Dark Cosmology Centre
Niels Bohr Institute

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Metallicity gradients in the halos of absorption selected galaxies

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EWASS Sp16: The outskirts of galaxies
June 23, 2015

Absorption line – galaxy connection

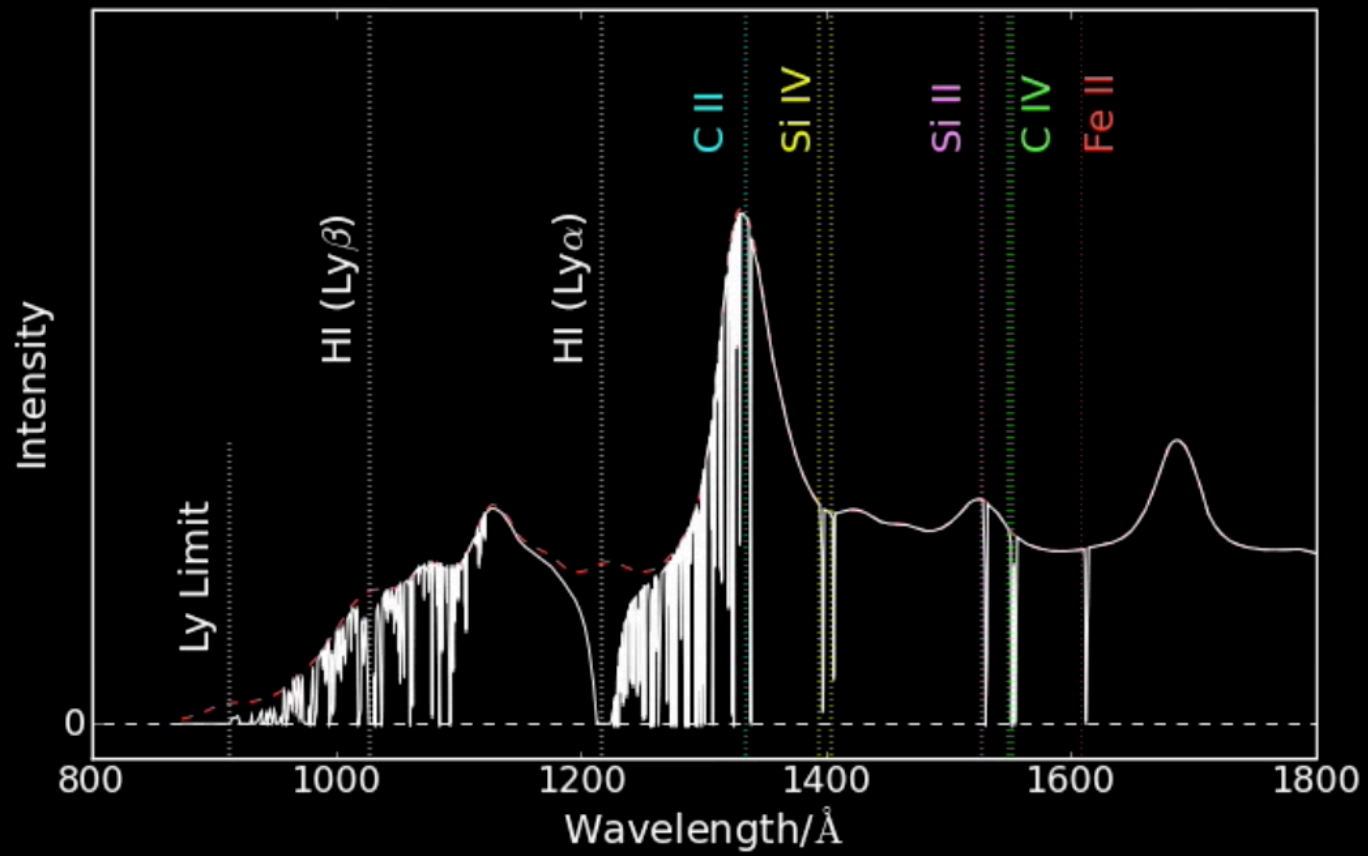
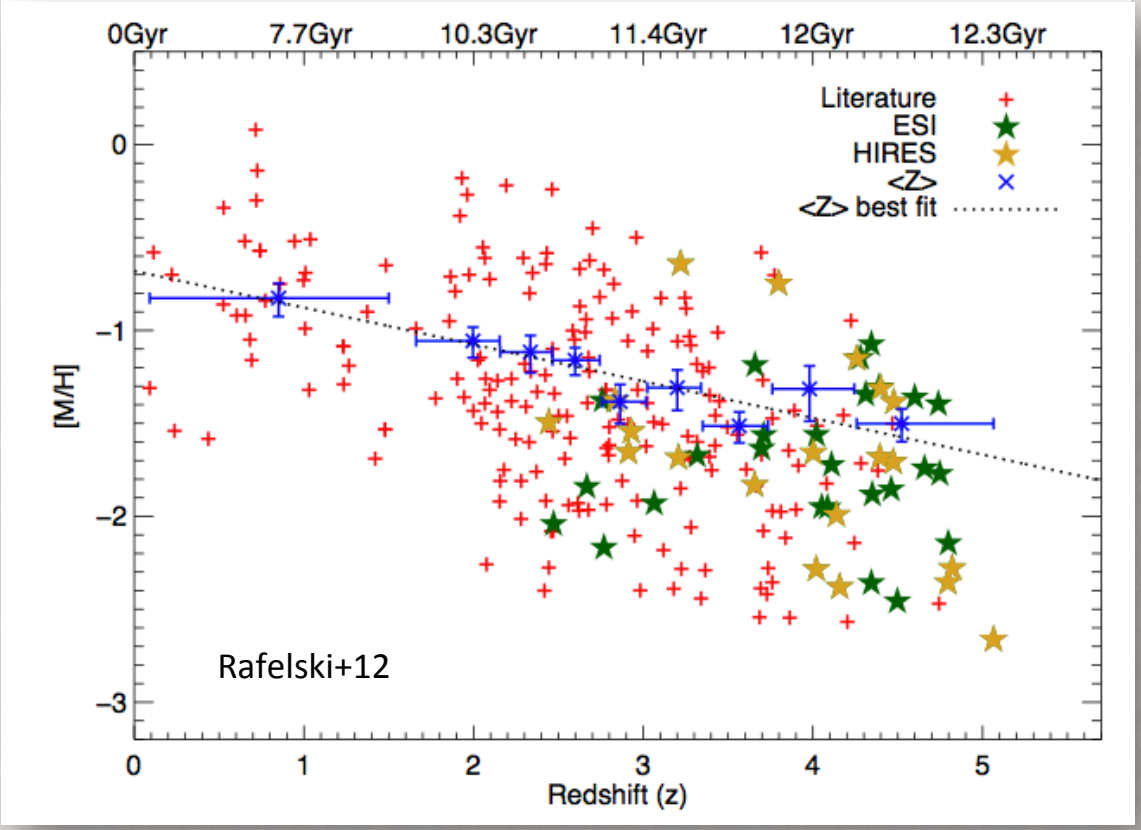


Image credit:
A. Pontzen

Absorption line – galaxy connection

Detailed metallicity information at all z



Most neutral gas is contained in damped Lyman-α absorbers (DLAs)

What type of galaxies do DLAs belong to:

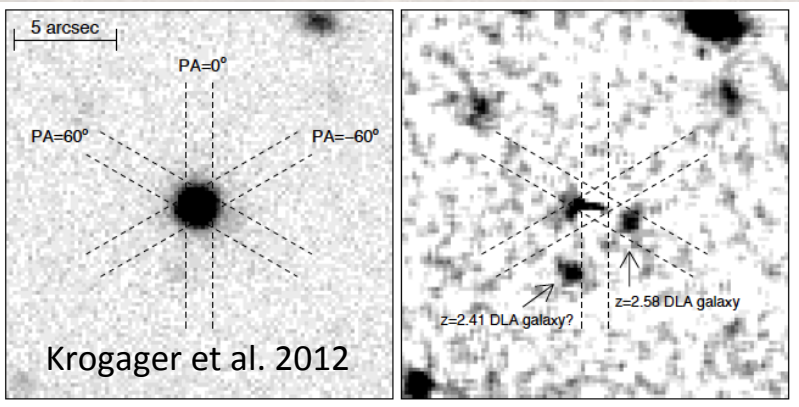
- Dwarfs, giants, LSB?
- Discs, halos?

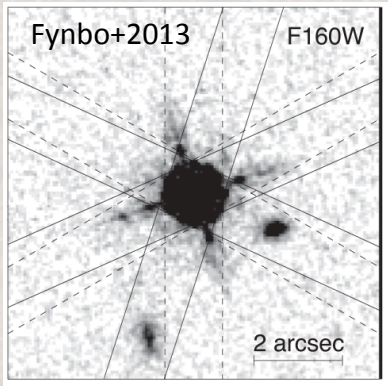
What stars form from the gas?

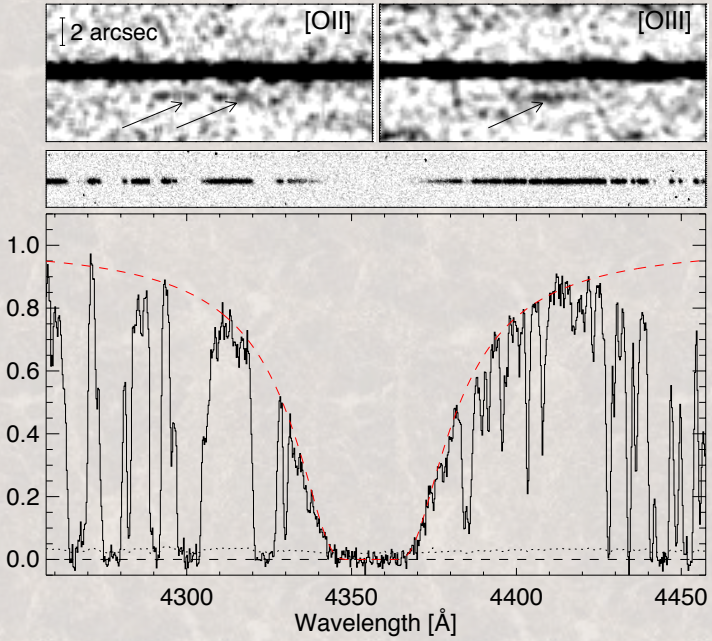
- Metal poor, halo stars?
- Do stars even form in situ?

Searching for galaxies associated with DLAs:

Q0918+1636 and Q2222-0946

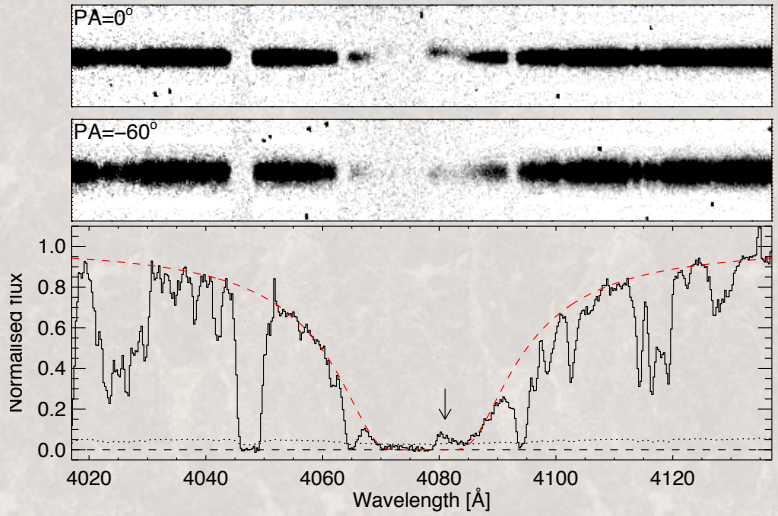






Fynbo et al. 2010,2011,2013, Møller+2002

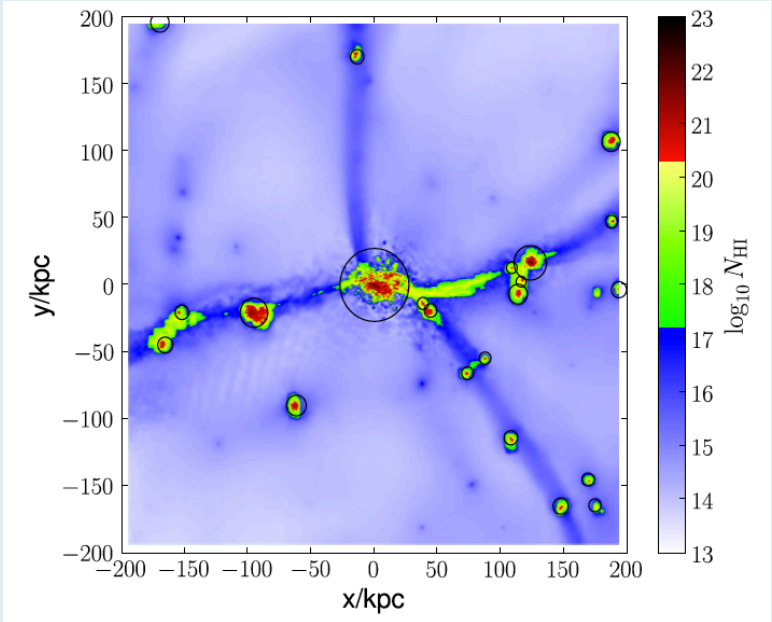
better to explore **metal rich DLA galaxies <-> brighter galaxies**

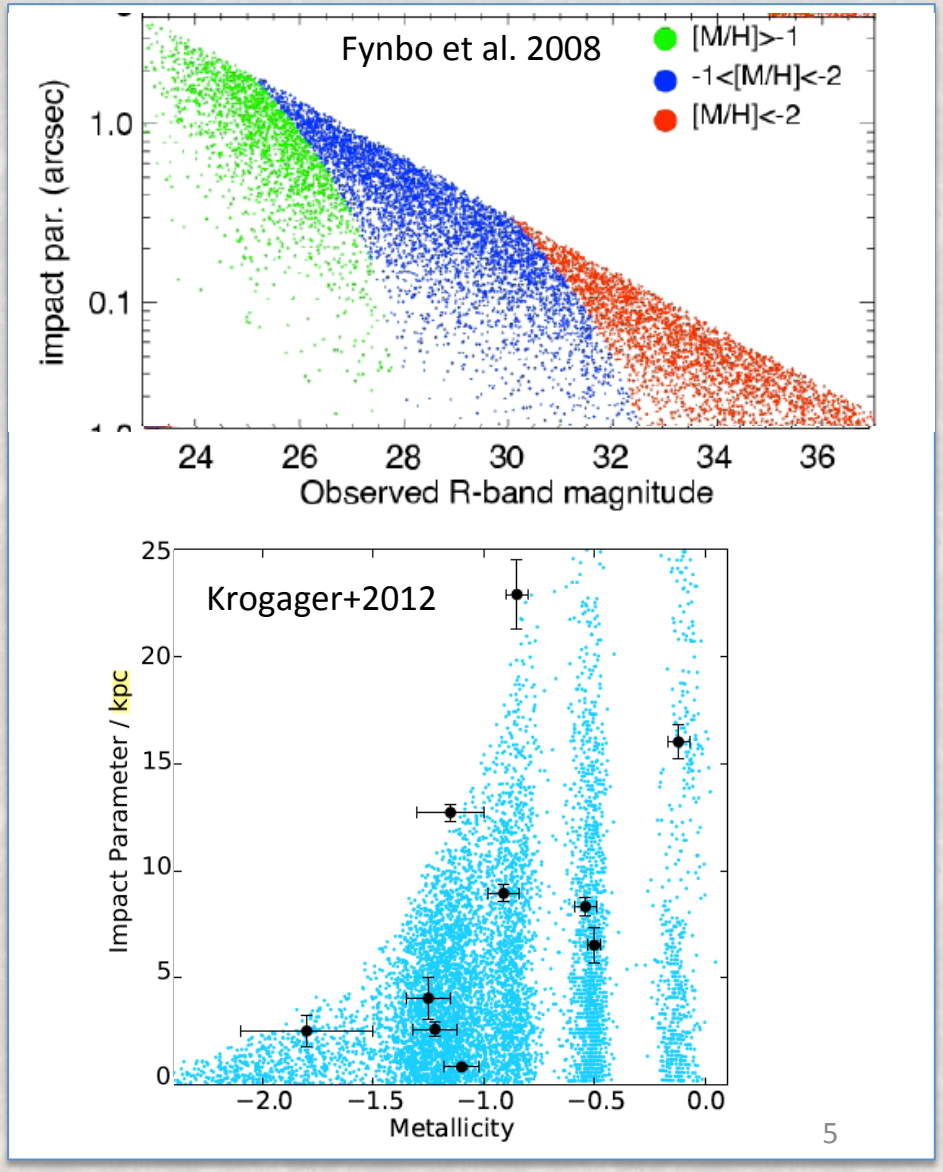


Impact parameter – probing the disc sizes

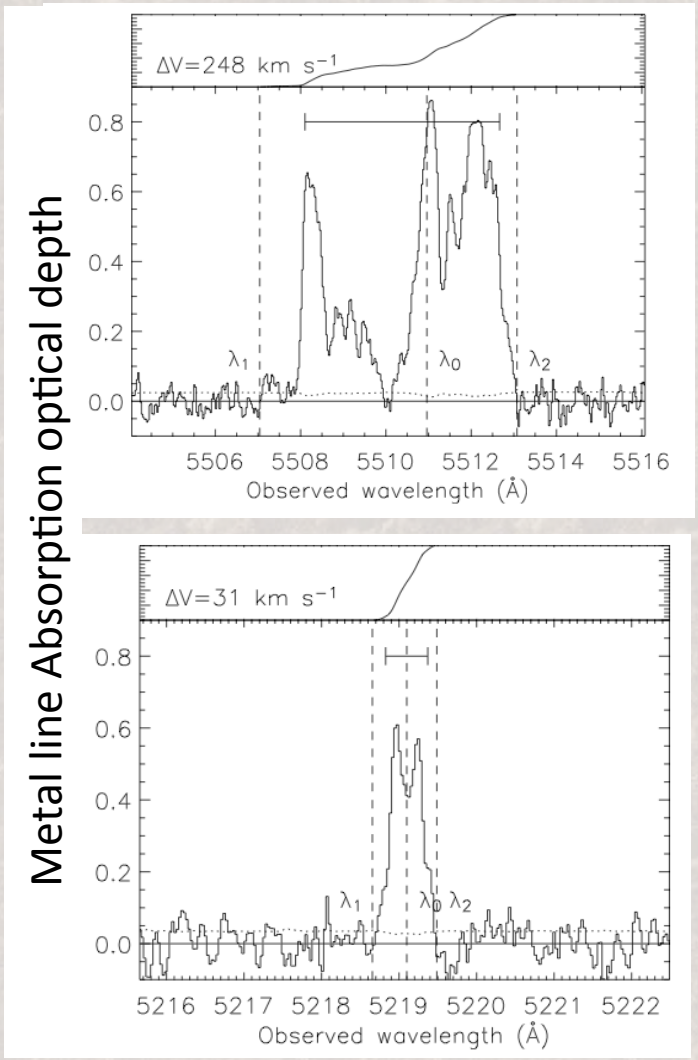
- Holmberg relation : $\frac{R(HI)}{R*} = \left(\frac{L}{L*}\right)^{t}$
- Mass and metallicity is related
- Model suggests b < 2” or < 15 kpc
- DLAs trace the faint end galaxy luminosity function

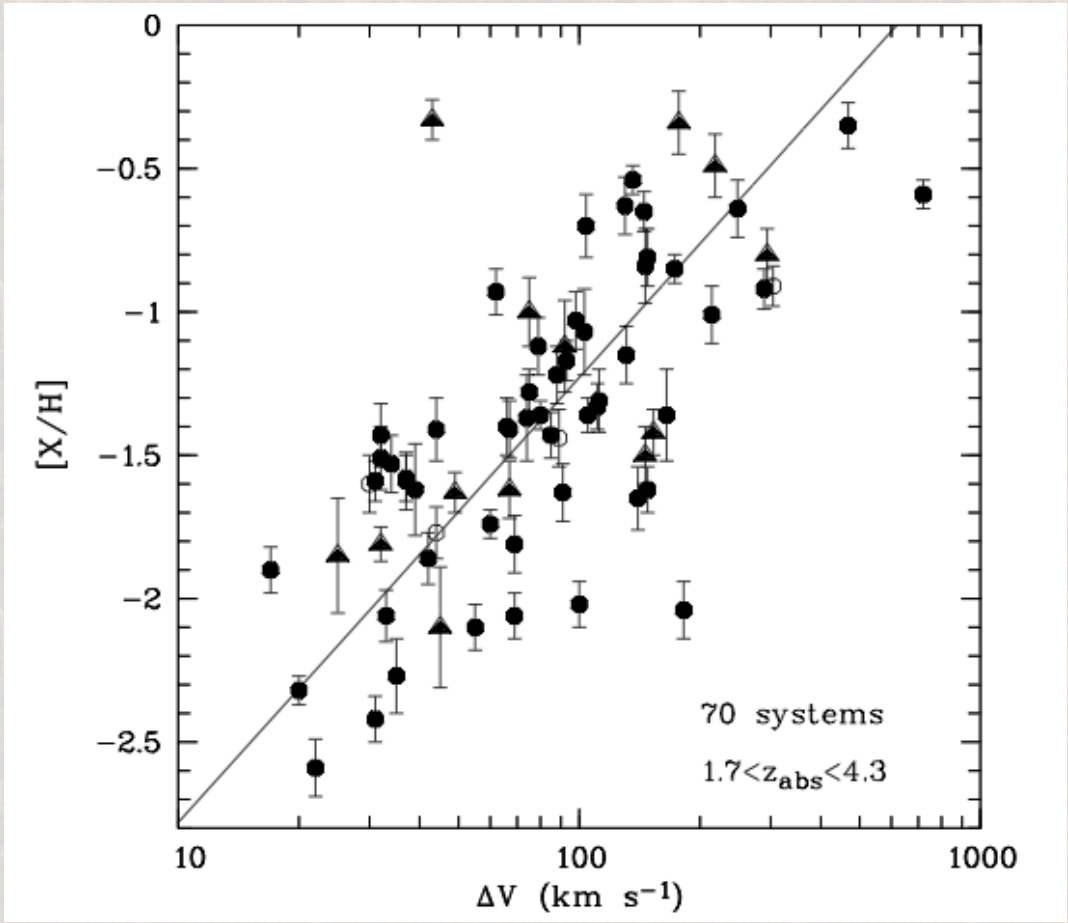
Numerical simulations suggests DLA radii ~4-8 kpc
(Pontzen+08, Fumagalli+11, Bird+14)





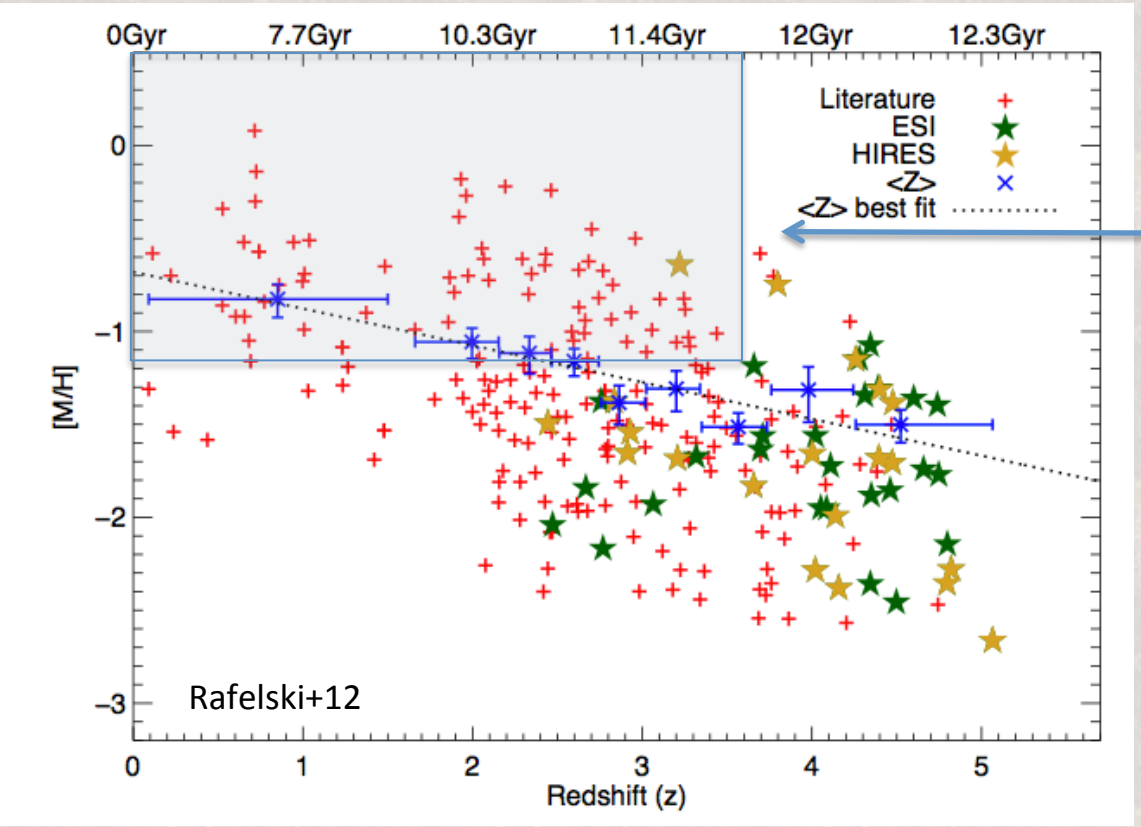
Absorption line widths



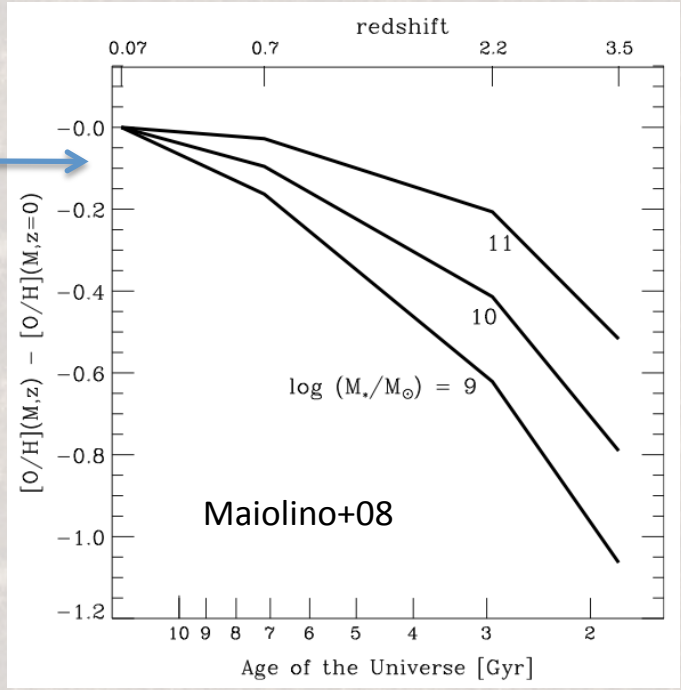


Ledoux+2006; Prochaska+2008; Neeleman+13

Absorption



Emission selected galaxies:
Mass related to metallicity



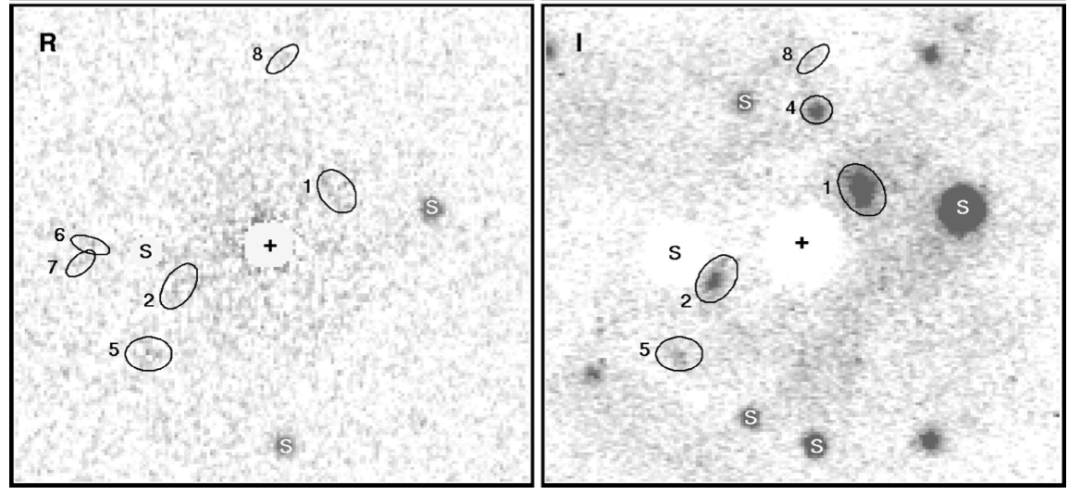
Combine relations to get a **testable prediction:**

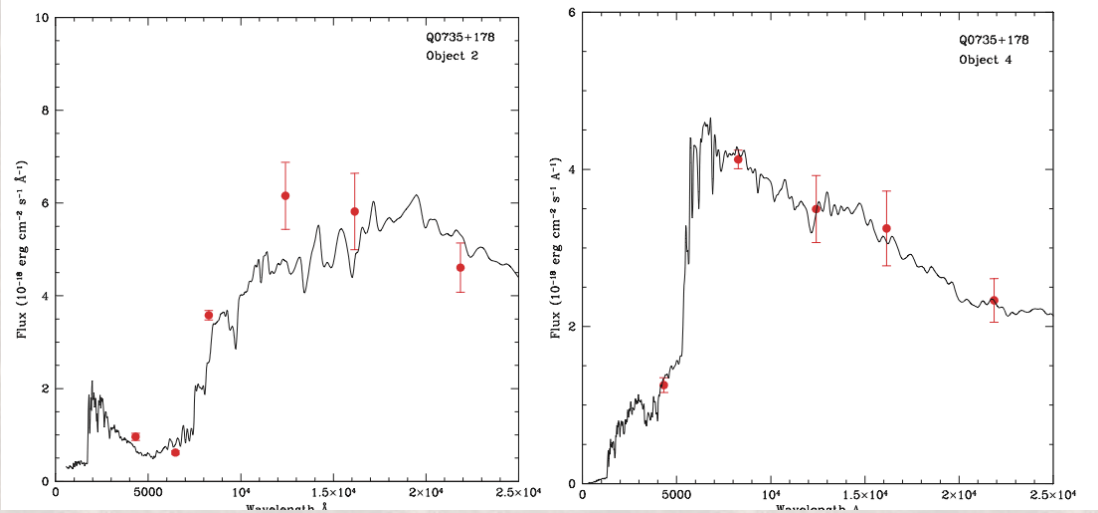
$$\log(M_*/\mathrm{M}_\odot) = 1.76([\mathrm{M/H}] + C_{[\mathrm{M/H}]} + 0.35z + 5.04)$$

Møller+2013

See EWASS SpS15, Thursday: Mass-metallicity relations

Measuring DLA galaxy stellar masses from SED fits





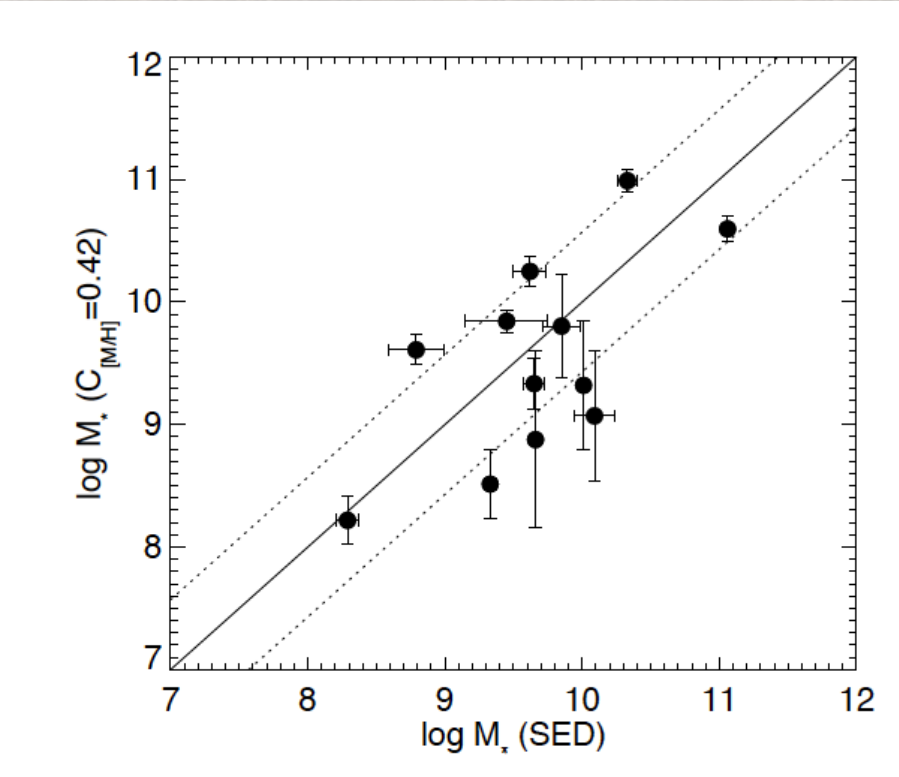
Exploiting the literature:
Turnsheck+01,Rao+03,05,11, Chen+03+05, Kulkarni+05, Fynbo+10-13, Krogager +12-13, Møller+Warren 98,01,02, Peroux 10-13 + more…

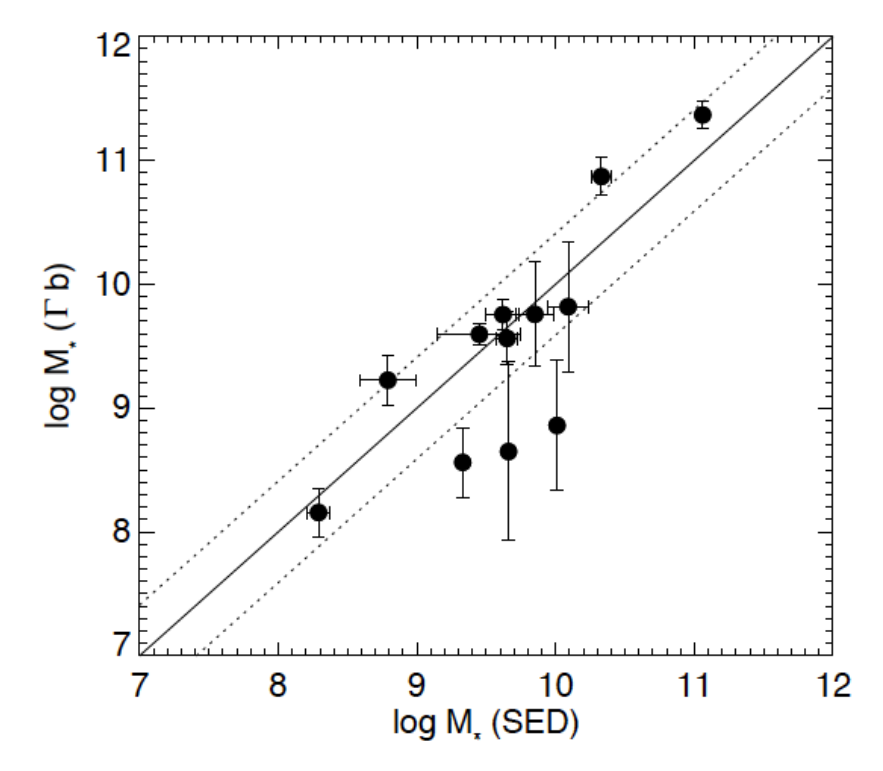
Selected DLA/galaxy pairs

1. Log N(HI) > 19.5
2. spectroscopic confirmed galaxy at DLA redshift
3. Impact param < 40 kpc
4. Impact param > 1 arcsec
5. Multi-band images
6. Absorption metallicity known [M/H]

>10000 DLAs are known,
but our sample consists of only
12 DLA-DLA galaxy pairs at
0.1 < z < 3.1

Verifying the scaling relation





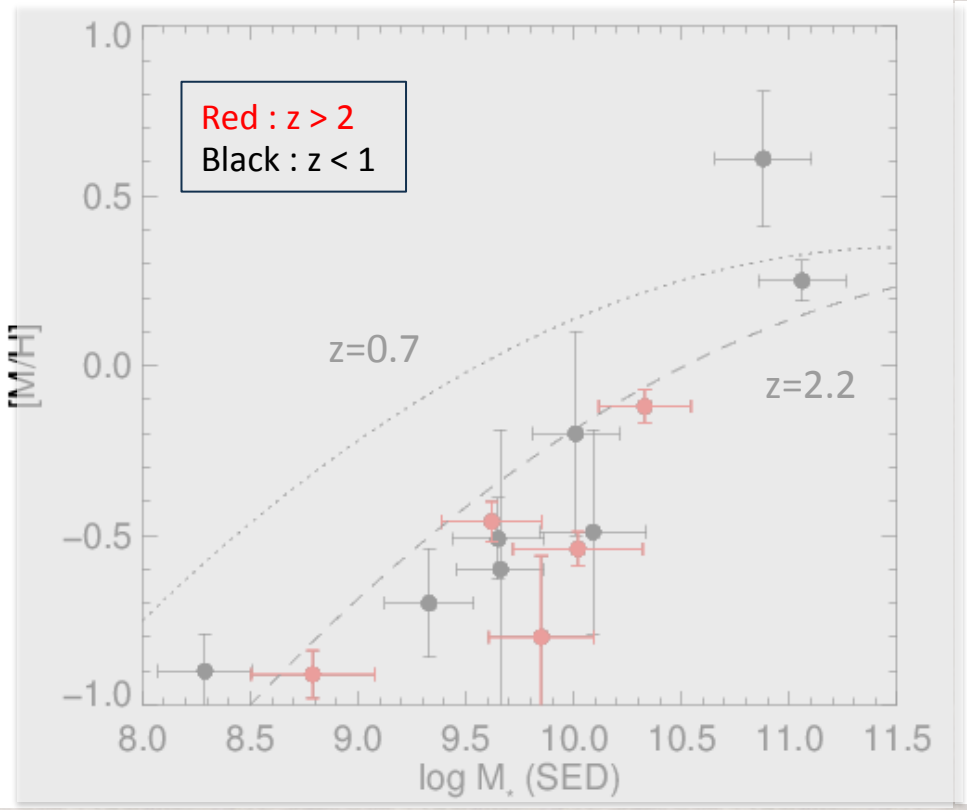
$$\log(M_*/\mathrm{M}_\odot) = 1.76([\mathrm{M/H}] + C_{[\mathrm{M/H}]} + 0.35z + 5.04)$$

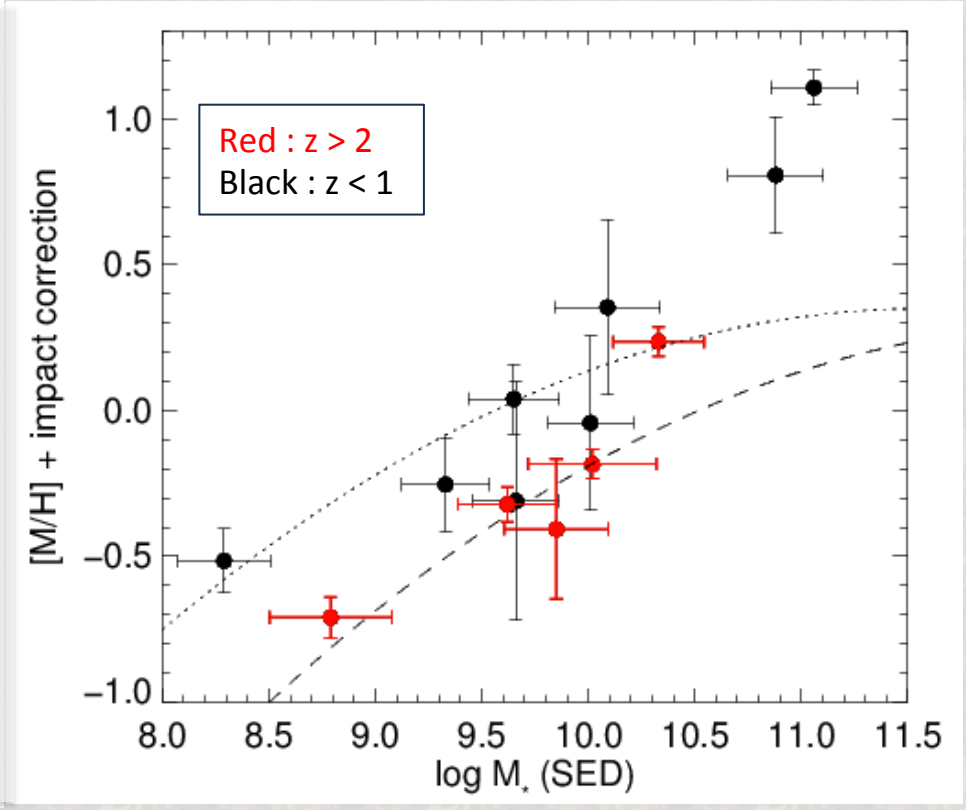
DLA galaxy stellar mass: Christensen +2014

$$\log(M_*^{\mathrm{DLA}}/M_\odot) = 1.76([\mathrm{M/H}] + 0.022b + 0.35z + 5.04).$$

$C_{[M/H]}$=
Average metallicity gradient (dex/kpc) * impact parameter

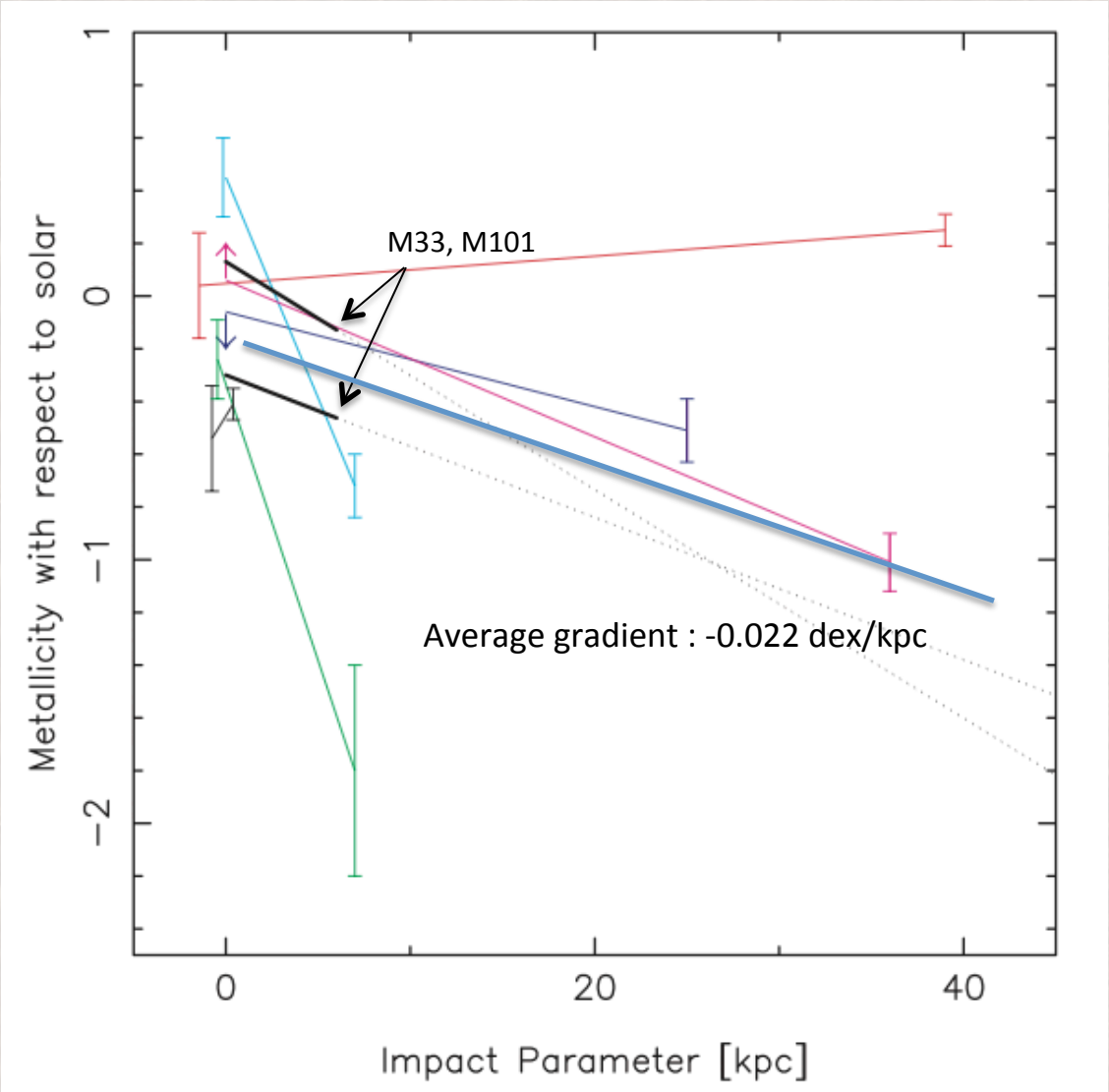
Halo gradients explain the mass-metallicity relation

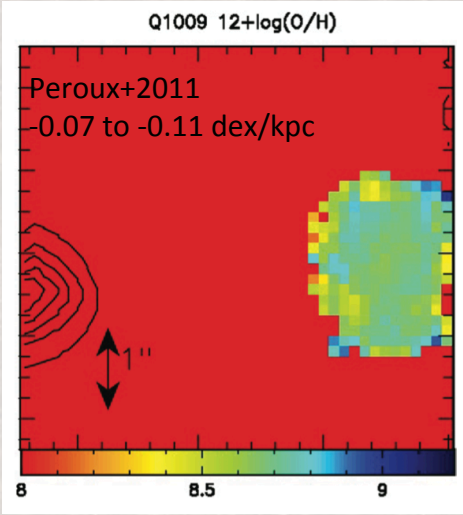


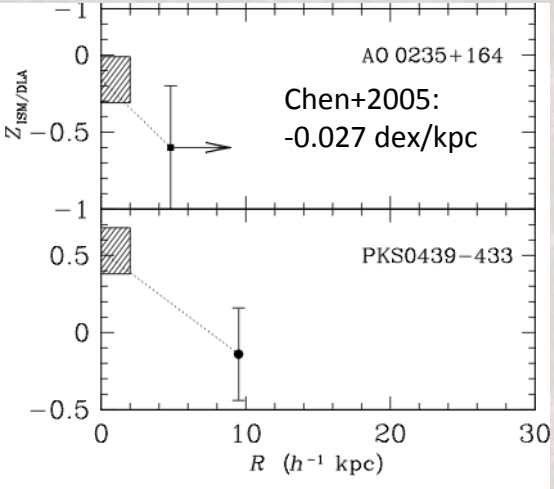


Christensen+2014: **DLA galaxies follow the MZ relation**

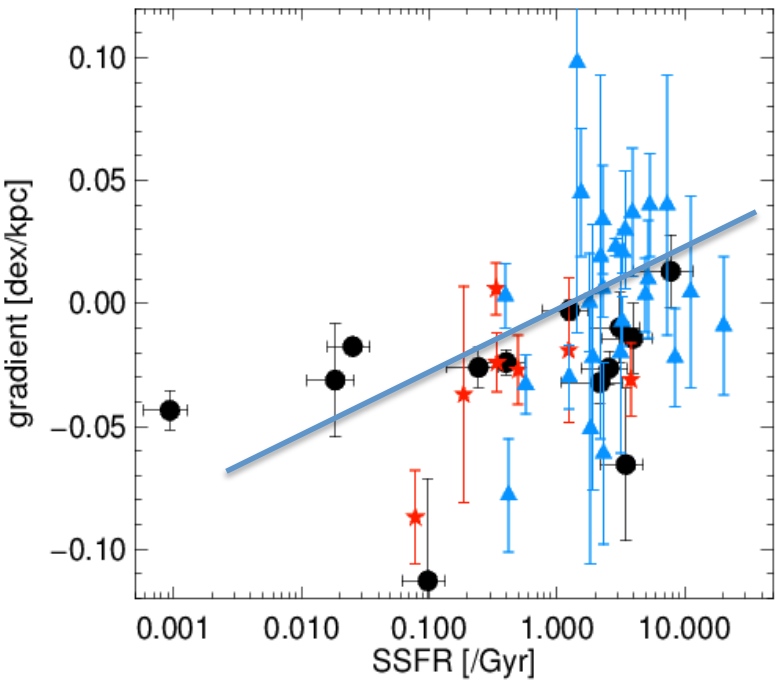
Measures of metallicity gradients

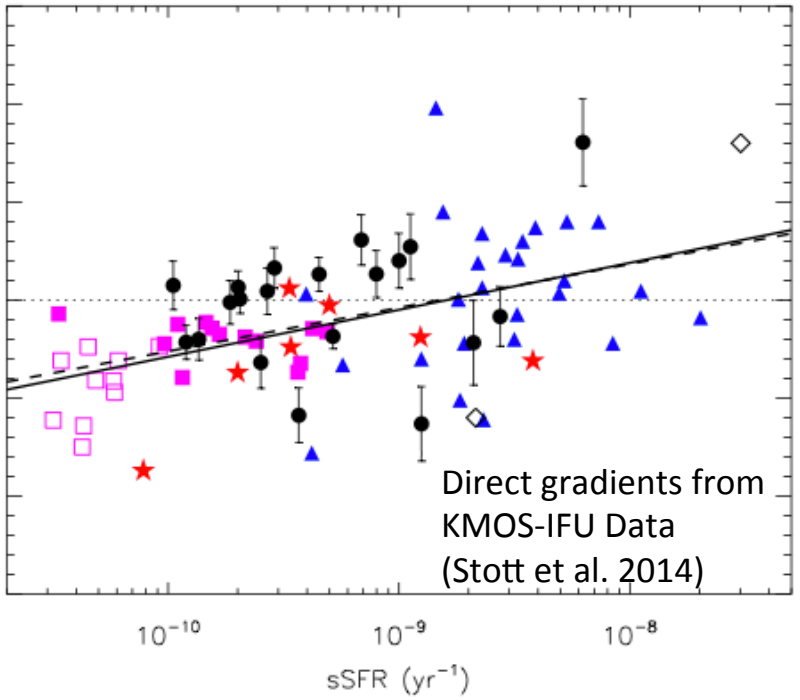






Galaxies, mergers and gradients





DLA galaxies follow the same relation.

Summary

DLA galaxy masses (at redshifts 0.1-3.):

- We can predict a DLA galaxy stellar masses to within 0.6 dex
- If we know the impact parameter, with a gradient of -0.022 dex/kpc, we can predict the DLA galaxy mass to within 0.4 dex

Scaling relations:

- DLA galaxies (Z rich) follow relations from the general galaxy population
- Galaxy halos (out to 40 kpc) have a gradient of –0.02 dex/kpc (similar to discs).
- Metallicity gradients are correlated with SSFR?