# The Ultraviolet Frontier:

## The Other Half Of Star Formation at its Peak Epoch


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UCR

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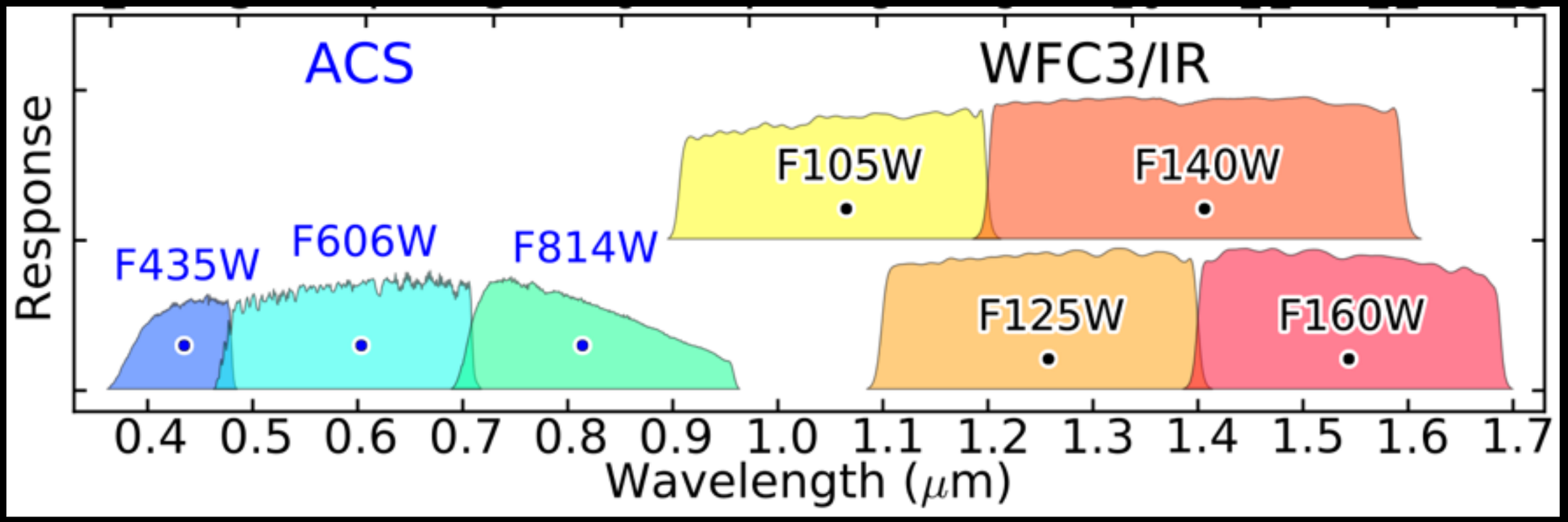
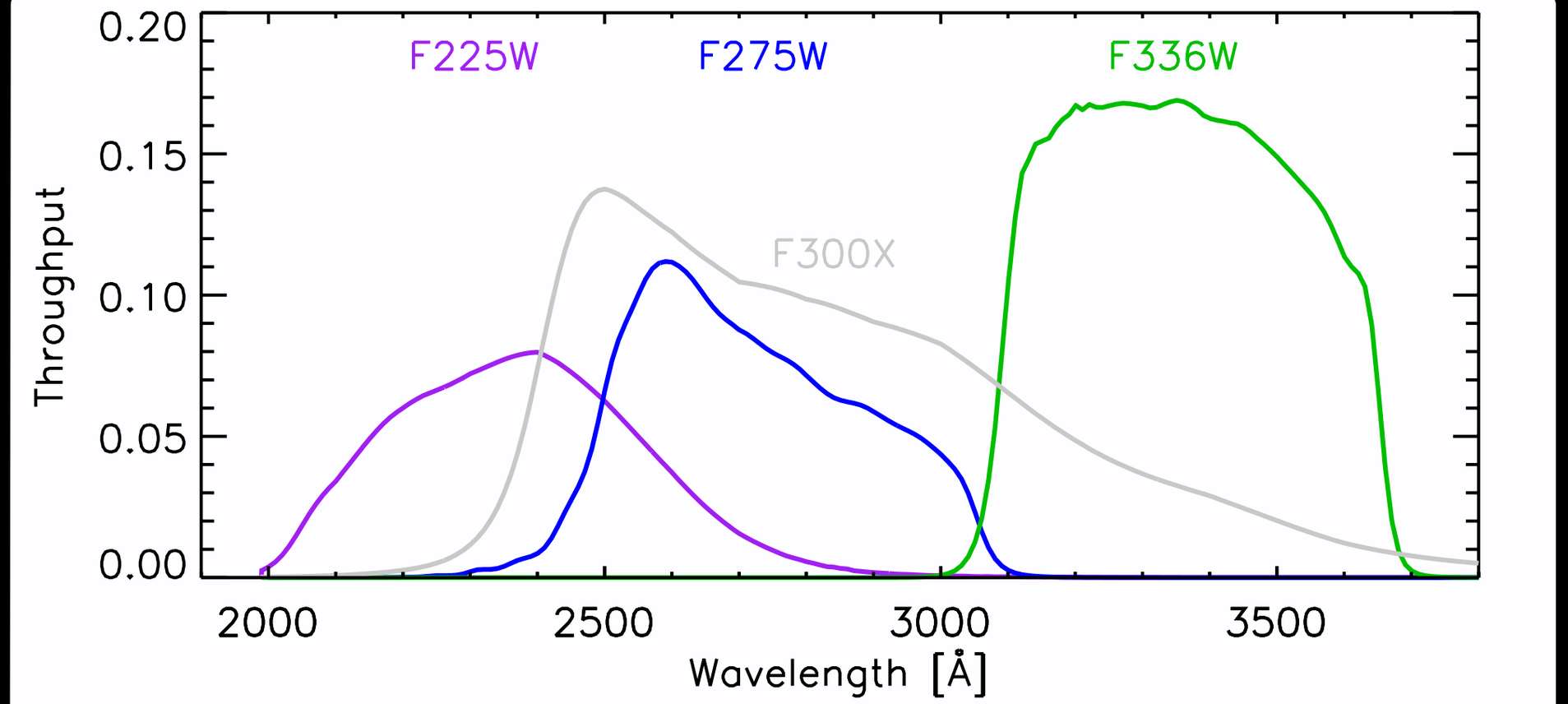
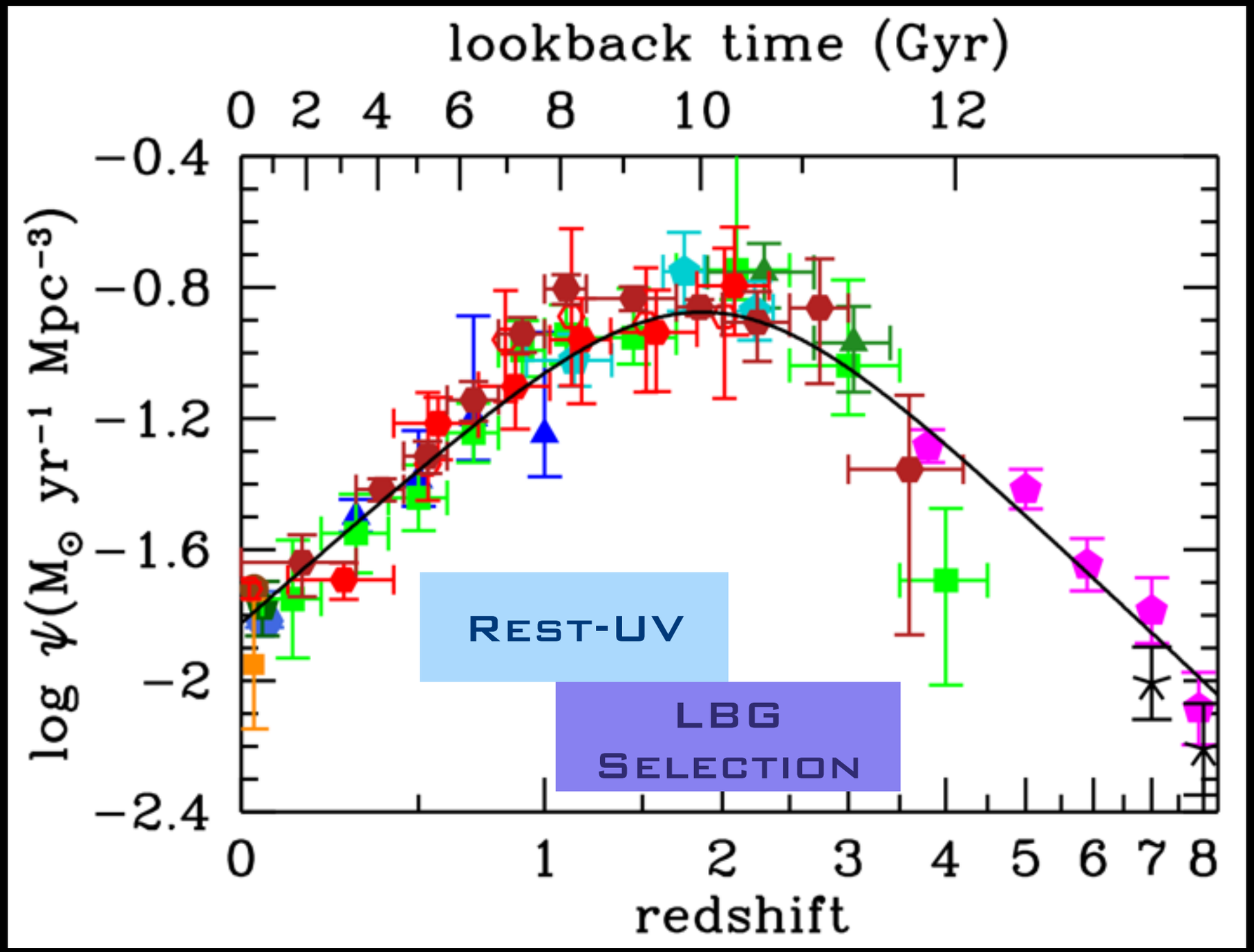
Coe et al. 2014




WFC3/UVIS



- Lyman Break Selection (1.2<z<3.5)
  - z-range of most multiple images
- Rest-UV (1500 Å) studies at z < 2




Madau & Dickinson (2014)

# The UV Cluster Wedding Cake

F275W Depth
(AB, 5σ)

28.7, 60 UVIS
orbits

27.8, 16 UVIS
orbits

26.4, 4 UVIS
orbits

A1689

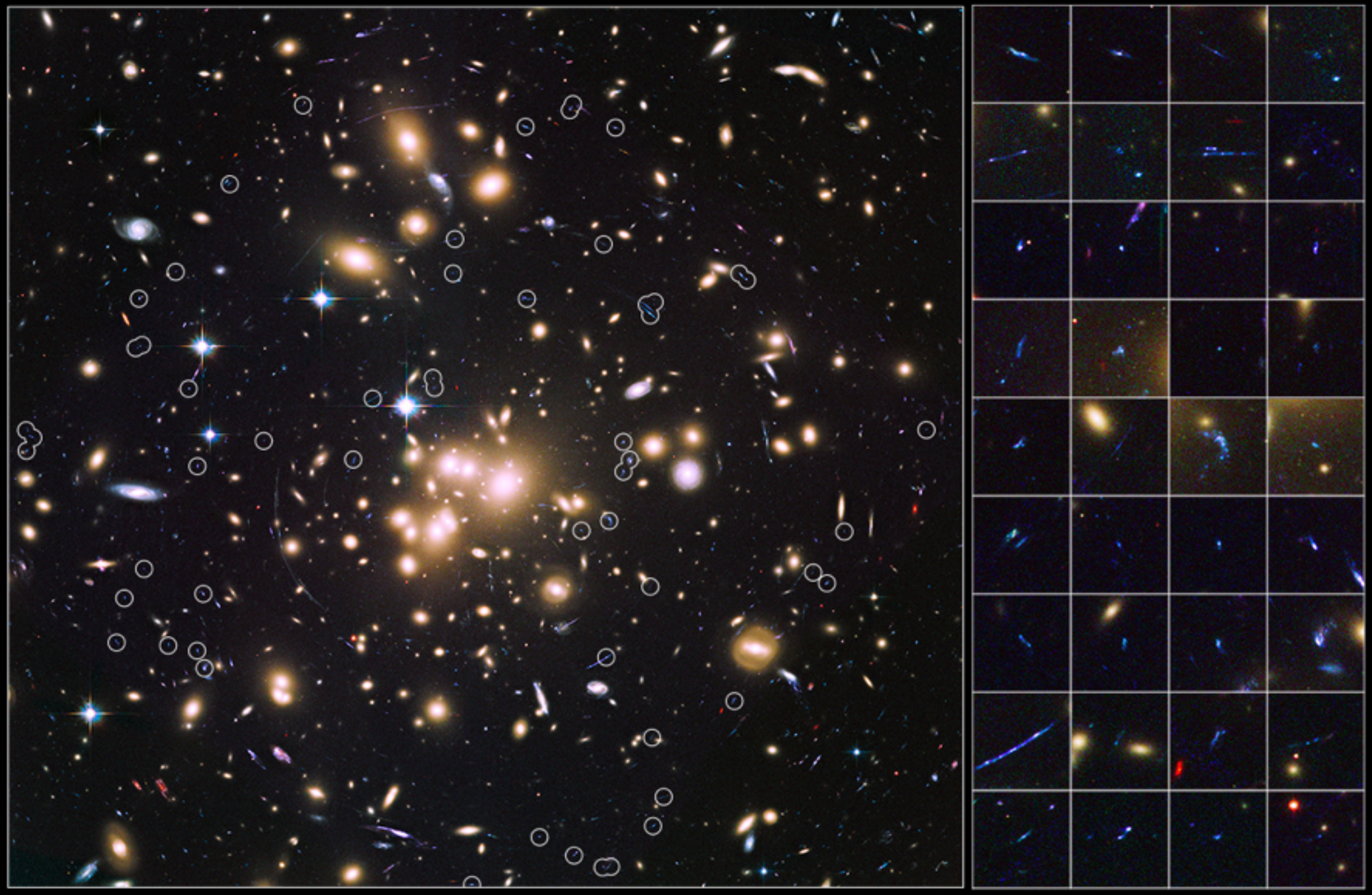
UV Frontier

CLASH

# First Results in A1689

Galaxy Cluster Abell 1689

*Hubble Space Telescope* ▪ ACS/WFC ▪ WFC3/UVIS

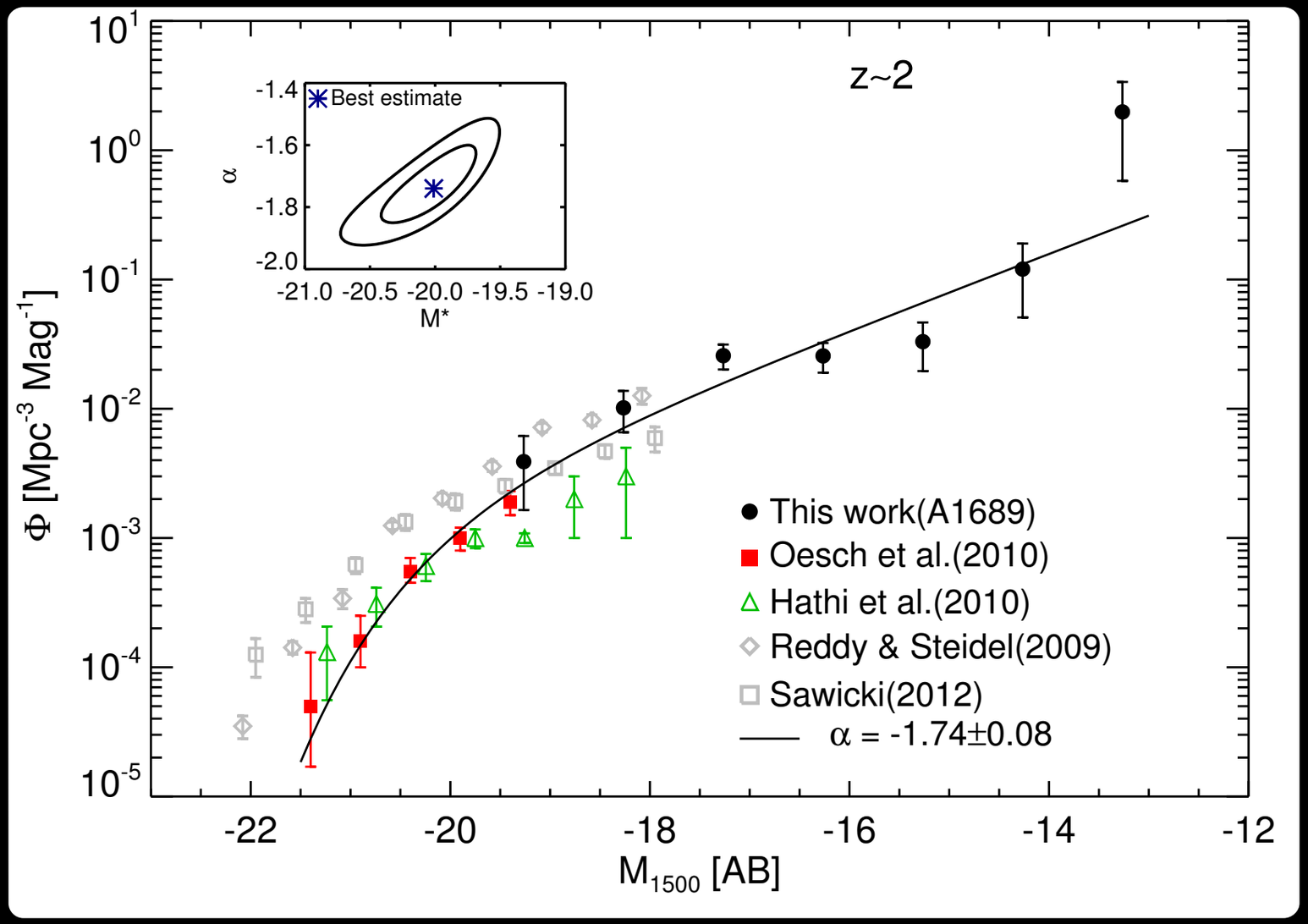


NASA and ESA

STScI-PRC14-07a

Alavi et al. (2014)

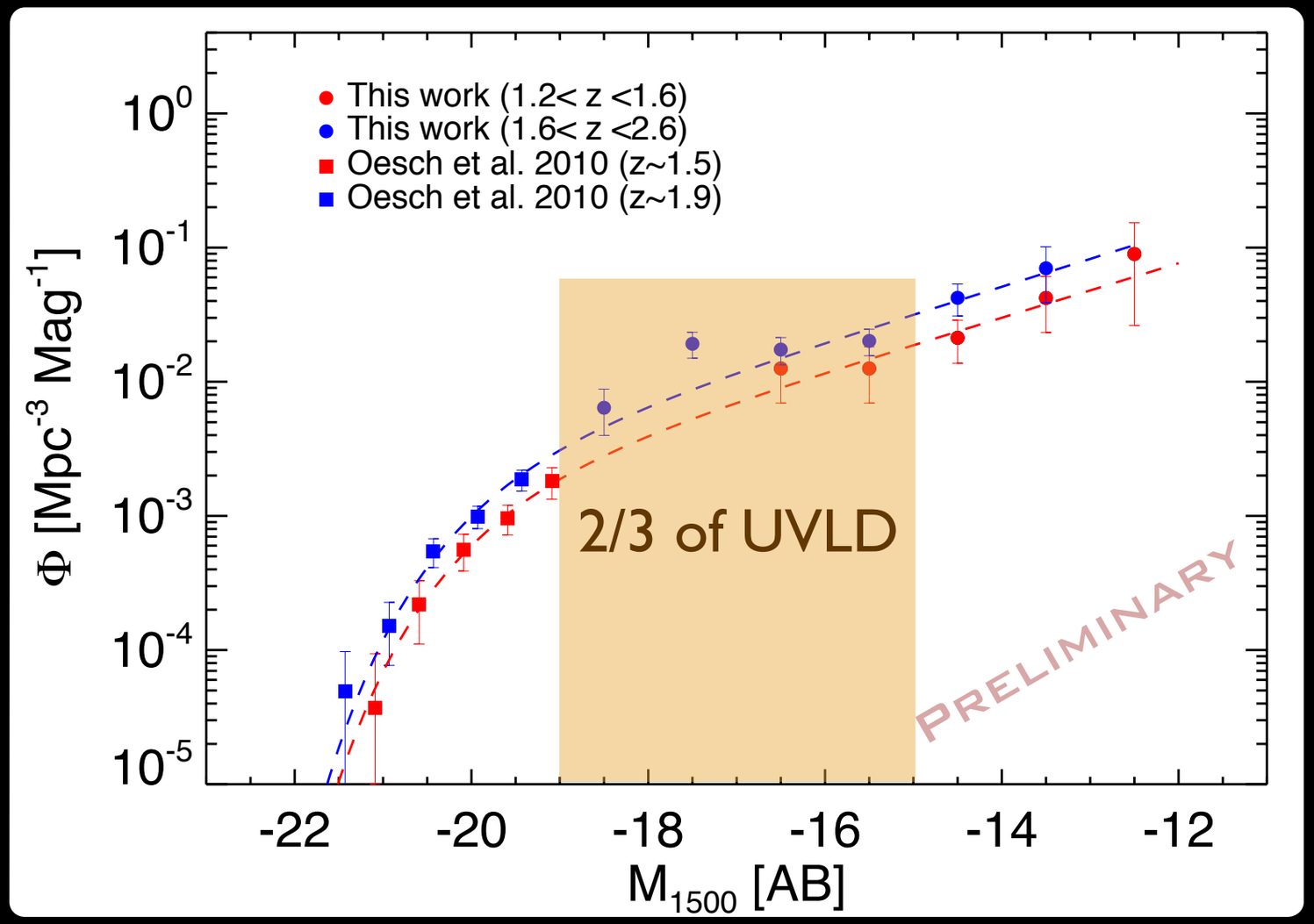
# z~2 Luminosity Function



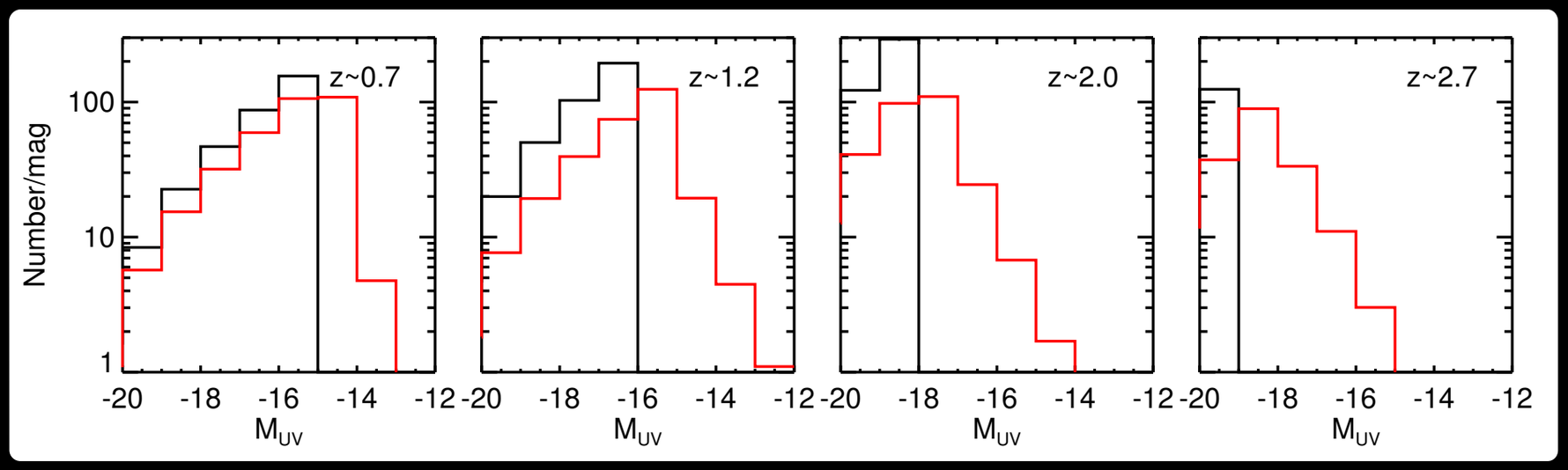

- 58 z~2 galaxies
- 100x fainter
- Step Faint Slope
  - α = -1.74 ± 0.08
- Doubled UVLD
- 166 galaxies from $1.2<z<3.0$

Alavi et al. (2014)

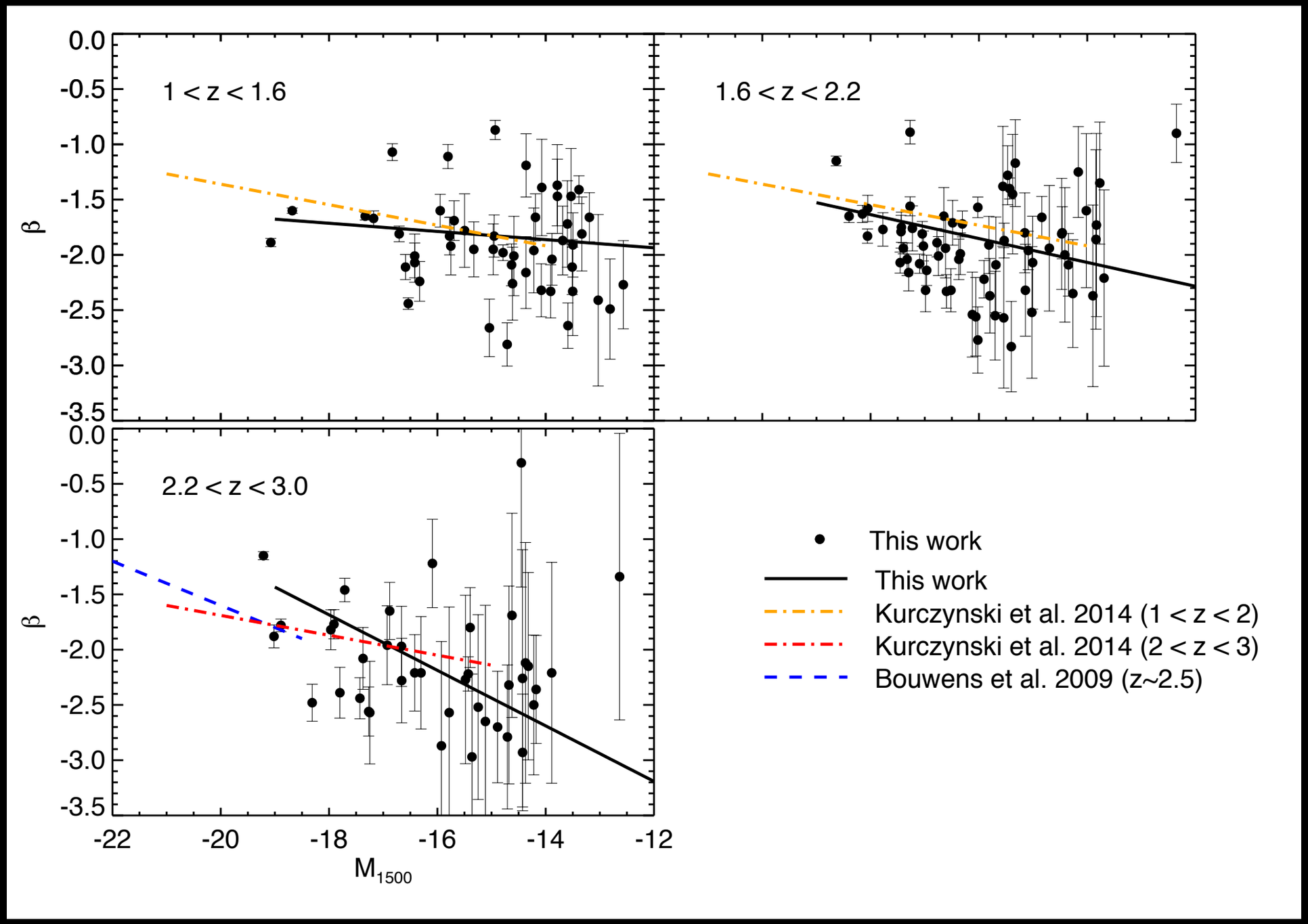
# LF Evolution




Alavi et al.
(in prep)

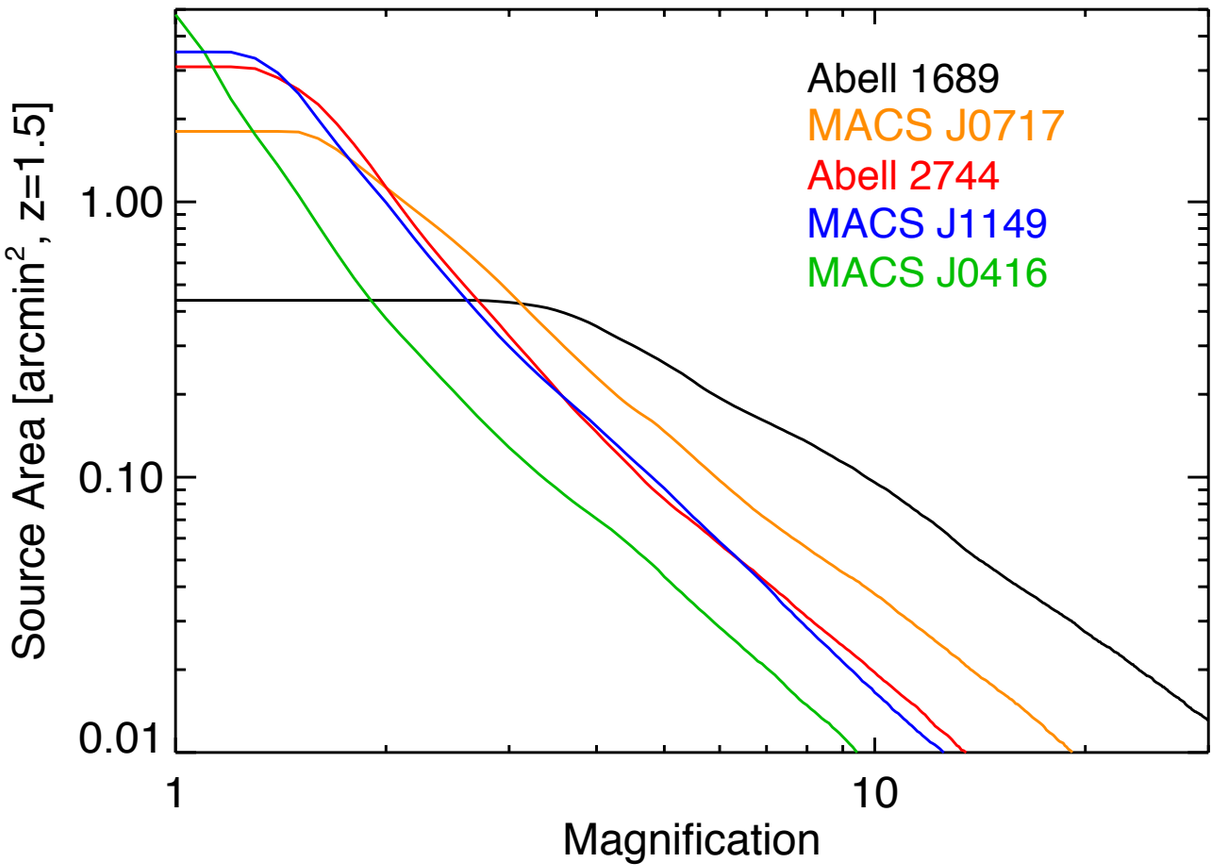


# UV Spectral Slope




Alavi et al. (2014, in prep)

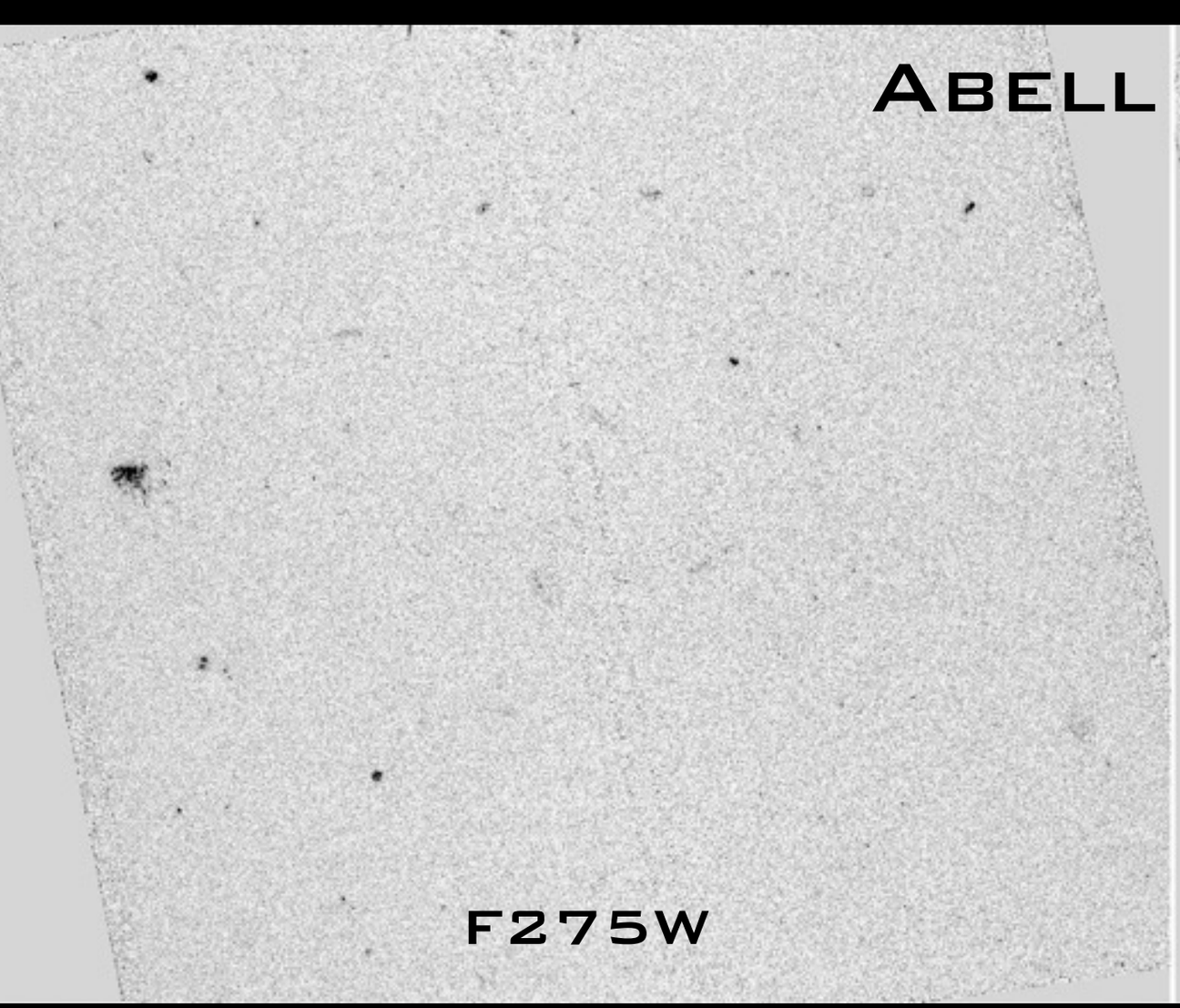
# Area vs. Magnification

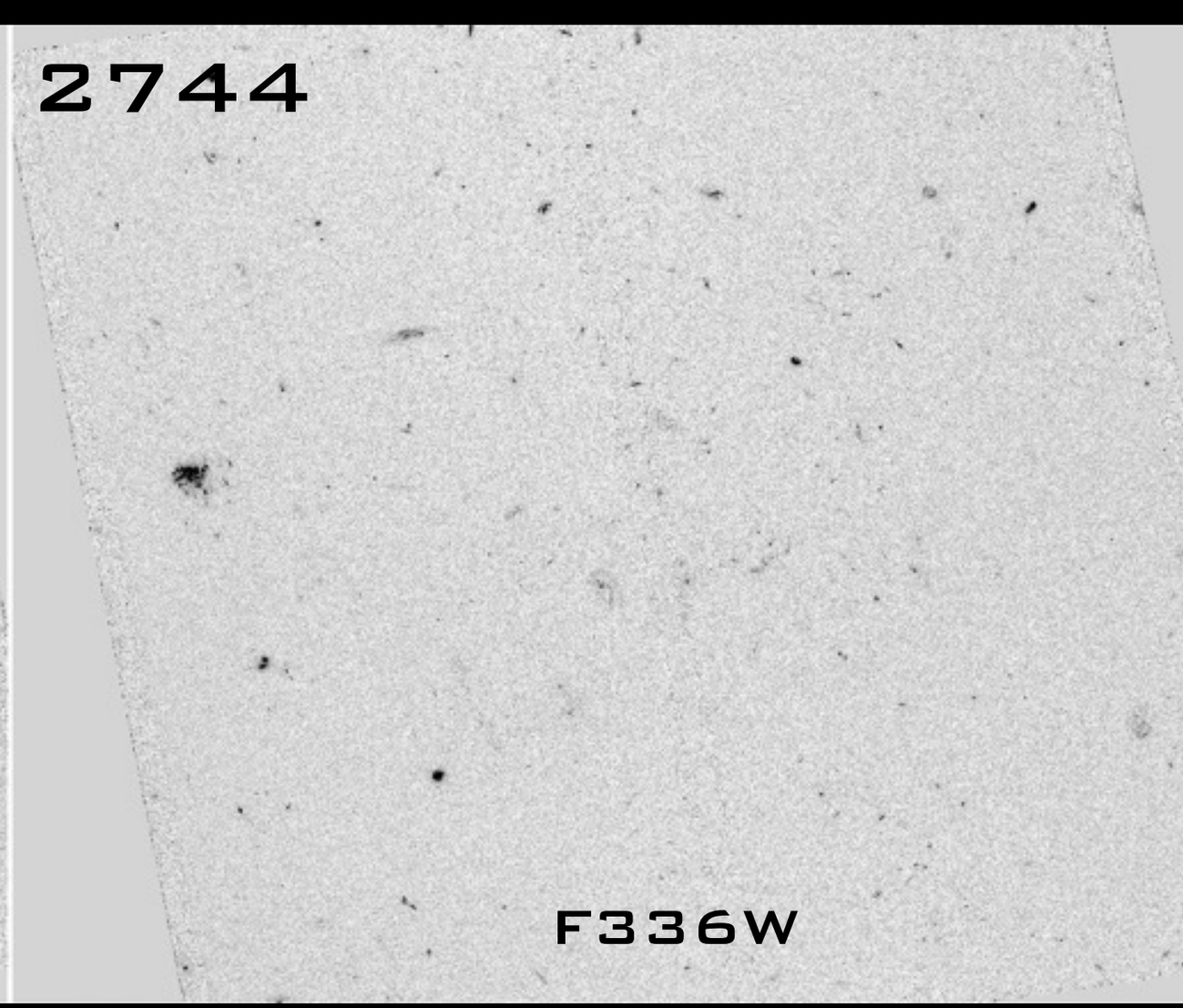



- Abell 1689 is a fantastic lens
  - volume too small
  - Need larger samples
- Not imaging MACS 0416 (one of first two FFs).
- Adding 3 HFFs increases area surveyed by > 10.
- Decreases sample variance by factor of ~2.

# The Ultraviolet Frontier

# Abell 2744

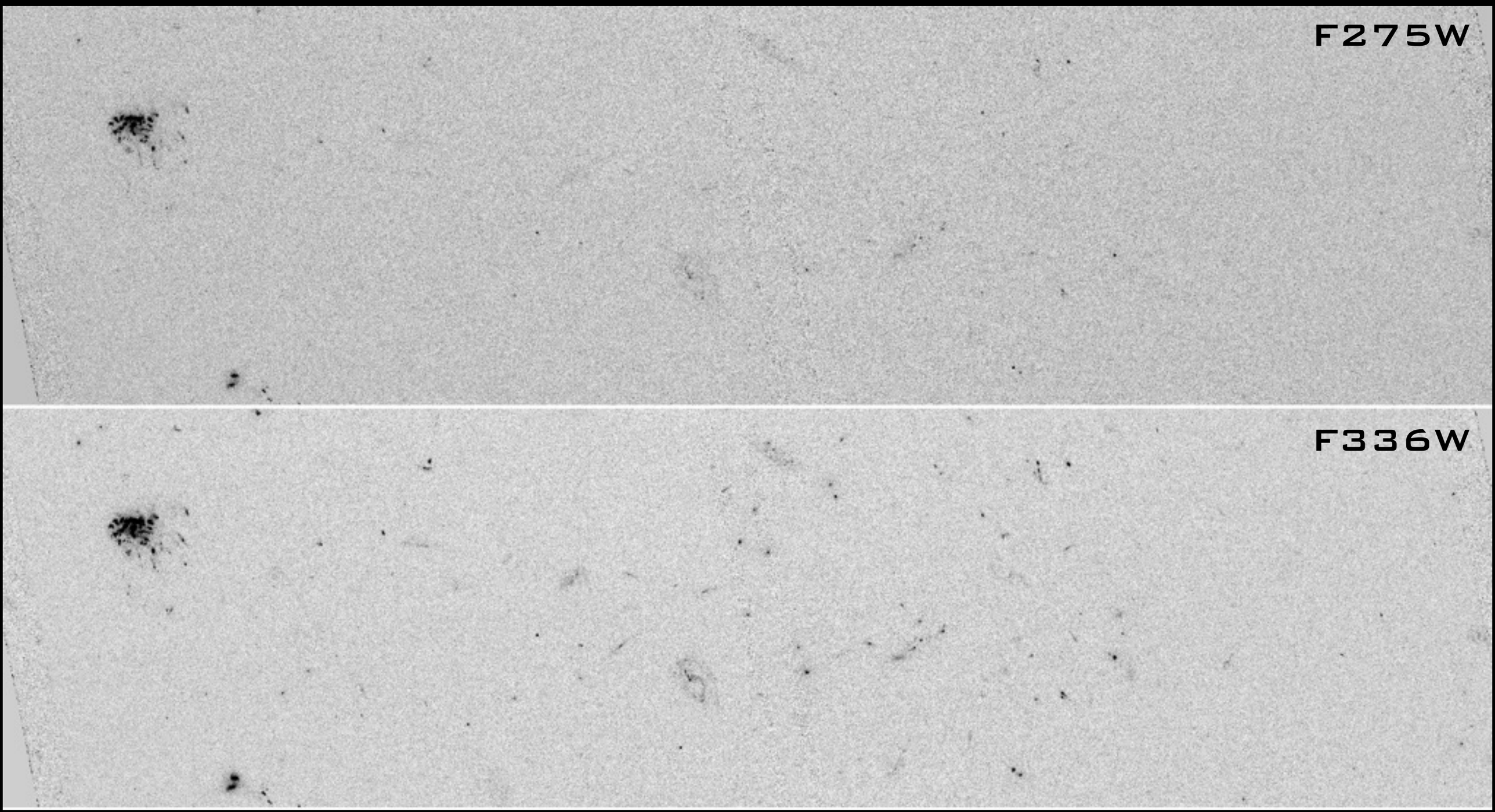


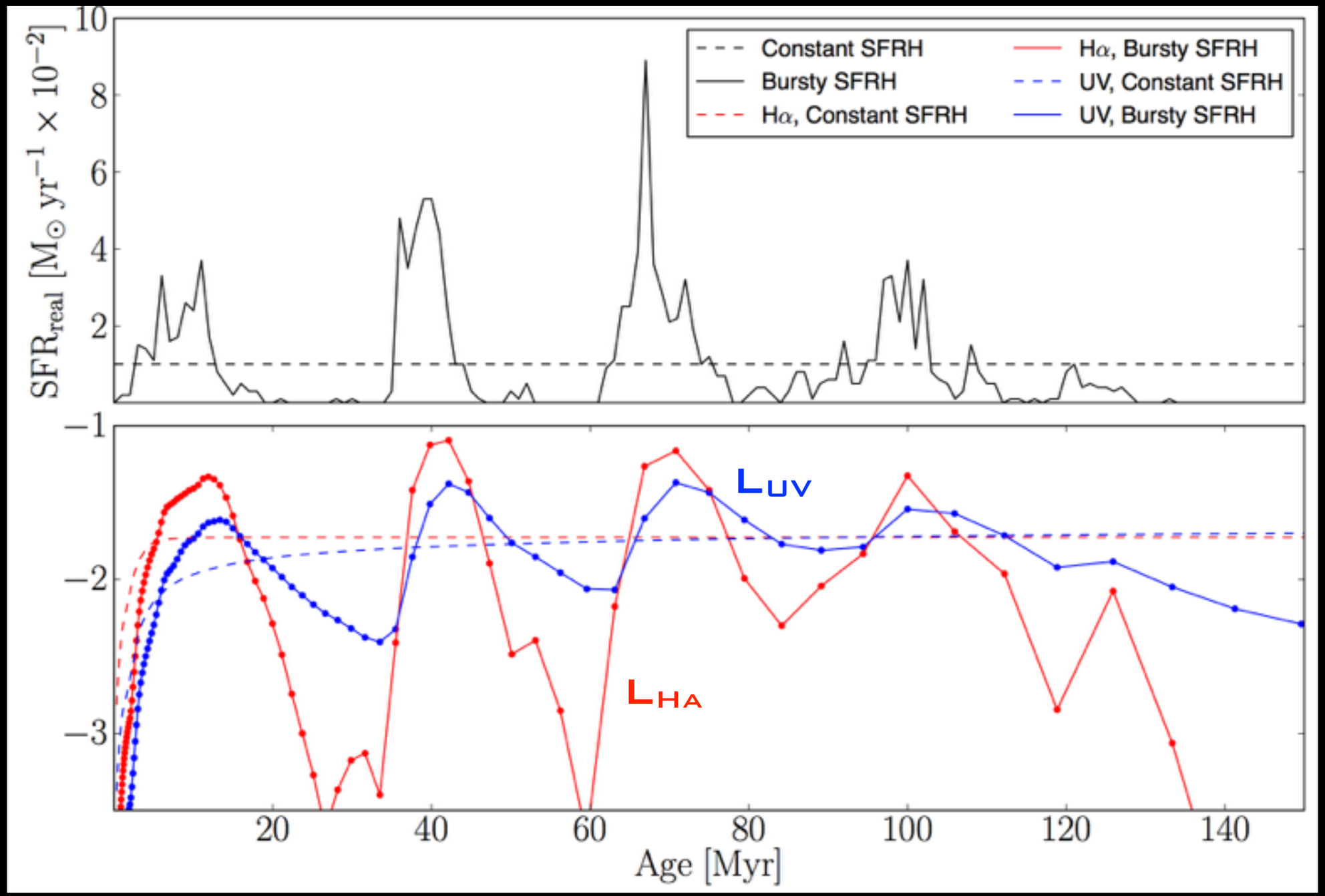

- 8 orbits in both F275W, F336W, 48 orbits total
- ~12 $e^-$ background w/Post-flash to mitigate CTI
- Full orbit exposures
- Custom dark subtraction using all darks in anneal cycle.
- Coordinated parallels in ACS/WFC F435W (10 orbits), F606W (6 orbits)

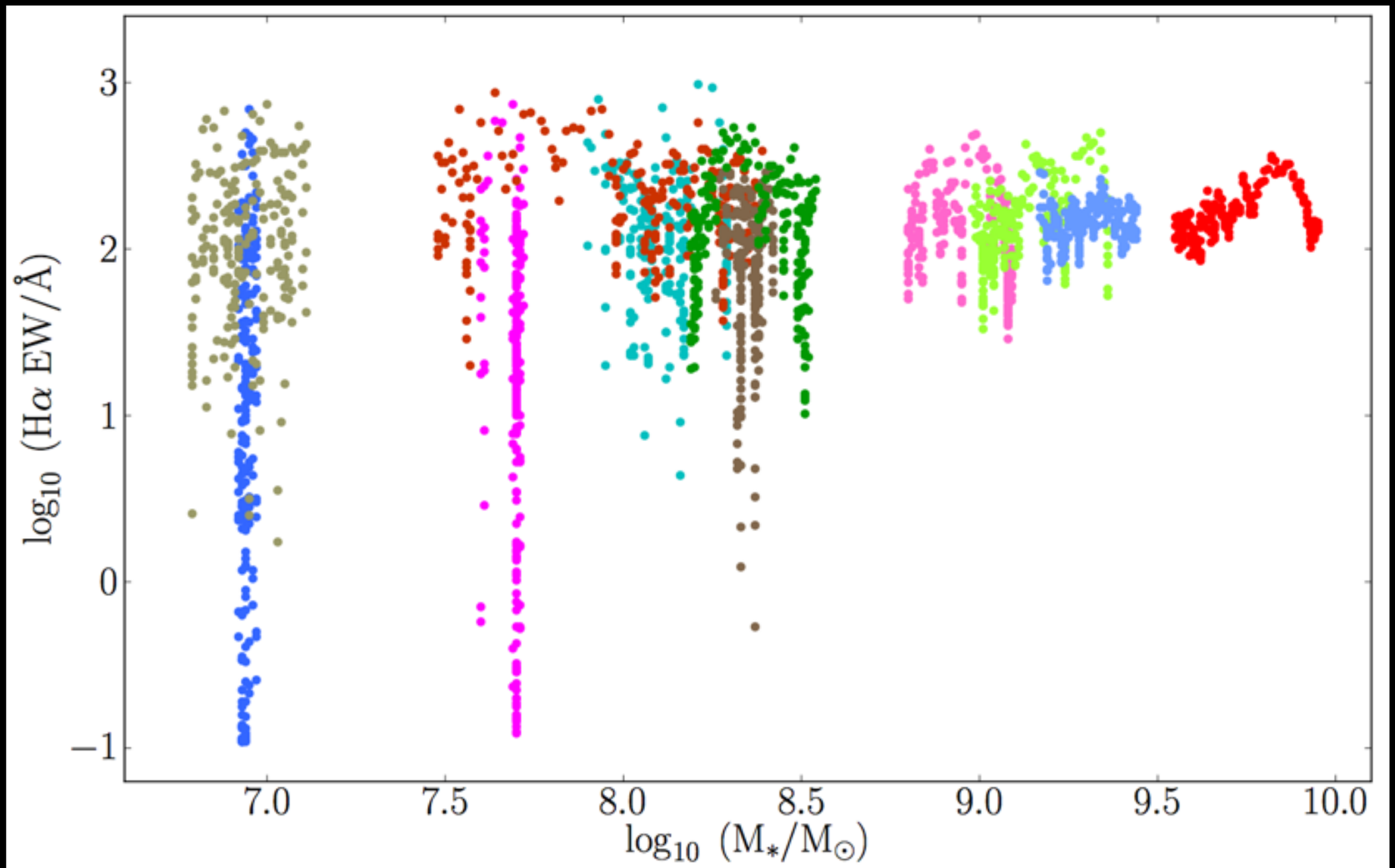
- Observations complete and Reduced/Mosaiced
- All images public May 2015 (~same time as optical/near-IR)

# Abell 2744



# Bursty Star Formation


Constant SFRH
Bursty SFRH
Hα, Constant SFRH
Hα, Bursty SFRH
UV, Constant SFRH
UV, Bursty SFRH
SFR_real [M⊙ yr⁻¹ × 10⁻²]
10
8
6
4
2
−1
−2
−3
LUV
LHA
20
40
60
80
100
120
140
Age [Myr]




## Explains high EW Ha at z~2

(Atek et al., van der vel et al.)



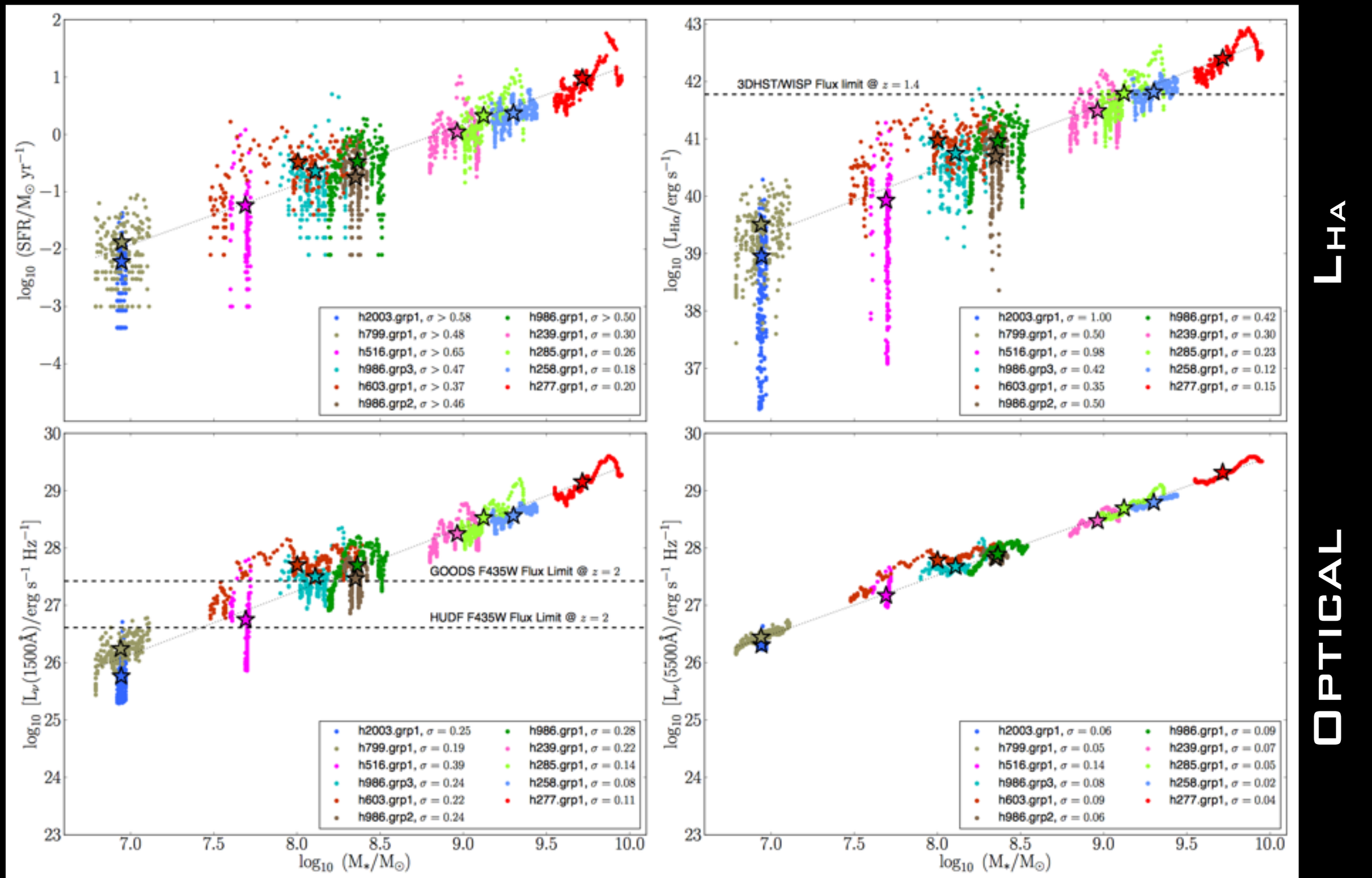
Dominguez et al (2014)

SFR

LHA

LUV

OPTICAL

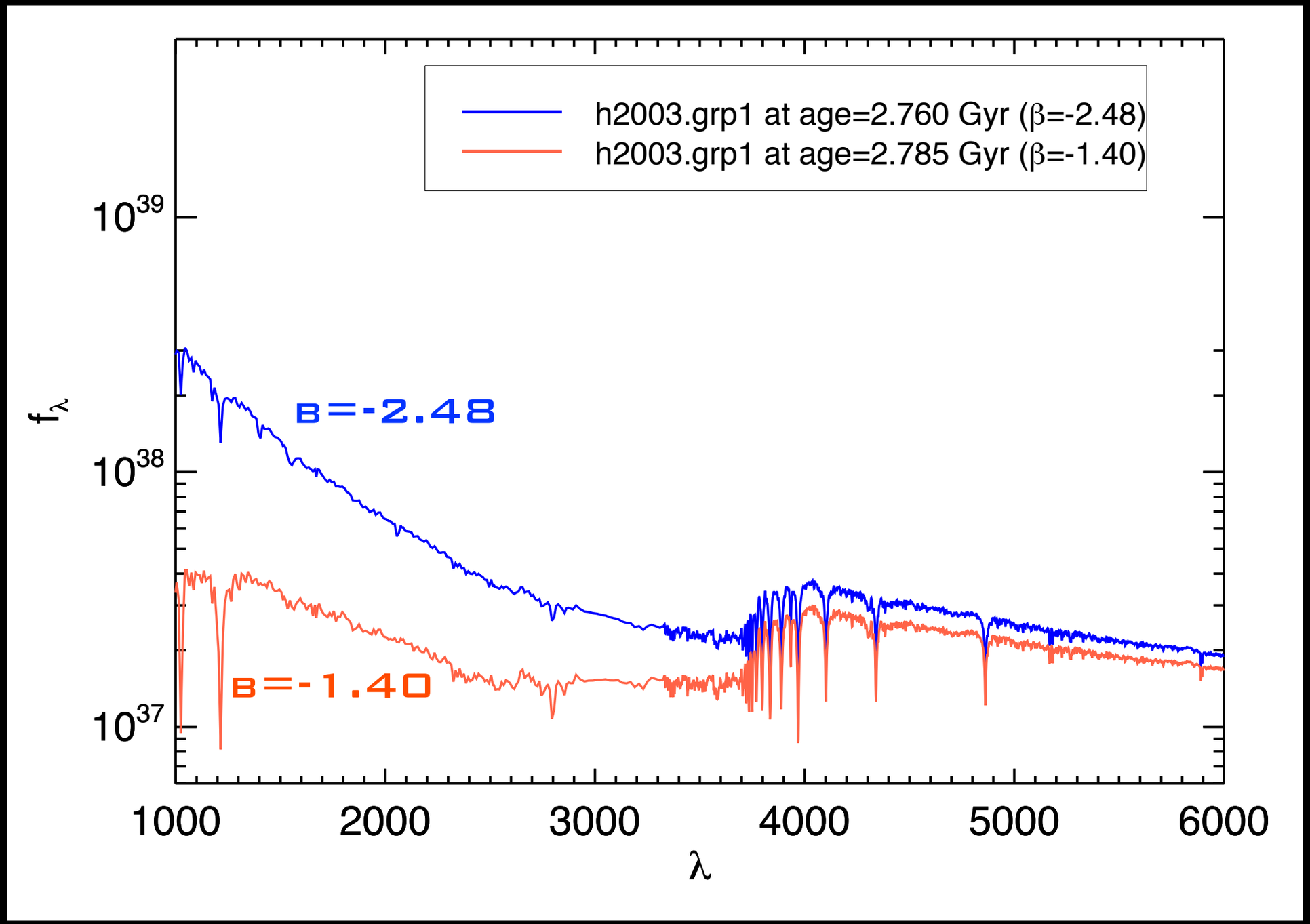



SELECTION HIGHLY BIASED
TOWARD GALAXIES IN A BURST

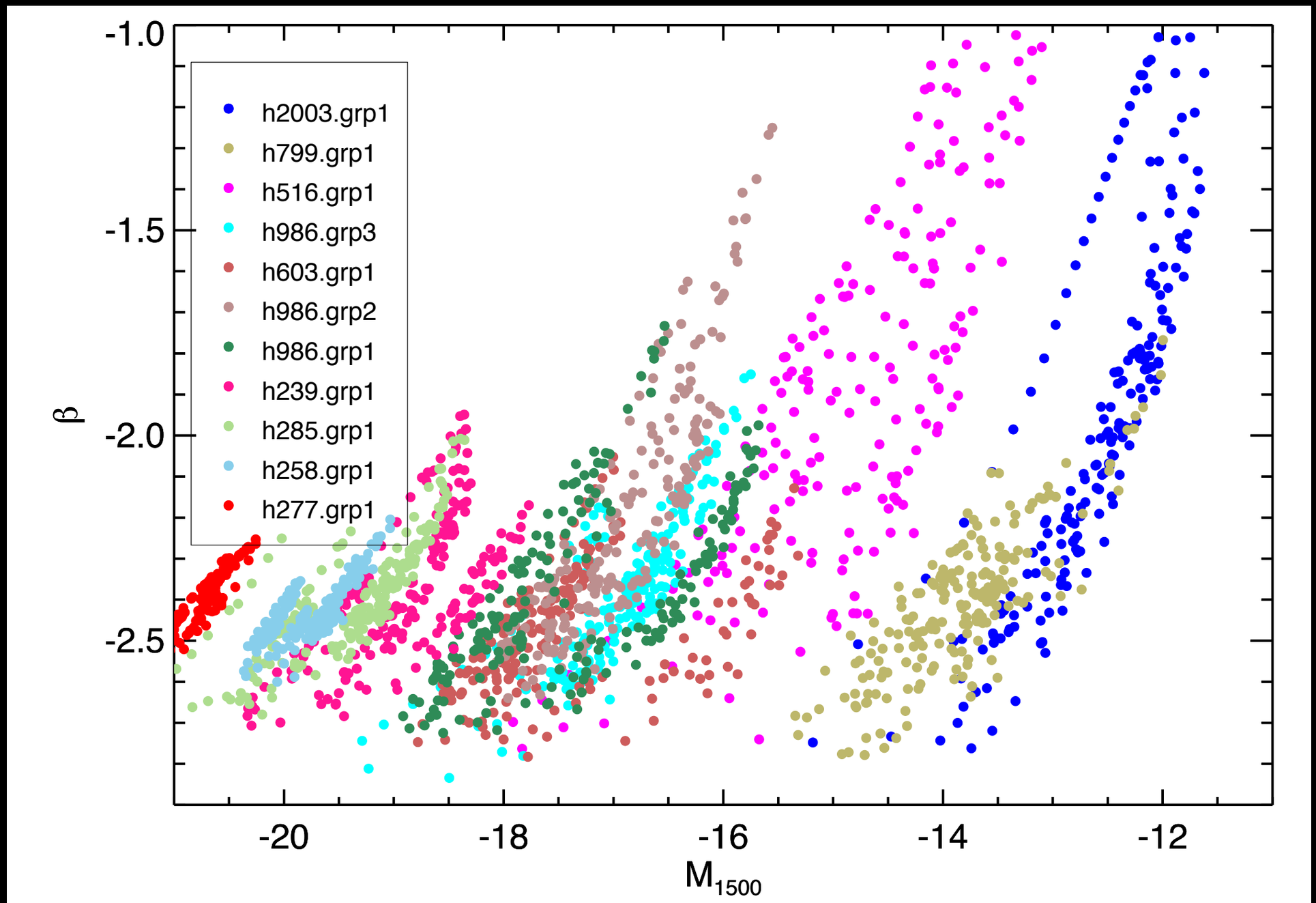


DOMINGUEZ ET AL (2014)

# Same Galaxy, 25 Myr Apart



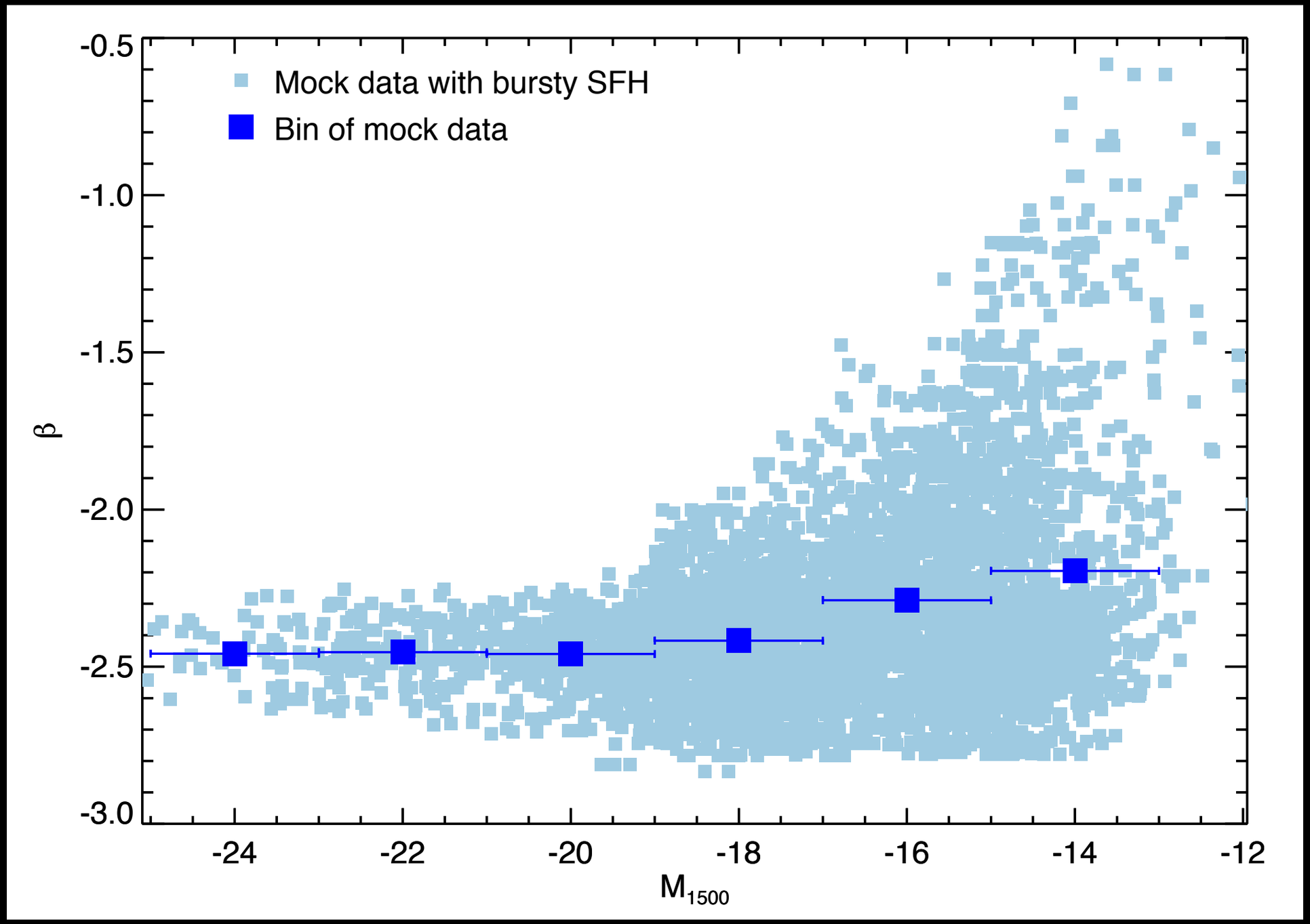
# Simulated Galaxies every 5 Myr





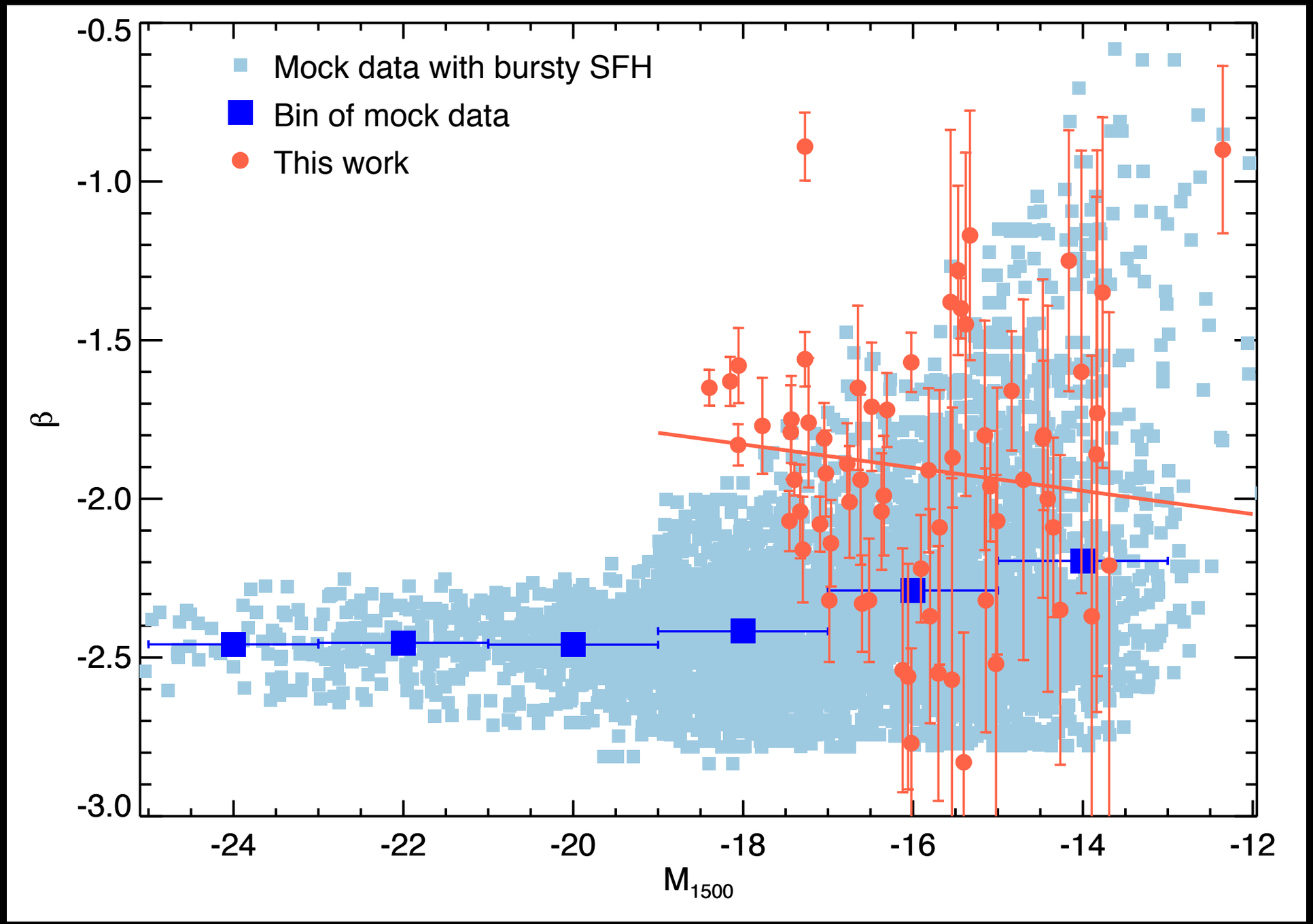

Alavi et al. (2014, in prep)

# Monte-Carlo w/out Dust





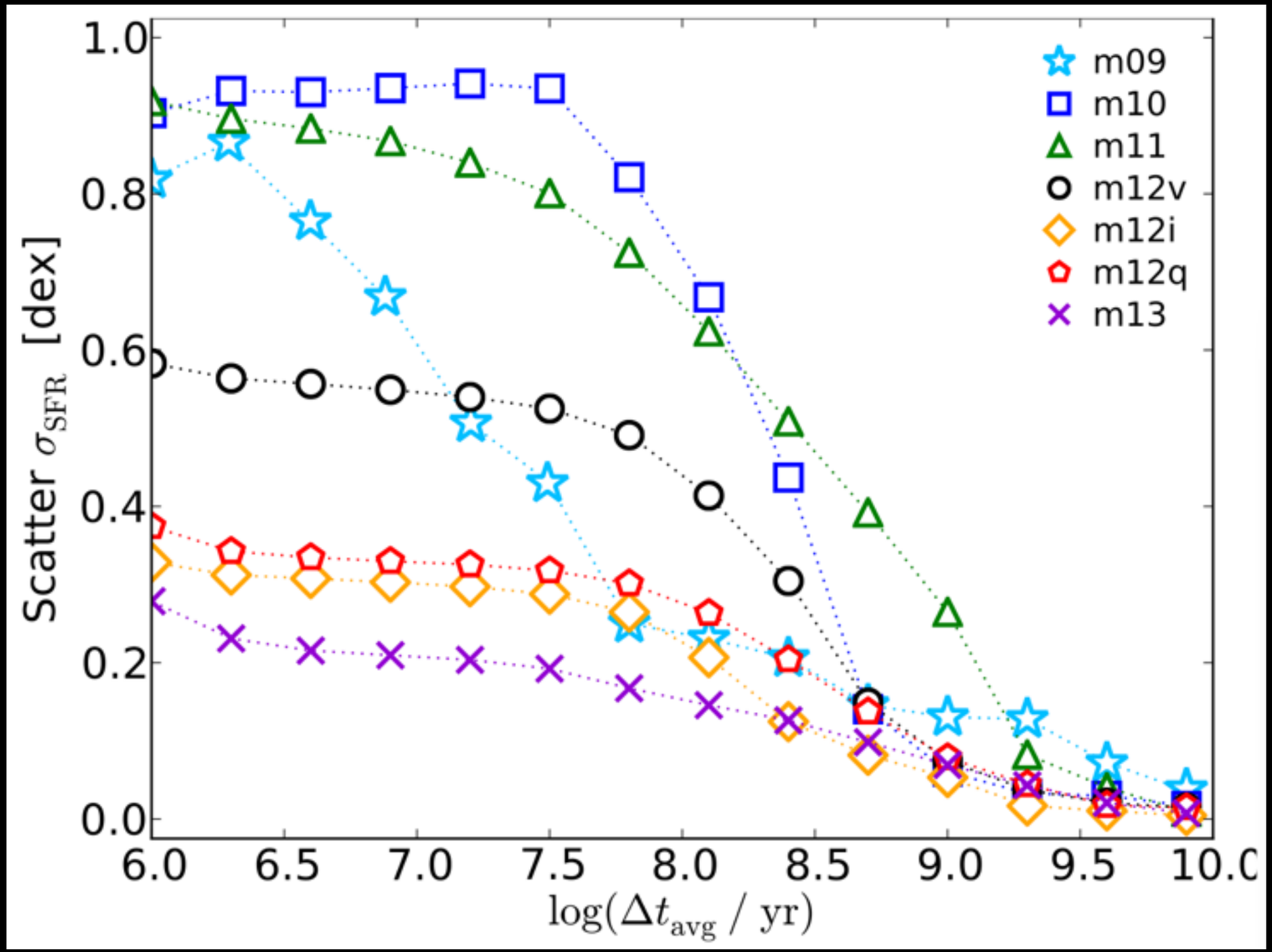

Alavi et al. (2014, in prep)





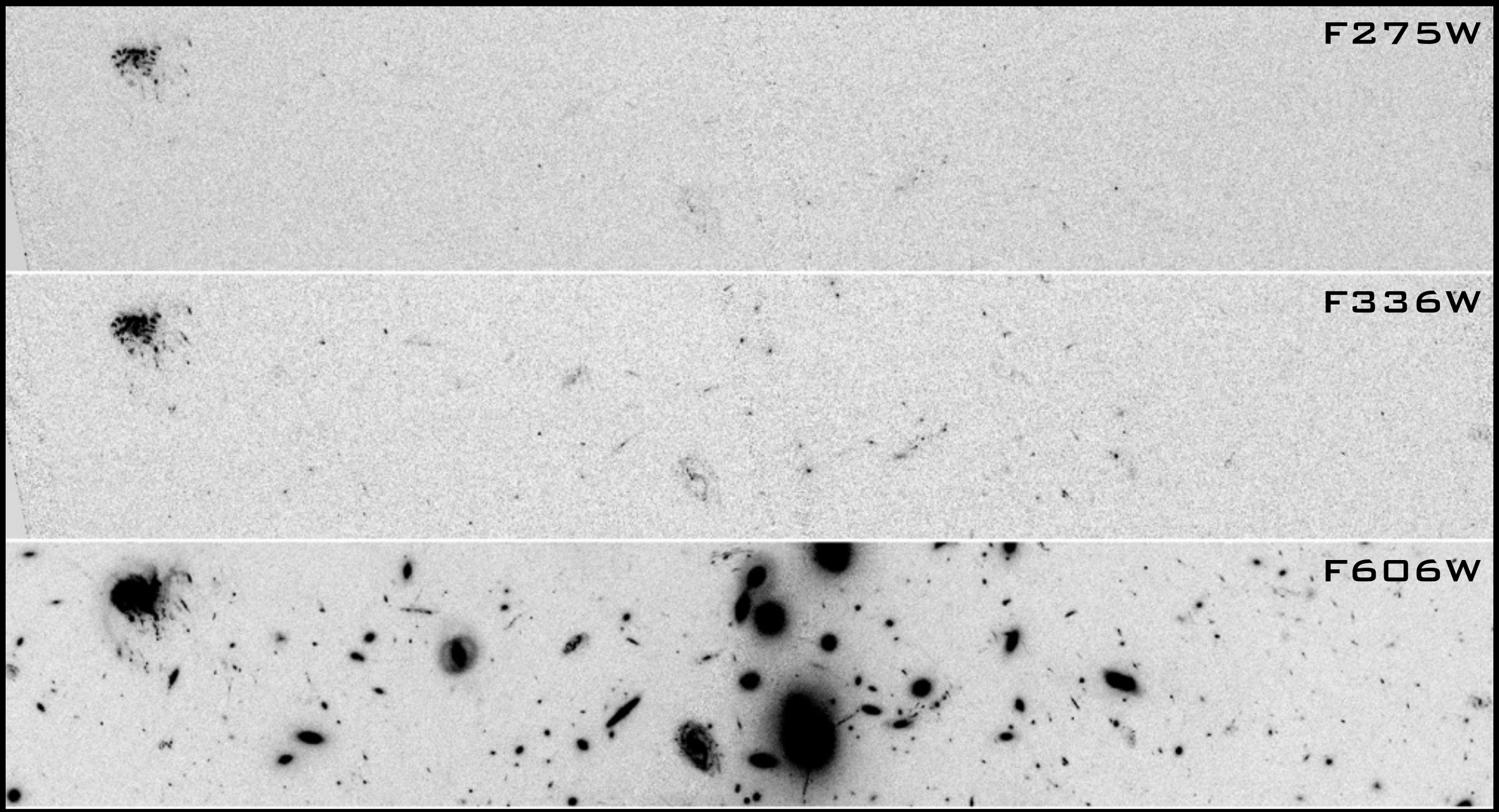

Alavi et al. (2014, in prep)

# Backup Slides




Other simulations predict similar things
Hopkins et al. (2014)

# Abell 2744

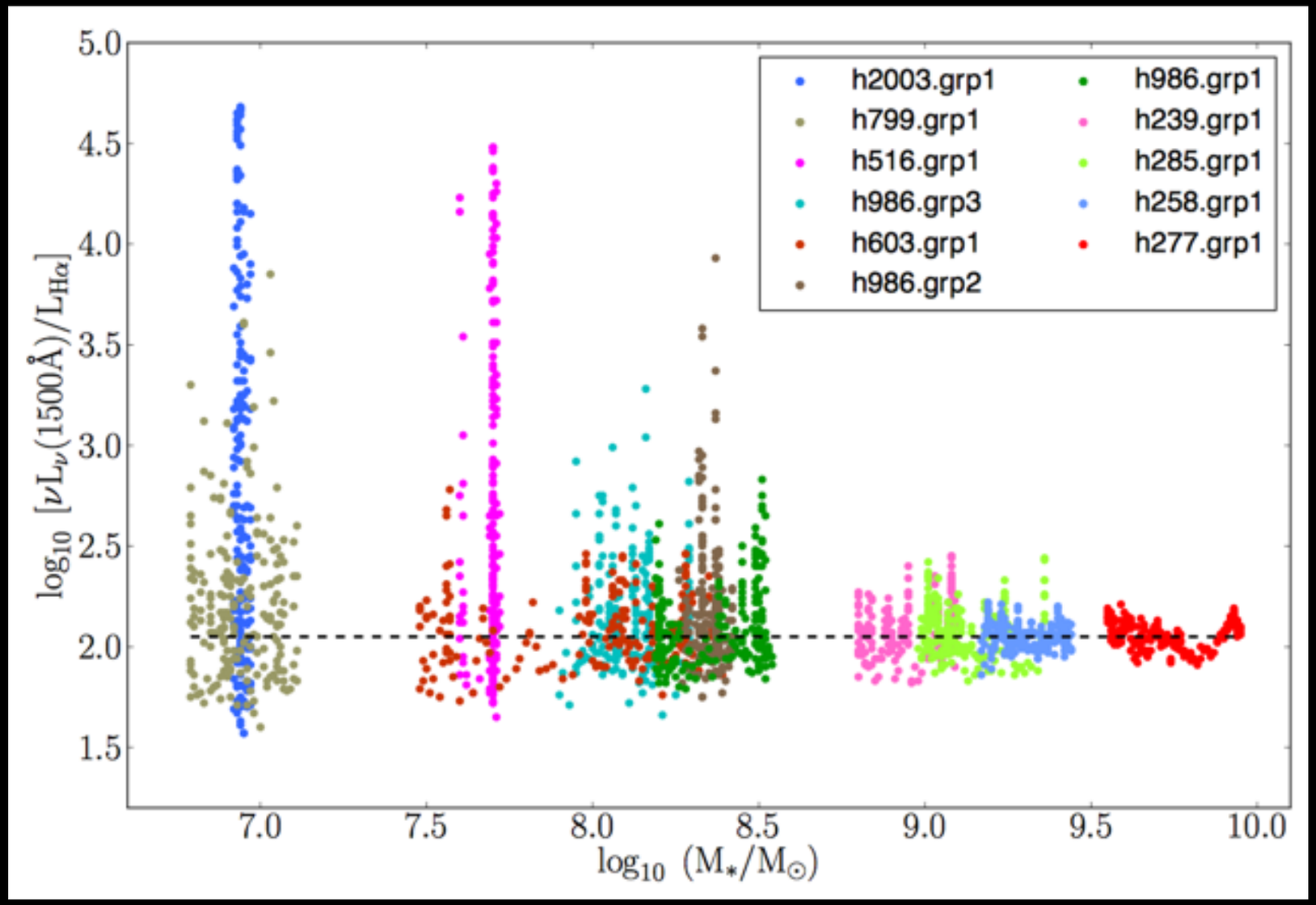


# UV Frontier Science

- **Background Dwarf Galaxies**
  - UV luminosity function
  - Dust extinction (UV spectral slope) } Total SFRD
  - Science w/UV & GLASS Ha
    - Characterization of bursty SF (Ha vs. UV)
    - Cont. vs. Line extinction
    - Lyman continuum escape fraction

- **Cluster Galaxies**
  - Star formation and quenching with radius.
  - Ram pressure stripping
  - Extreme horizontal branch vs. SF

# Evidence of Bursty Star Formation

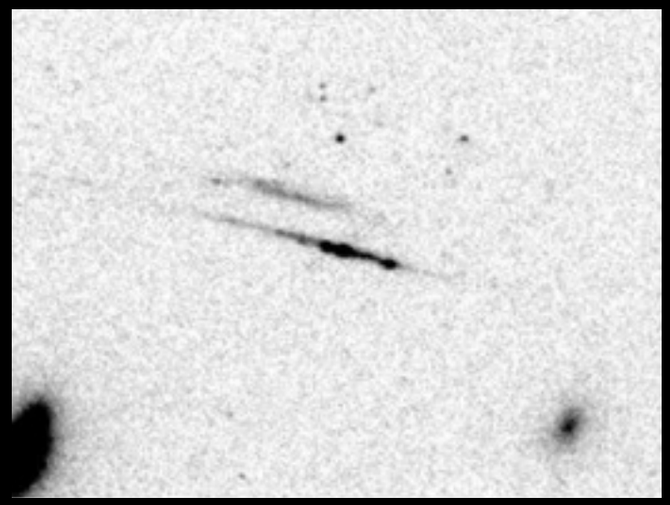


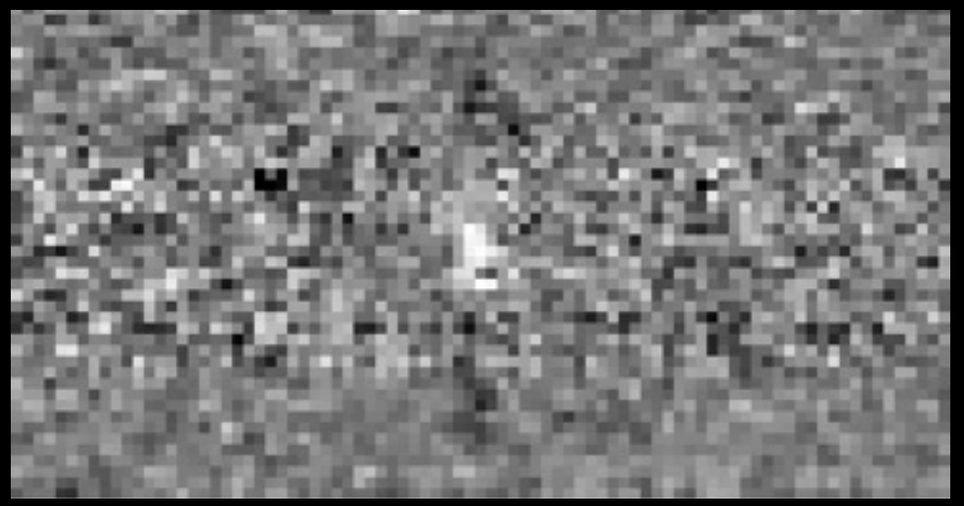

Domínguez et al. (2014)

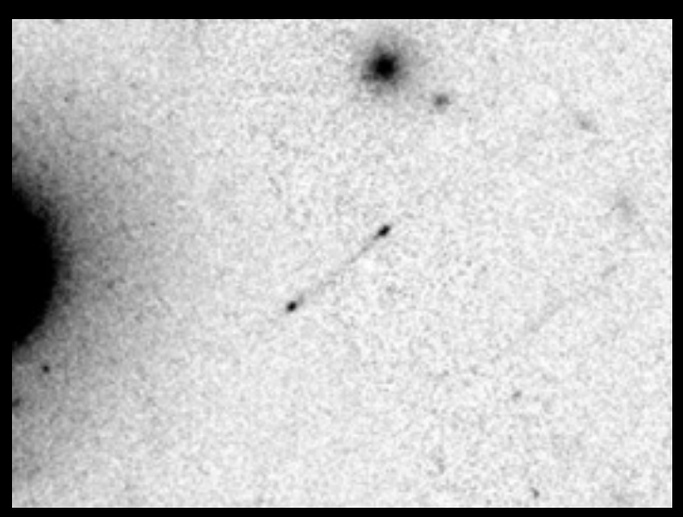
# $L_{UV}/L_{HA}$ RATIOS

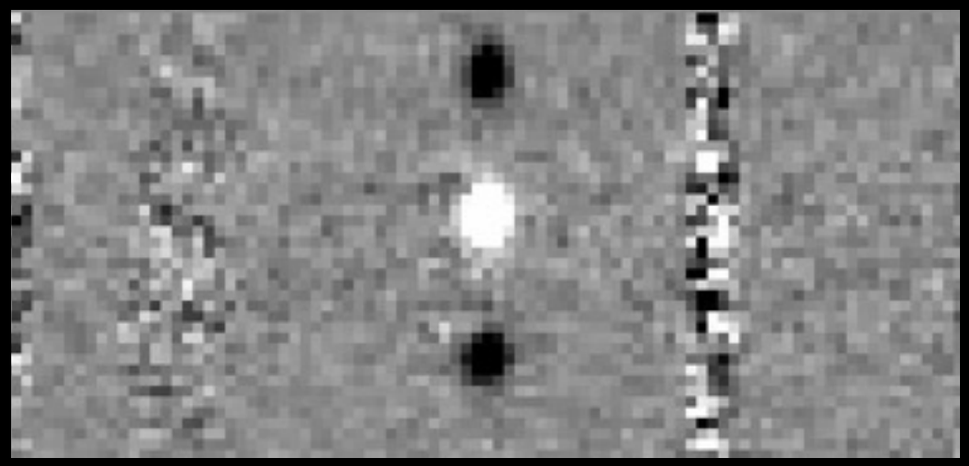
UV = HST

Hα = Keck / MOSFIRE



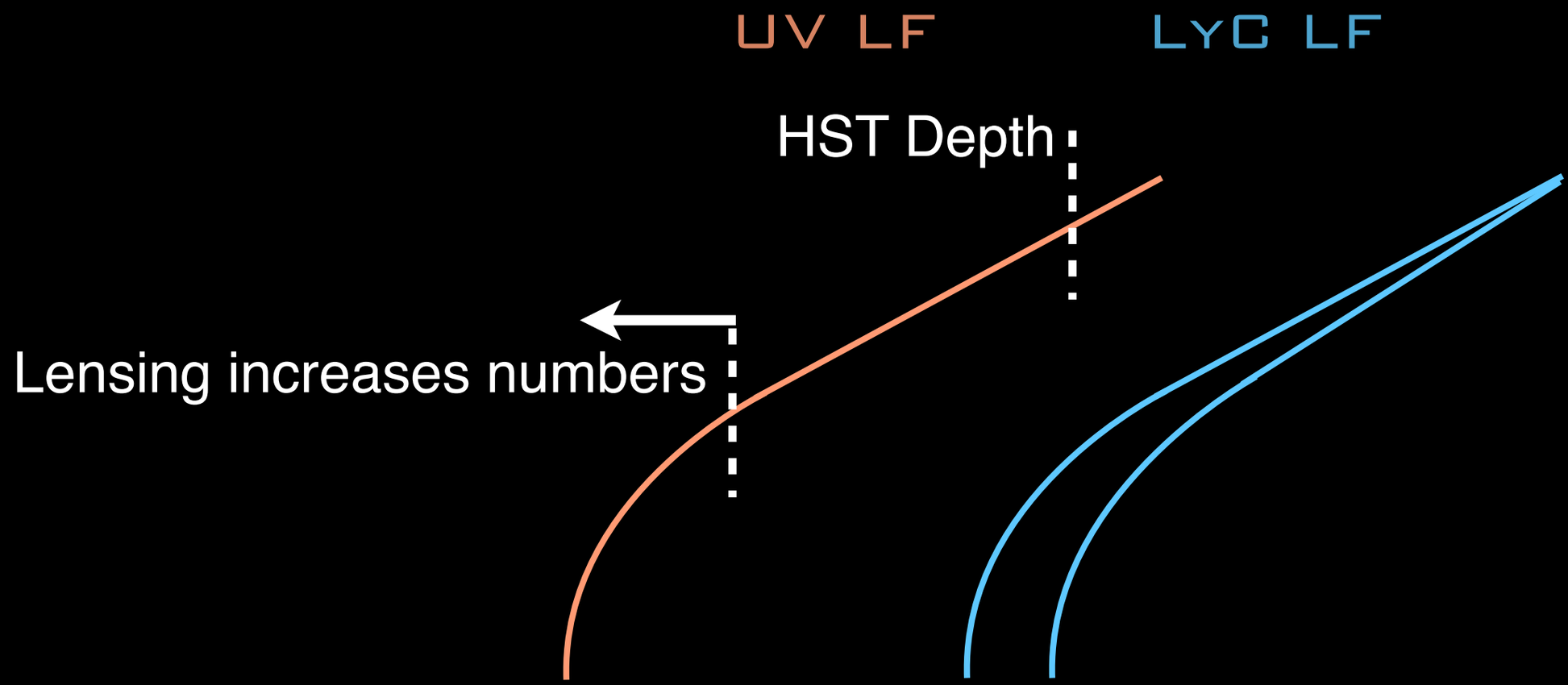




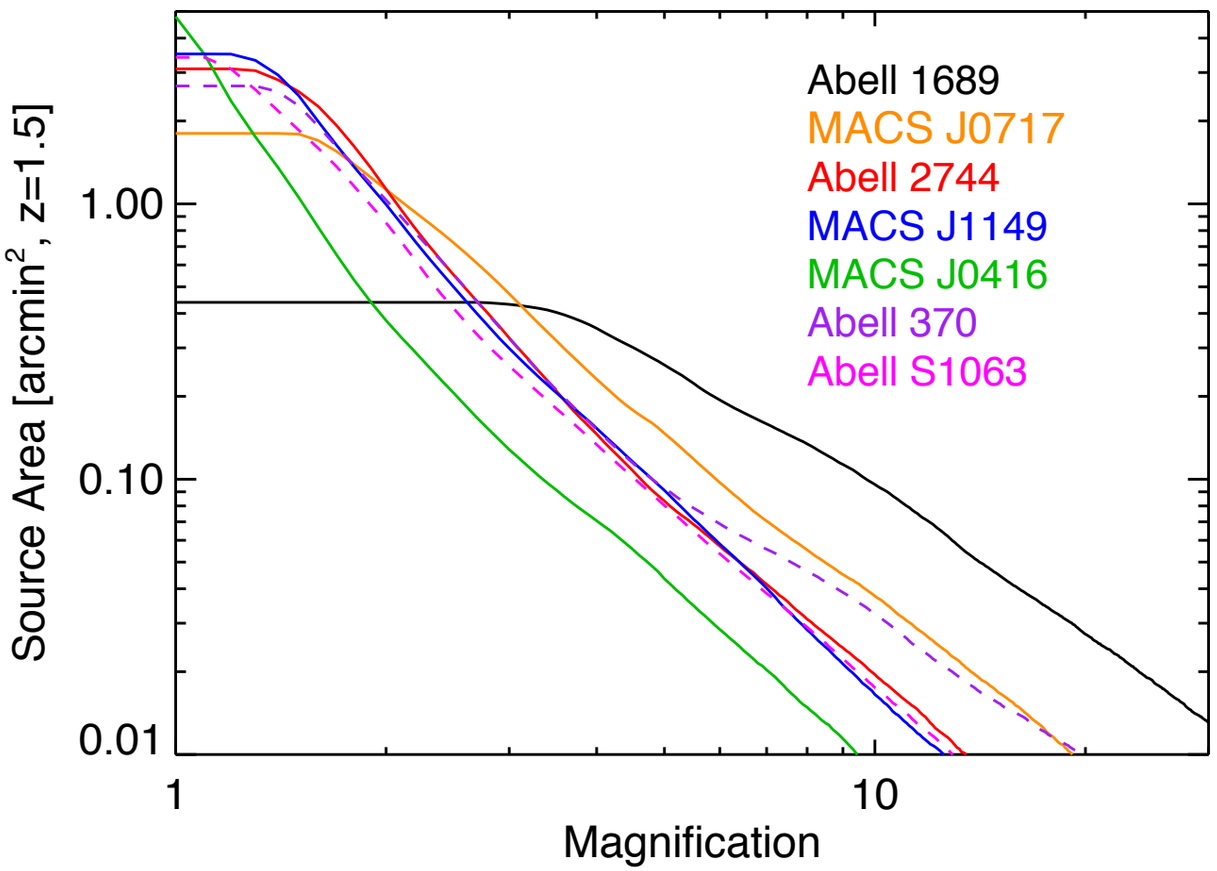


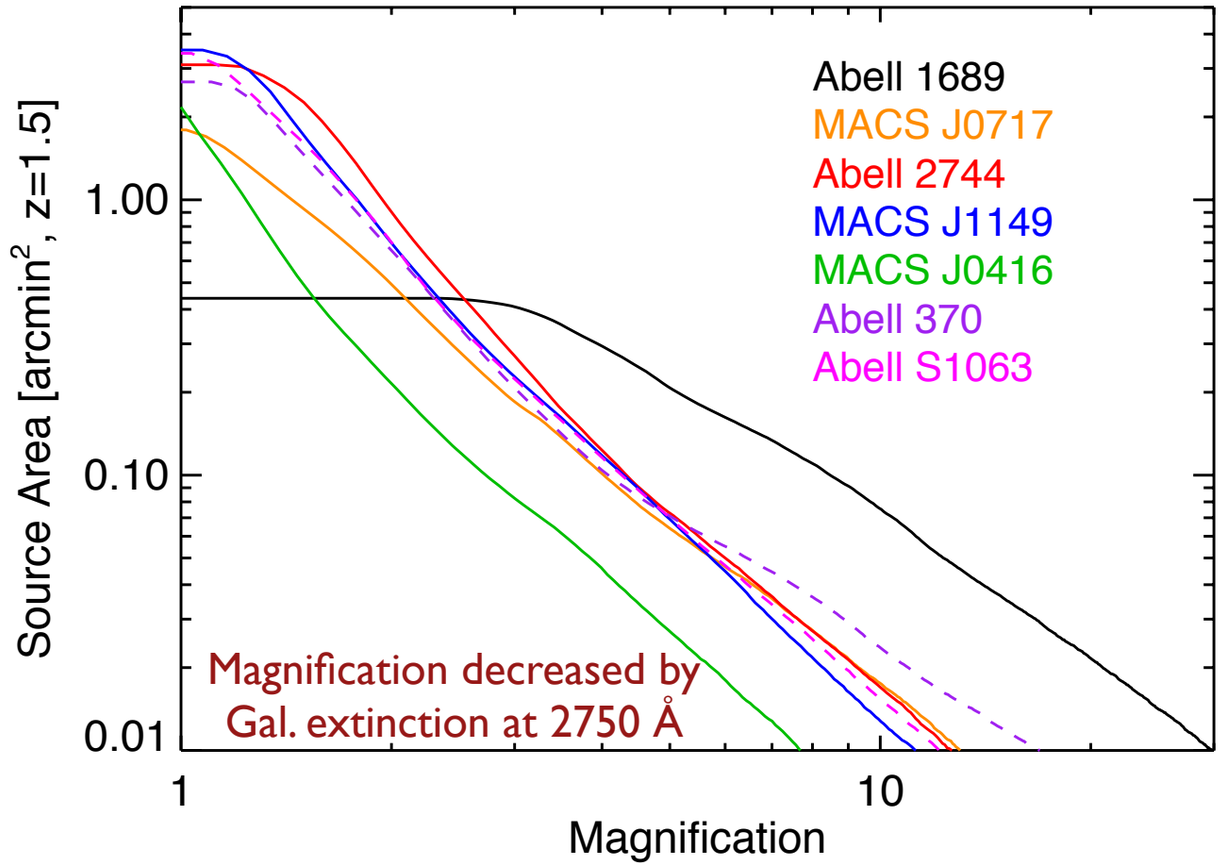
## Factor ~30x difference in $L_{UV}/L_{HA}$

# Escape Fraction of Lensed Galaxies

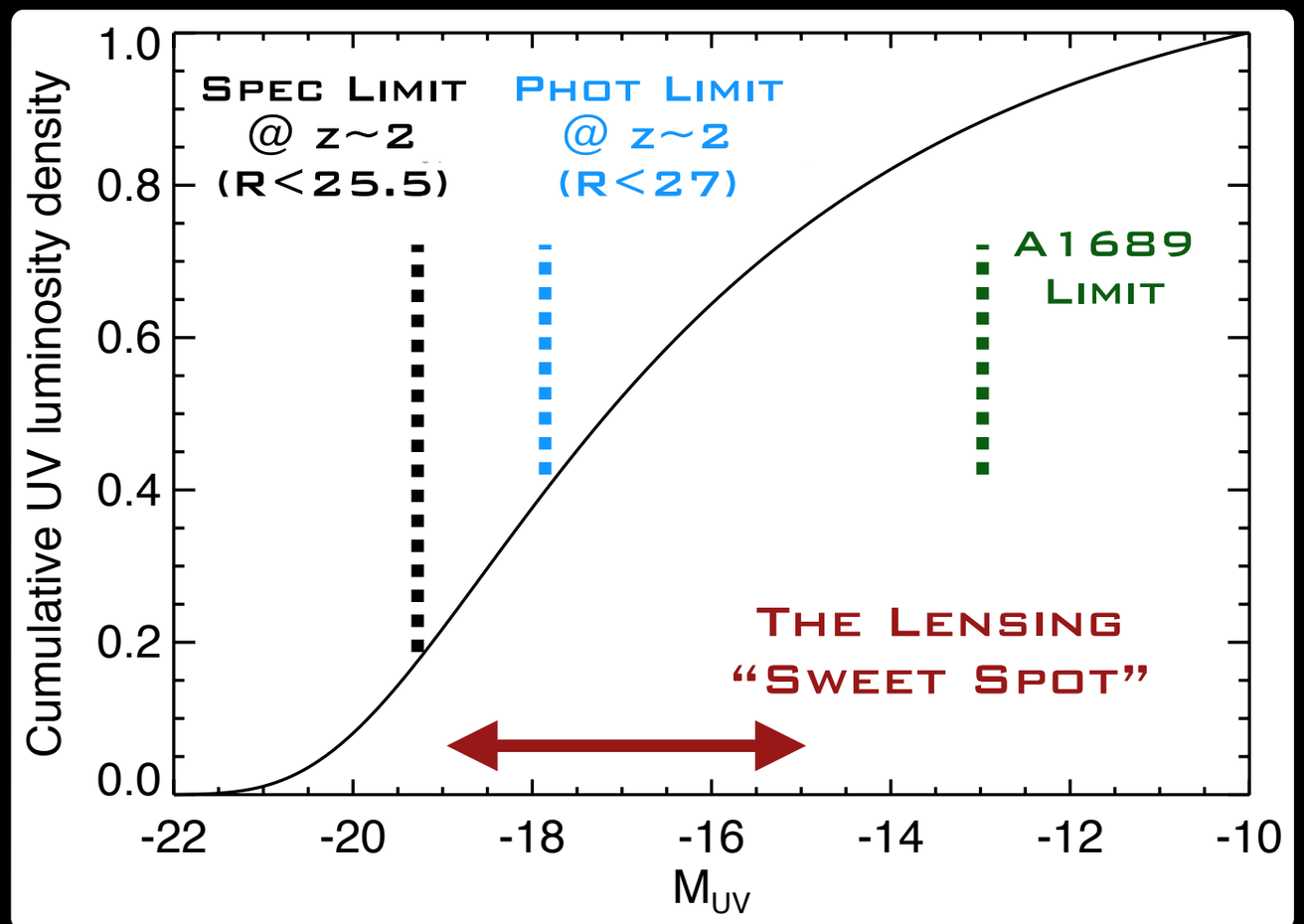


# Opinion on 2 Additional Fields




- Both have minimal Galactic Extinction!
- Abell 370 is a good lens for high magnification.
- Abell 370 equatorial, can follow-up from Chile/Hawaii
- Need more high-magnification spec targets.
  - Do A370!




Alavi et al. (2014)

## Expected HFF Numbers (3 fields)