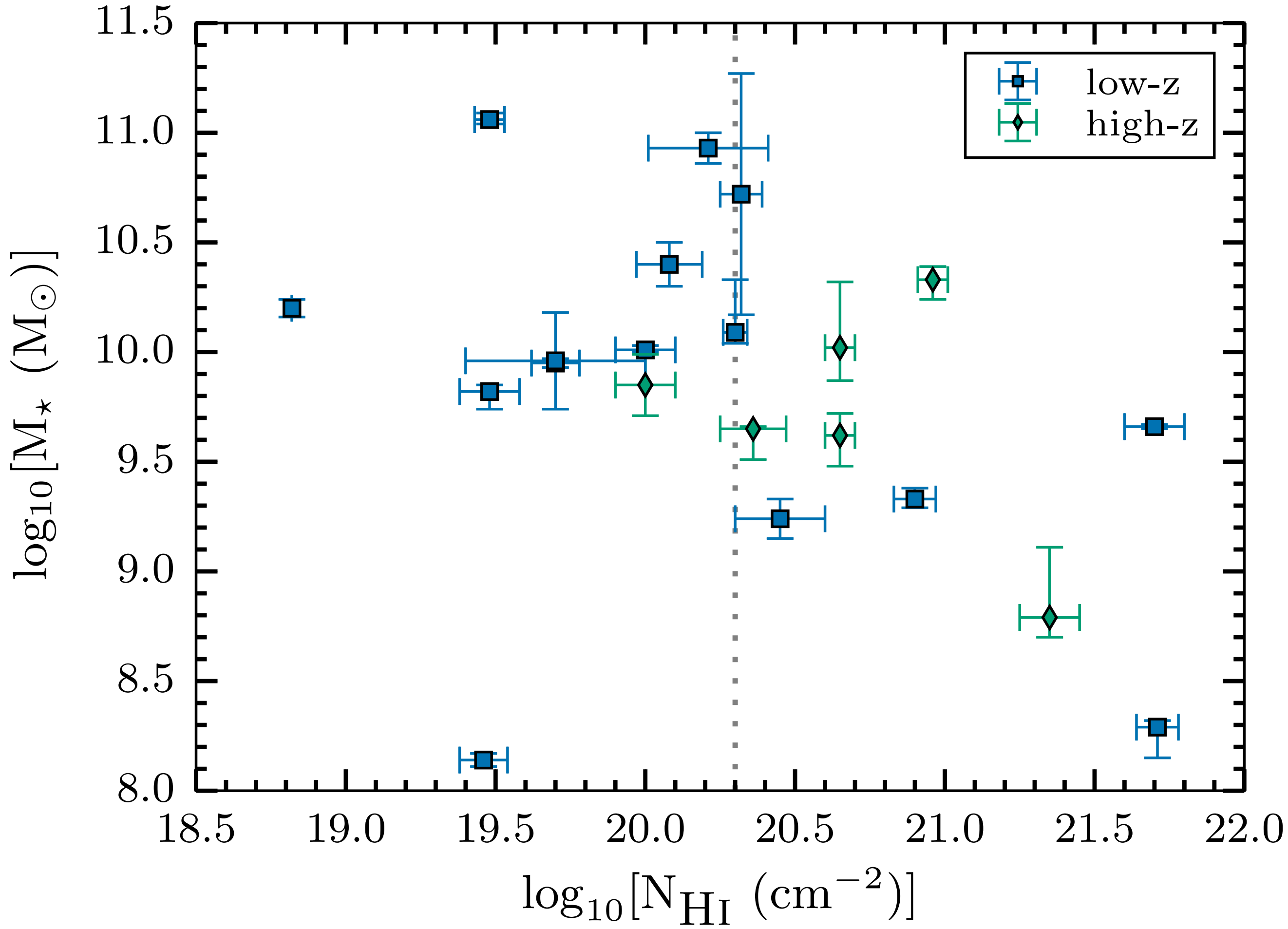
Sub-DLAs show more scatter and higher mean impact parameters than DLAs

- Trace different relations to their host
- Consistent with the velocity-metallicity relation (Som et al. 2015)

High-metallicity absorbers span larger ranges in impact parameter

- Consistent with impact parameter as probe of disc size (Fynbo et al. 2008)
- Low-z consistent with high-z observations (Krogager et al. 2012)

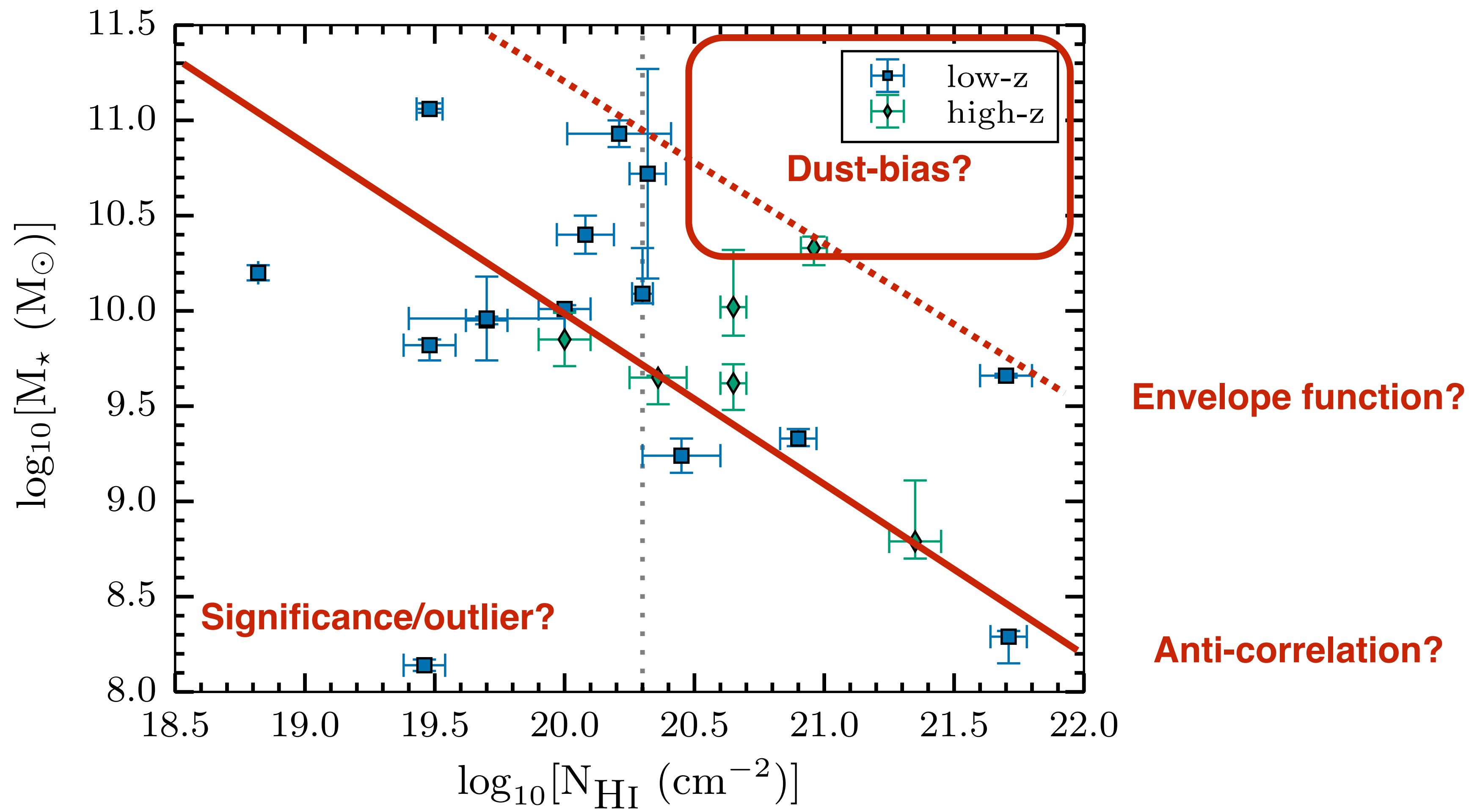
Characterising the absorber-galaxy connection



Observation

- Anti-correlation in host galaxy stellar mass and HI column density

Characterising the absorber-galaxy connection



Observation

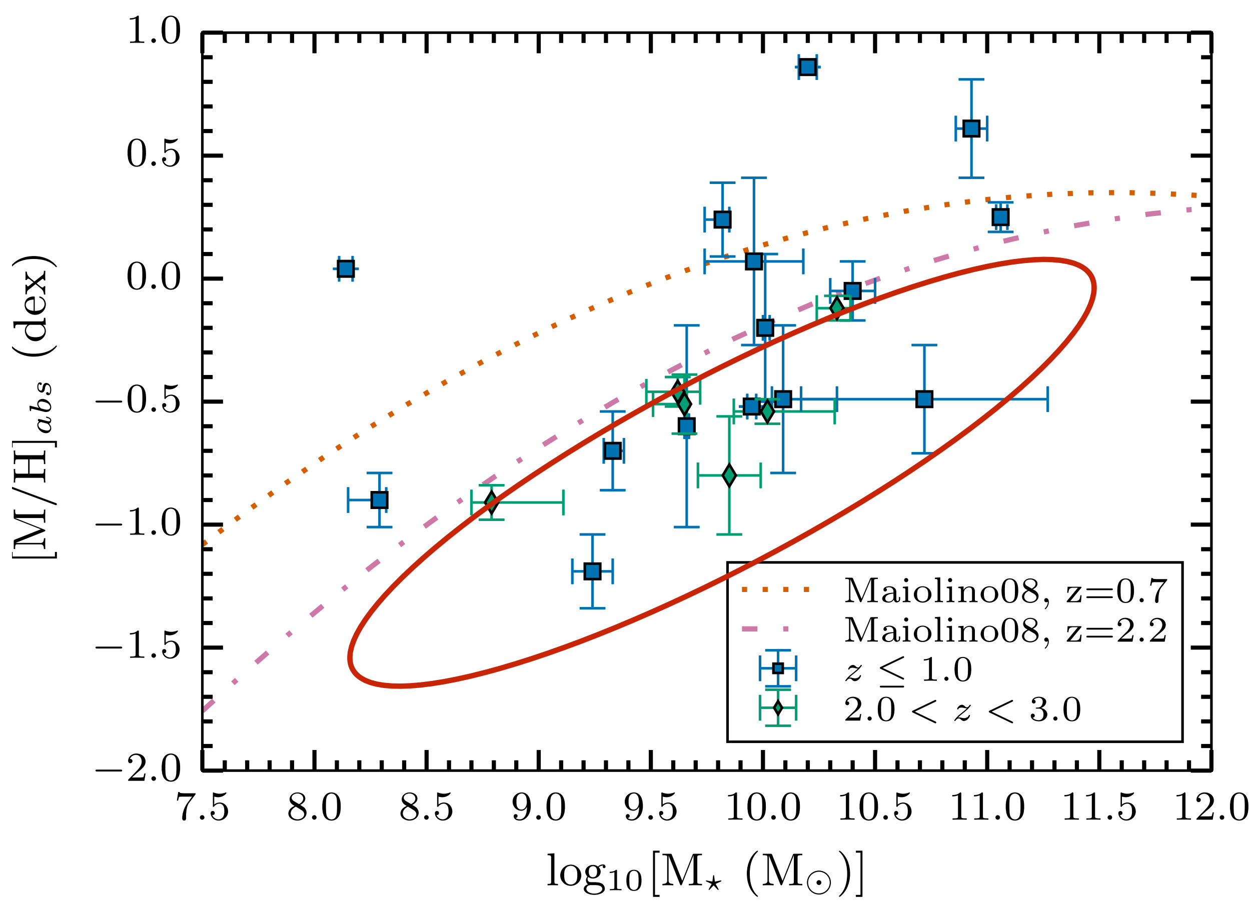
- Anti-correlation in host galaxy stellar mass and HI column density

Interpretation(s)

- Sub-DLAs arise in more massive (metal-rich) galaxies (Kulkarni 2010)
- Dust-bias in high-mass/metallicity galaxies (Vladilo & Peroux 2005)
- Low column density systems as the consequence of converting of neutral hydrogen to molecular gas that forms stars (Meiring et al. 2011)

The Mass-Metallicity Relation

Undershoot?

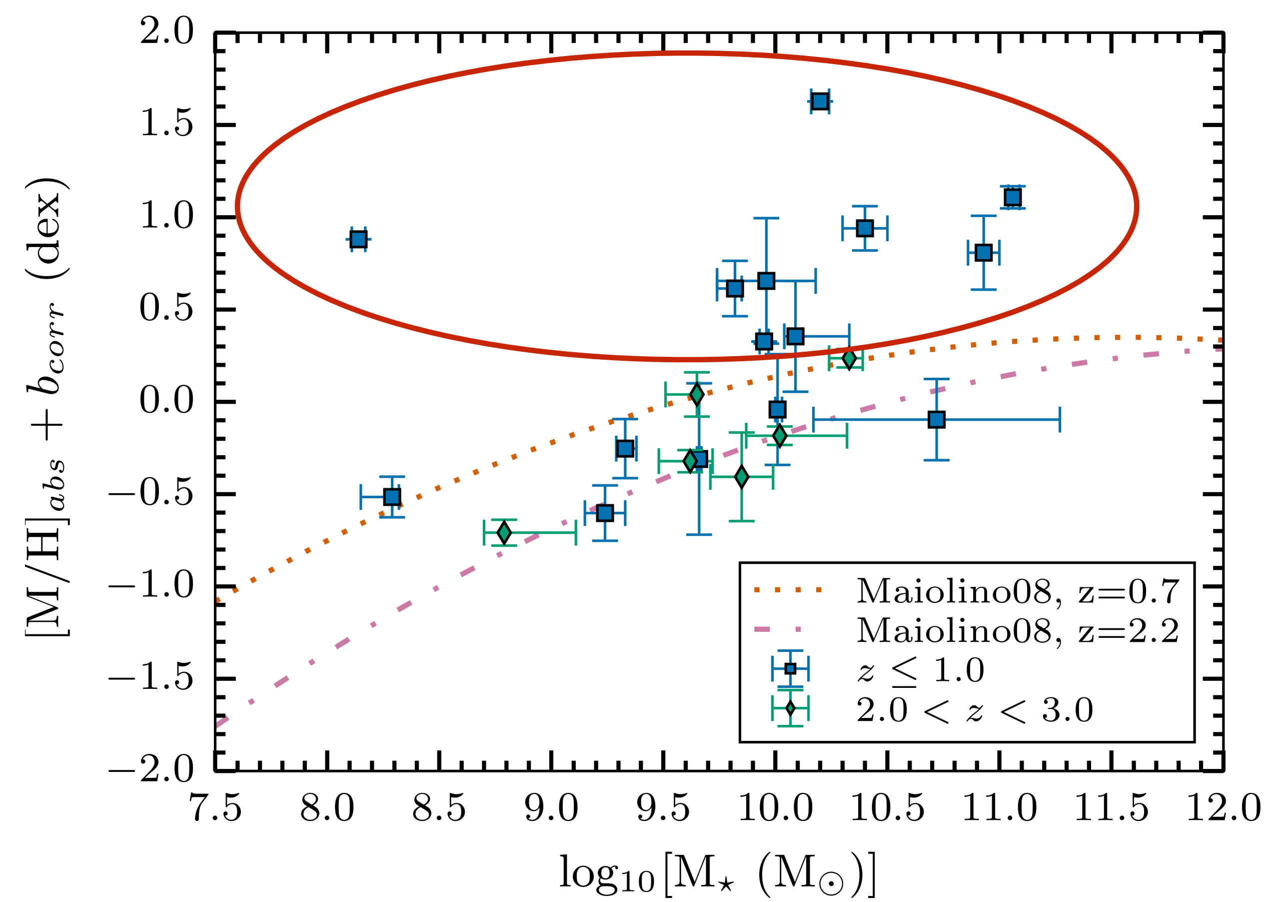


Luminosity-selected galaxies follow redshift-dependent M-Z relations (Tremonti et al. 2004; Maiolino et al. 2008)

Absorption-selected galaxies systematically lie below the M-Z relation for luminosity-selected galaxies

Scatter driven by random sampling of sight-lines through the galaxies.

Overshoot?

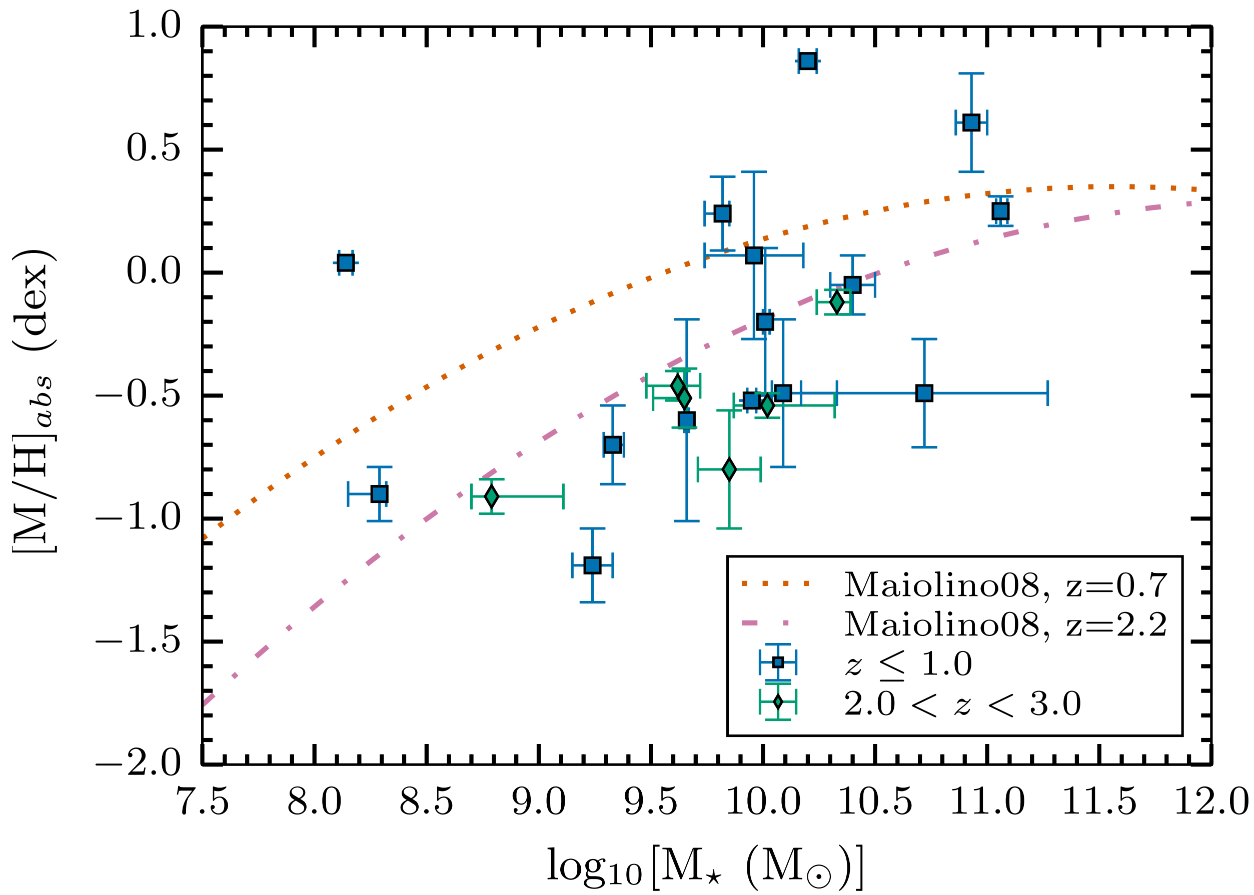


Include average halo metallicity-gradient (Christensen 2014): bcorr = 0.022 dex/kpc x b kpc

Linear metallicity gradient causes us to overcompensate metallicities

The Mass-Metallicity Relation

Undershoot?



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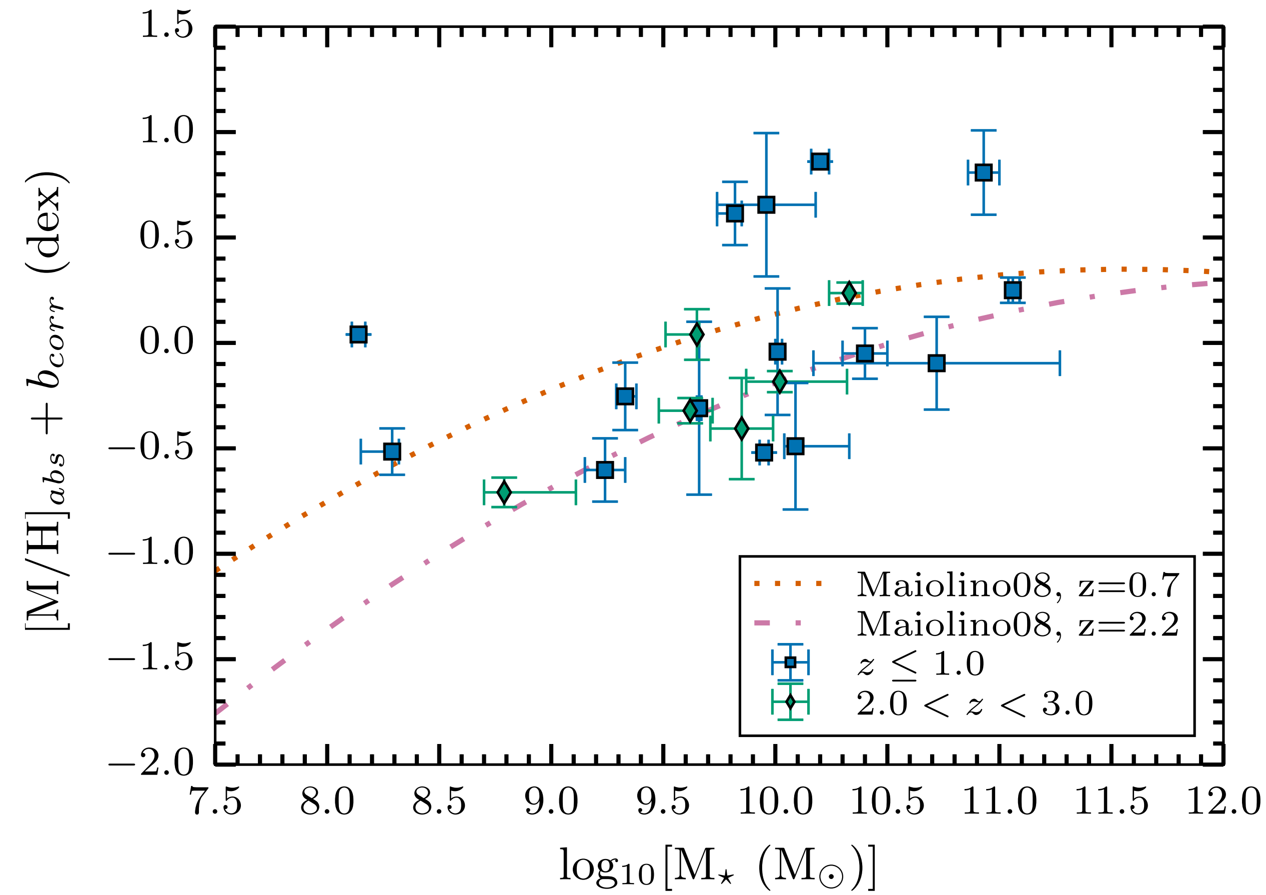
Reconciliation?



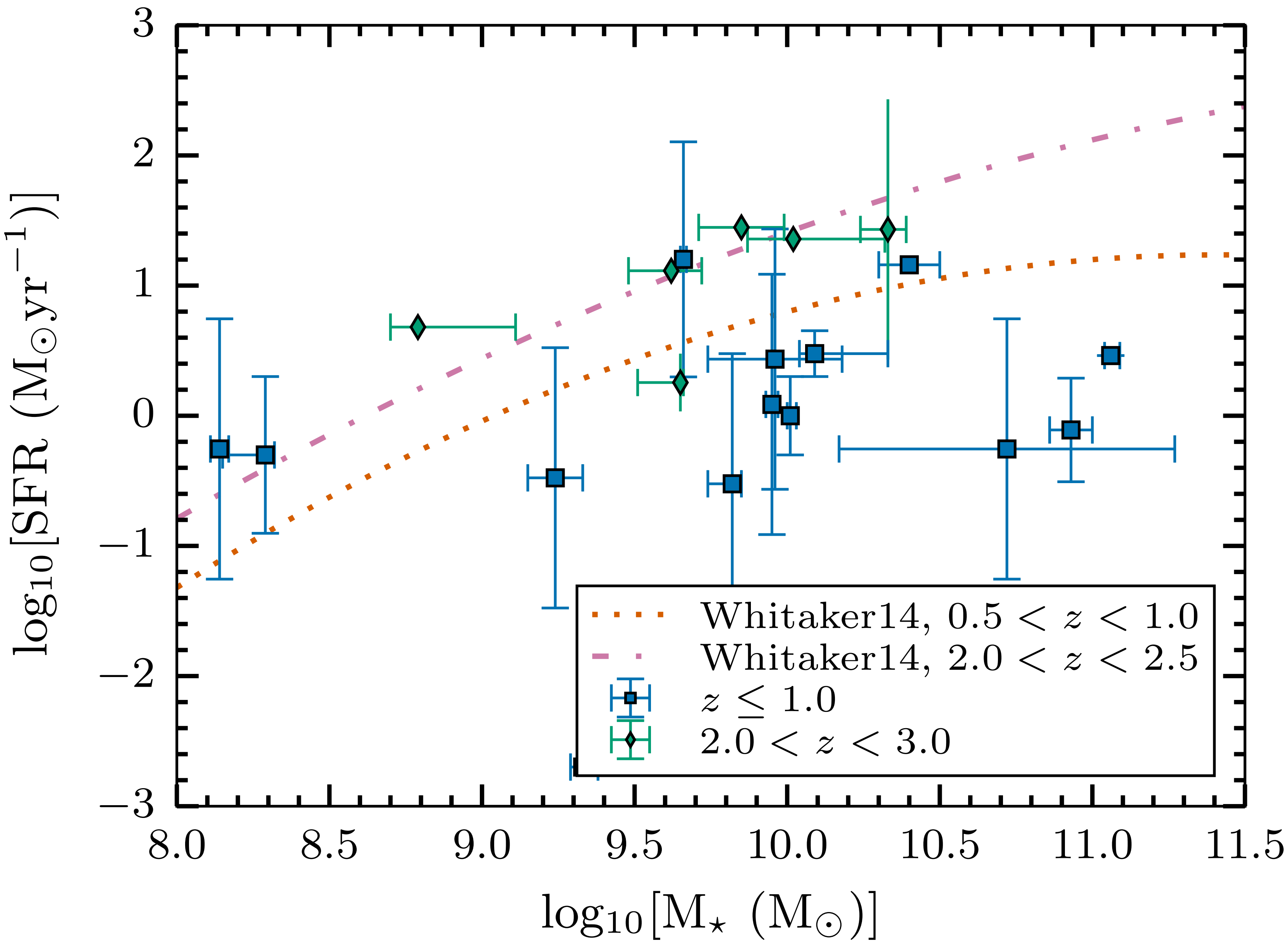
Include average halo metallicity-gradient (Christensen 2014): bcorr = 0.022 dex/kpc x b kpc

for b <= 34 kpc

Absorption-selected galaxies can be made to follow the M-Z relation for luminosity-selected galaxies

Next question: How do we determine the cutoff?

The star-forming sequence

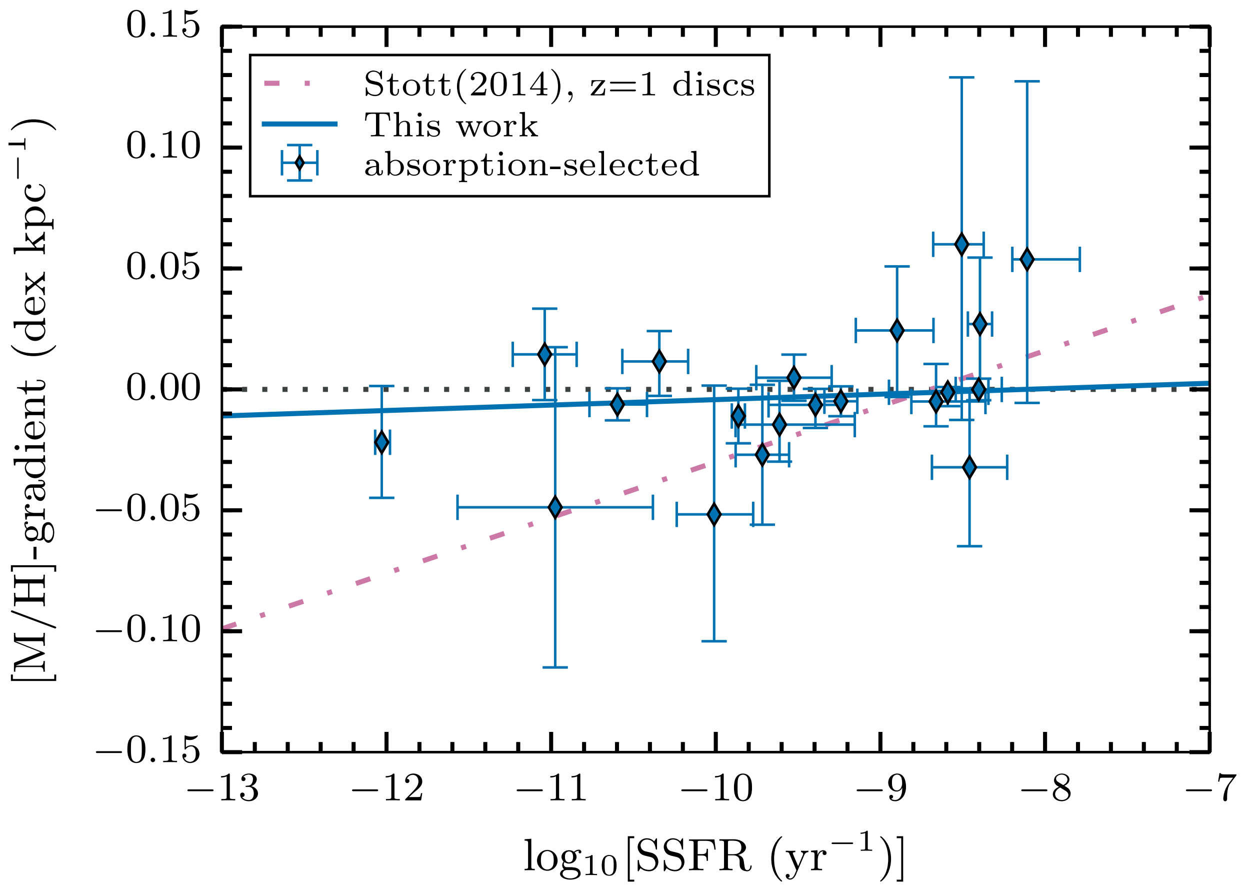


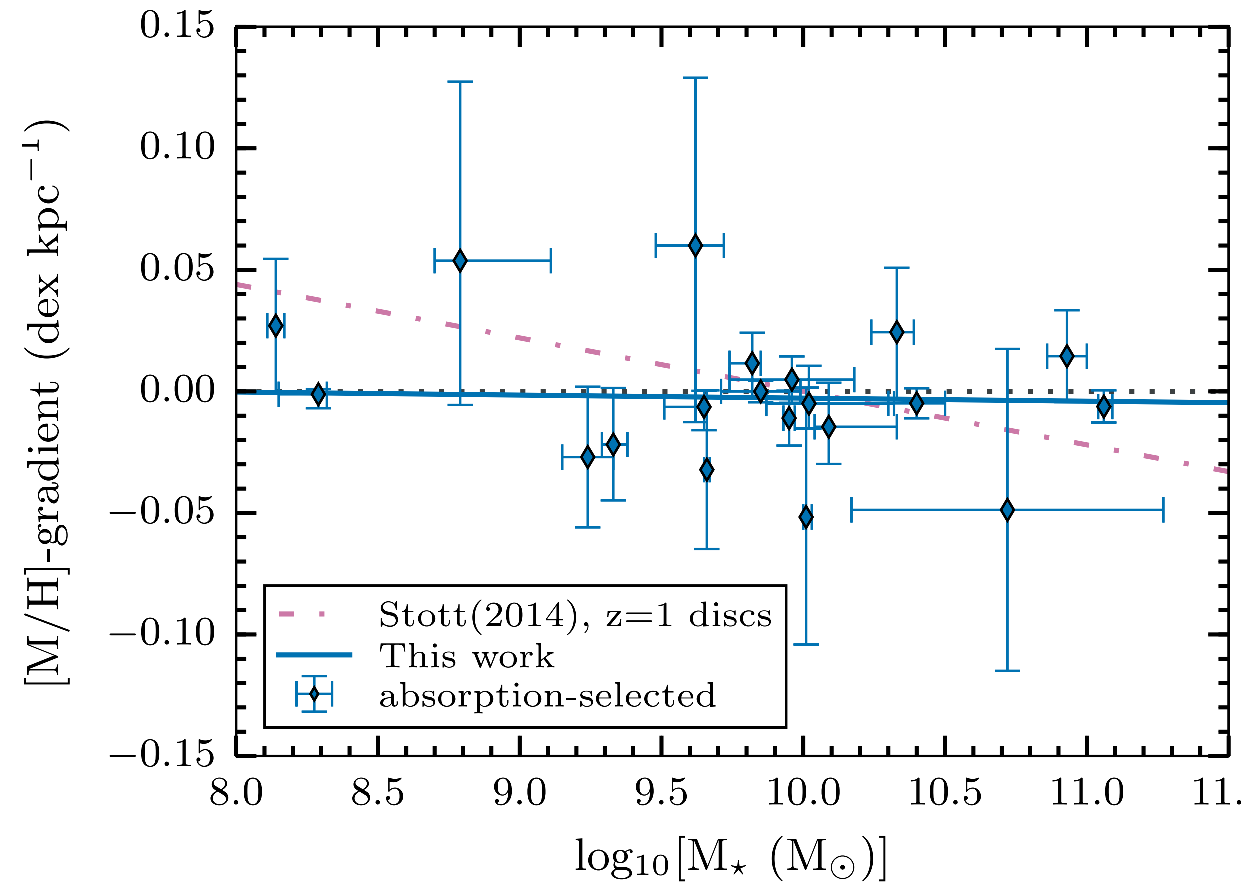
Absorption-selected galaxies are consistent with the star-formation sequence based on $\mathrm{SFR}_{[OII]}$ and $\mathrm{SFR}_{H\alpha}$

Metallicity gradients

Weighted average: -0.0024 ± 0.0022 dex/kpc (Rhodin et al. 2017, in prep.)
-0.023 ± 0.015 dex/kpc (Christensen et al. 2014)
-0.002 ± 0.007 dex/kpc (Rahmani et al. 2016)

No significant correlation with sSFR or Mstar





Keep a lookout!

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Spectroscopic confirmation and new identifications of host galaxies for 8 low-z strong Lyα absorbers with VLT/FORS2

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ABSTRACT

Context. Strong absorption-lines observed in spectra of background quasars tell of intervening absorber-systems, thought to probe outskirts of gaseous galaxies. The strongest of these absorbers trace the bulk of neutral gas through cosmic time, and are thought to act as reservoirs feeding star-formation. We do not know the exact relation that connects these absorbers with their galaxy counterparts, the one influences the other. The proximity of the faint hosts to the bright quasar lines of sights makes it hard to separate their (respective?)

Conclusions

FORS2 long-slit campaign success-rate: 78% (one non-detection, one wrong photo-z candidate)

Sub-DLAs are observed at systematically higher impact parameters with more scatter, and correlate with stellar mass, suggesting an origin in more massive galaxies

Robust identification of the galaxy counterpart allows us to infer emission-metallicity and scaling relations for absorption- and luminosity-selected samples can be reconciled

Albeit gas-rich (atomic and molecular), absorption-selected galaxies are consistent with the star-forming sequence, not showing enhanced star-formation

The metallicity gradient is weak, and at most shows a weak (if any) dependence on stellar mass and specific star formation rate