

Census of the Local Universe (CLU) – H α Galaxy Survey

M51



PTF H α (6563 Å)

David Cook
Caltech

PTF/ZTF Meeting
Maryland
May 20th, 2016

Collaborators: Mansi Kasliwal
(Caltech), Angie Van Sistine (U of
Wisconsin, Milwaukee), PTF

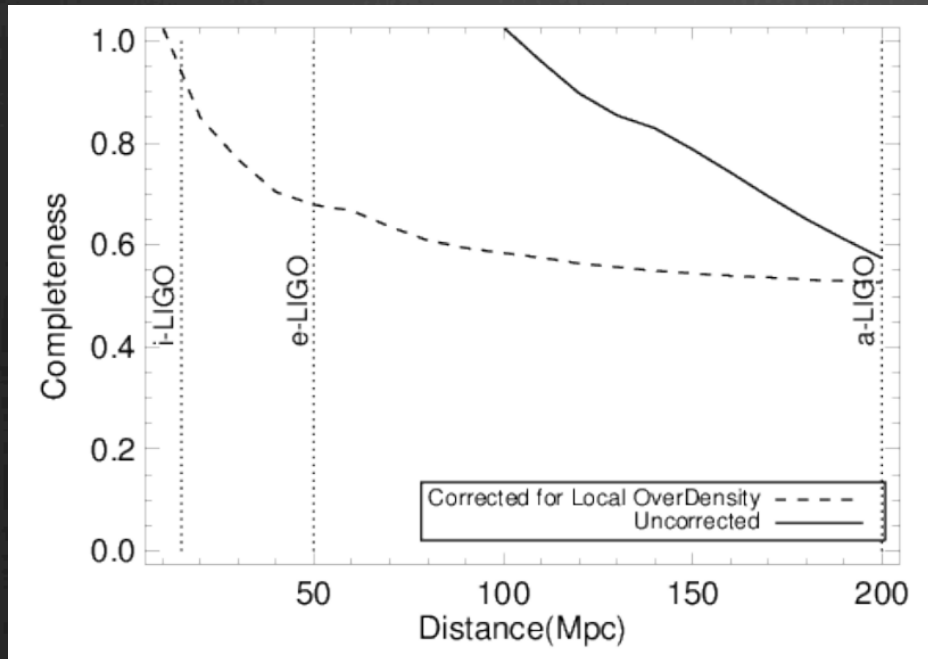


Scientific Goals

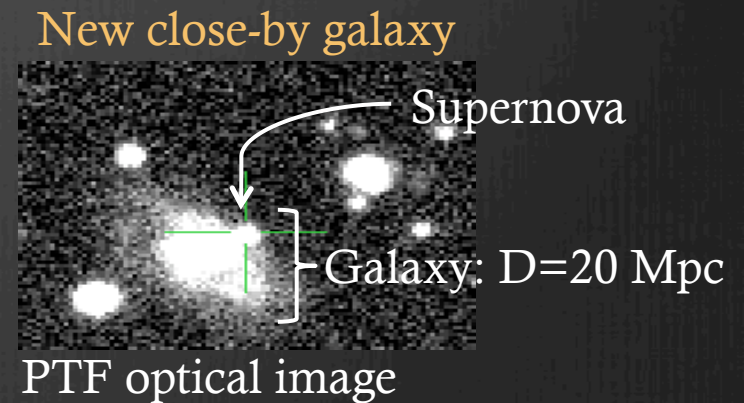
- **Galaxy Catalog out to 200 Mpc**
 - Pinpoint an electromagnetic counterpart of a gravitational wave event
 - Assisting transient surveys (e.g. ZTF, LSST, VLASS, etc.)
- **Star formation rate (SFR) density at $z=0$**
 - Reduce cosmic variance
- **SFR(H α)/SFR(FUV) discrepancy**
 - Better constraints for low SFR galaxies
- Plus many more...

Why Do We Need a Nearby Galaxy Survey?

- NED, SDSS, +other studies: $N \sim 250,000$ galaxies
 - B-band light $\sim 50\%$ complete at 200 Mpc



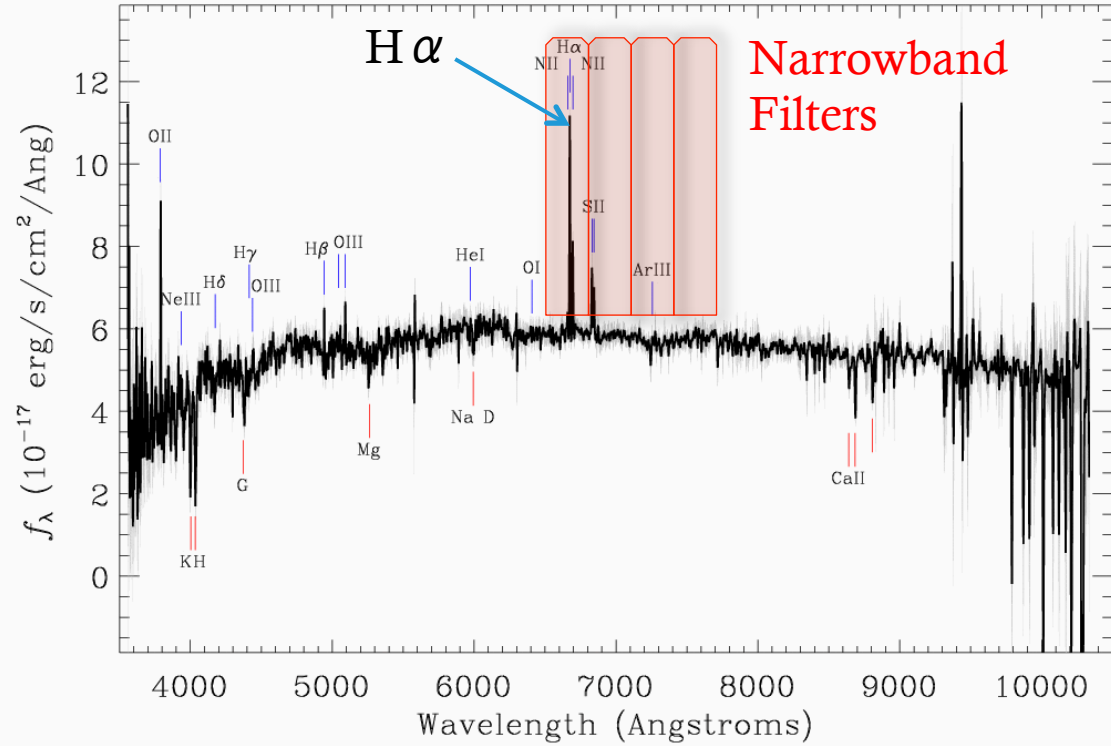
Courtesy: Mansi M. Kasliwal

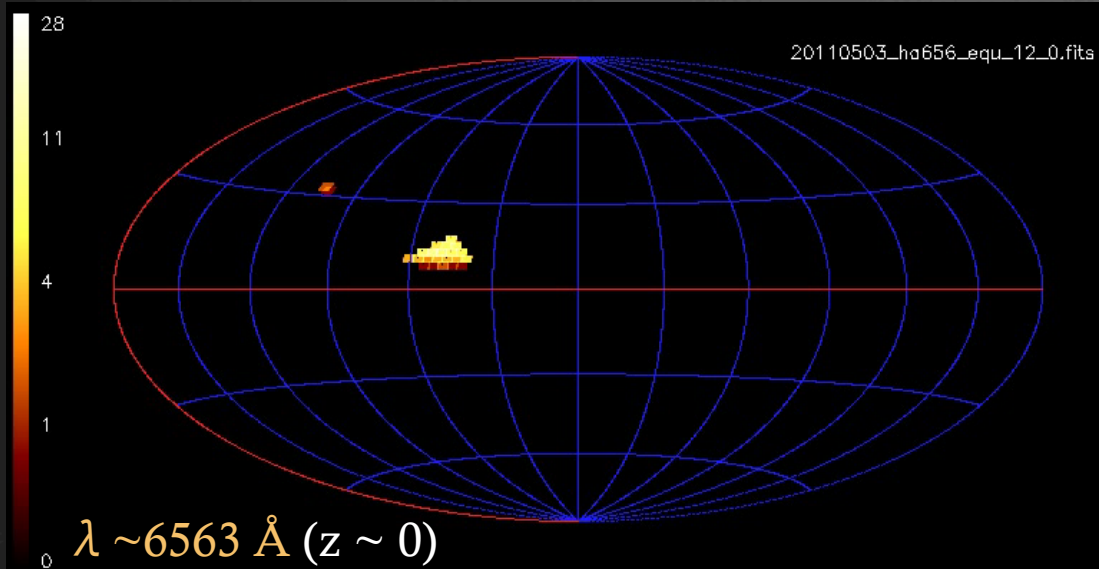


Galaxies



Survey: *boss* Program: *boss* Target:
RA=347.31566, Dec=19.88782, Plate=6122, Fiber=262, MJD=56246
 $z=0.01676 \pm 0.00002$ Class=GALAXY STARFORMING
No warnings.



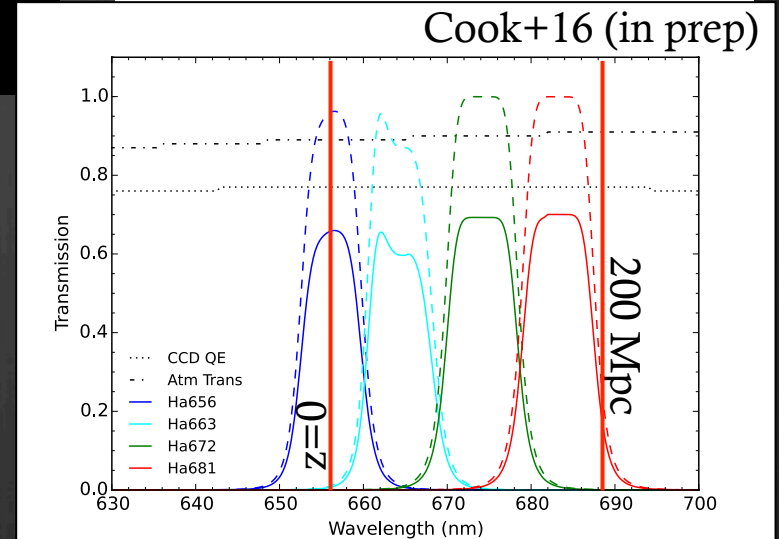


PTF H α

Narrowband H α Filter Properties

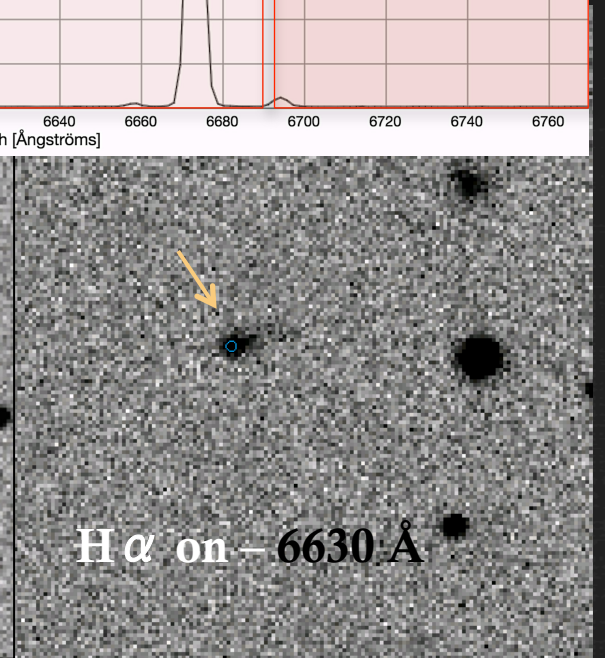
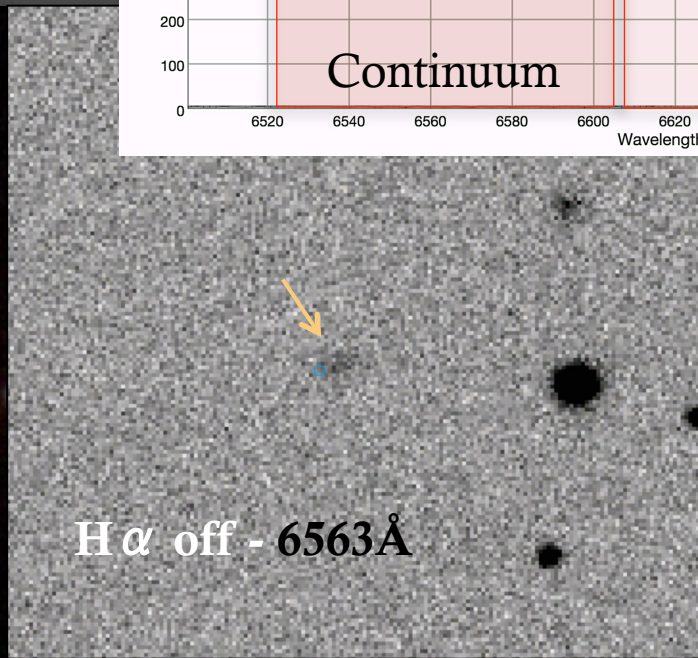
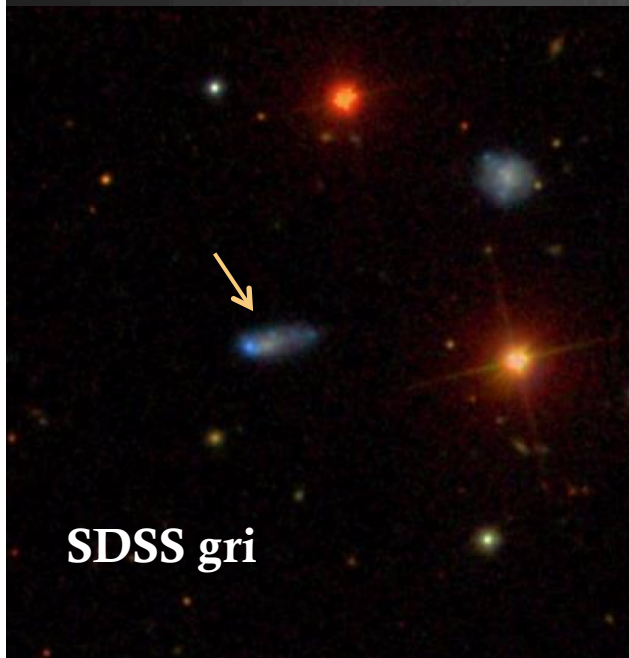
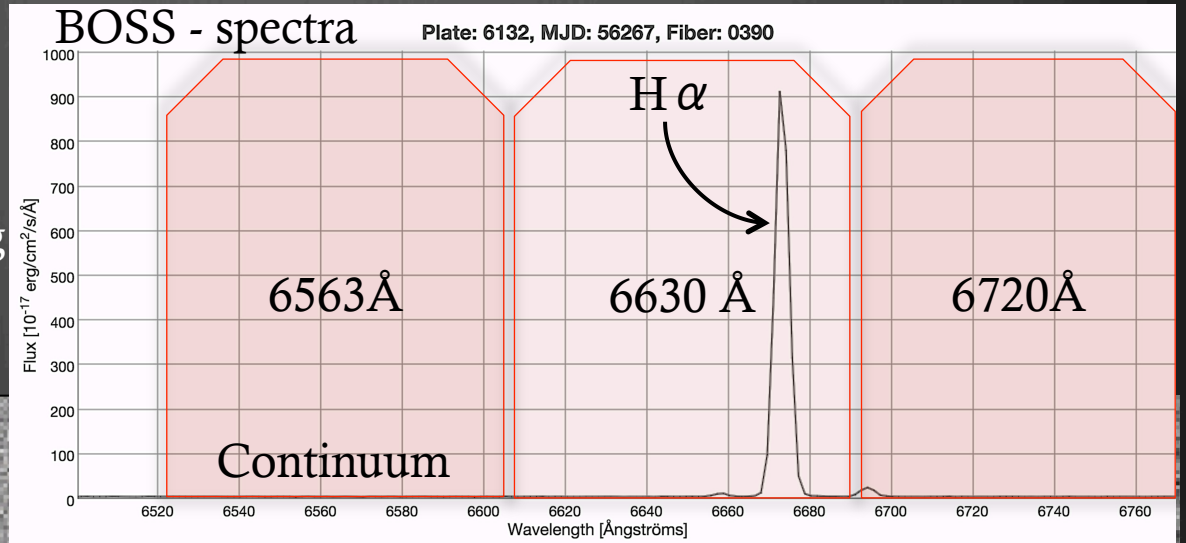
Filter name	Filter λ (Å)	Filter $\Delta\lambda$ (Å)	Redshift range (#)
H α 1	6562.4	76.2	-0.0059 < z < 0.0057
H α 2	6642.5	78.8	0.0061 < z < 0.0181
H α 3	6741.5	91.7	0.0202 < z < 0.0342
H α 4	6832.4	91.7	0.0341 < z < 0.0480

- 15,000 deg² of the sky
- 4 narrow-band filters
 - H α at different z
- >75% finished in all filters
- Observations will be finished by end of 2016



Narrowband Strategy

- New Galaxy
- $H\alpha$ color (On - Off) = 1.5 mag
- at $z \sim 0.017$ (~ 75 Mpc)
- $H\alpha$ EW = 675 Å



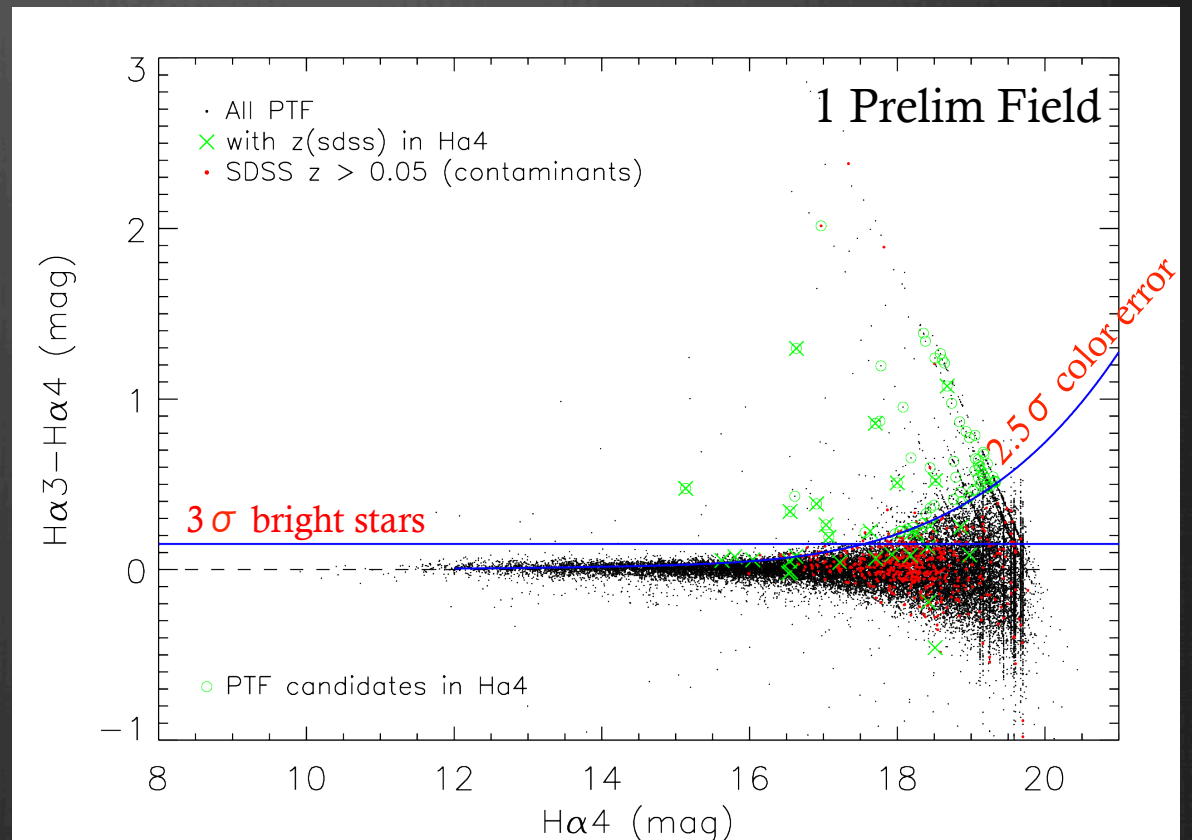
Selection Criteria

➤ Selection Criteria

- (Sobral+09, Lee+12)
- Continuum sources $> 3\sigma$
 - mag < 15
- Excess H α color $> 2.5\sigma$
- Extended sources

➤ Galaxy candidates

- 4 preliminary fields
- With SDSS coverage
- N~500 total
- N=273 new candidates



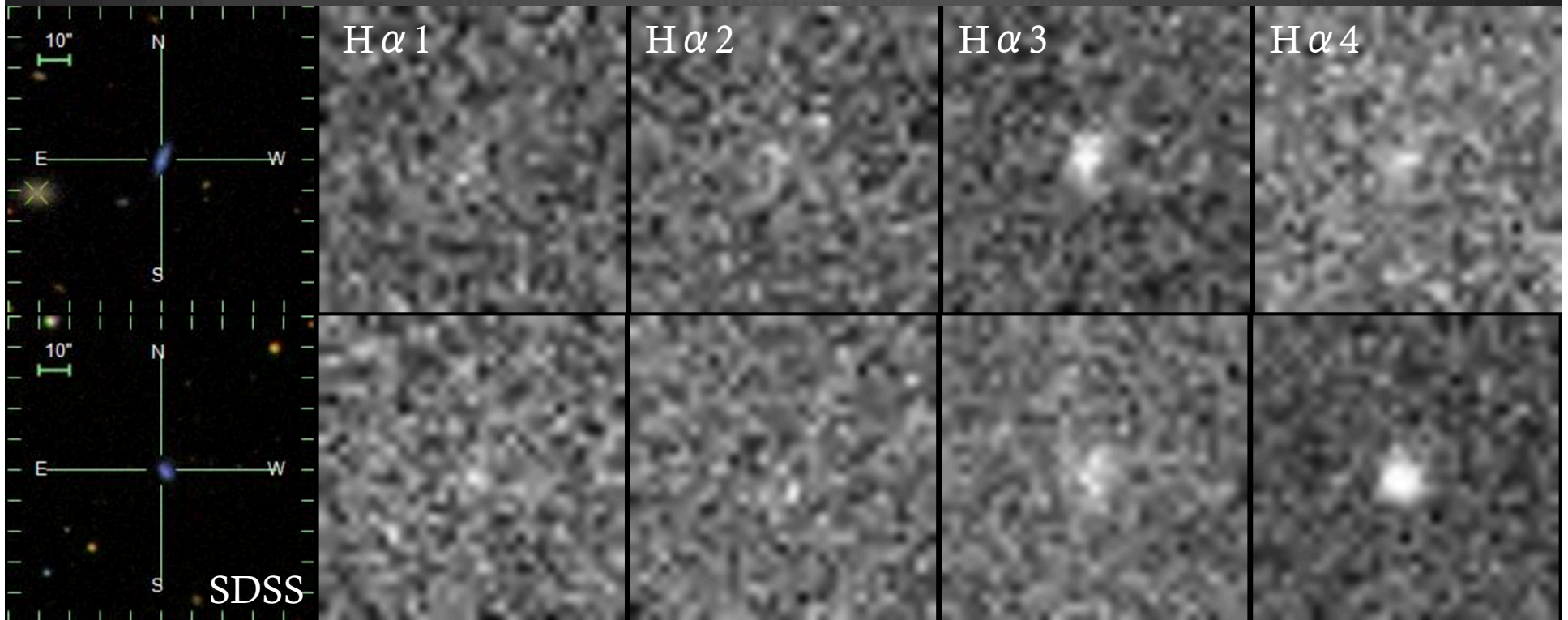
Cook+16 (in prep)

Comparison to SDSS galaxies

- Galaxy candidates (4 fields with SDSS overlap)
 - N=273 new candidates
 - ~half are known SDSS galaxies
- Completeness (galaxies with redshifts that have H α in the filter they were found)
 - 95% at EW \sim 50 Å
 - 75% at EW \sim 20 Å
 - 15% are high redshift galaxies (False Positives)
- Estimated new galaxies:
 - $273 * 0.15$ (contaminants) $* 0.05$ (junk via visual inspection) / 4 = 54 per PTF field
 - N=109,000 new galaxies for all \sim 2000 PTF fields
 - Lower limit on new galaxies - Half area covered by SDSS \rightarrow \sim 150,000 new galaxies?

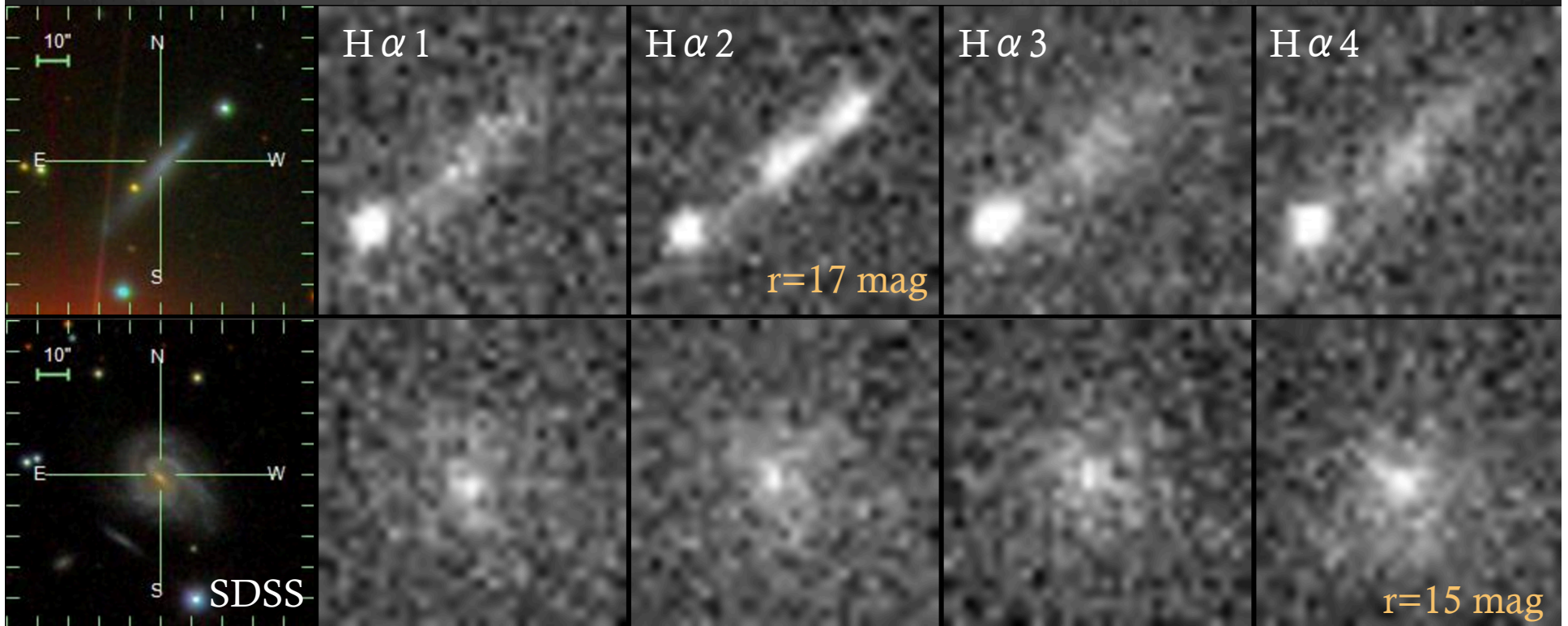
New Candidates

➤ No redshifts!



Impressive New Candidates

➤ No redshifts!



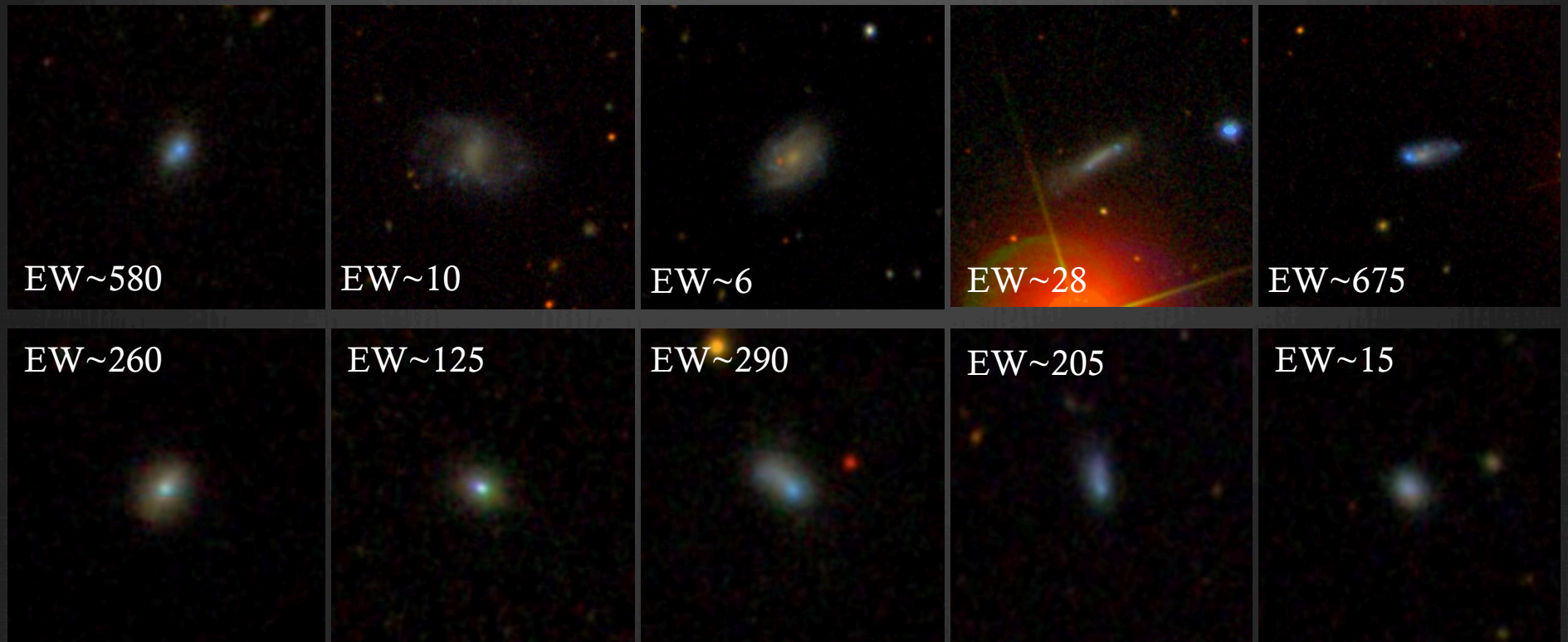
Spectroscopic Follow-up

- SDSS/BOSS – 20 candidates confirmed
- Palomar
 - 200 inch
 - Awarded 3 nights in 2016
 - 1 night – another 21 candidates confirmed
 - 2 nights in July
 - Proposing for more
 - 60 inch – 60+ hours in Summer-Fall 2016
- WIRO 2.3m
 - 10 nights in April 2016
 - Data still needs to be reduced

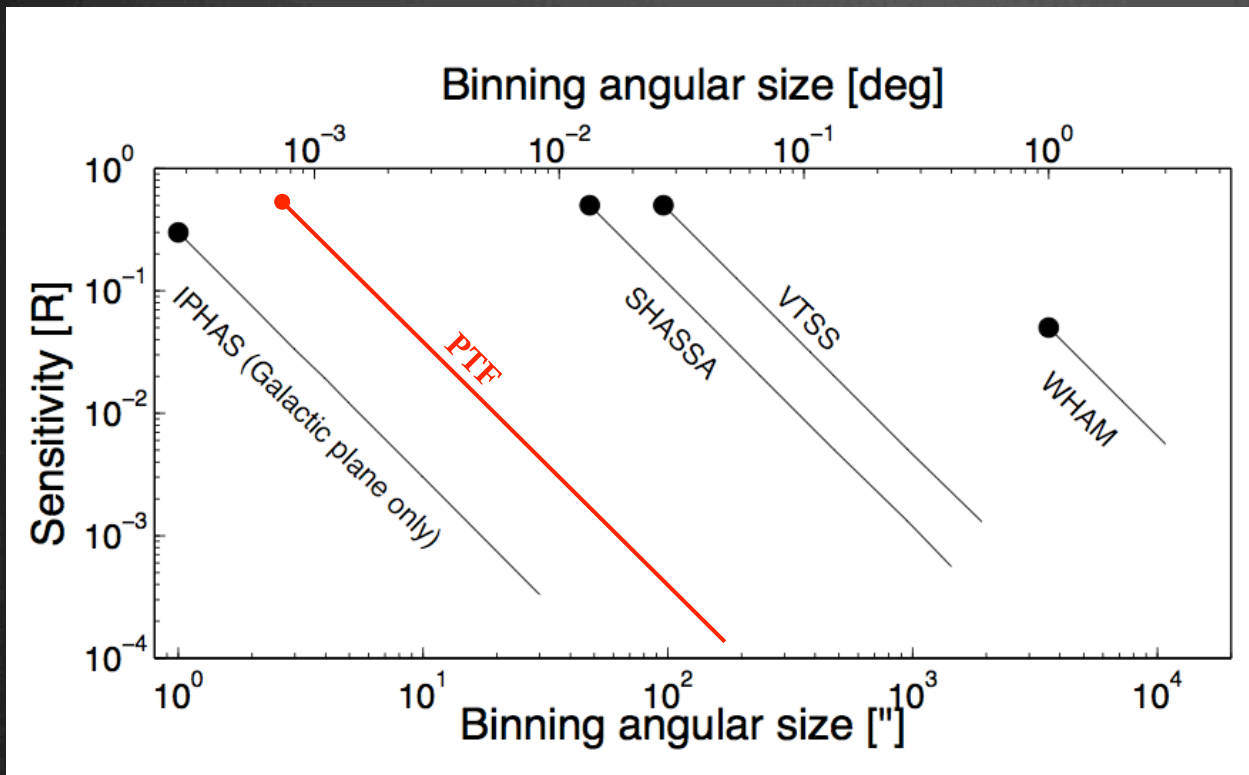
New Local Galaxy Discoveries

➤ All with BOSS/SDSS spectra

- Prelim sensitivity using SDSS overlap:
- EW~tens Å
- Line flux~1e-15 erg/s/cm²



Sensitivity

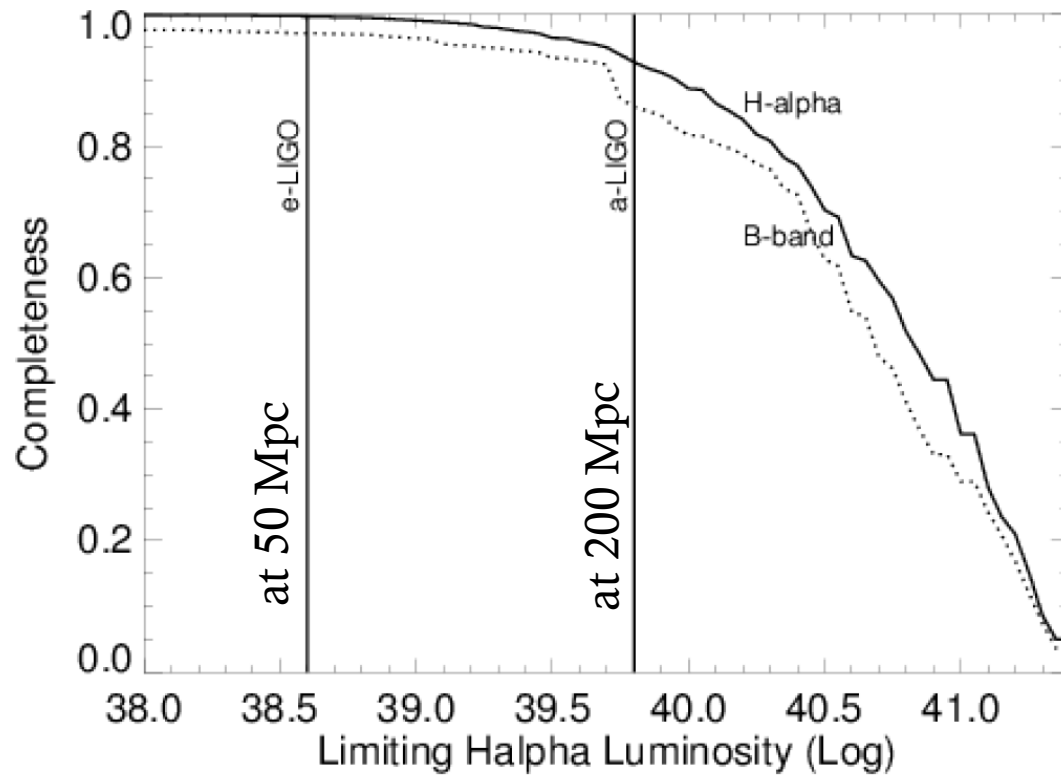


- PTF H α Sensitivity
 - point source
 - ~~2e-17 erg s⁻¹cm⁻²~~
 - 1e-15 erg s⁻¹cm⁻²
 - R ~ 10 Rayleigh

- In order of area:
 - ~~PTF – 30,000 deg²~~
 - PTF – 15,065 deg²
 - SHASSA – 17,000 deg²
 - WHAM – 17,000 Deg²
 - IPHAS – 1,800 deg²
 - Galactic plane
 - VTSS – 1,000 deg²

Rau+2009 – Modified by Cook

CLU Completeness



- PTF H α Sensitivity
 - EW $\sim 20 \text{ \AA}$
- At 200 Mpc
 - Log L(H α) $\sim 39.8 \text{ erg/s}$
 - 85% complete B-band
 - 90% in L(H α)

Courtesy: Mansi M. Kasliwal

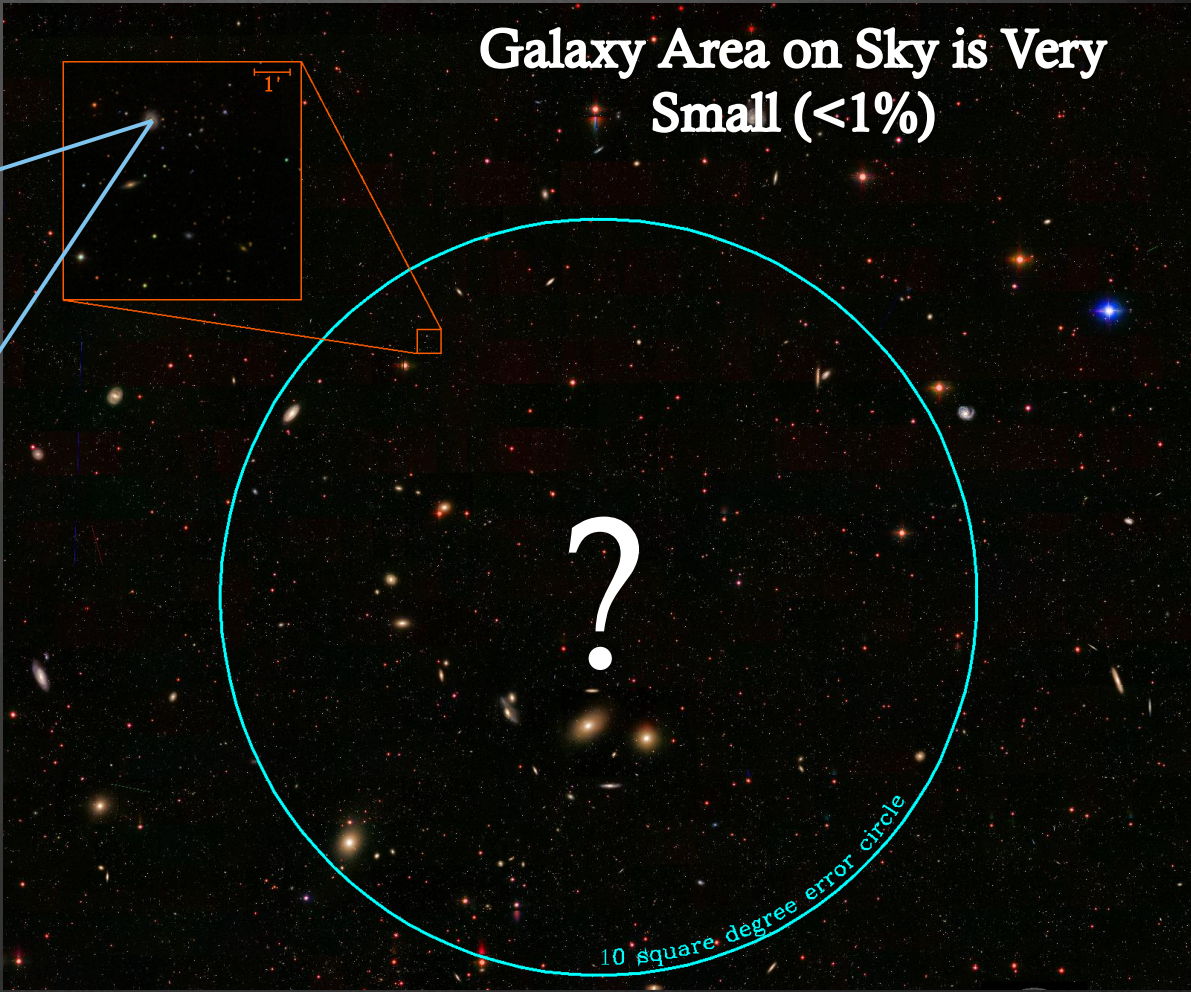
A comparison to 11HUGS complete out to 11 Mpc

- Kennicutt+08, Lee+09

Gravitational Waves



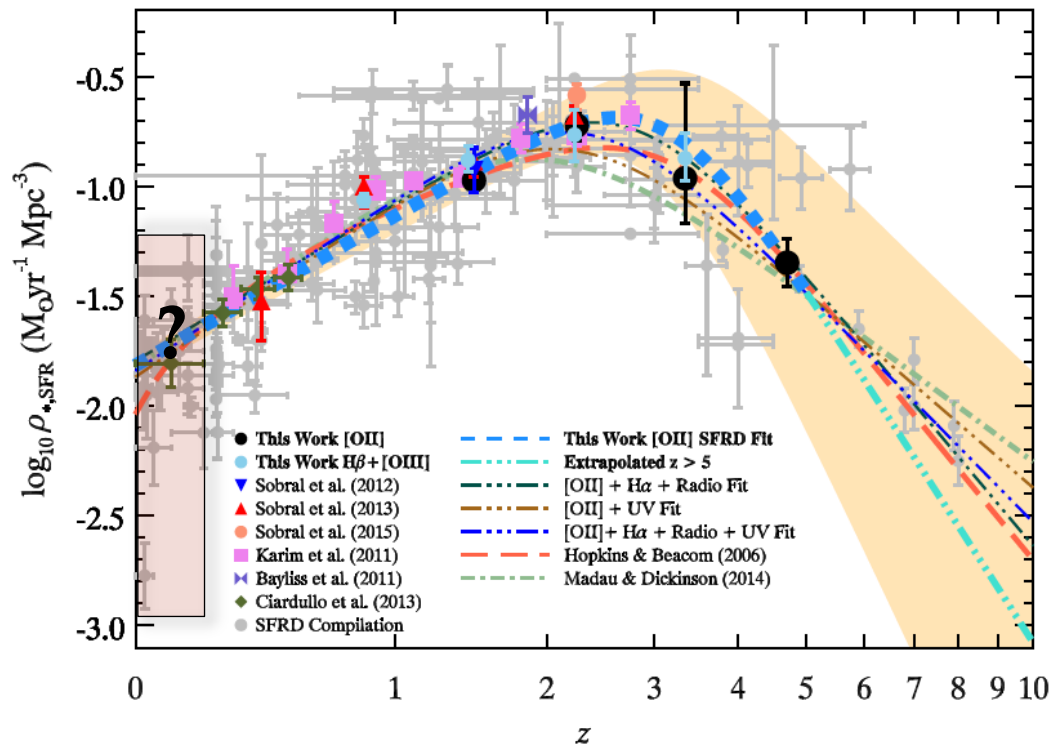
Credit: Simulating eXtreme Spacetimes



Galaxy Area on Sky is Very Small (<1%)

10 square degree error circle

Galaxy Science - SFR Density



- Cosmic SFR density
 - $\rho = \text{SFR}/\text{Mpc}^3$
- $z=0$ Luminosity Function
 - Where is the $z=0$ anchor???
 - What is the intrinsic shape???
- CLU – 15,000 deg^2
 - Less cosmic variance
 - ρ error can be $\sim 100\%$ for small areas (Stroe+2015)
 - 150,000s of galaxies

Khostovan+2015

Galaxy Science - Ha/FUV

➤ Implications

- Stochastic IMF vs IGIMF
- Different timescales
- SSP models
- L-derived physical properties

- At $D \sim 50$ Mpc

➤ PTF Halpha

- $1e-15$ erg/s/cm²
- SFR (M_{\odot} /yr) $\sim 1e-3$
- 15,000 deg²

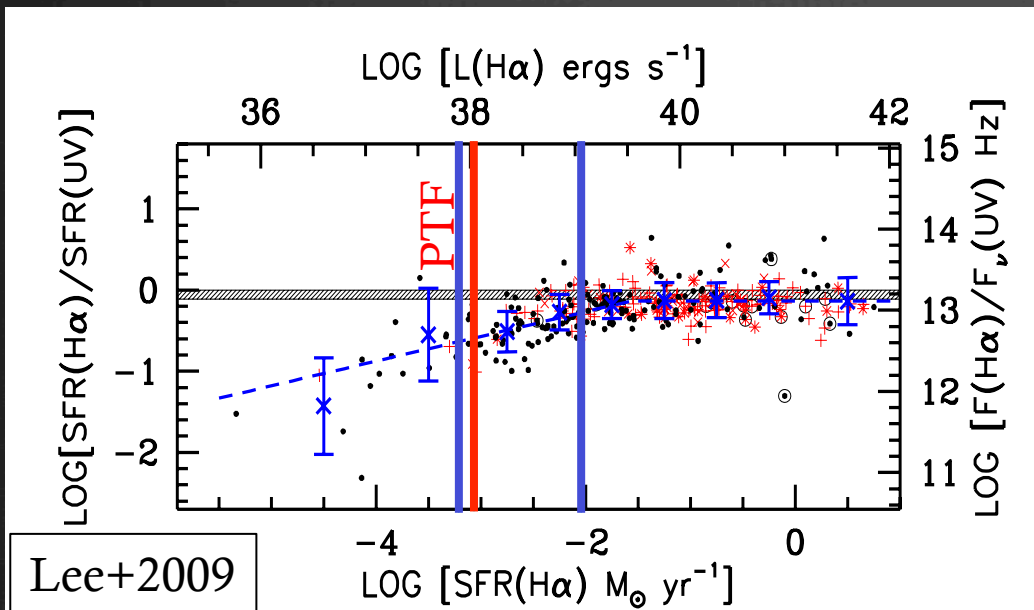
➤ GALEX (5σ)

➤ All sky Survey

- $m_{\text{lim}} \sim 20.5$ mag \rightarrow SFR (M_{\odot} /yr) $\sim 1e-2$
- 26,000 deg²

➤ Medium Imaging

- $m_{\text{lim}} \sim 23.5 \rightarrow$ SFR (M_{\odot} /yr) $\sim 6e-4$
- 1,000 deg²

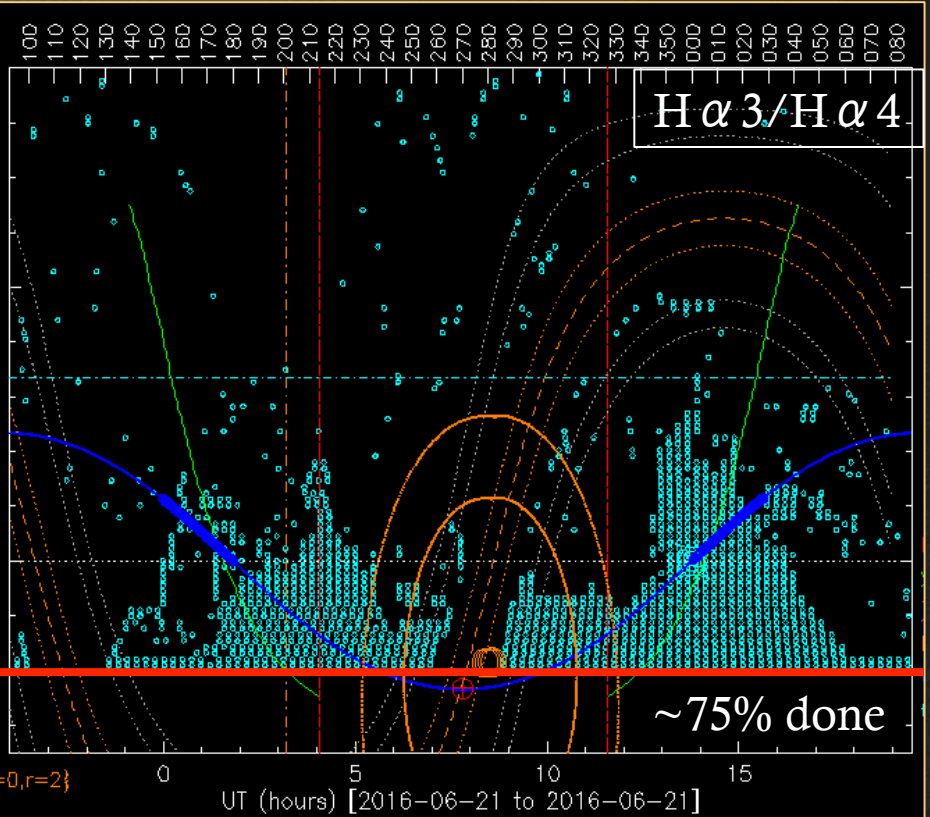
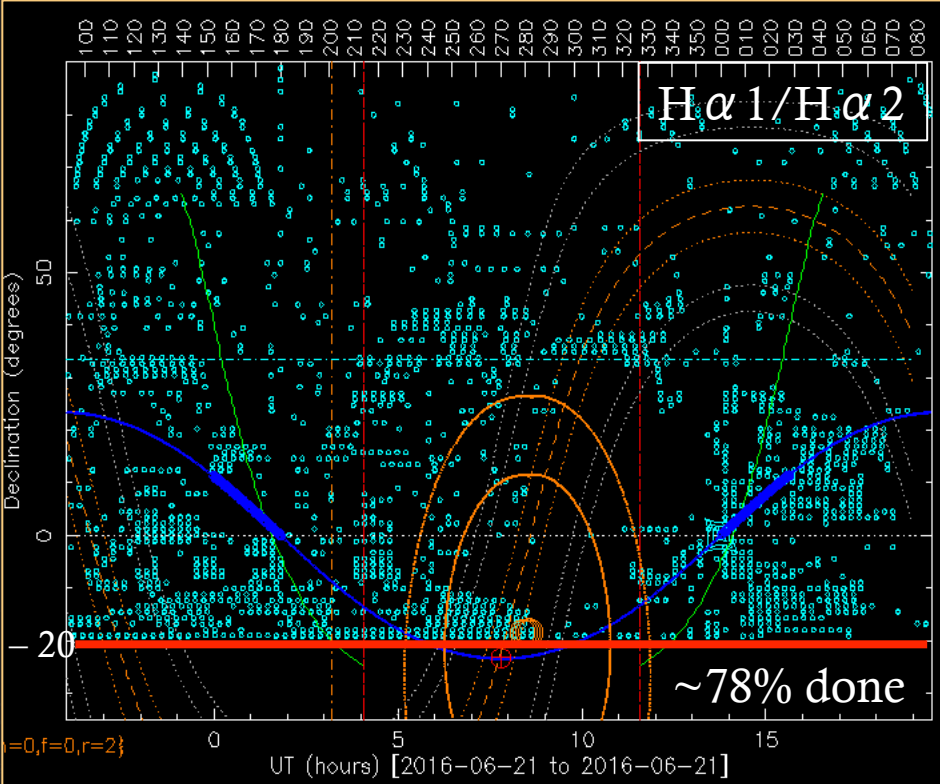


Timeline

- Limiting step is calibration (i.e., SDSS)
- With SDSS overlap
 - End of Summer 2016
- All PTF
 - Will be calibrated to PanStarrs
 - PanStarrs release: this year???
 - CLU candidates for all PTF timeline: Early-Mid Next year...

Additional Slides

Left-to-Go

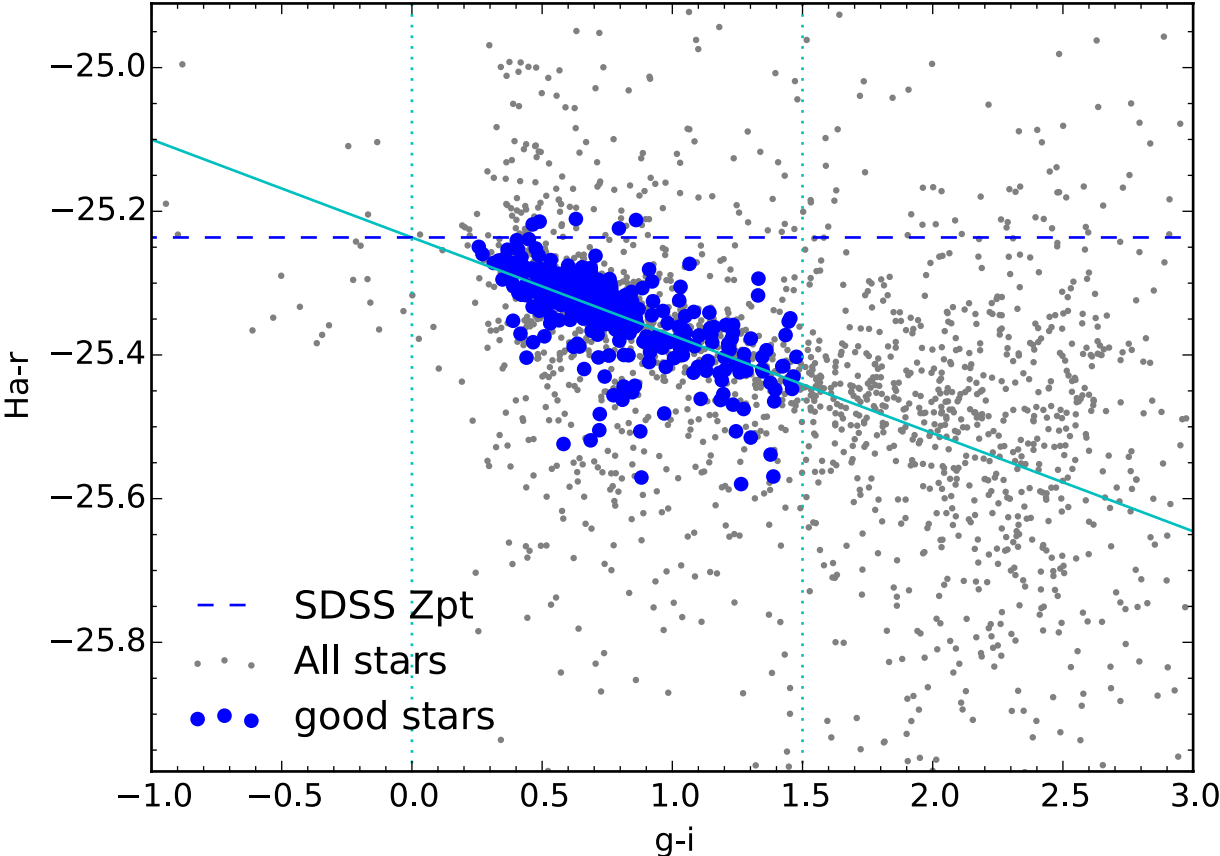


➤ Observations will be finished by end of 2016

- 20 dec

Calibration

Cook+16 (in prep)



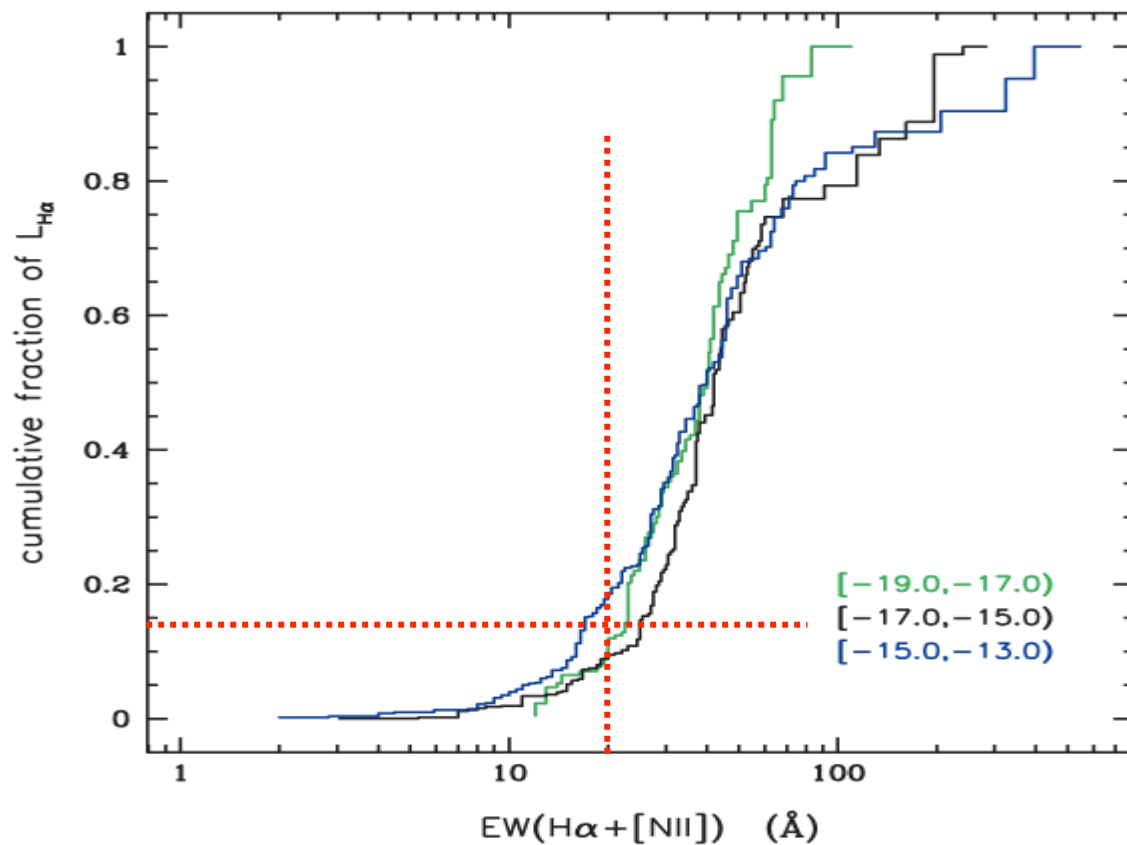
Completeness: H α Luminosity

➤ CLU completeness

➤ $\sim 20 \text{ \AA}$ EW



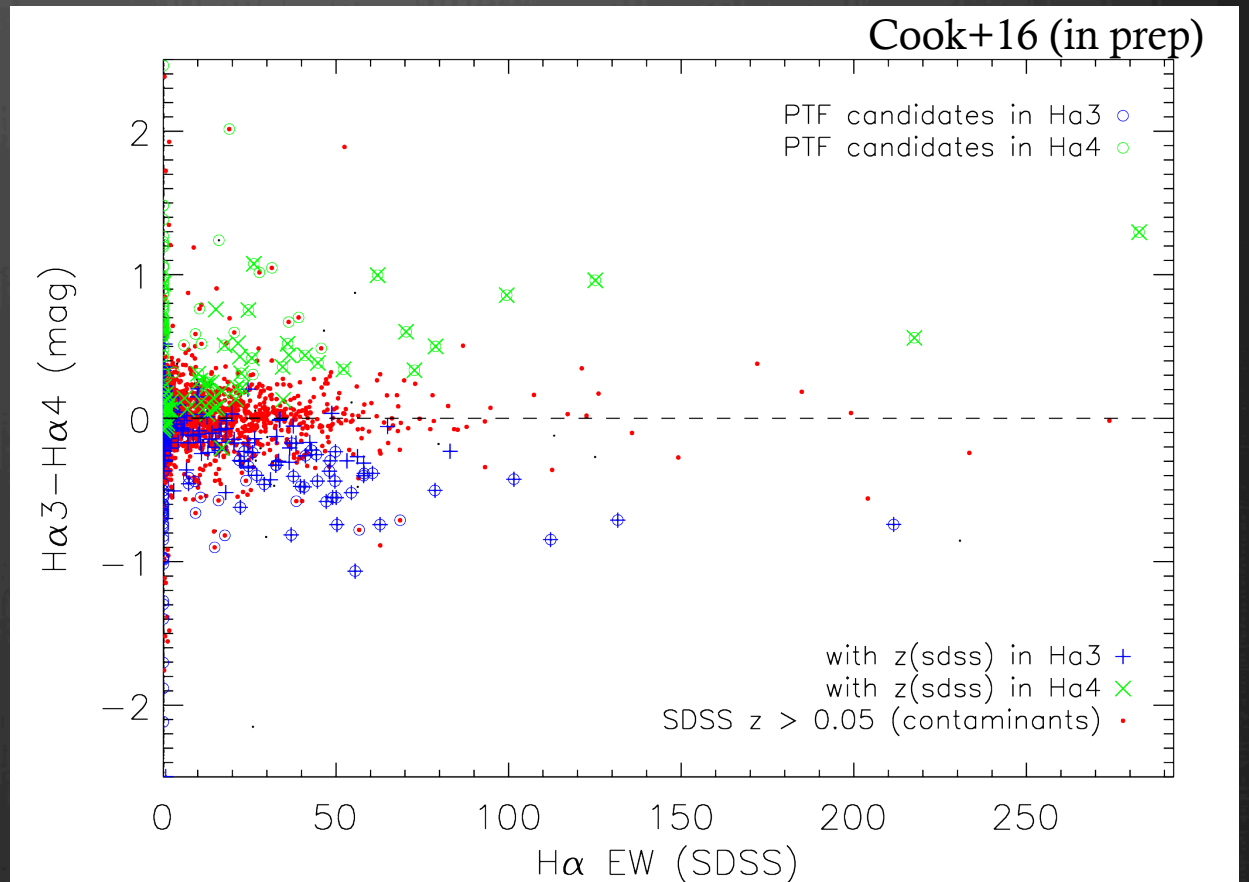
➤ $>85\%$ complete in $L(\text{H}\alpha)$



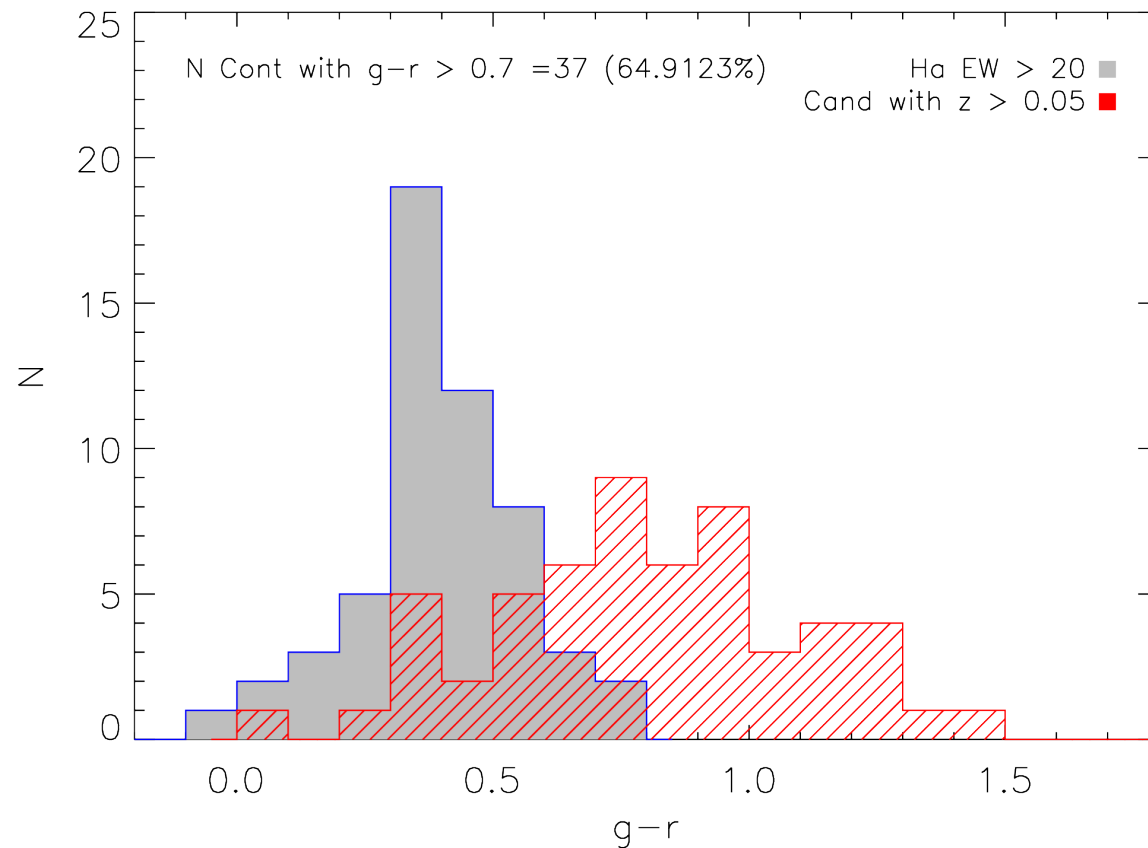
11HUGS - Kennicutt et al., 2008 and Lee et al., 2009

Survey Sensitivity

- SDSS Equivalent width
 - Limit $\sim 20 \text{ \AA}$
 - SDSS spec mag
lim $\sim 17.8 \text{ mag}$...
- EW limit \rightarrow Flux density
 - $1e-15 \text{ erg/s/cm}^2$
 - $\sim 9 \text{ Raleighs}$

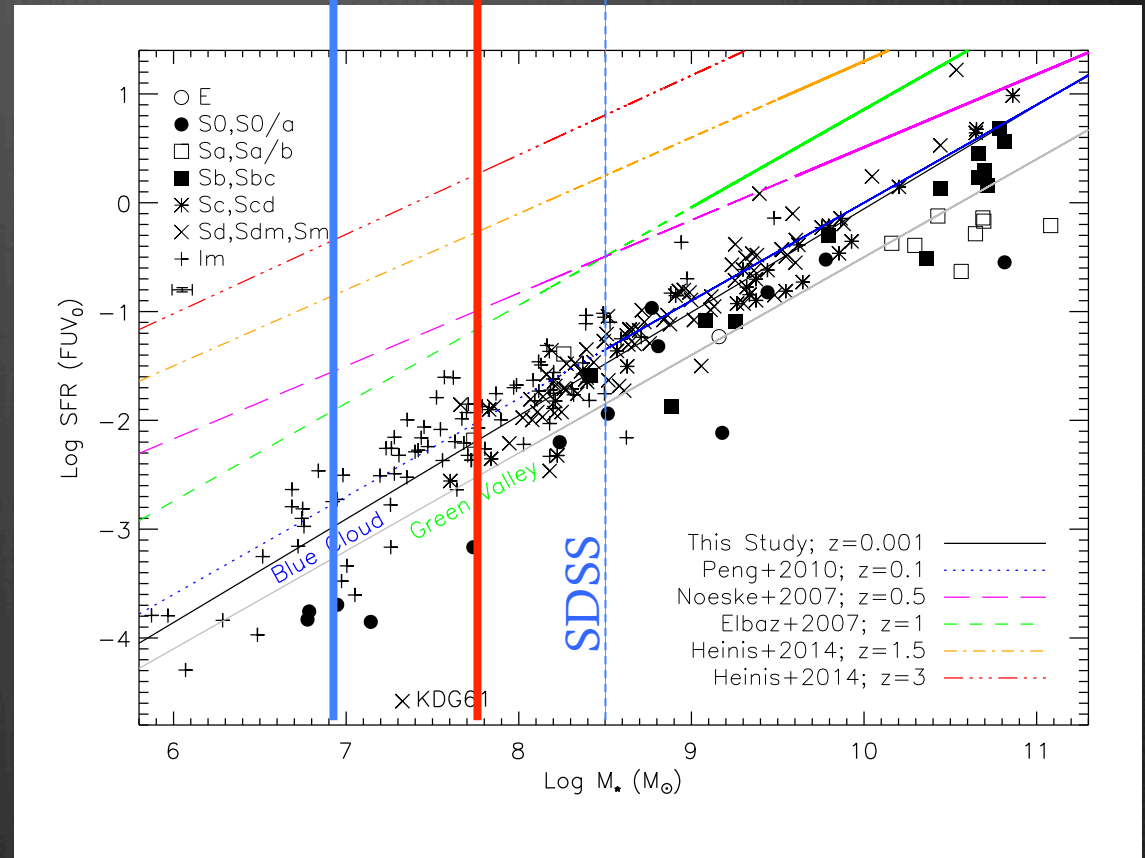


High-z Elliptical Galaxies



Galaxy Catalog

- What kind of galaxies will we probe?
- H α emission lines
 - Star-forming galaxies



Cook+2014c

Kennicutt-Schmidt Law?

