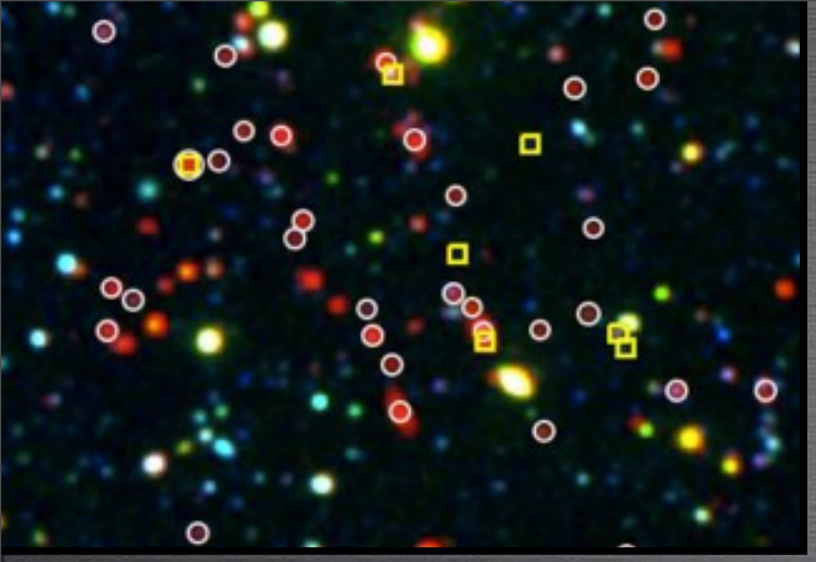
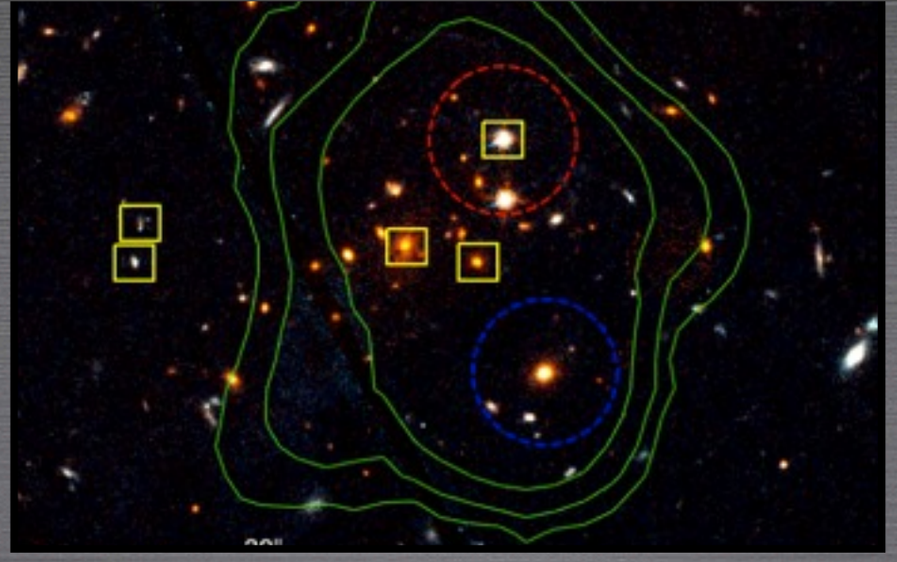
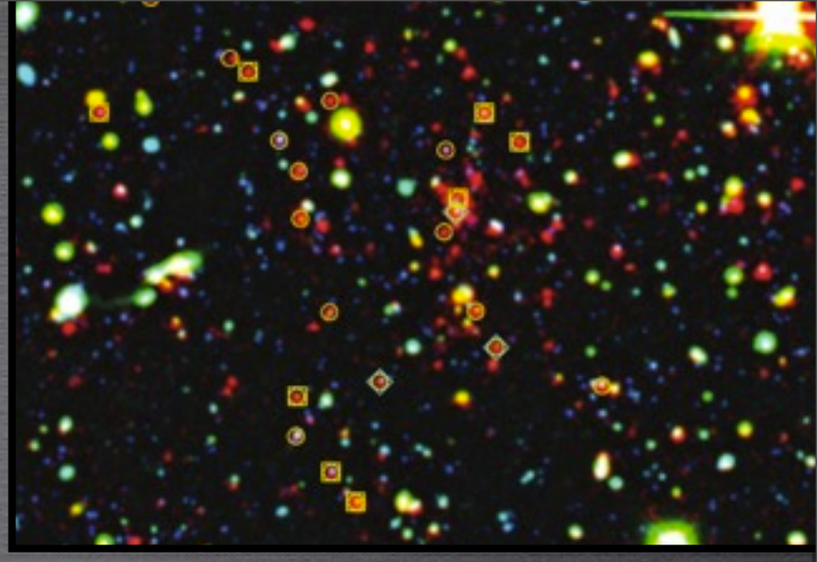


zeimann+12



Stanford+12



Eisenhardt+08

Tracing the Evolution of Star Formation Activity in Galaxy Clusters out to z~2

with Herschel Spire

Stacey Alberts (Umass)

With Collaborators: Alex Pope (Umass), Mark Brodwin (UMKC), Arjun Dey (NOAO) Peter Eisenhardt (JPL), Dan Gettings (Uflorida), Anthony Gonzalez (UFlorida), Buell Jannuzi (NOAO), Conor Mancone (UFlorida), Lexi Moustakas (JPL), Greg Snyder (CFA), Adam Stanford (UCDavis), Dan Stern (JPL), Greg Zeimann (UCDavis)

OVERVIEW

Question: How does dust-obscured star formation in cluster environments compare to field galaxies from z=0.2-2?

Method: SPIRE stacking analysis of galaxies in over 300 clusters in 9 sq. deg. field to obtain $\langle L_{IR} \rangle$ --> $\langle SFRs \rangle$

Answer! Cluster galaxies show a rapid rise in SF activity from z=0.2-2 within the virial radius of clusters compared to the field which is driven by (roughly) Mass <~ 3×10^{10} M_{sun} galaxies!

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Cluster Sample

IRAC Shallow Cluster Survey (ISCS; Eisenhardt+08)

- Bootes field (~9 sq. deg)
- photometric redshift overdensities
- over 300 clusters, 100 at z>1 (20 spec-z confirmed) from z=0-2
- average cluster mass ~10^{14} M_{sun}
- ~10% false detection rate

Thousands of spec-z and photo-z cluster members + many, many field galaxies with redshifts and mass estimates

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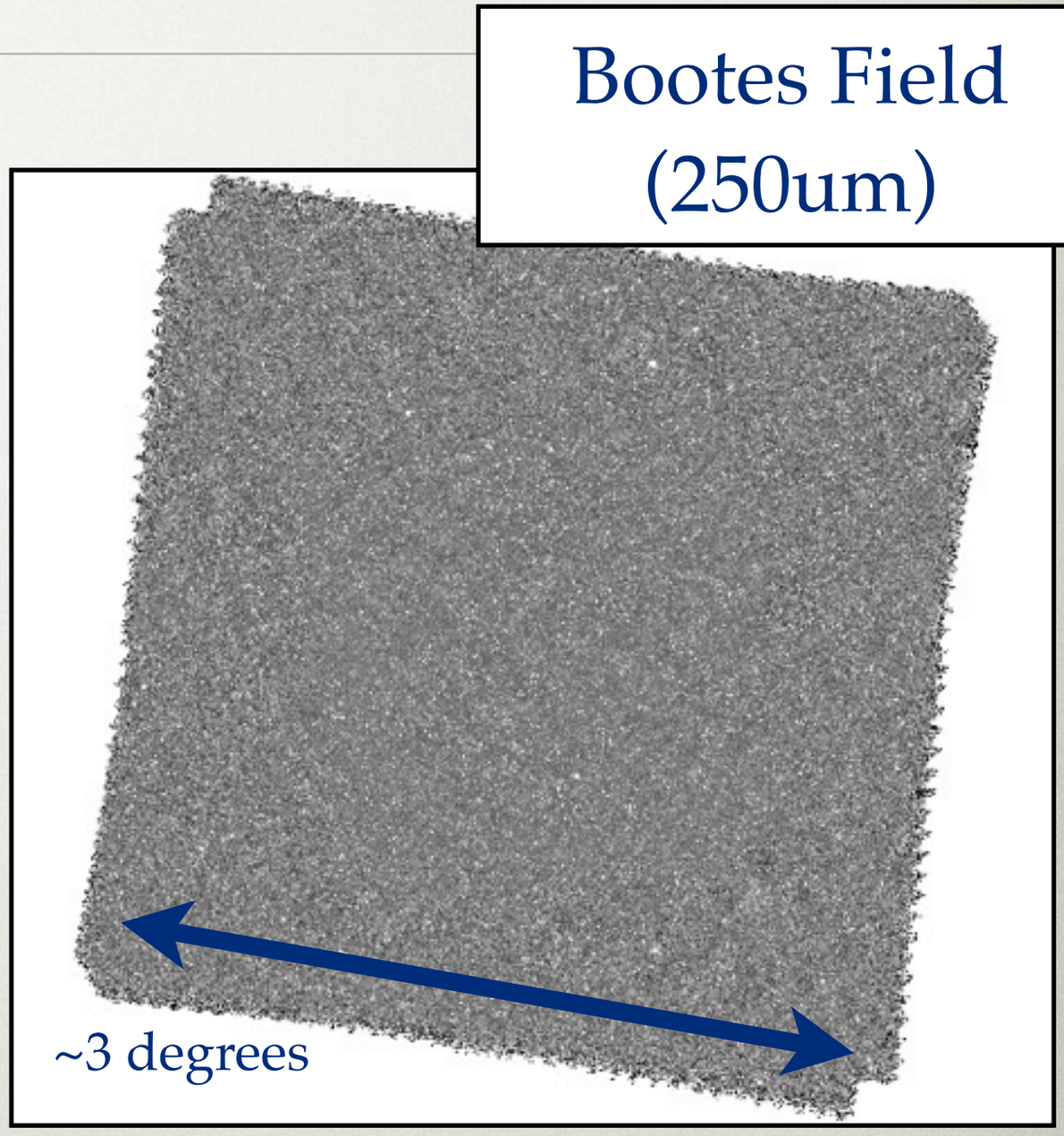
Herschel Spire Data

- Publicly available from HerMES (Oliver+12), reduced and mosaicked for this work
- 250um, 350um, and 500um
- 15-25 mJy (5σ) depth
- blending and confusion at longer wavelengths



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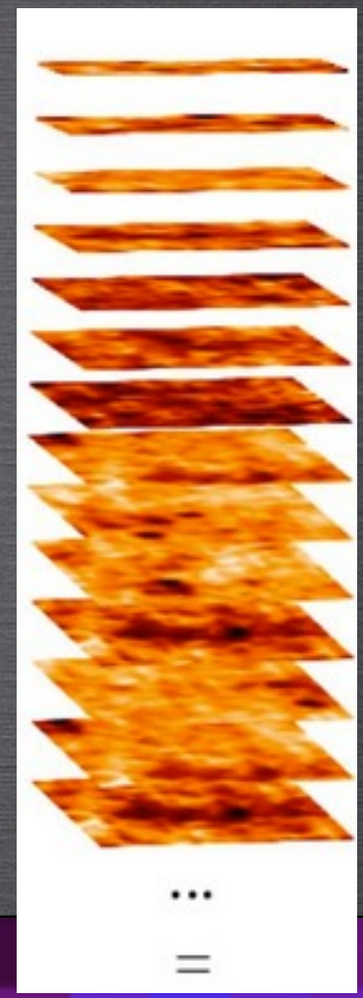
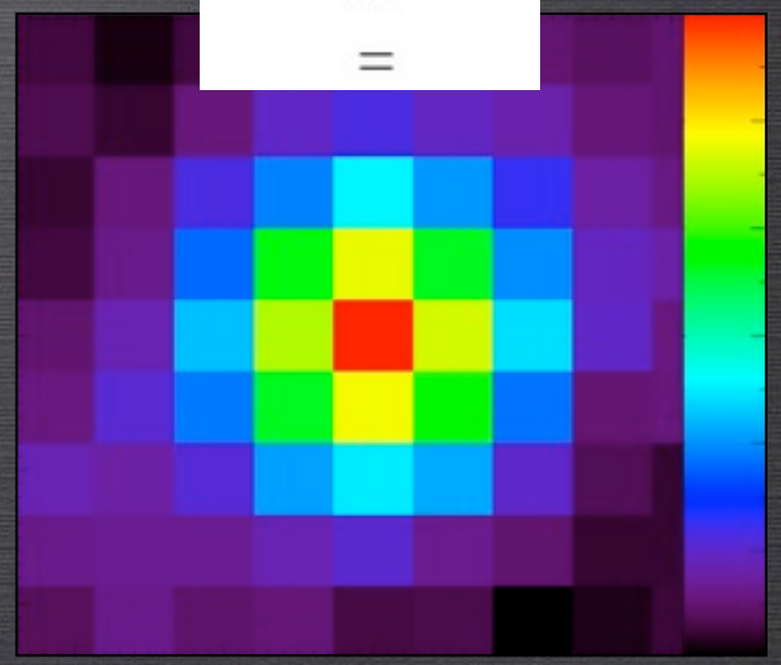
Method: stacking

- <10% with tentative detections
- Variance-weighted mean
  - SPIRE maps in Jy/beam with zero mean
- Bootstrap resampling errors
- Obtain average 250um flux -> L_{IR} via empirical template (Kirkpatrick et al., submitted)
- SFR derived linearly from L_{IR}



Credit: H. Dole/IAS/ Arizona/ NASA/JPL-Caltech



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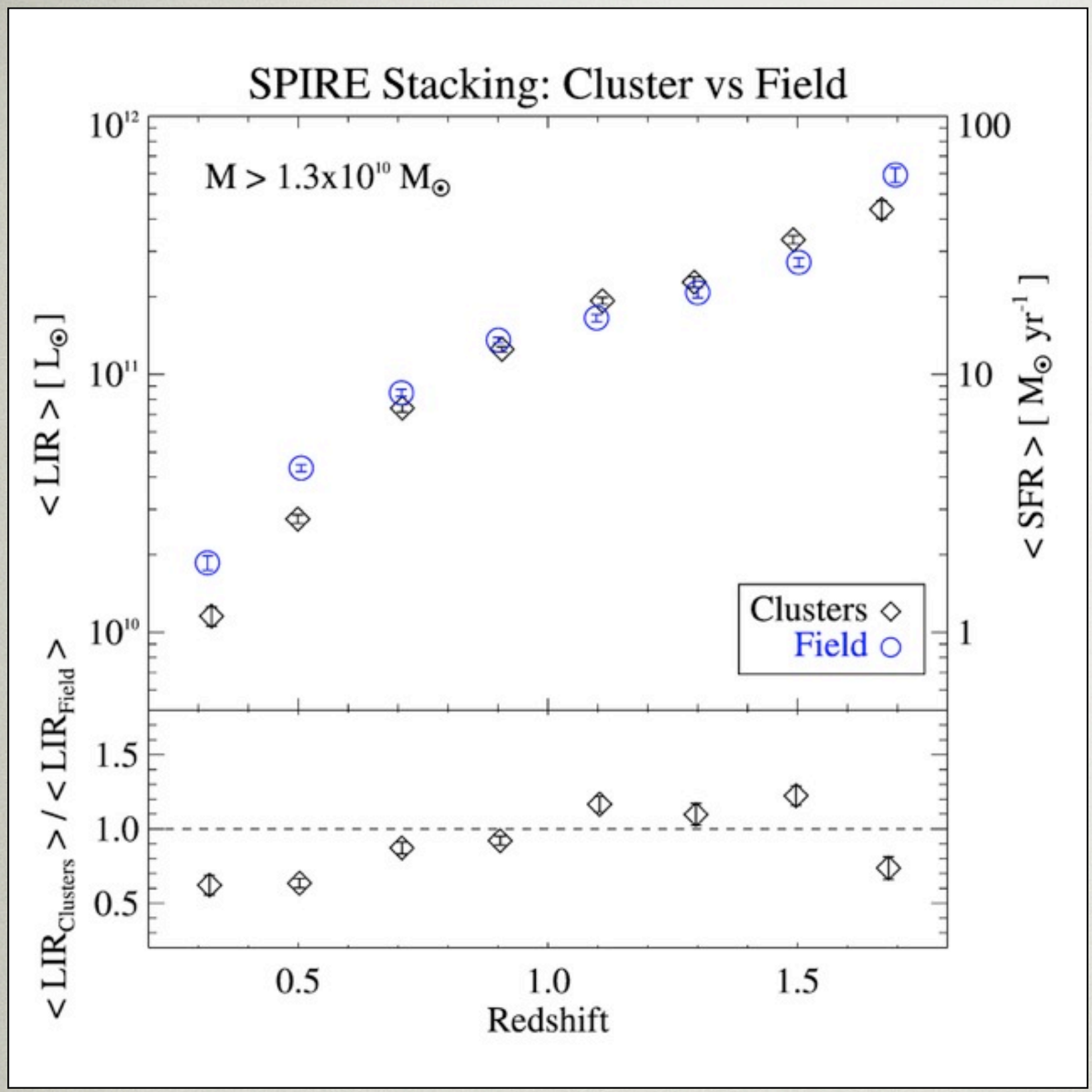

RESULTS

-- Thousands of cluster members per bin

-- Stellar Mass Limited

-- Cluster members within 2Mpc (~2x virial radius)

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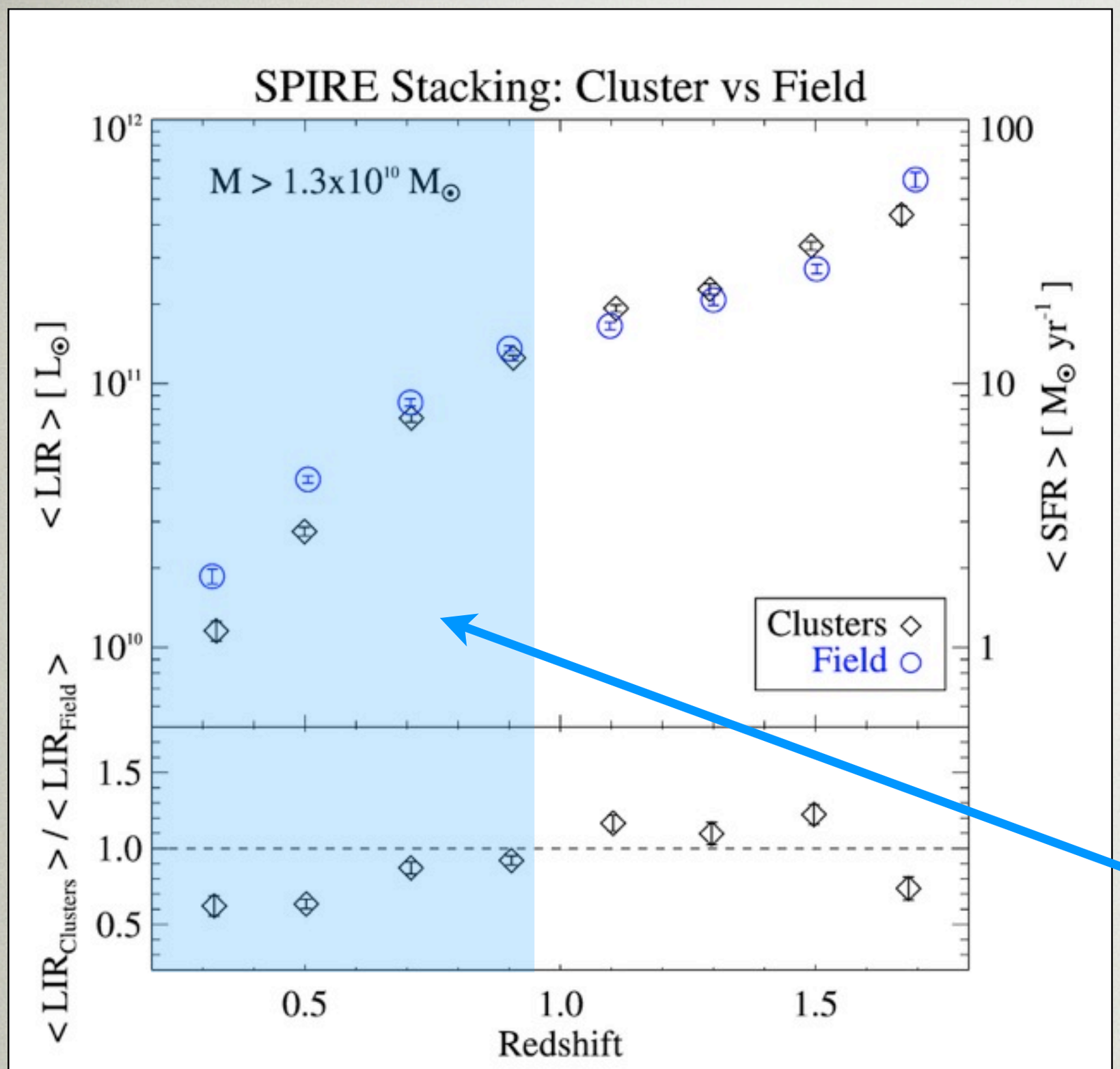
RESULTS



Star formation activity suppressed relative to the field

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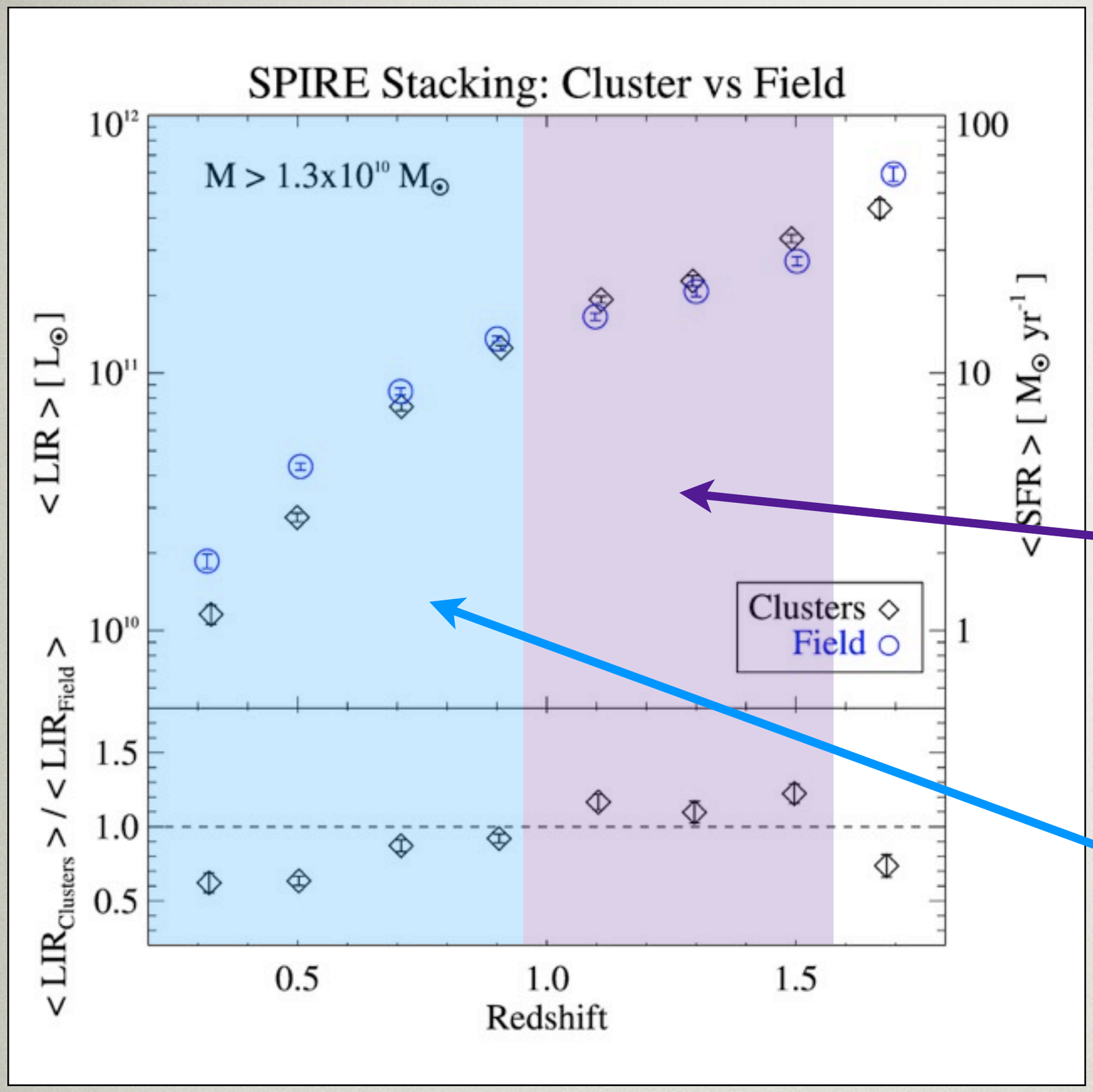
RESULTS



Star formation activity even with or enhanced relative to the field

Star formation activity suppressed relative to the field

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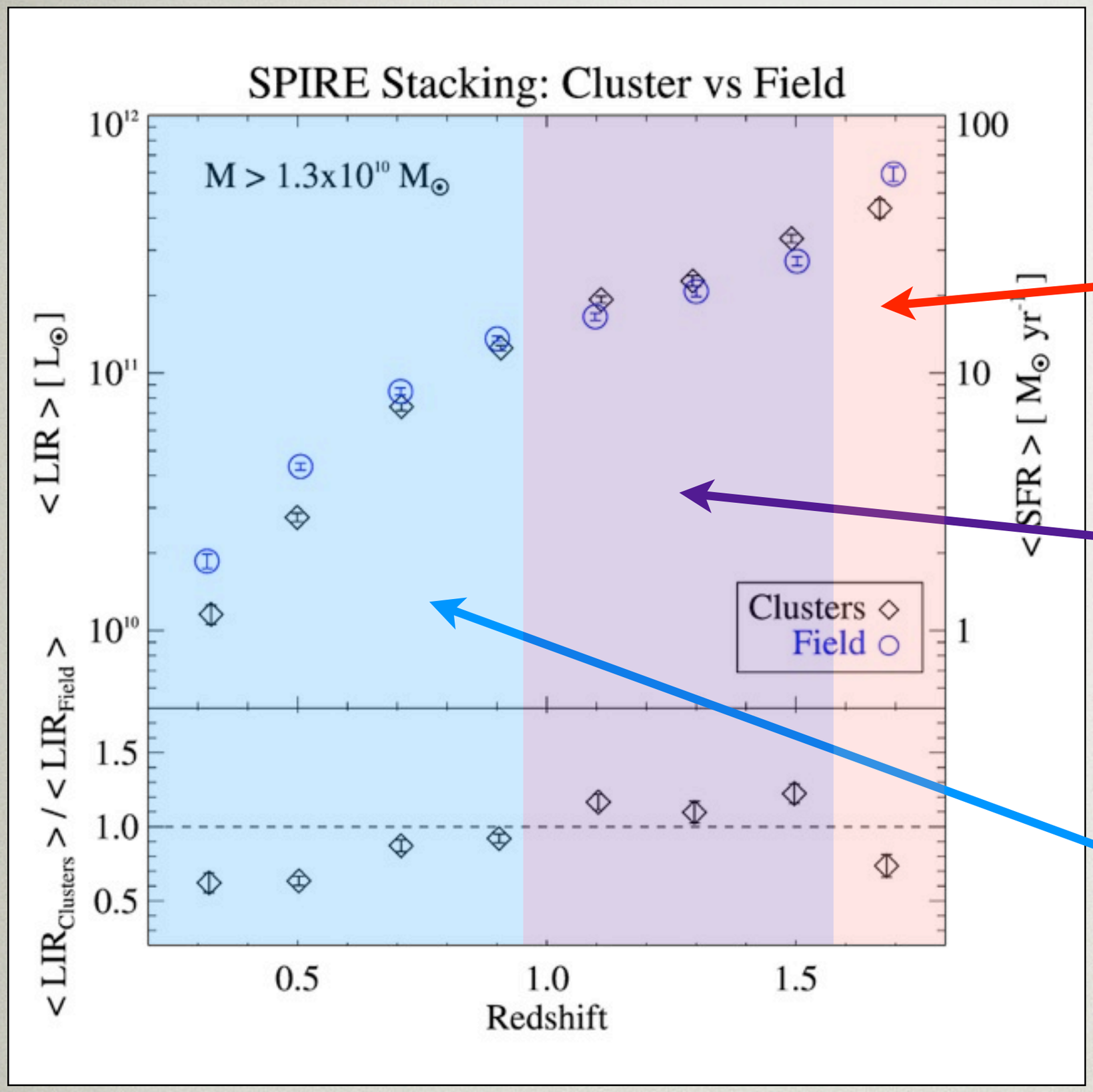
RESULTS



Uncertain photozs? Better data on the way!

Star formation activity even with or enhanced relative to the field

Star formation activity suppressed relative to the field

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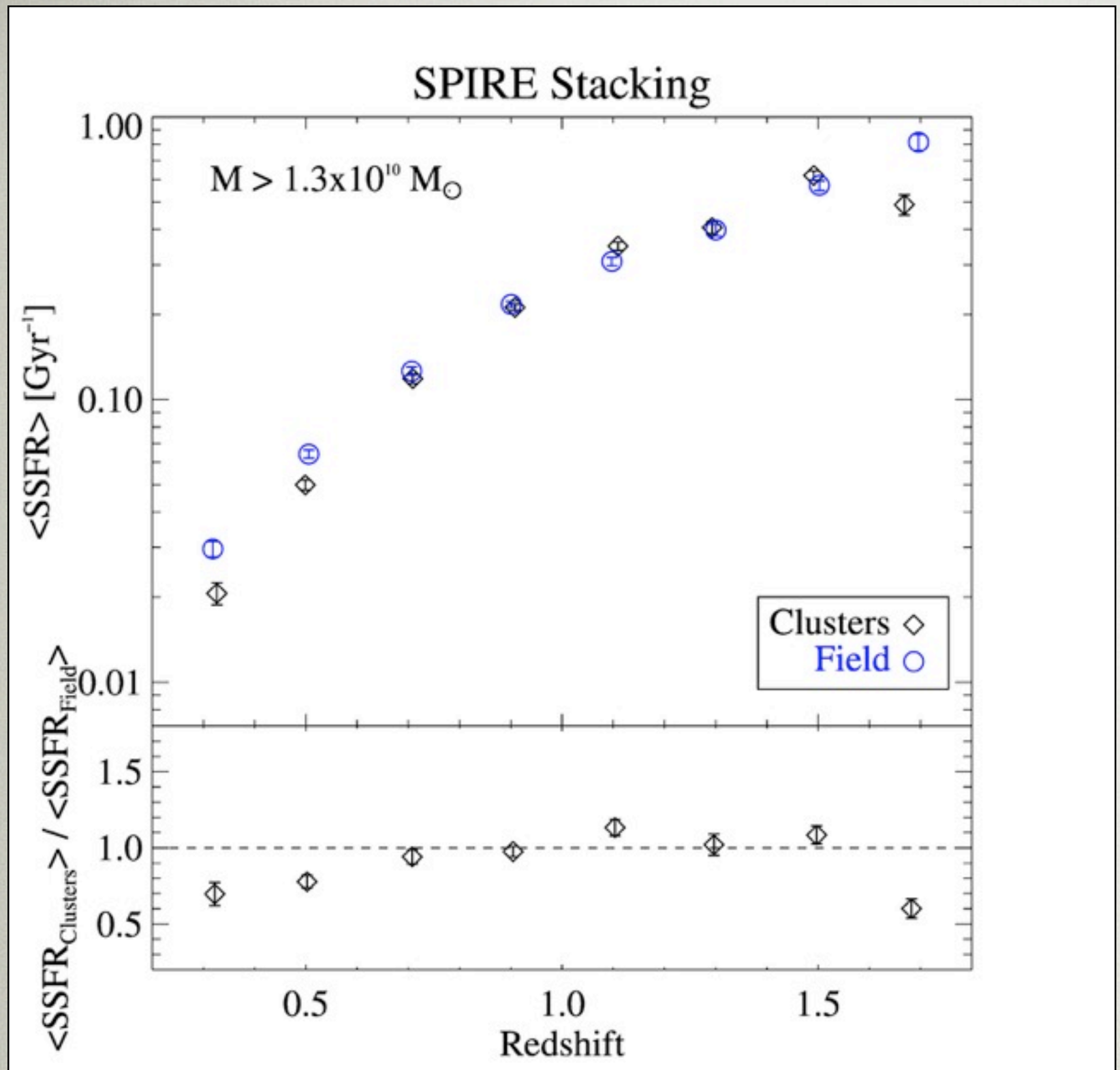

RESULTS

Specific Star Formation Rate

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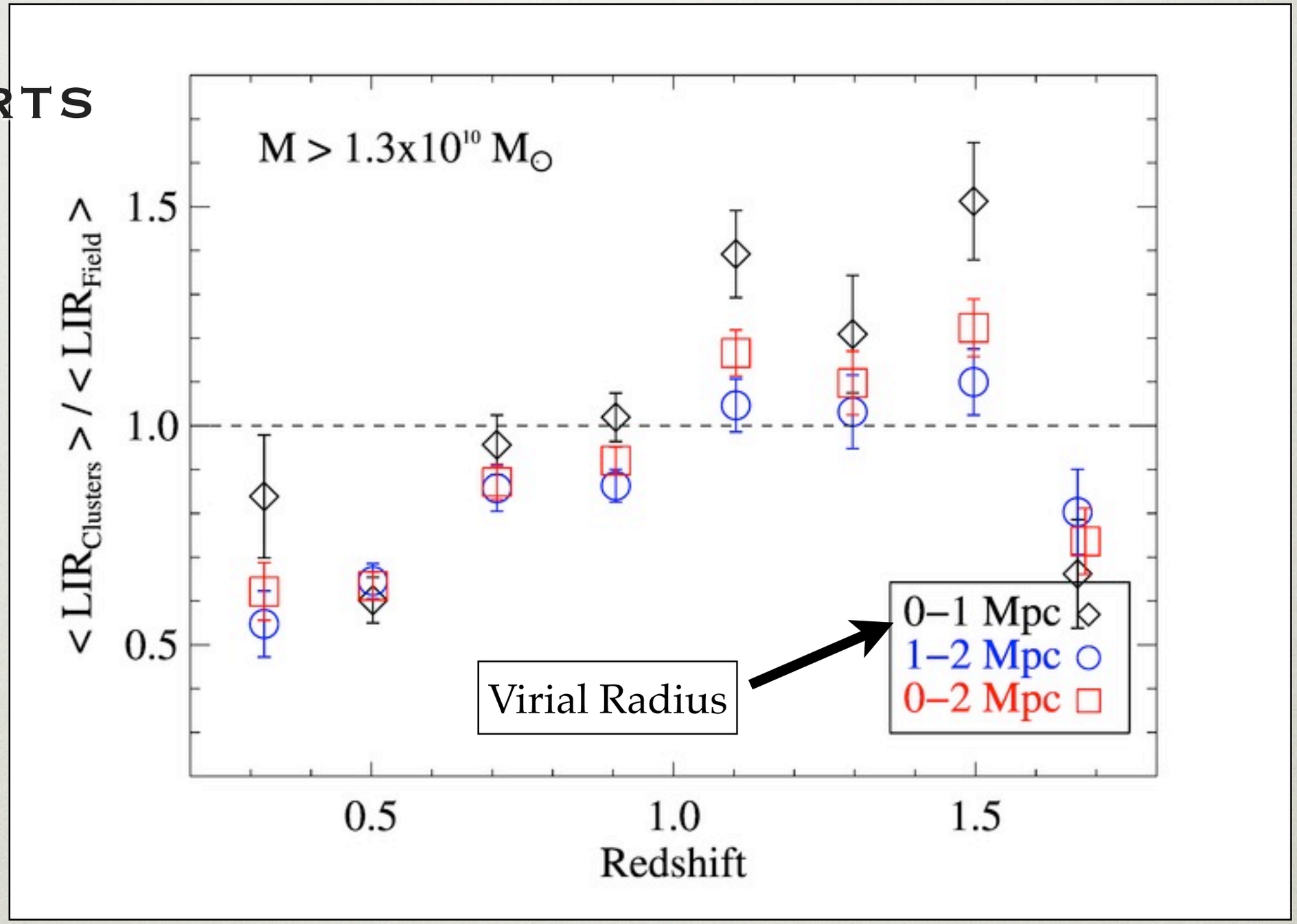
Results: Inner Region versus Outskirts



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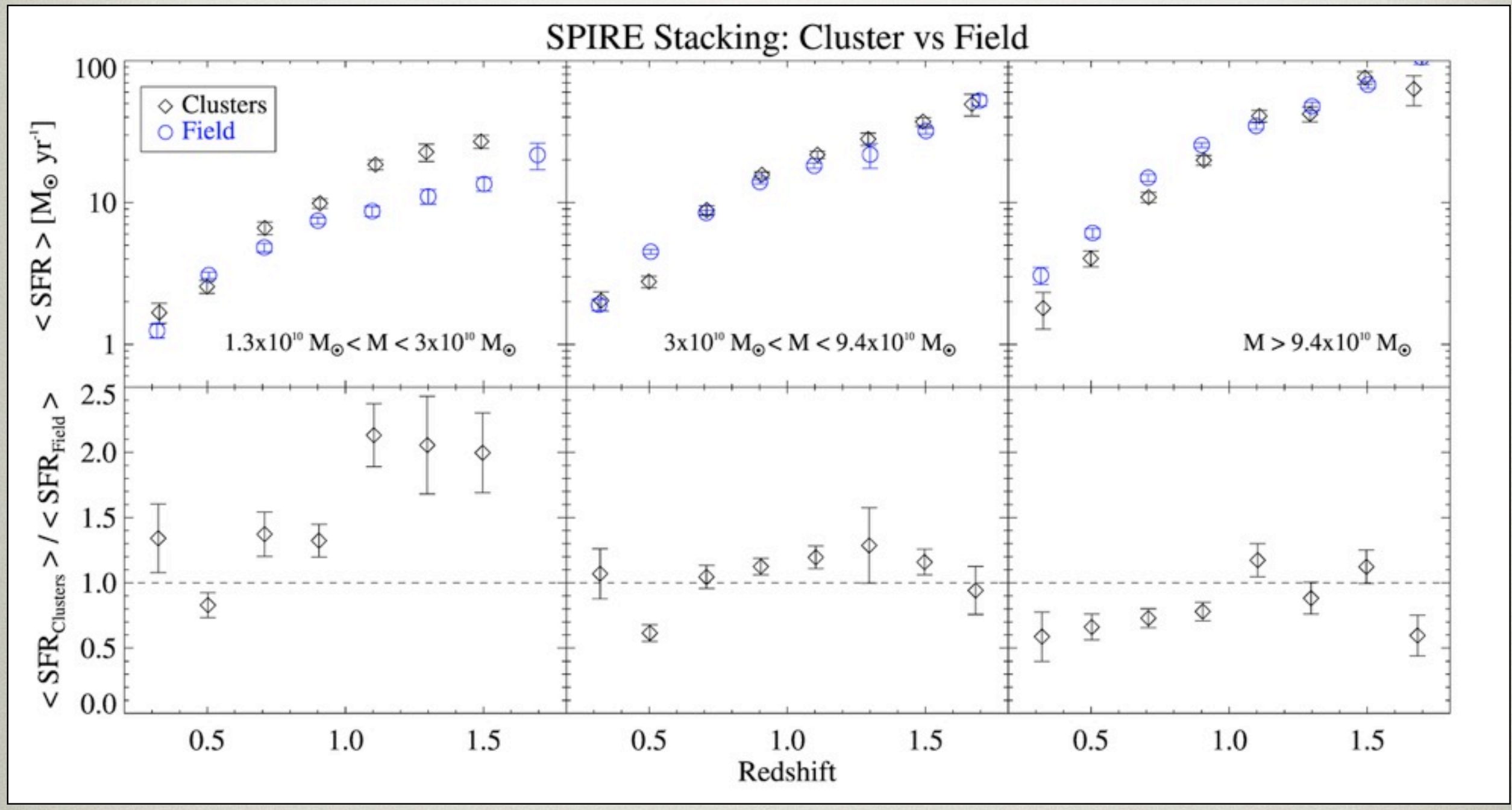
Results: As a function of mass (Within Virial Radius)



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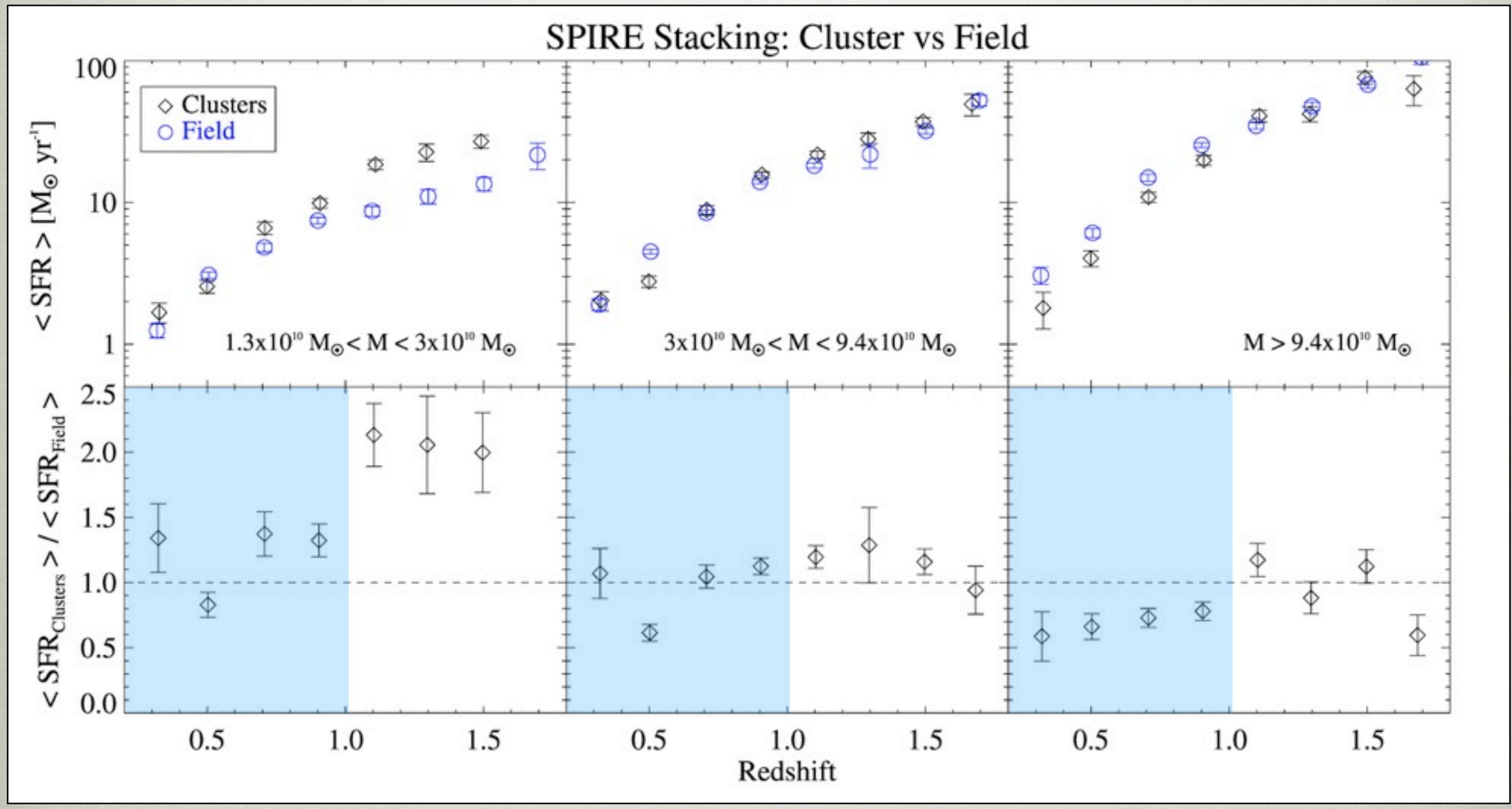

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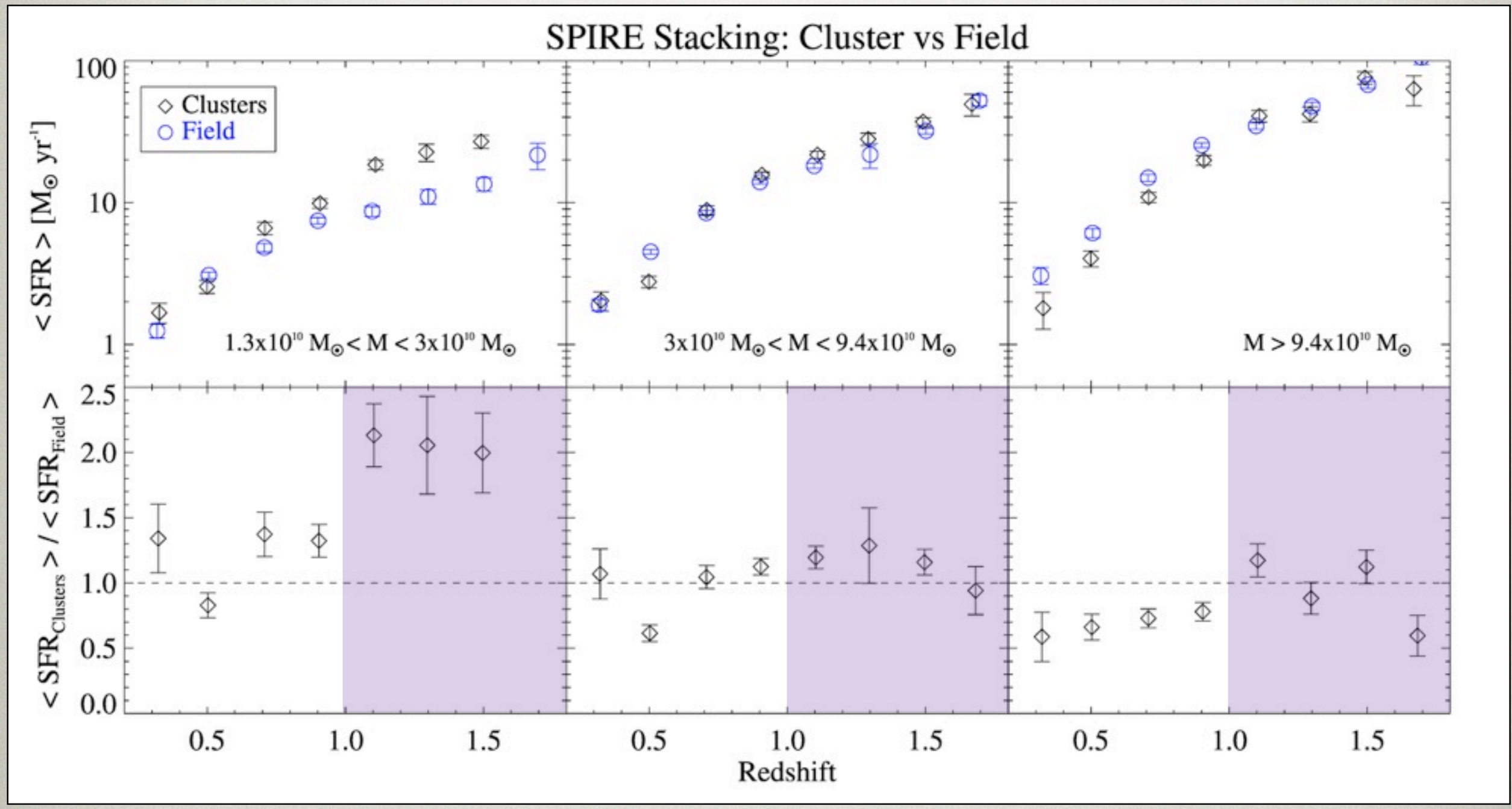

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Summary and Future Work

- **250um Stacking Analysis Summary:**
  - a rapid rise in star formation activity in clusters from z=0-->2
  - SF activity occurring within the virial radius at high redshift
  - the SF activity is being driven by <~1-3x10^{10} M_{sun} galaxies
- **Future Work:**
  - **Stacking**: 70, 350, 500um; SSFRs as a function of clustercentric radius, wedge AGN, and red sequence galaxies
  - **PACS:** deep observations of 11 clusters from z=1-2
  - **SCUBA-2:** IDCS J1426.5+3508 (Stanford+12, **see Anthony Gonzalez's talk tomorrow!**) at z=1.75

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