GLASS

Spatially Resolved Spectroscopy of Lensed Galaxies in the HFF

Tucker Jones (UCSB/CGE)
& the GLASS team

Yale Frontier Fields Workshop, 12 November 2014

Frontier Field goals:

"These Frontier Fields will combine the power of HST with the natural gravitational telescopes of high-magnification clusters of galaxies. Using both the Wide Field Camera 3 and Advanced Camera for Surveys in parallel, **HST will produce the deepest observations of clusters and their lensed galaxies ever obtained**, and the second-deepest observations of blank fields (located near the clusters). **These images will reveal distant galaxy populations ~10-100 times fainter than any previously observed**, improve our statistical understanding of galaxies during the epoch of reionization, and provide unprecedented measurements of the dark matter within massive clusters."

At intermediate redshifts ($z \approx 1{-}3$):

1. Detailed structure of massive galaxies ($>10^9\ M_\odot$)
2. First glimpse of dwarf galaxy properties

THE GLASS SCIENCE DRIVERS

1. Galaxies at the epoch of reionization

   Kasper Schmidt's talk

   - Observing Lyα at $5.5 < z < 13.0$

   This talk

2. How gas and metals cycle in and out of galaxies

   - Emission line ratio maps of 100s of galaxies at $1.3 < z < 2.3$

3. Galaxy evolution in dense environments

   - Spatially resolved star formation in cluster cores and outskirts

4. Super Novae for cosmology etc.

   Steve Rodney's talk (tomorrow)

   - SN discoveries in up to 4 epochs of imaging per cluster

GLASS

The Grism Lens-Amplified Survey from Space

- HST Grism Spectroscopy of 10 massive clusters (Cycle 21)
- P.I. Tommaso Treu (UCSB)

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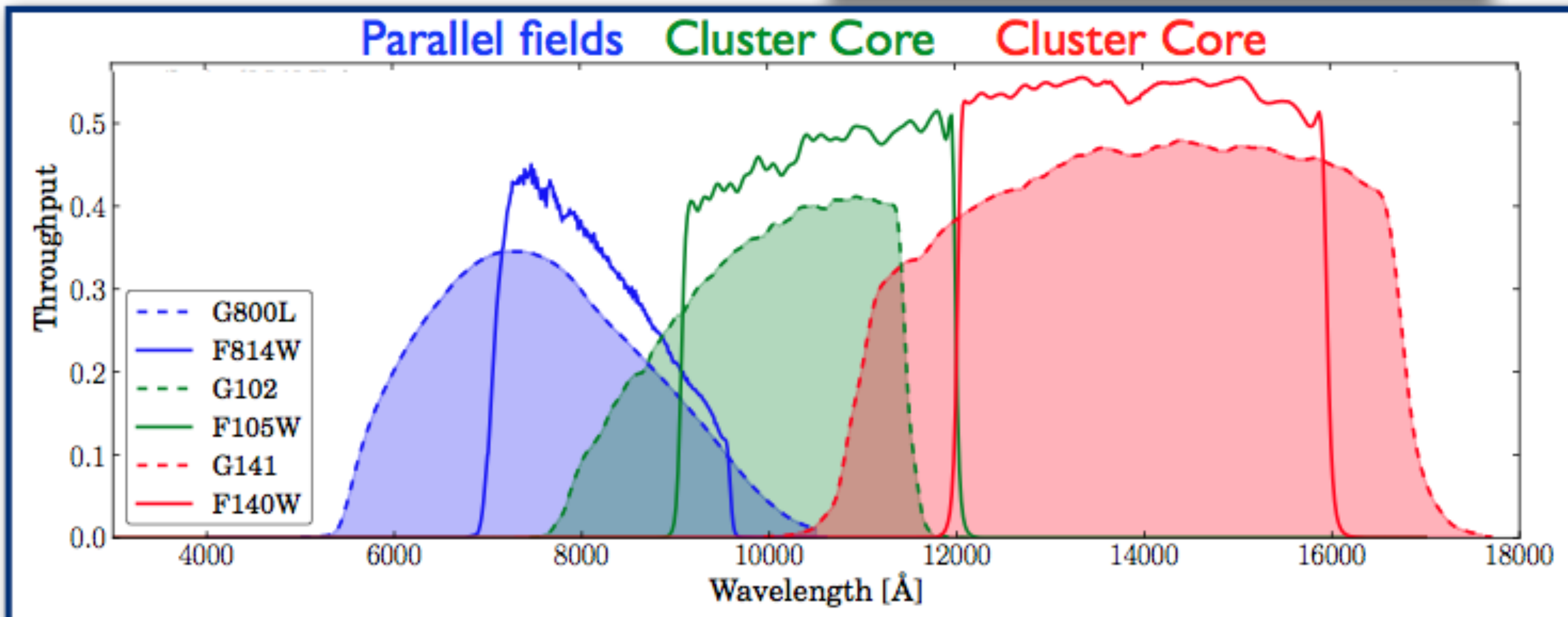
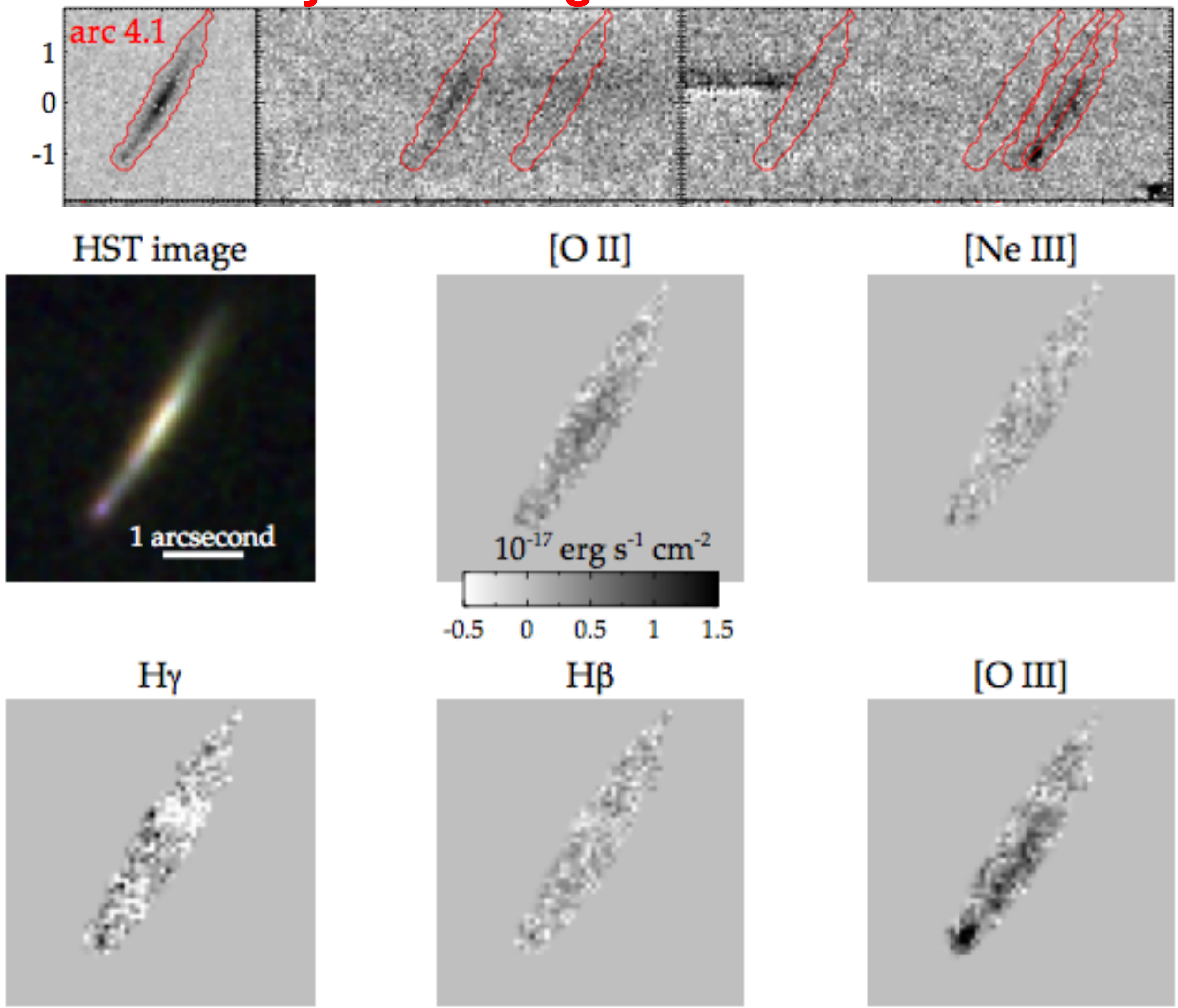


- Spectra of ~20000 objects (~10000 down to m_{F140W} ~ 24)
  Complete wavelength coverage from 0.8−1.7 μm
  Strehl ≈ 1, resolution ≤ 0.13 arcsec, no sky lines, no telluric absorption

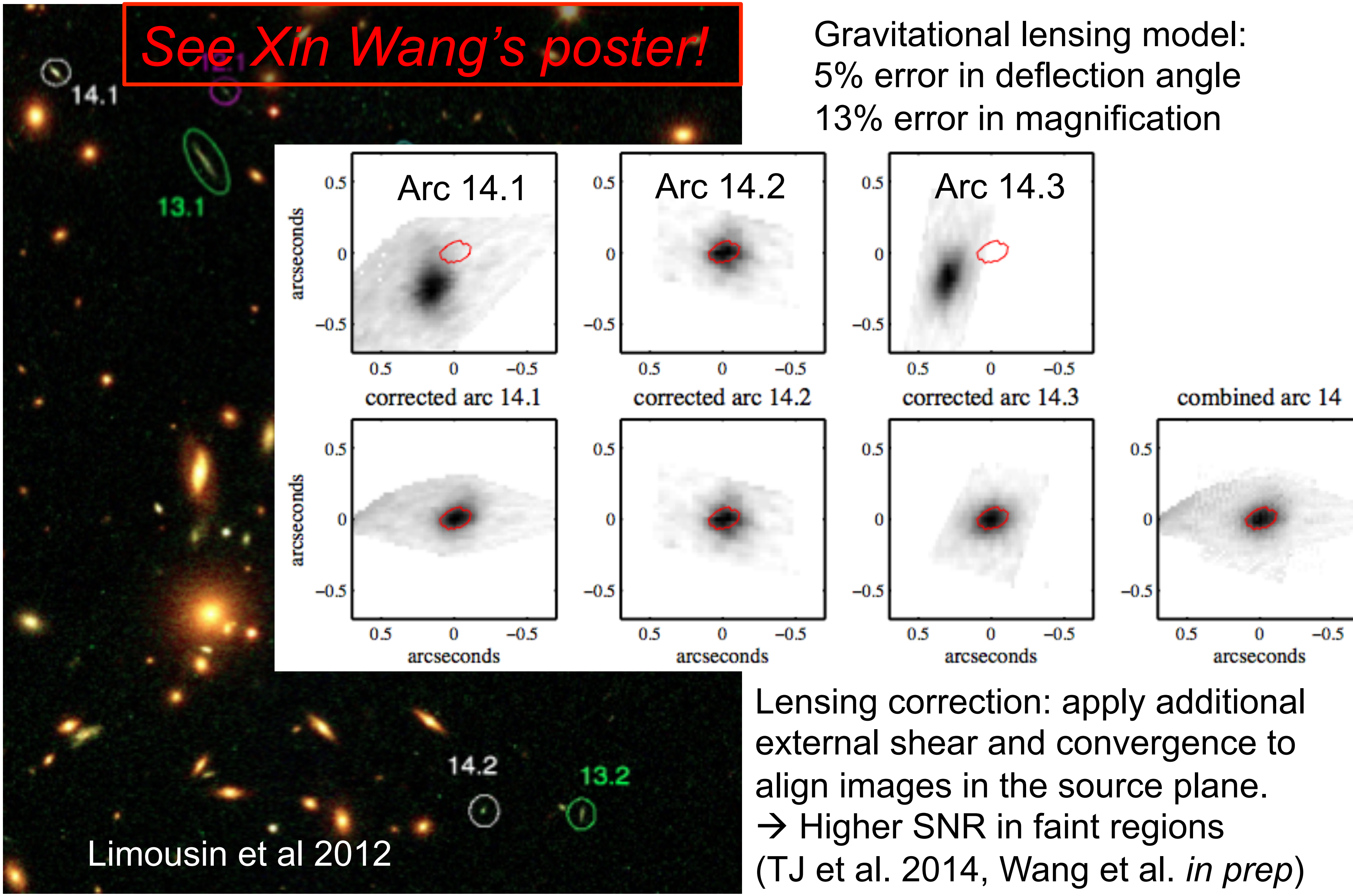
Emission line maps with GLASS

System of 3 galaxies at z=1.855



TJ et al. 2014

Source plane reconstruction



Gravitational lensing model:
5% error in deflection angle
13% error in magnification

Lensing correction: apply additional external shear and convergence to align images in the source plane.
→ Higher SNR in faint regions
(TJ et al. 2014, Wang et al. *in prep*)

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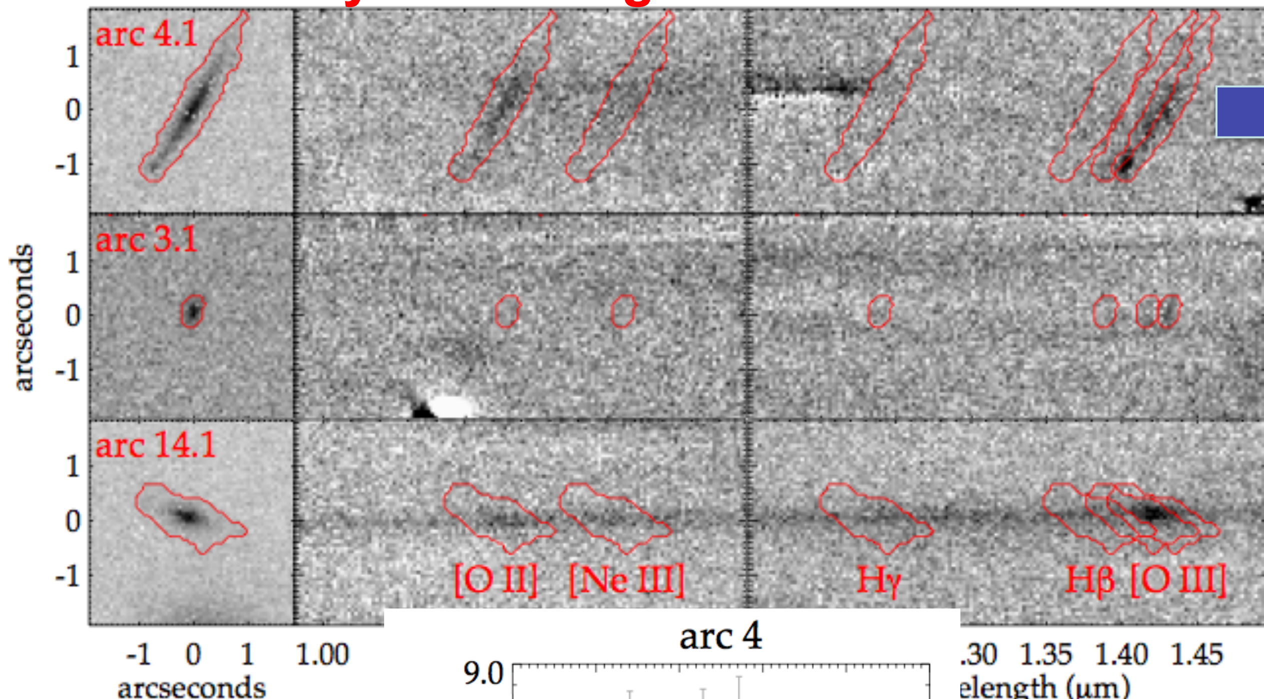
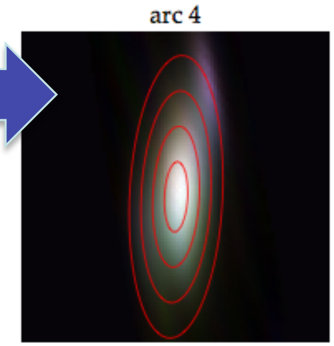
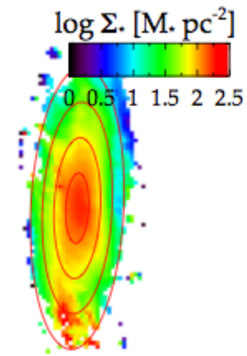
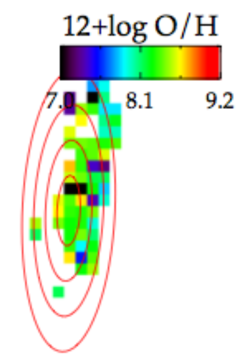


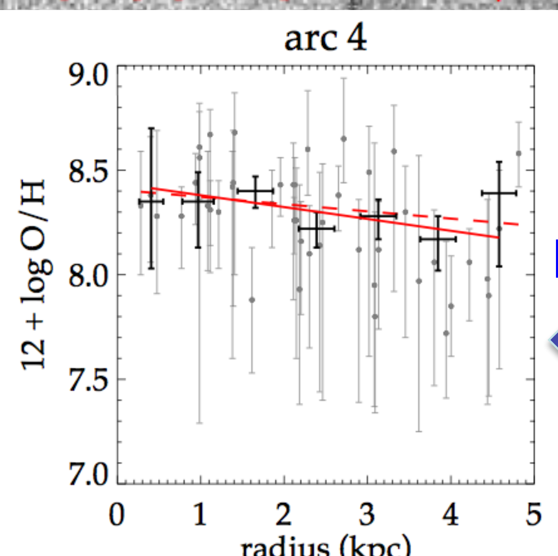
Source plane





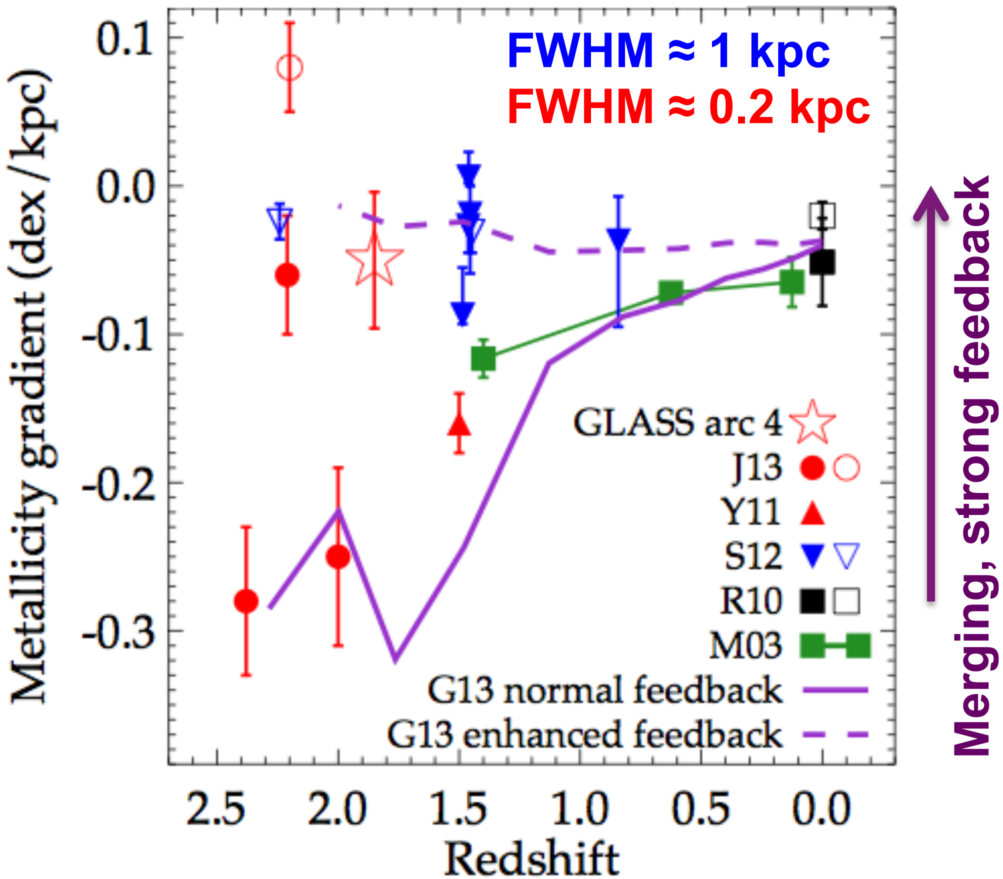


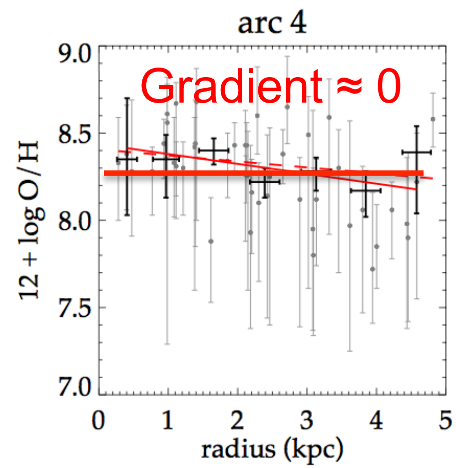
Metallicity gradient

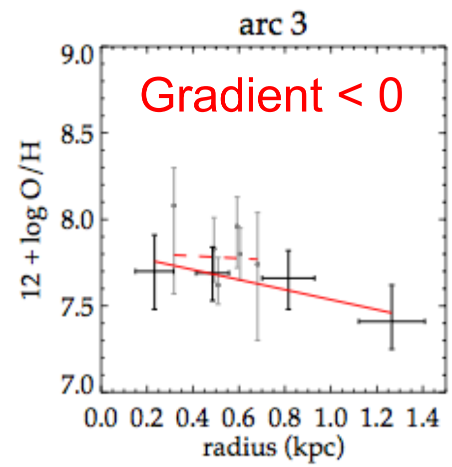


TJ et al. 2014

Metallicity gradient evolution





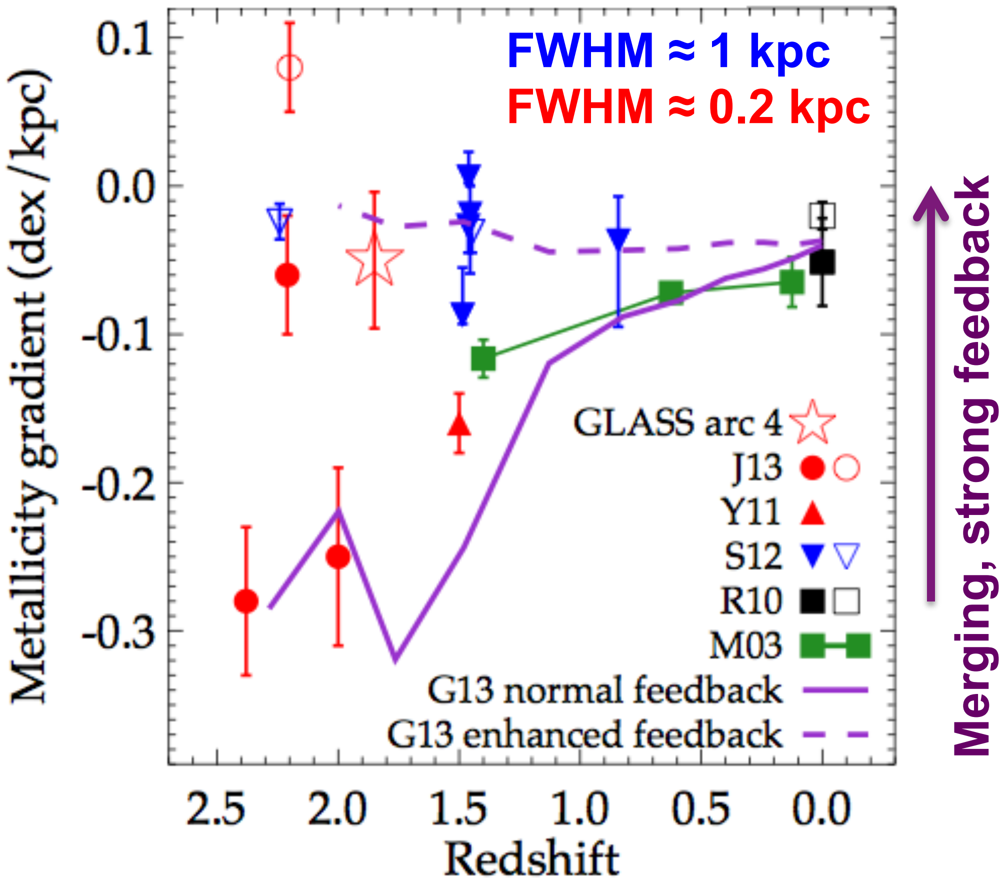


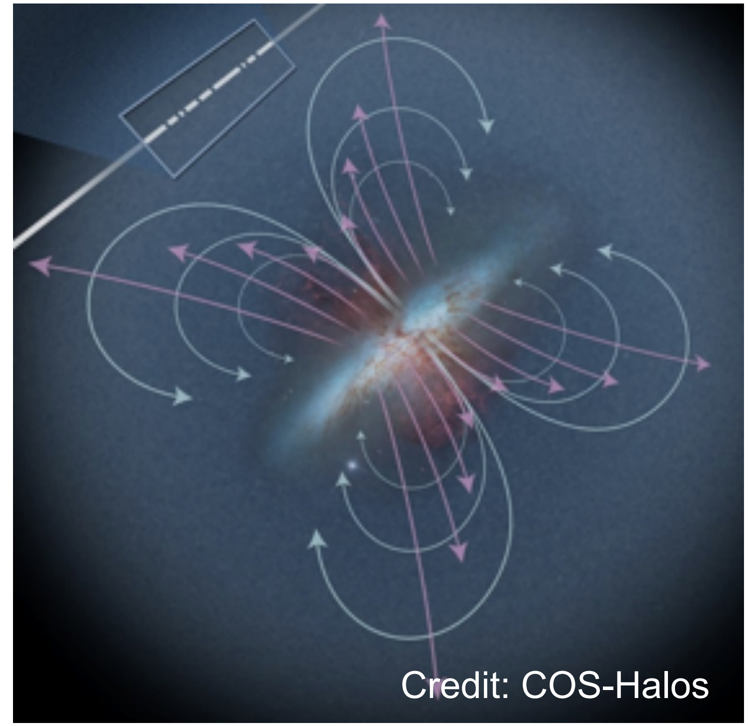
Mergers flatten metallicity gradients (Rupke et al. 2010; Rich et al. 2012)
Strong feedback/outflows flatten metallicity gradients (Gibson et al. 2013; Angles-Alcazar et al. 2014)

→ Gradient evolution is sensitive to galaxy evolution processes

TJ et al. 2013, 2014

Metallicity gradient evolution





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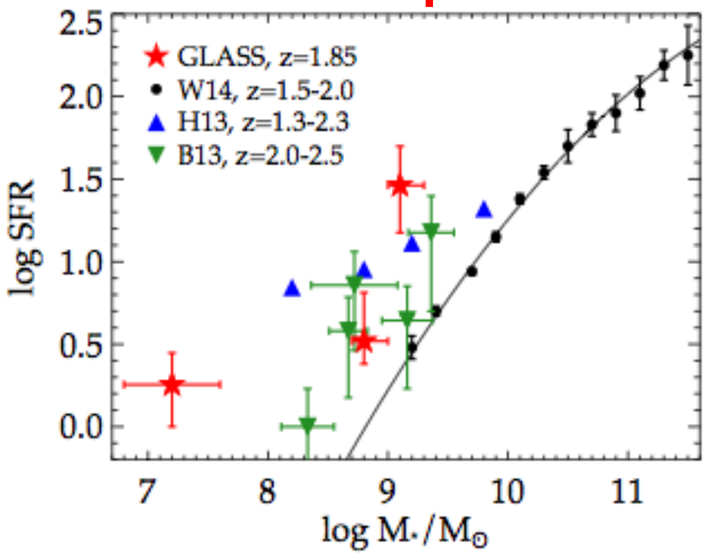
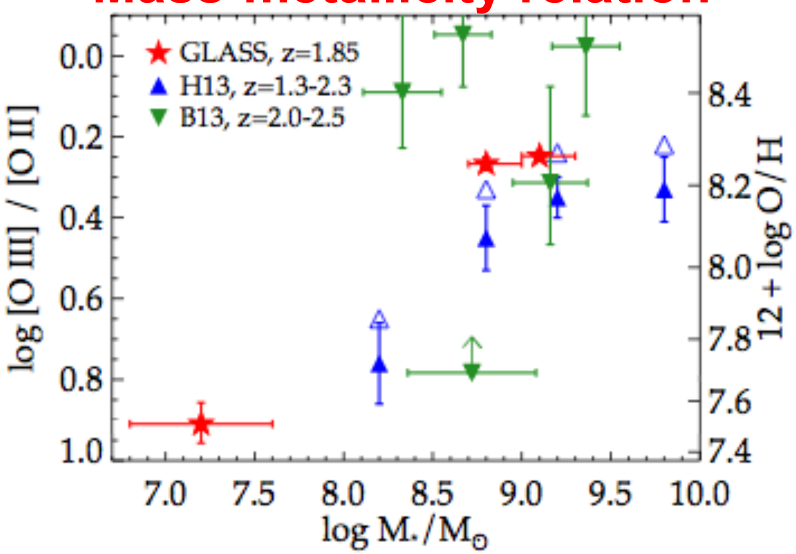
GLASS/HFF data c.f. field surveys at z=2

"Main sequence"



Mass-metallicity relation



GLASS data in the Frontier Fields probe *an order of magnitude lower stellar mass* compared to field surveys.

→ Increased dynamic range

→ Probes the mass range of local group dwarf progenitors at z~2

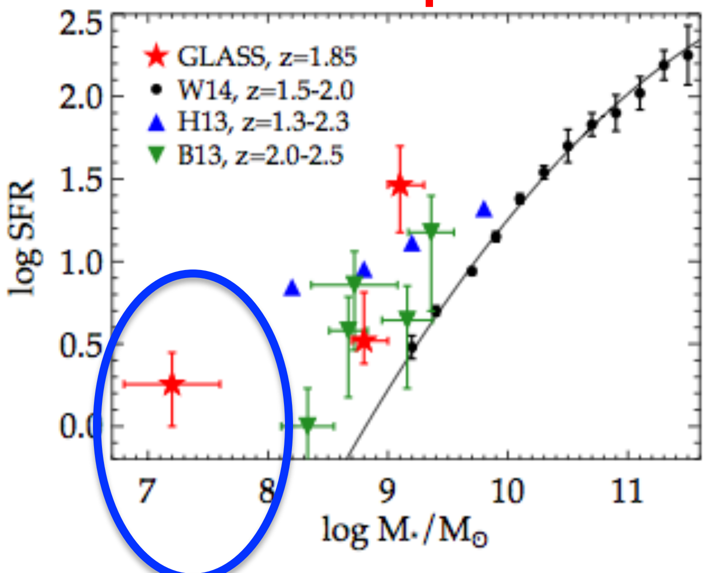
Mass-metallicity(-SFR) relation: consistent with previous data, possible steep slope at low mass

GLASS initial results reveal a dwarf galaxy progenitor at z=1.85 with very high specific SFR. Can possibly explain:

- The "cusp-core" problem
- The "too big to fail" problem
- The "missing satellites" problem

GLASS/HFF data c.f.

"Main sequence"



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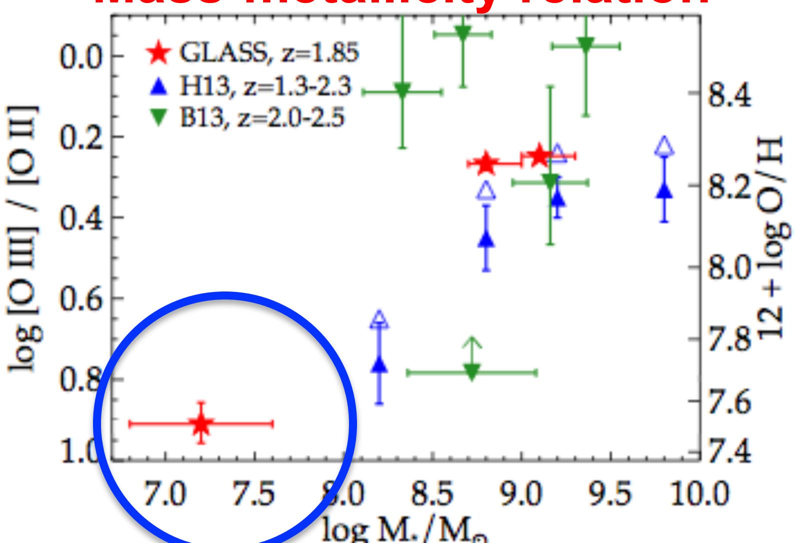

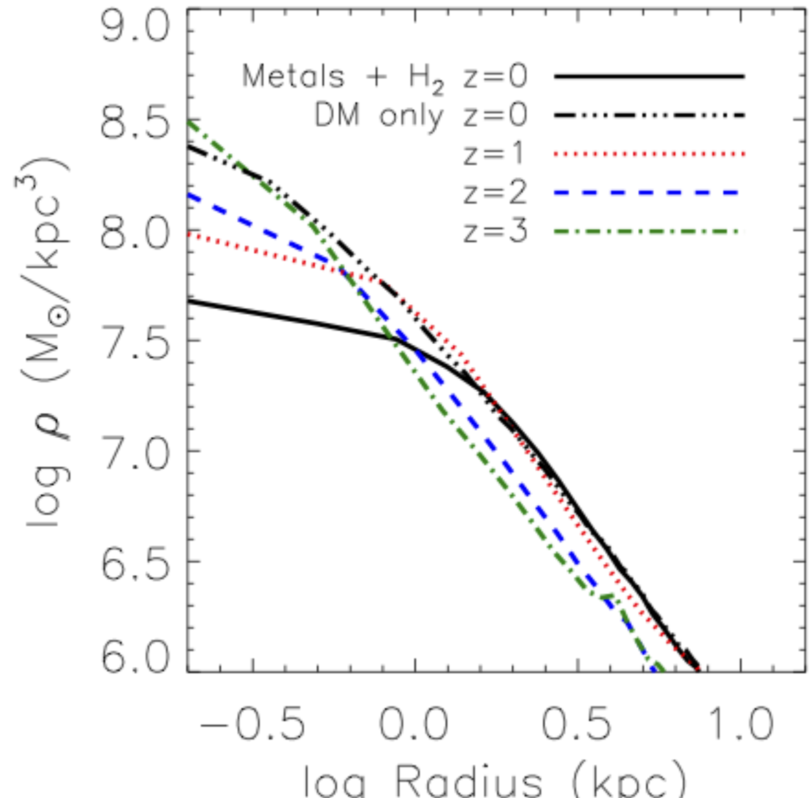

Governato et al. 2012

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GLASS

THE GRISM LENS-AMPLIFIED SURVEY FROM SPACE

Bottom line

Detailed structure of massive galaxies at $z > 1$ ($M_* \sim 10^9\ M_\odot$)

→ Emission line maps for 100+ galaxies

→ Resolved M_*, SFR, metallicity

→ Metallicity gradient evolution

Properties of dwarf galaxy progenitors at $z > 1$

→ GLASS probes down to $M_* \sim 10^7\ M_\odot$ at $z\sim2$

→ Will address whether feedback can resolve tension between observed dwarf galaxies and ΛCDM theory

THE GLASS TEAM

glass.physics.ucsb.edu

Attending HHF @ Yale

- **Tommaso Treu**, PI (UCLA)
- Marusa Bradač (UCD)
- Gabriel Brammer (STScI)
- Mark Dijkstra (UoO)
- Alan Dressler (Carnegie Obs.)
- Adriano Fontana (INAF Rome)
- Raphael Gavazzi (IAP)
- Alaina Henry (NASA Goddard)
- Austin Hoag (UCD)
- Kuang-Han Huang (UCD)
- Tucker Jones (UCSB)
- Patrick Kelly (UCB)
- Matt Malkan (UCLA)
- Charlotte Mason (UCSB)
- Laura Pentericci (INAF Rome)
- Bianca Poggianti (INAF Padova)
- Kasper Schmidt (UCSB)
- Massimo Stiavelli (STScI)
- Michele Trenti (Cambridge)
- Anja vd Linden (DARK/Stanford)
- Benedetta Vulcani (KIPMU Tokyo)
- Xin Wang (UCSB)