Characterizing High-redshift Interactions within the Environments of the First Structures: ʻŌnohiʻula PFS Observations of COSMOS and CFHTLS-D1

Finn Giddings & the C3VO team

(Brian Lemaux, Dave Sanders, Grey Murphree + More!)

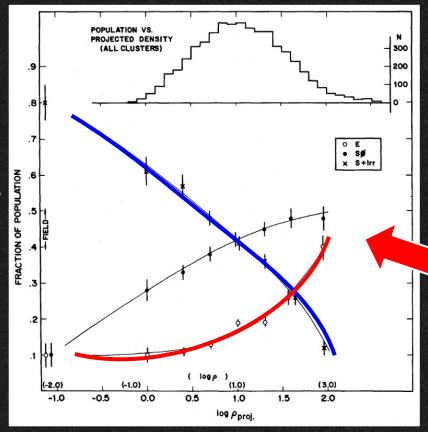
Subaru Users Meeting 2026, NAOJ – Mitaka, Japan

"Hyperion" @ z ~ 2.5
Credit: ESO

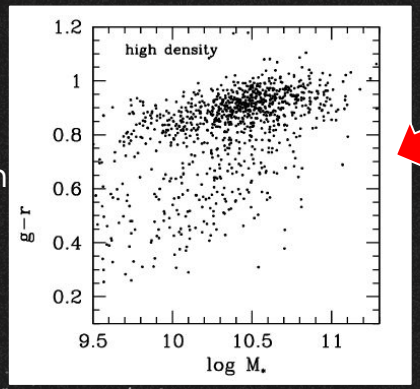
"The First Structures" → Protoclusters

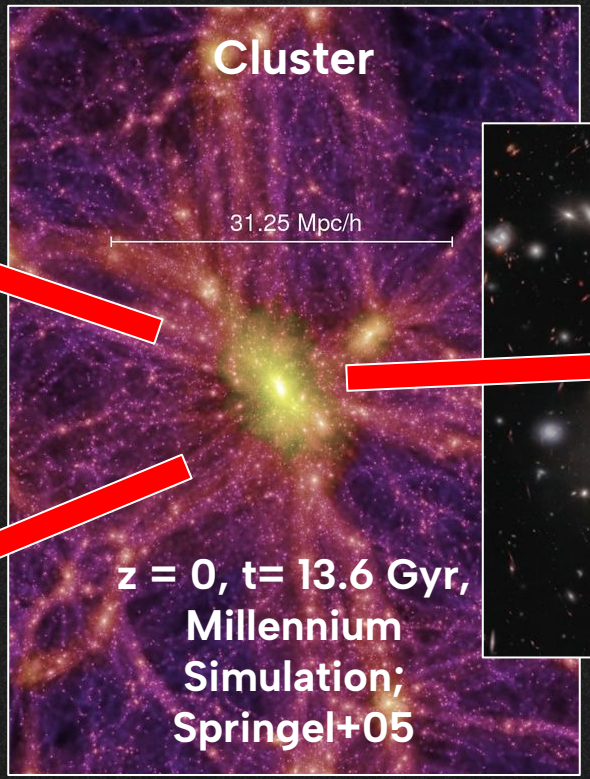
Why protoclusters?

Dressler+ 80



Kauffmann +04

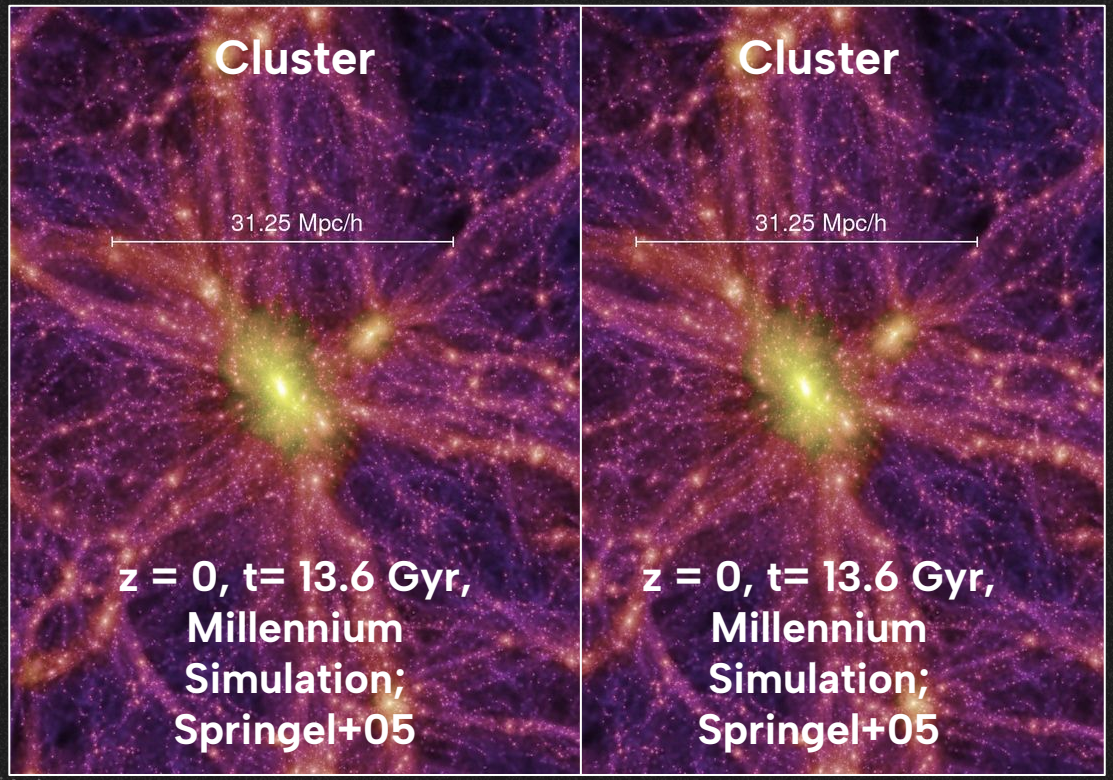




Abell 2744 (z~0.3)

From: NASA, ESA, CSA, Swinburne, University of Pittsburgh

Why protoclusters?



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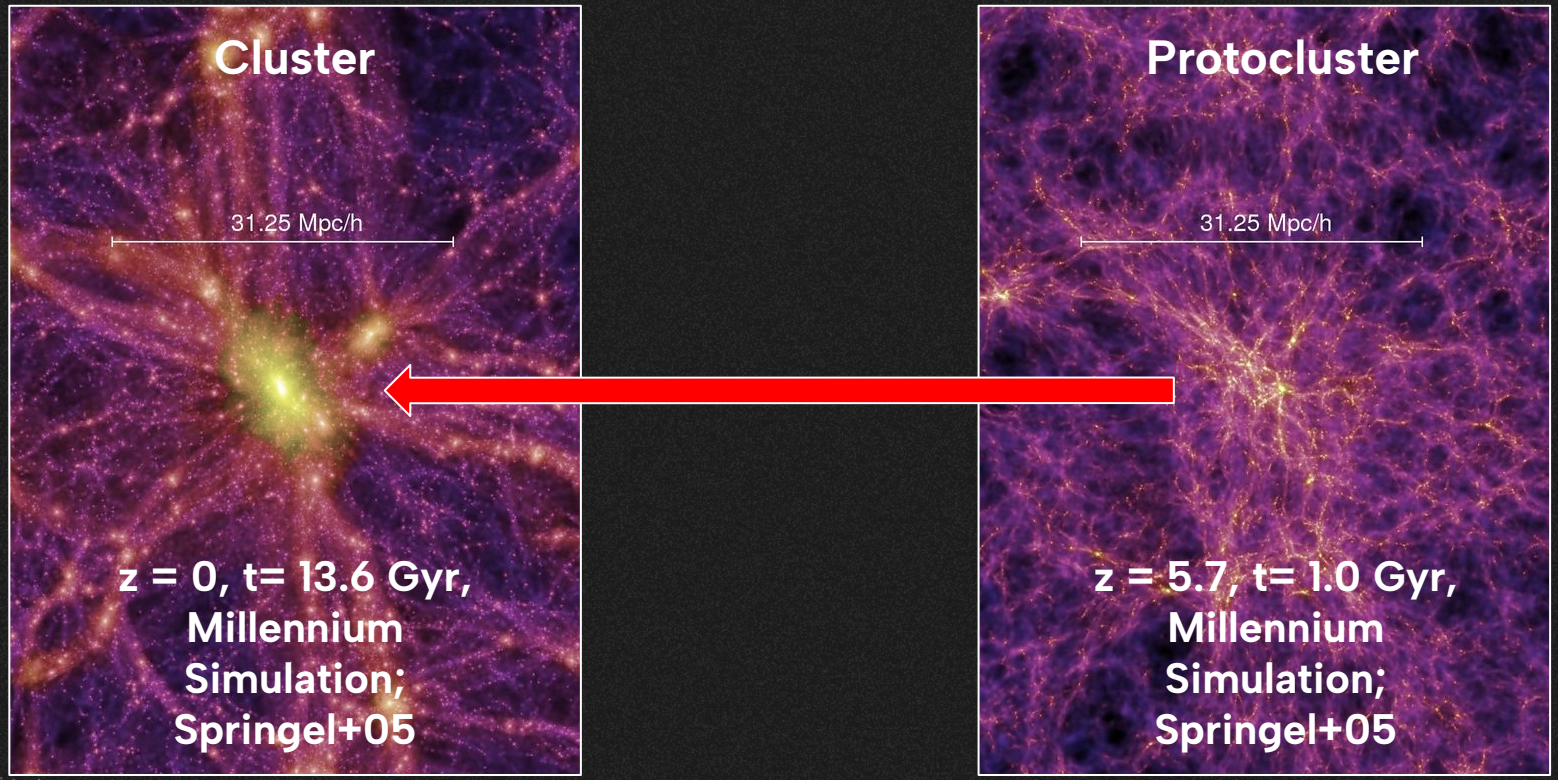

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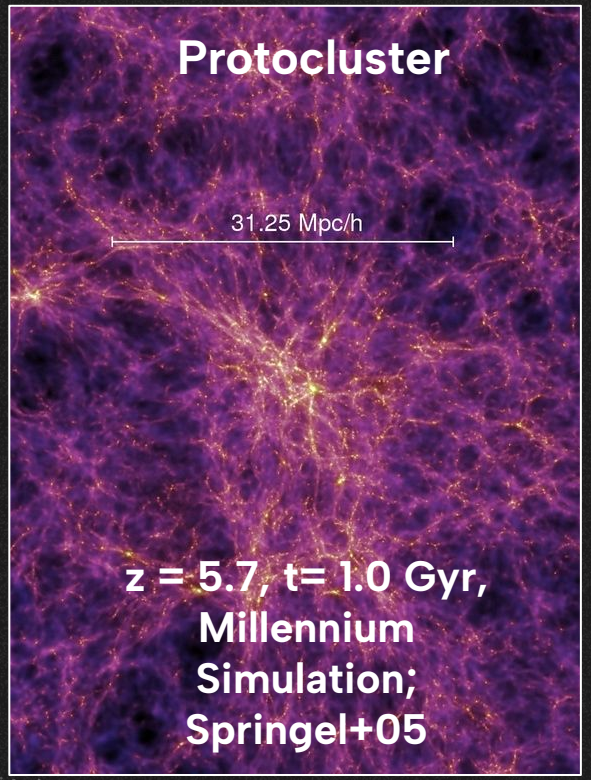
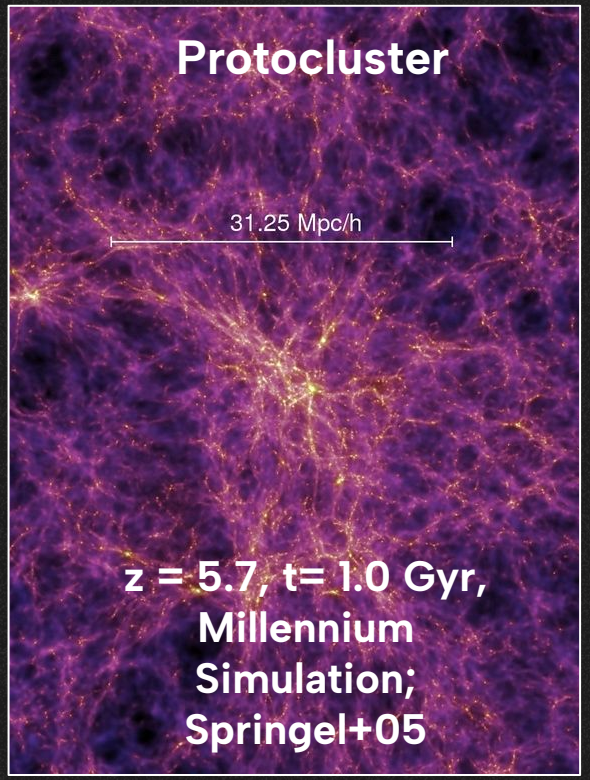
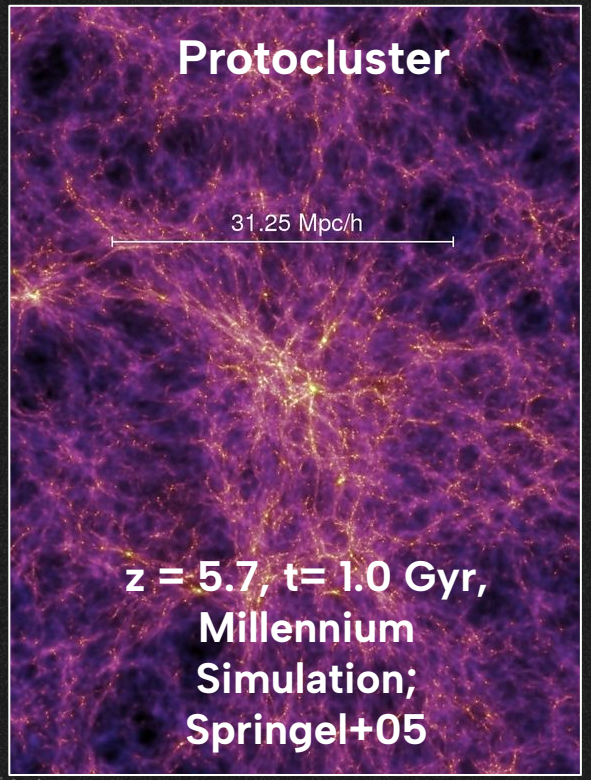
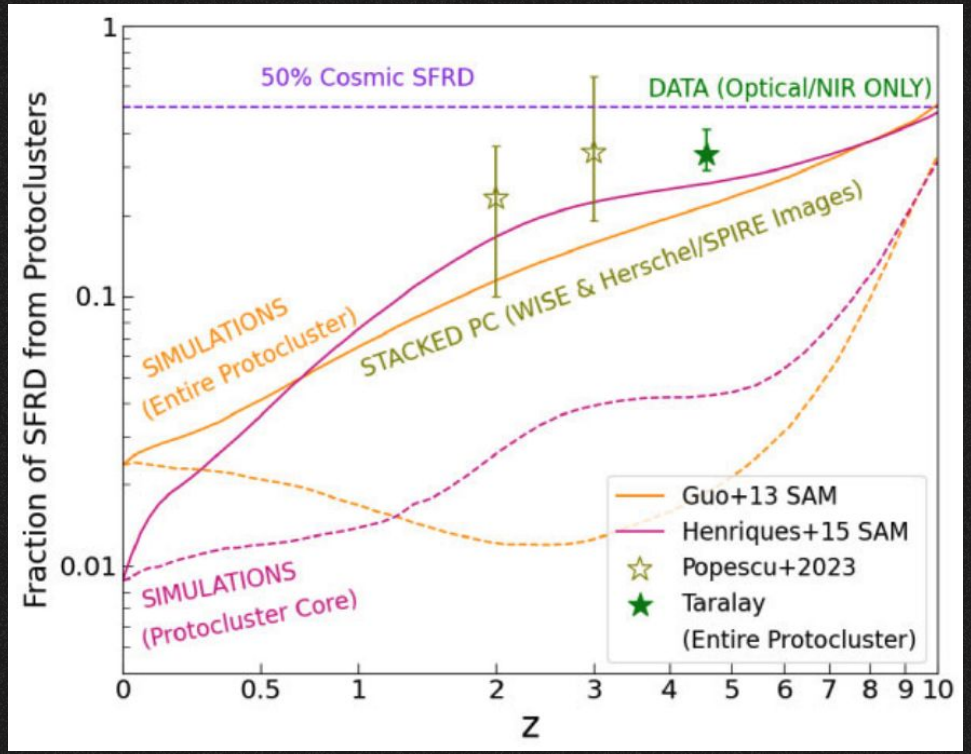




Why protoclusters?

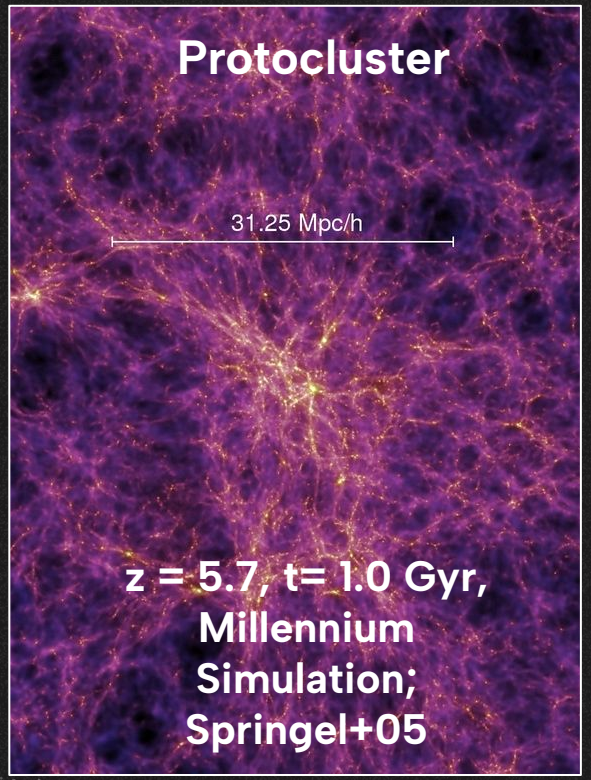
Increased SF!



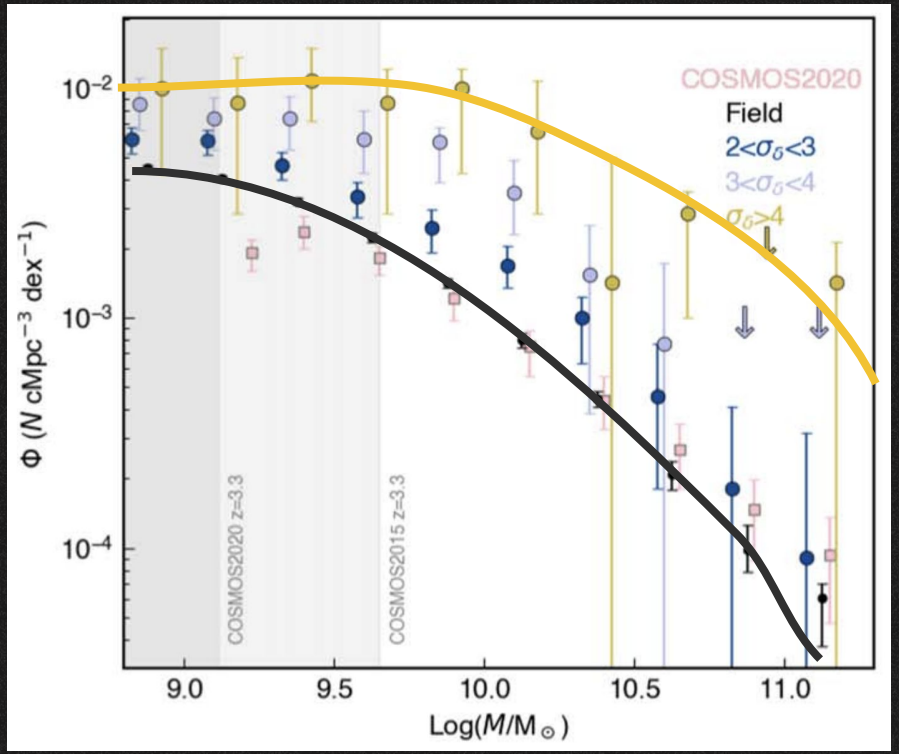


Staab+24

Why protoclusters?

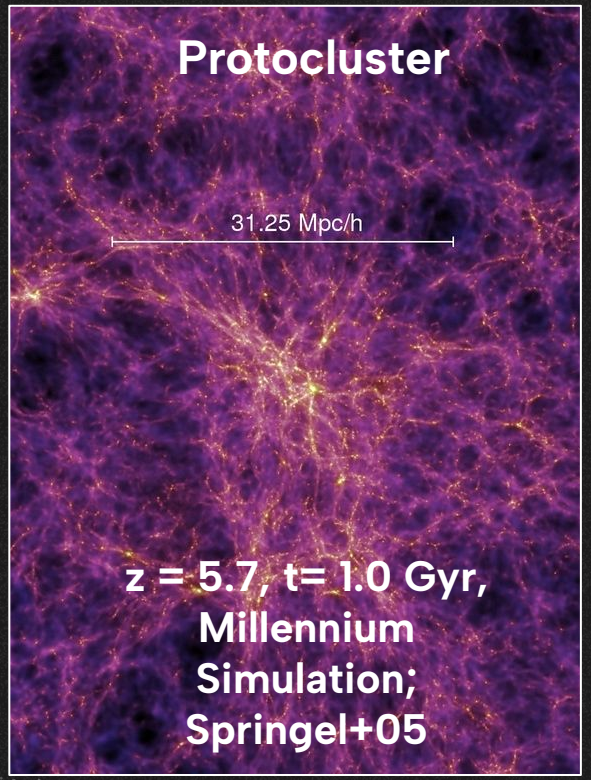


Elevated stellar mass!

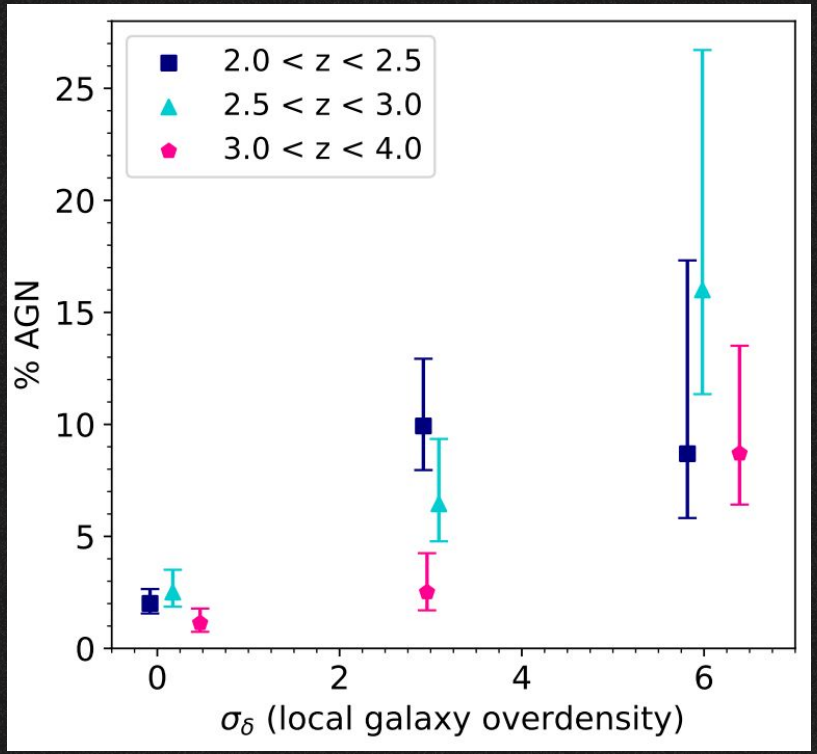


Forrest+24

Why protoclusters?

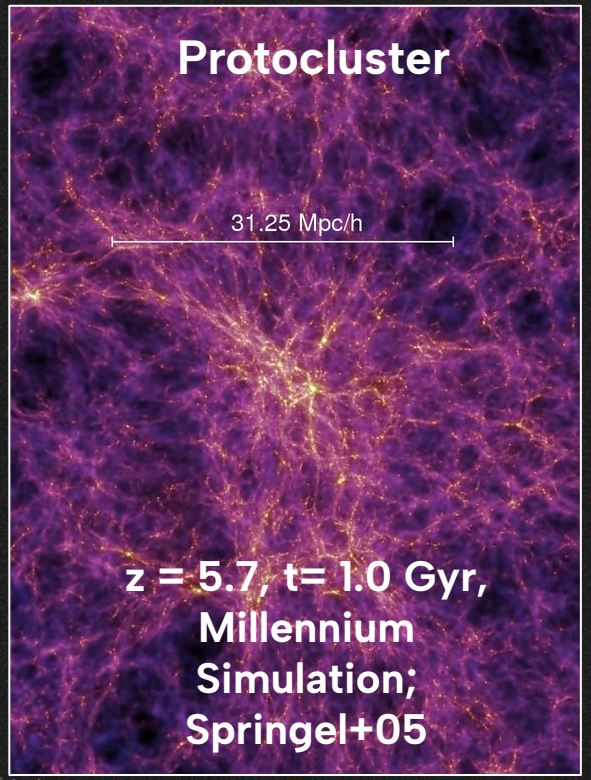


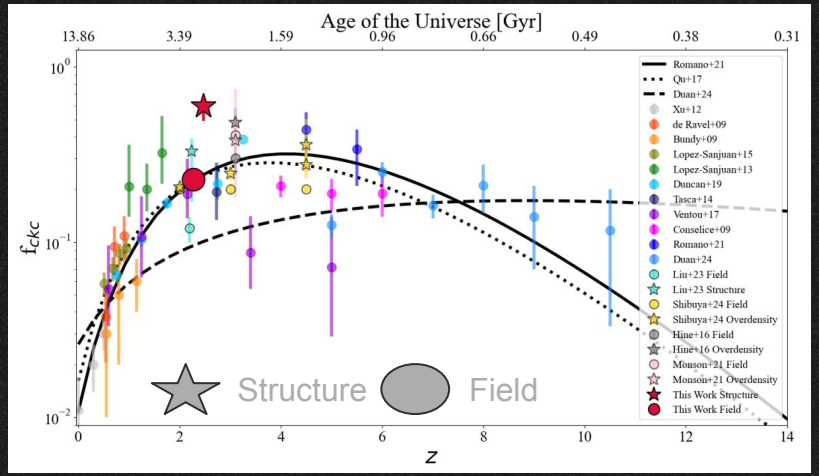
More AGN!



Shah+25

Why protoclusters?

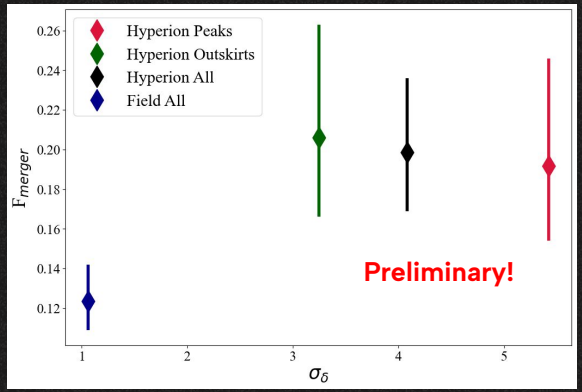




Giddings+26

Giddings+In Prep.

Evidence of increased future merger rates (above) and ongoing (right) mergers!



How do we characterize protoclusters and study their member galaxies?

Large numbers of accurate spectroscopic redshifts (spec-zs)!

Why we use PFS!

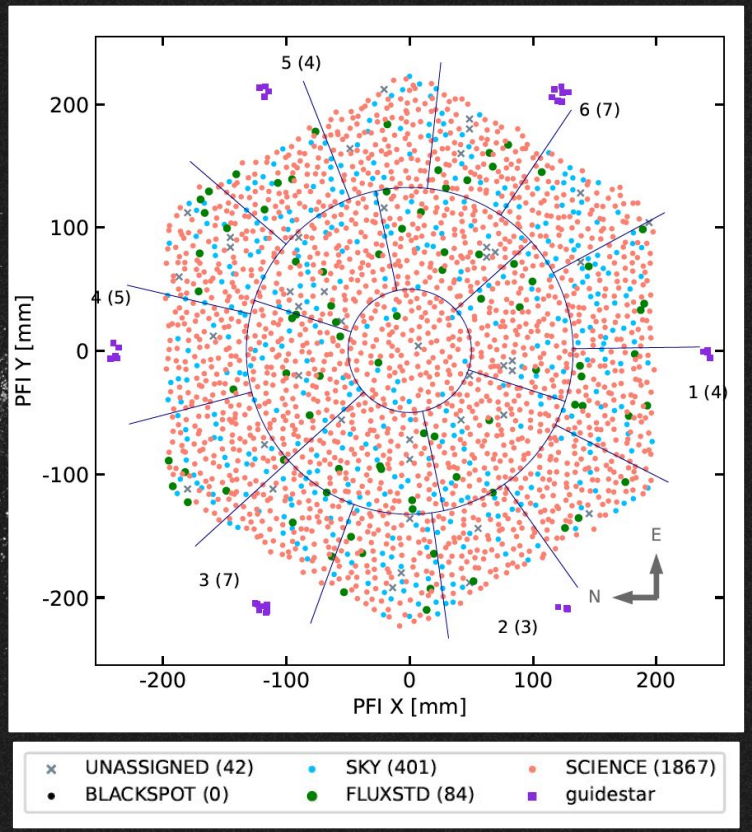
Better d… maps!

What galaxies … dense structure (or not)?

…ed merger …cation!

…s actually in close proximity vs projection effects?

Fiber Design #2
COSMOS 25B



Charting Cluster Construction with VUDS and ORELSE (C3VO) Observations

Large (≳15,000) galaxy spec-z survey! ($2 < z < 5$)

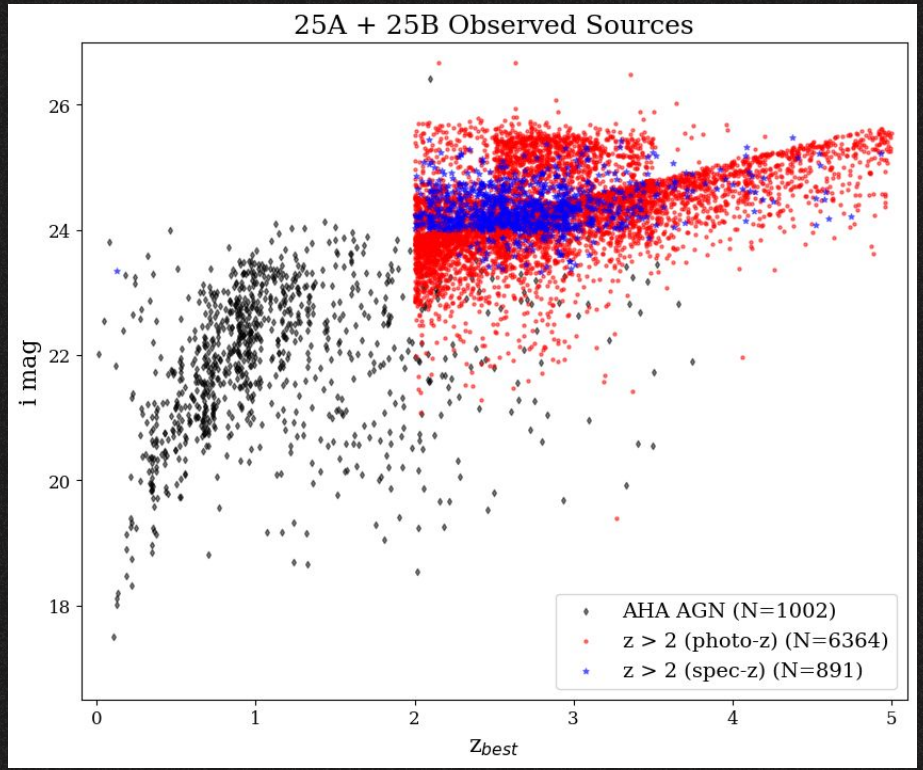
Observation Details I

Fields: COSMOS & CFHTLS-D1 (XMM-LSS)

Select sources based on:
- i band magnitude ($i \lesssim 25.5$)
- Spitzer/IRAC detected
- photo-z ($2 \lesssim z \lesssim 5$)
- zPDF "well constrained"

Up weight sources that are potentially:
- galaxy pairs
- Belong to large scale structure
- AGN (high-z; $z > 2$)
- Brighter (dependant on redshift)

Include some sources with secure spec-z for validation
Fillers for COSMOS are low-z AGN from AHA



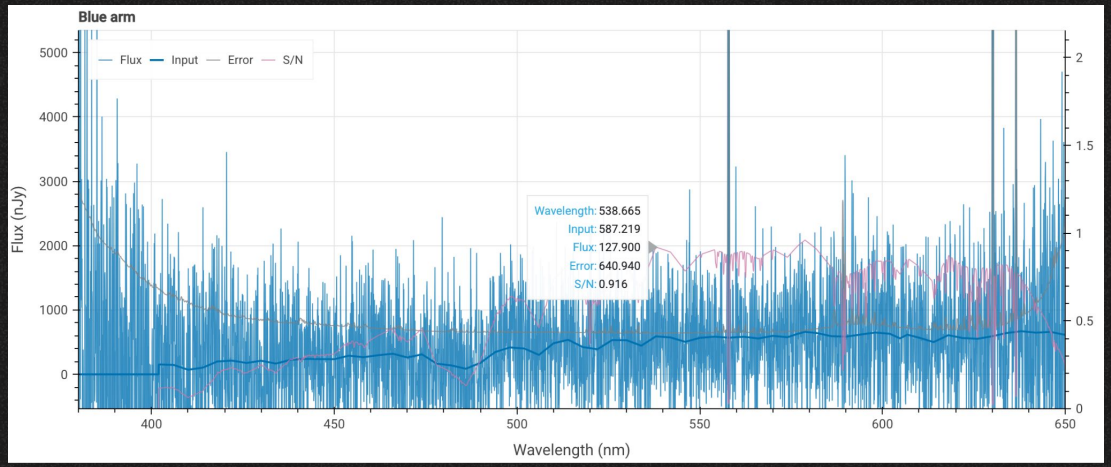
Observation Details II

For z > 2 with PFS → redshifts measured primarily in blue arm (observed) → rest frame UV

- Lyman alpha, Lyman break, ISM absorption, etc.
- **Goal is to reach SNR ≳ 1 in the blue arm !**

Required exp times tiered on mag (roughly):

- i < 23.5 → ~4 hr t_exp
- 23.5 < i < 24 → ~8 hr t_exp
- 24 < i < 24.5 → ~12 hr t_exp
- 24.5 < i → ~16 hr t_exp
  - If possible!



PFS Spectral Simulator (left) params:

- i ~ 24.25 at z = 3
- 12 hr t_exp

Observation Details III

25A

1.5 nights

- ~1,800 z > 2 and ~600 AGN
- ~4 – 9.25 hr t_exp

25B

3 nights

- ~5,500 z > 2 and ~350 AGN
- ~3 to 15 hr t_exp

26A

2 nights

- All nights lost to Kona low storm :(

26B

1.5 nights

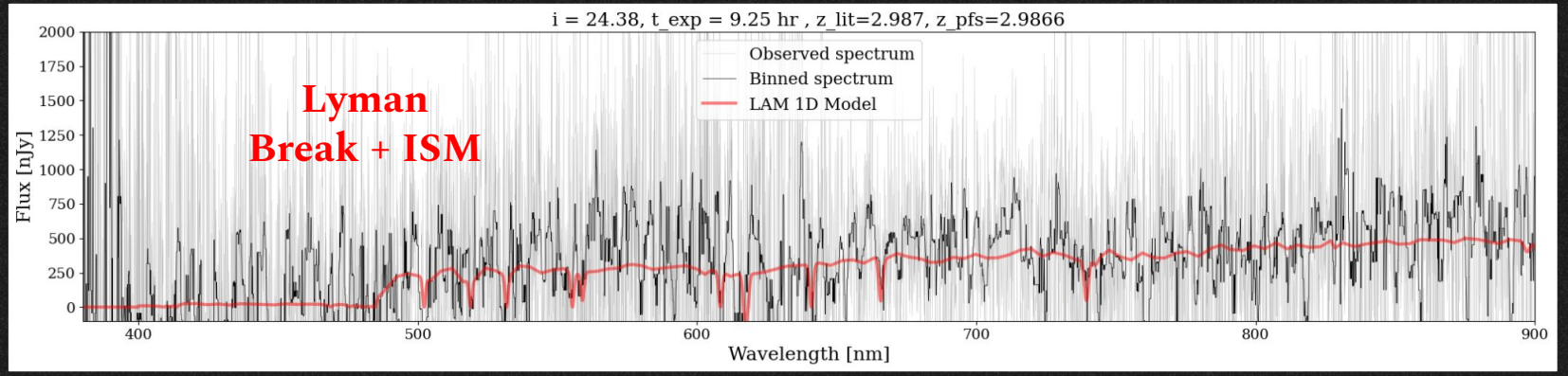
- ~3,500 sources expected
- Nights upcoming (Nov)

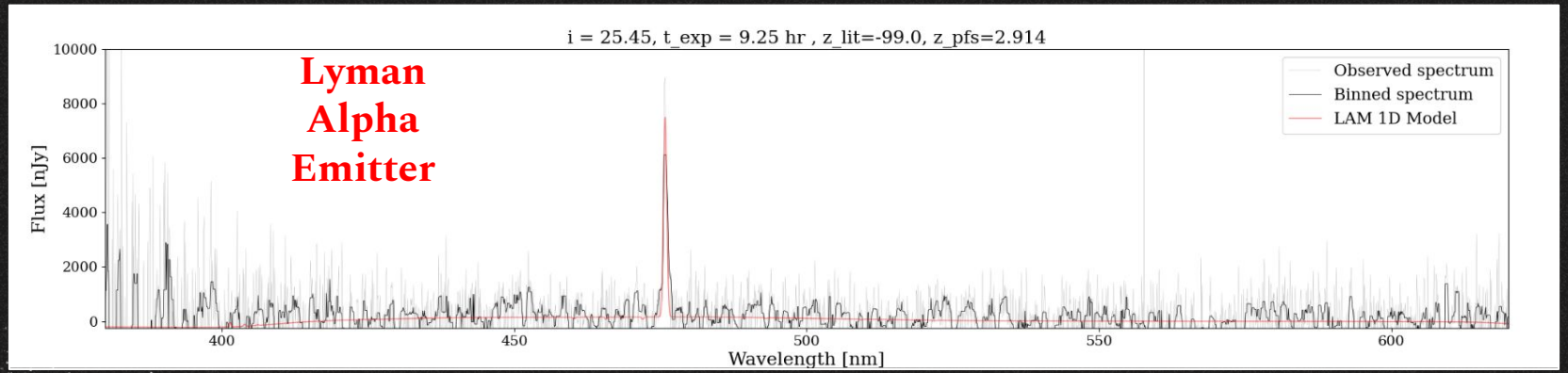
More Future

TBD

- Likely 4-6 more nights over the next 1.5 years!

Observation Details IV





RVSNUpy (Kim+25) z Fitting

PRELIMINARY!

Low SNR → need to verify z fits!

Use RVSNUpy → cross correlation z fitting

Custom templates! (via DEEP2)

Interactive GUI to assess z fits!

Conclusions & Future Work

Current Observations

~8,000 galaxies and AGN observed + more to come!

Redshift Measurement

LAM 1D pipeline less tested at z > 2 + low SNR...
working on our own spec-z measurement with RVSNUpy (Kim+25)

Protocluster Science

Improved density maps!

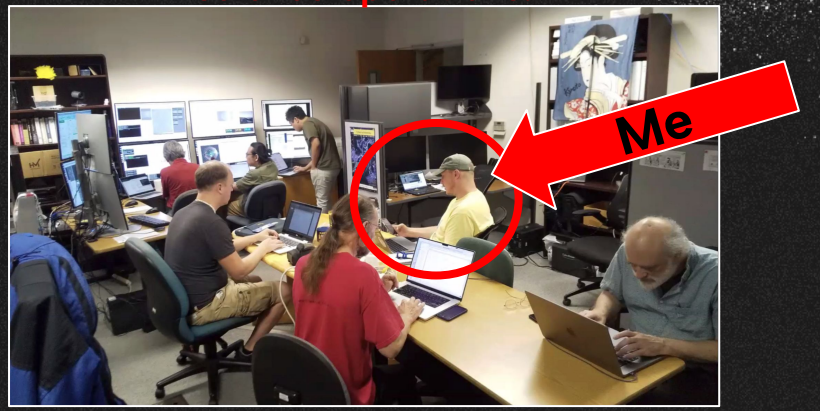
Identification future and current merger activity!

+ more upcoming!

Mahalo!

(especially to the PFS team, the PFS SAs, and the pipeline team + many more!)

Image from 1st night of PFS science operations!



Any questions?