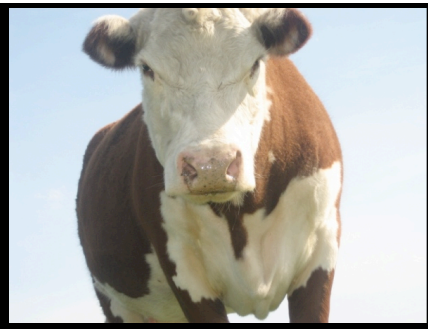


A WISE View of Galaxy Clusters

Anthony Gonzalez

at low redshift

Sun Mi Chung
Peter Eisenhardt
Adam Stanford
Mark Brodwin
Daniel Stern
Thomas Jarrett

at high redshift

Daniel Gettings
Adam Stanford
Mark Brodwin
Peter Eisenhardt
Conor Mancone
Cosimo Fedeli
Daniel Stern
Ned Wright
Sean Lake
Alexey Vikhlinin
Casey Papovich
Matt Hilton

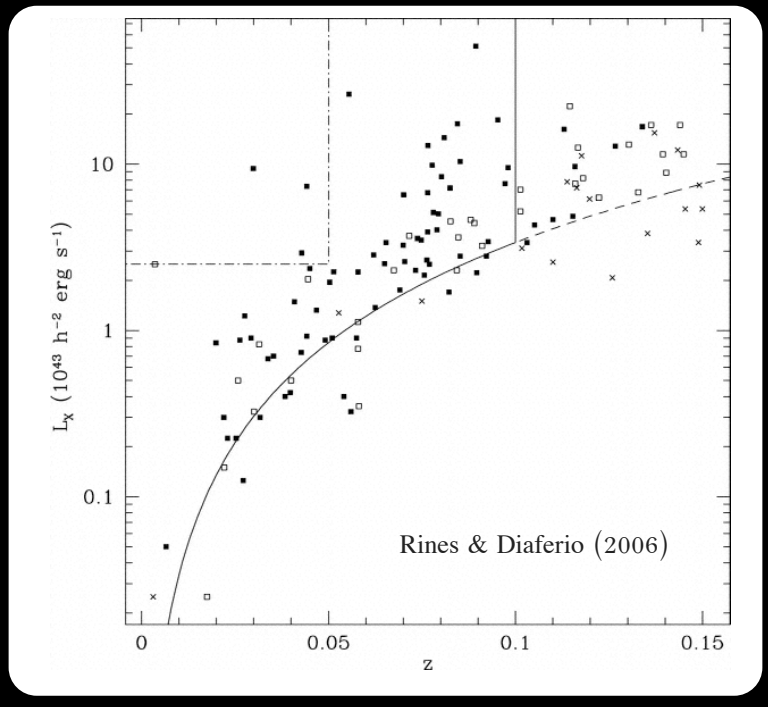
Poster #34

A WISE View of Galaxy Clusters

at low redshift

WISE enables mid-IR view of star formation in local clusters from core to outskirts

- All sky coverage ➞ can construct statistical samples
- 22μm sensitive to $L_{IR}>5x10^{10}$ L_{sun} (demi-LIRGs) @z<0.1
- Unique means to probe mass and radial dependence of star formation



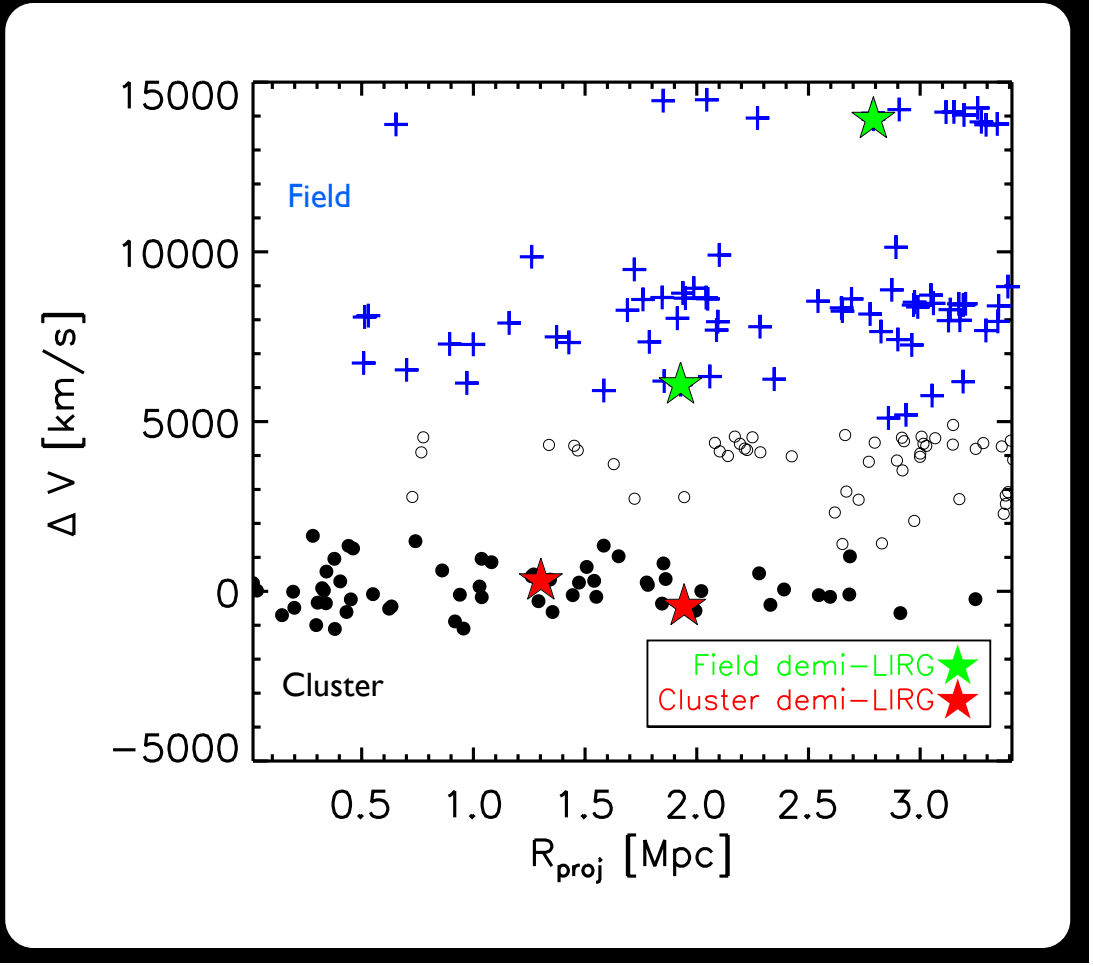
The CIRS Sample

Cluster Infall Regions in the SDSS
72 X-ray selected clusters & groups at z<0.1
Extensive SDSS spectroscopy
Dynamical masses via infall method
Wide mass range ($2x10^{13}<M<8x10^{14}$ $M_\odot$)

A WISE View of Galaxy Clusters

at low redshift

- Membership based on caustic infall pattern out to $3R_{200}$
  - $L_{IR} > 5x10^{10} L_o$
  - SFR > 5 M_o/yr
- M_r<-20.3
- AGN rejection
- Field comparison sample: >5000 km/s from cluster velocity centroid.

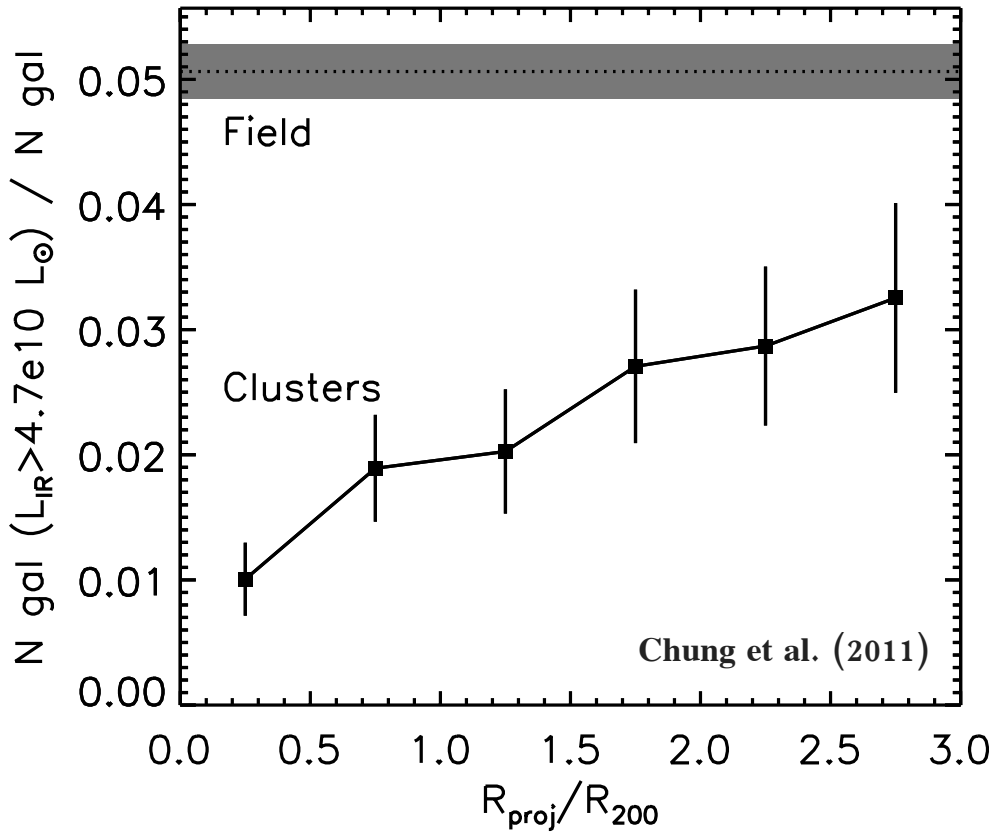


A WISE View of Galaxy Clusters

at low redshift

Radial dependence

- Strong radial dependence
- Systematic offset from field even at $3r_{200}$
- Observed in both star-forming fraction and specific star formation rate

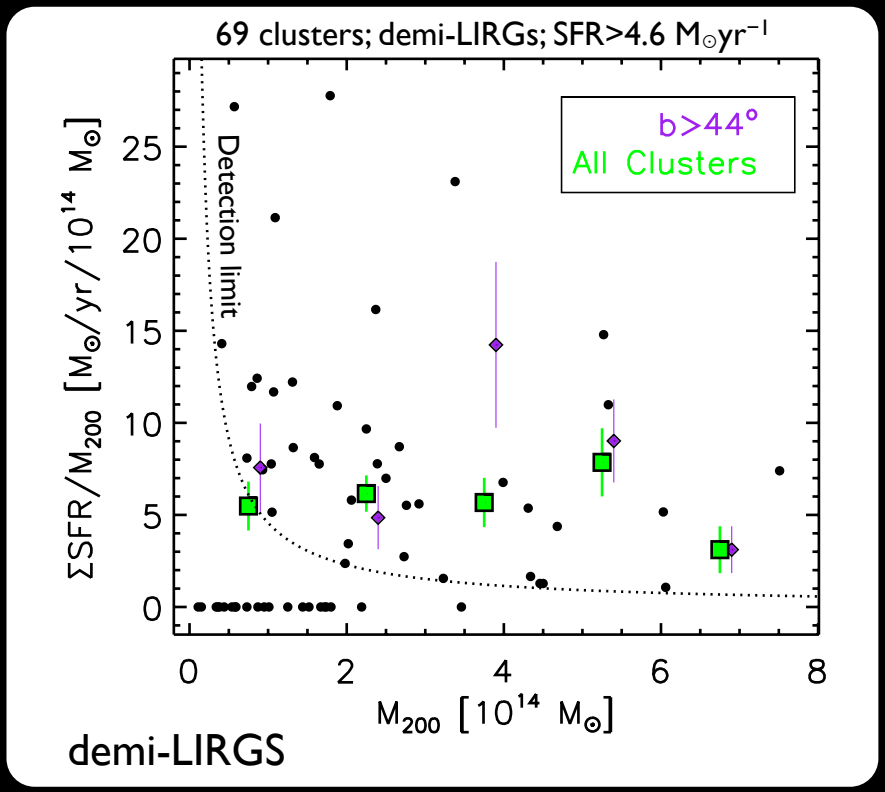


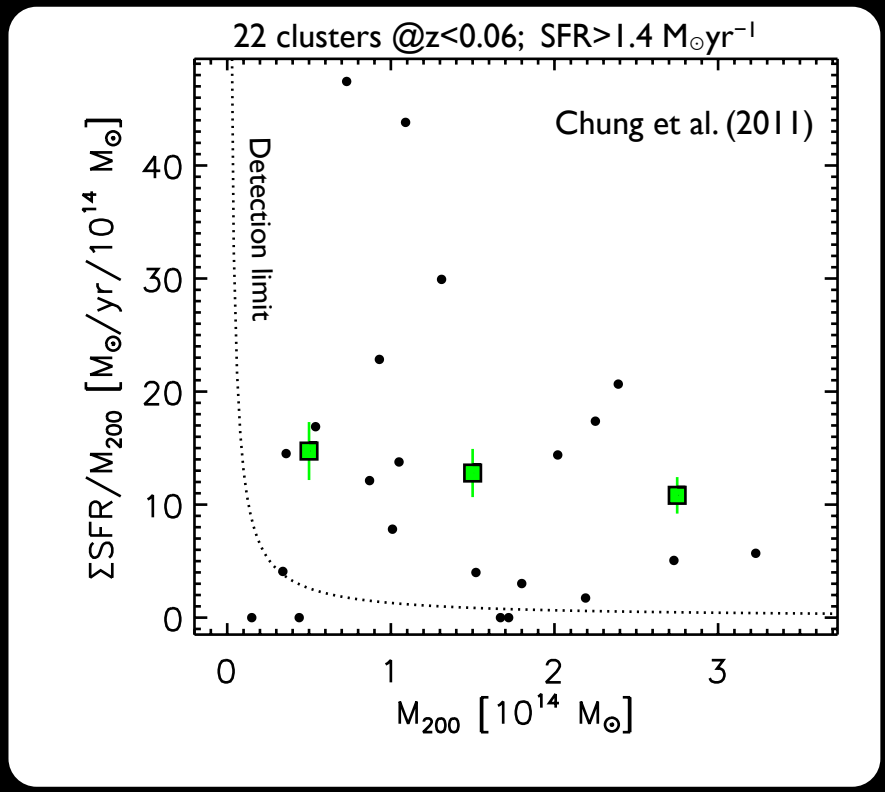
A WISE View of Galaxy Clusters

at low redshift

Global Cluster Specific Star Formation Rate (Σ SFR/ M_{200})

- Large variance
- No strong mass dependence
- Results not strongly dependent on SFR threshold



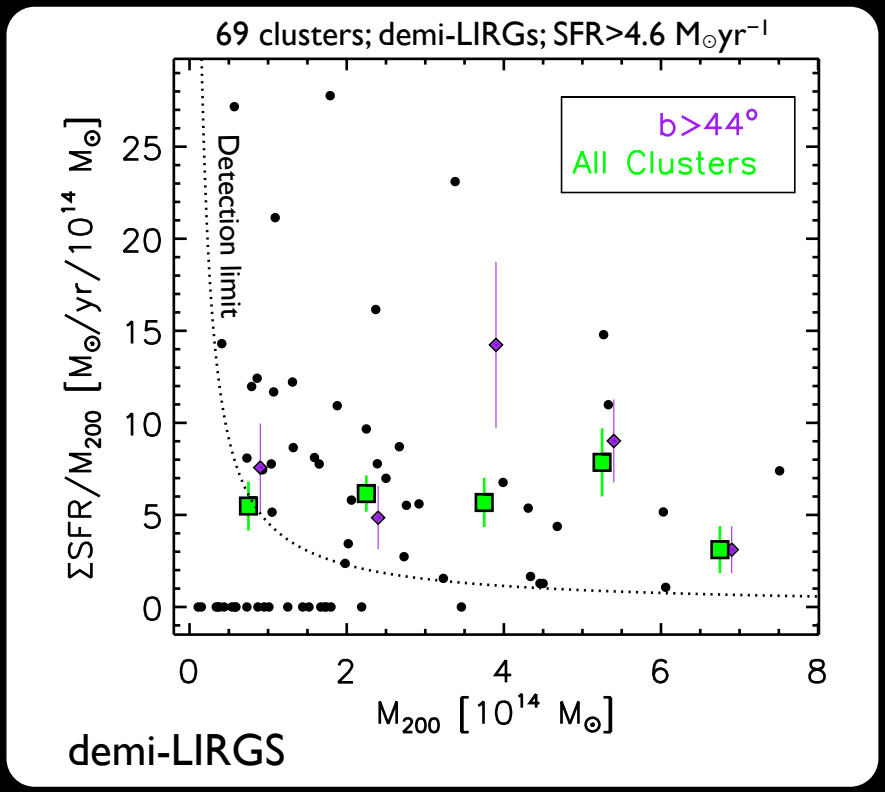


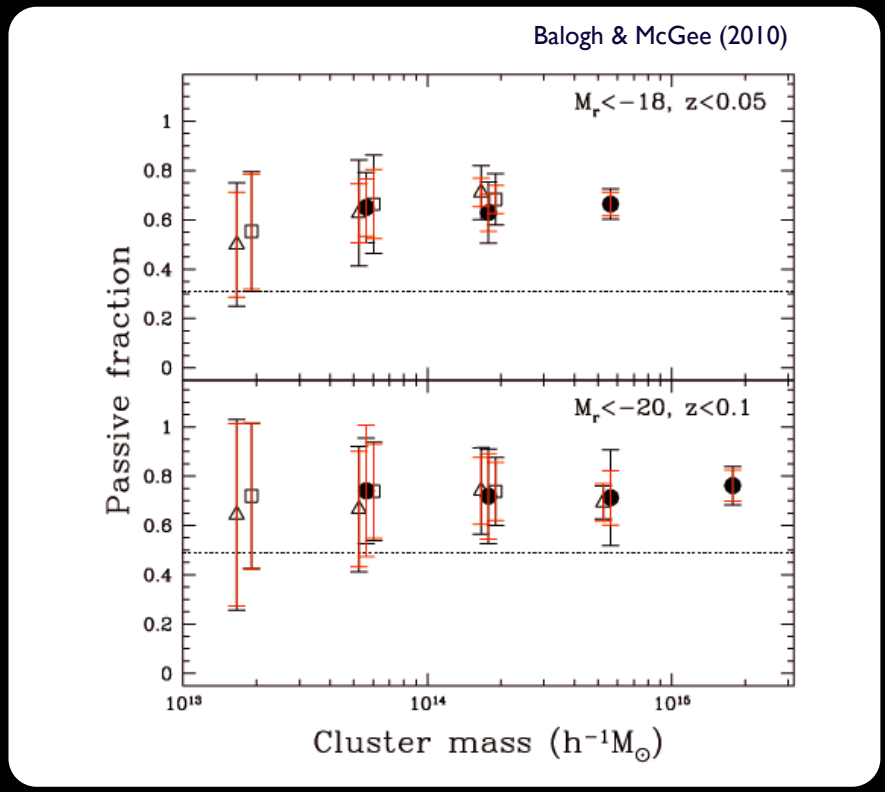
A WISE View of Galaxy Clusters

at low redshift

Physical implications

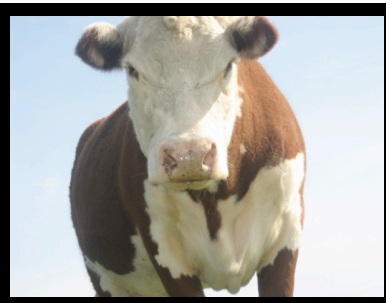
- Dominant mechanism for quenching star formation not dependent on cluster environment: group preprocessing
- Evidence for environmental effect even at relatively low overdensity





A WISE View of Galaxy Clusters

at high redshift



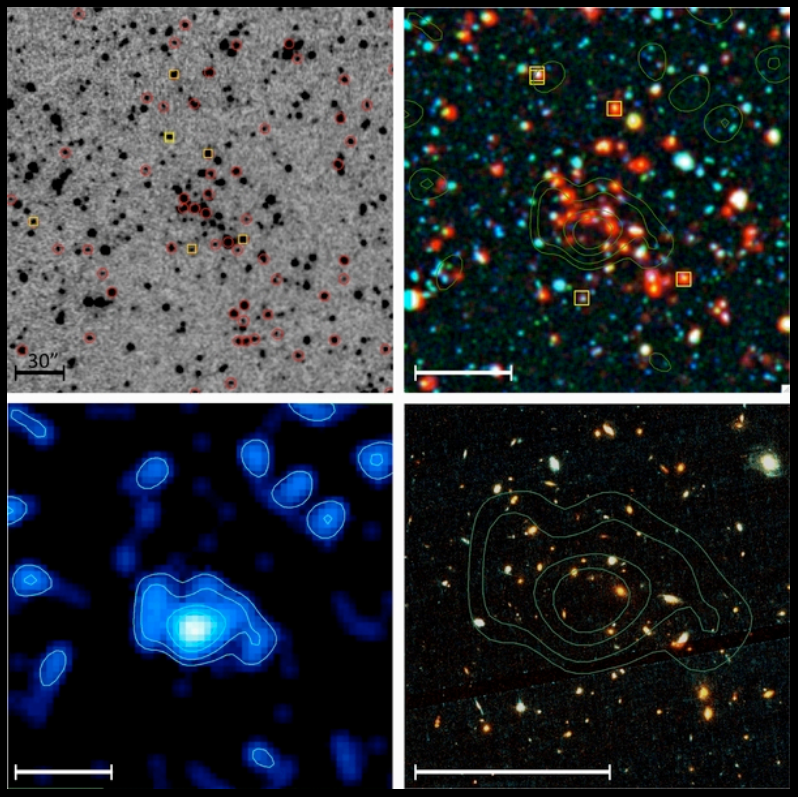
Spitzer IRAC data is very efficient for finding high-z clusters.

+ large redshift reach

+ sensitive down to low masses

- limited area

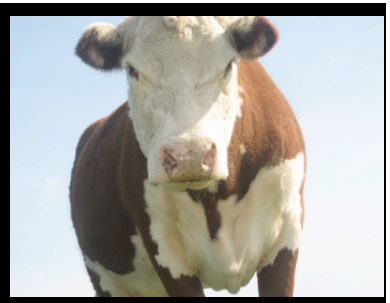
ISCS (z=1.487; Brodwin et al. 2011)



IDCS (z=1.75; Stanford et al. 2011)

A WISE View of Galaxy Clusters

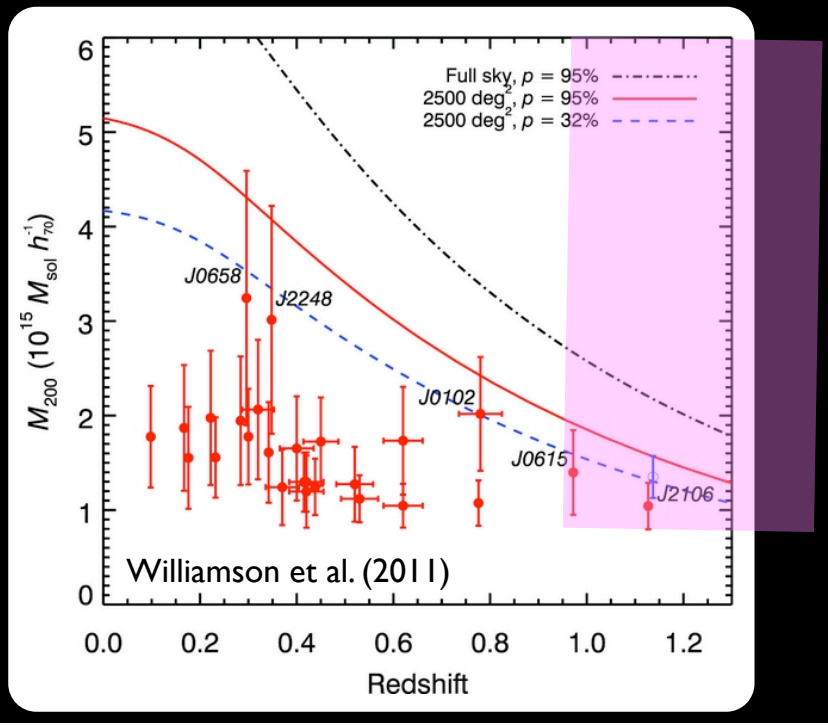
at high redshift

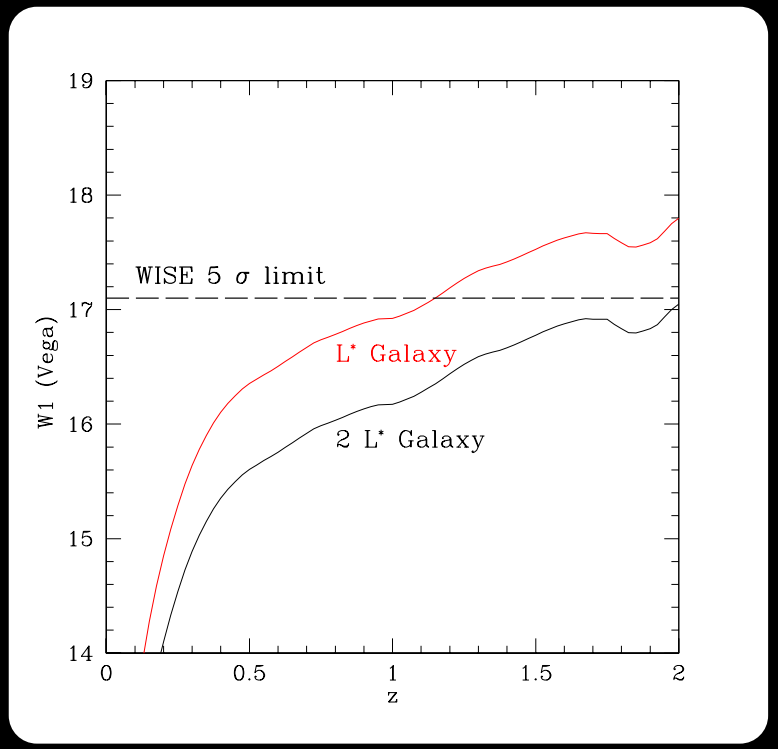


How high-redshift can one really go with WISE?

- **L* to z>1.1**
- **overdensities of >L* galaxies should be visible to z~1.4-1.5**

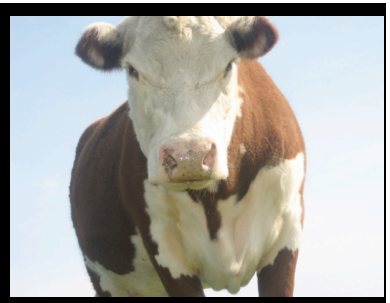
Can provide complement to SZ search for massive clusters as cosmological probe.



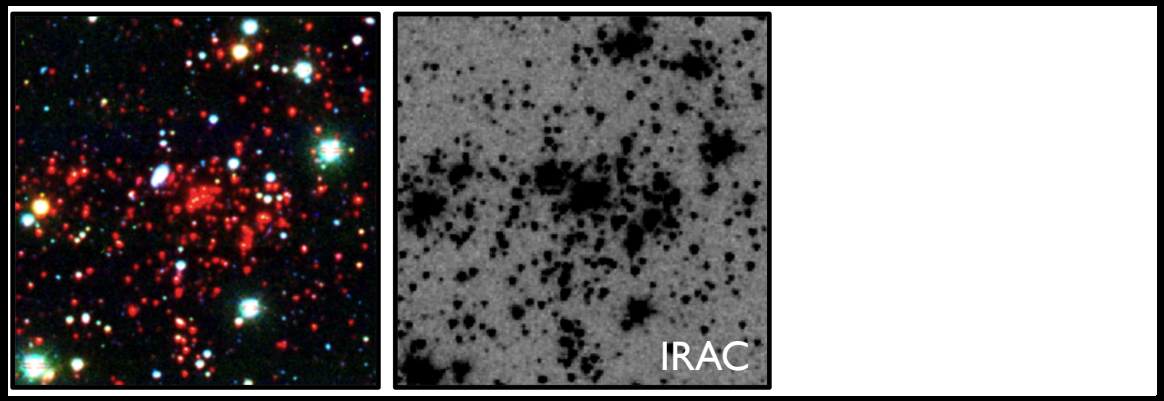


A WISE View of Galaxy Clusters

at high redshift

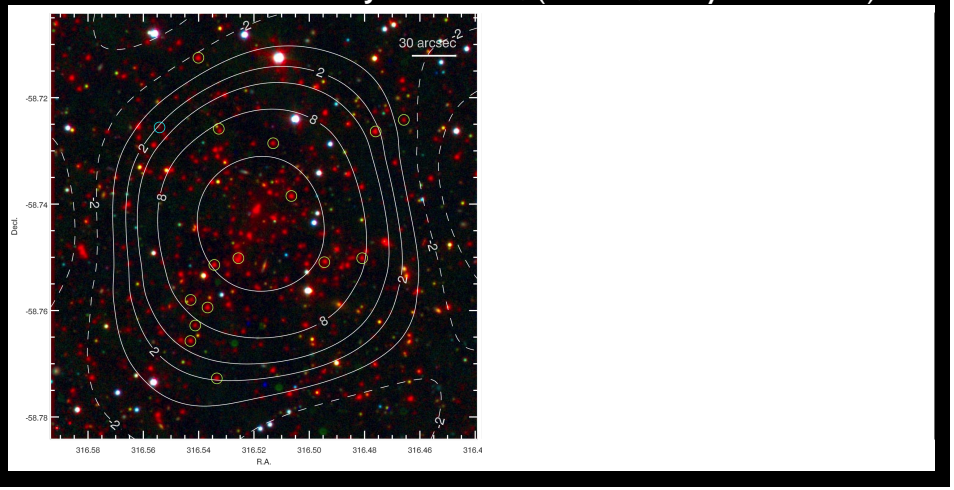


SPT Clusters as a Test Case



SPT-CL J0546-5345 (z=1.06; Brodwin et al 2011)

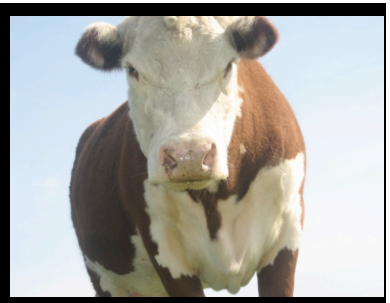
SPT-CL J2106-5844, (z=1.13; Foley et al 2011)



Significant blending, but clusters remain visible.

A WISE View of Galaxy Clusters

at high redshift



The Massive Distant Clusters of WISE Survey (MaDCoWS)

Cluster Detection

Approach: Papovich (2008) style algorithm

- Start with >5σ WISE sources
- Simple W1-W2 color cut
- Reject optically bright sources
- Construct wavelet-smoothed density map to identify cluster overdensity peaks.

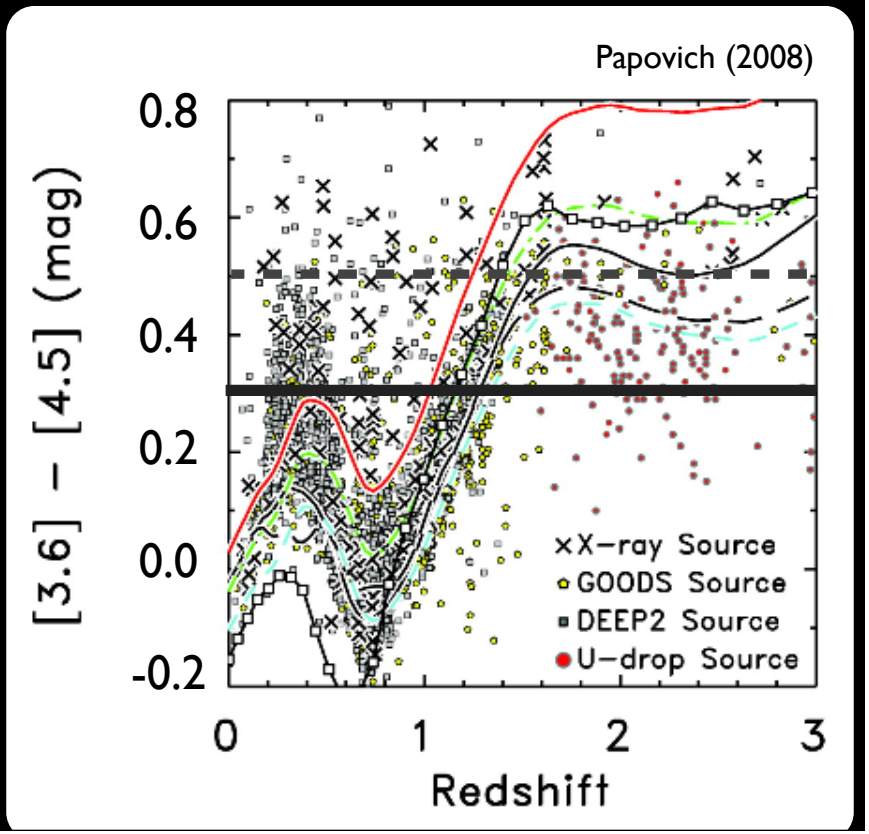
Northern Hemisphere (WISE + SDSS DR8):

- W1-W2>0.3 (Vega)
- reject i<21

Southern Hemisphere (WISE + USNO):

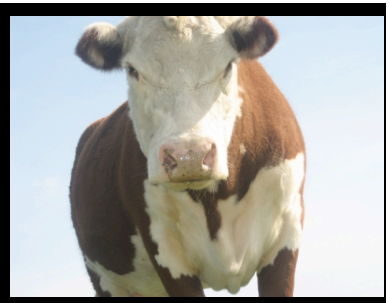
- W1-W2>0.5 (Vega)

  redder, higher-z cut
- reject USNO detections (V<21)

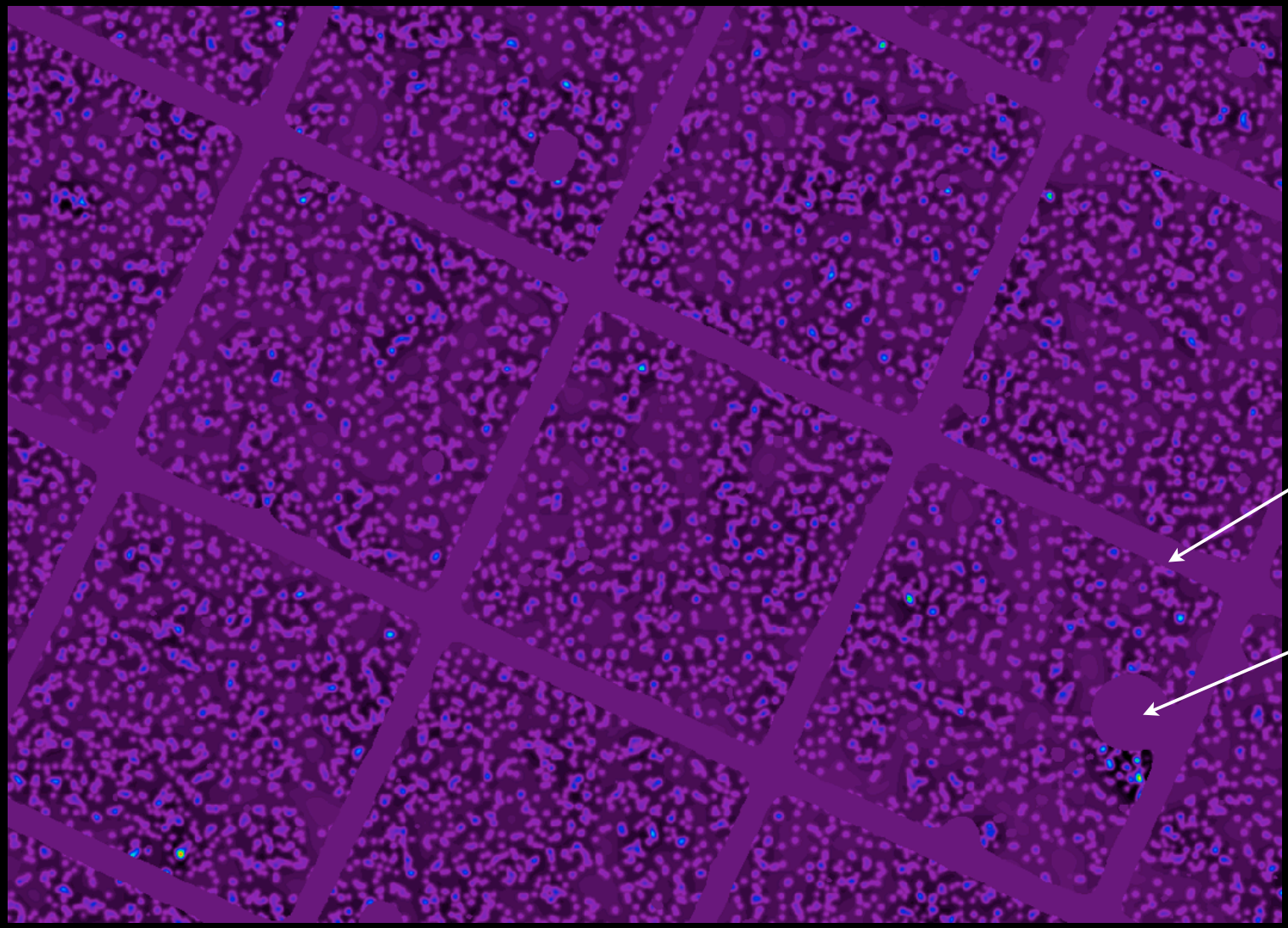


A WISE View of Galaxy Clusters

at high redshift



MaDCoWS



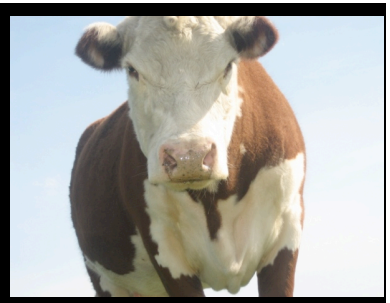
Smooth Detection Map

Masked overlap regions

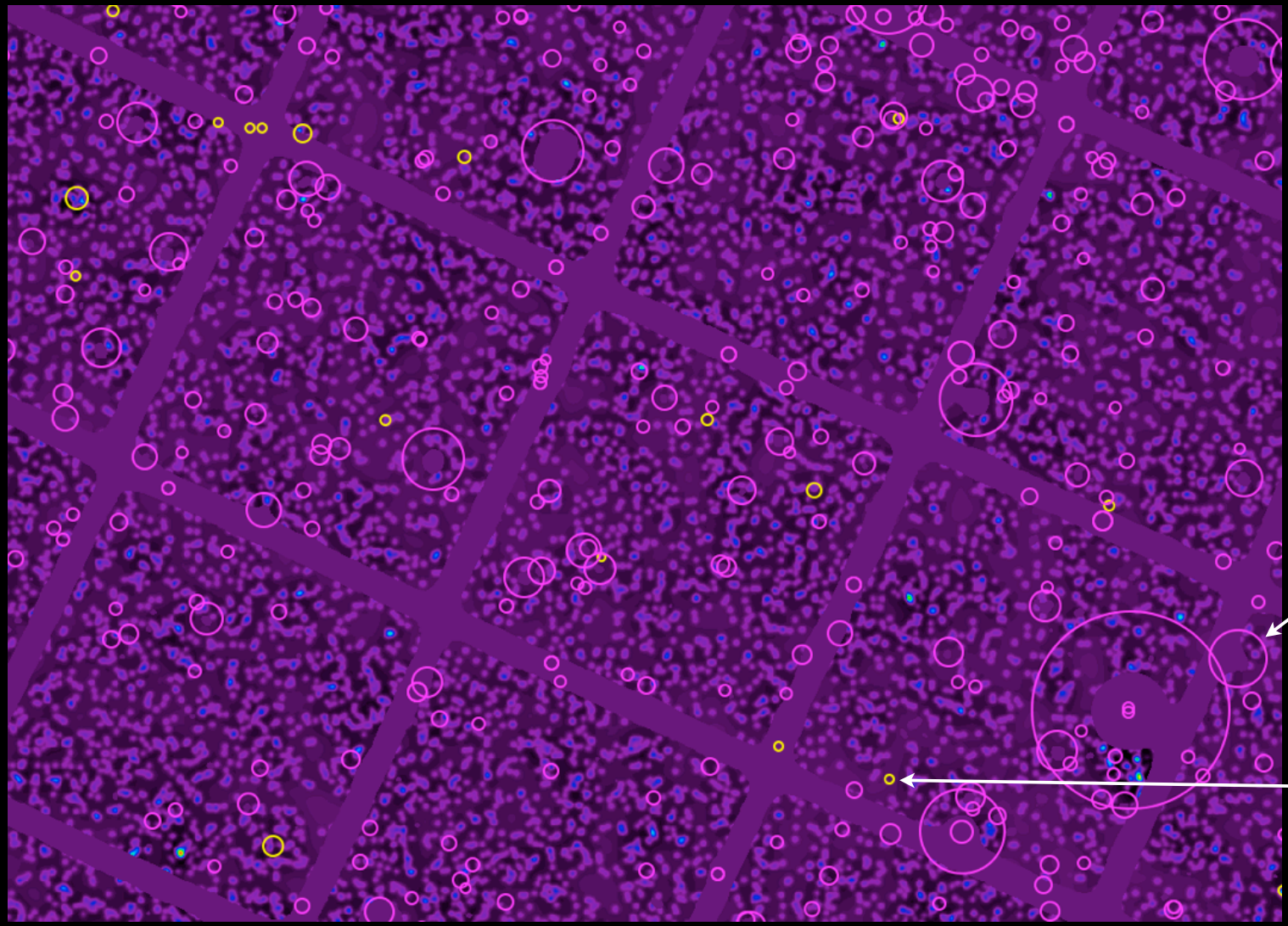
Masked bright sources

A WISE View of Galaxy Clusters

at high redshift



MaDCoWS



Smooth Detection Map

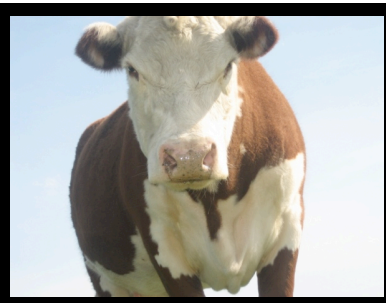
Additional rejection

W1<9

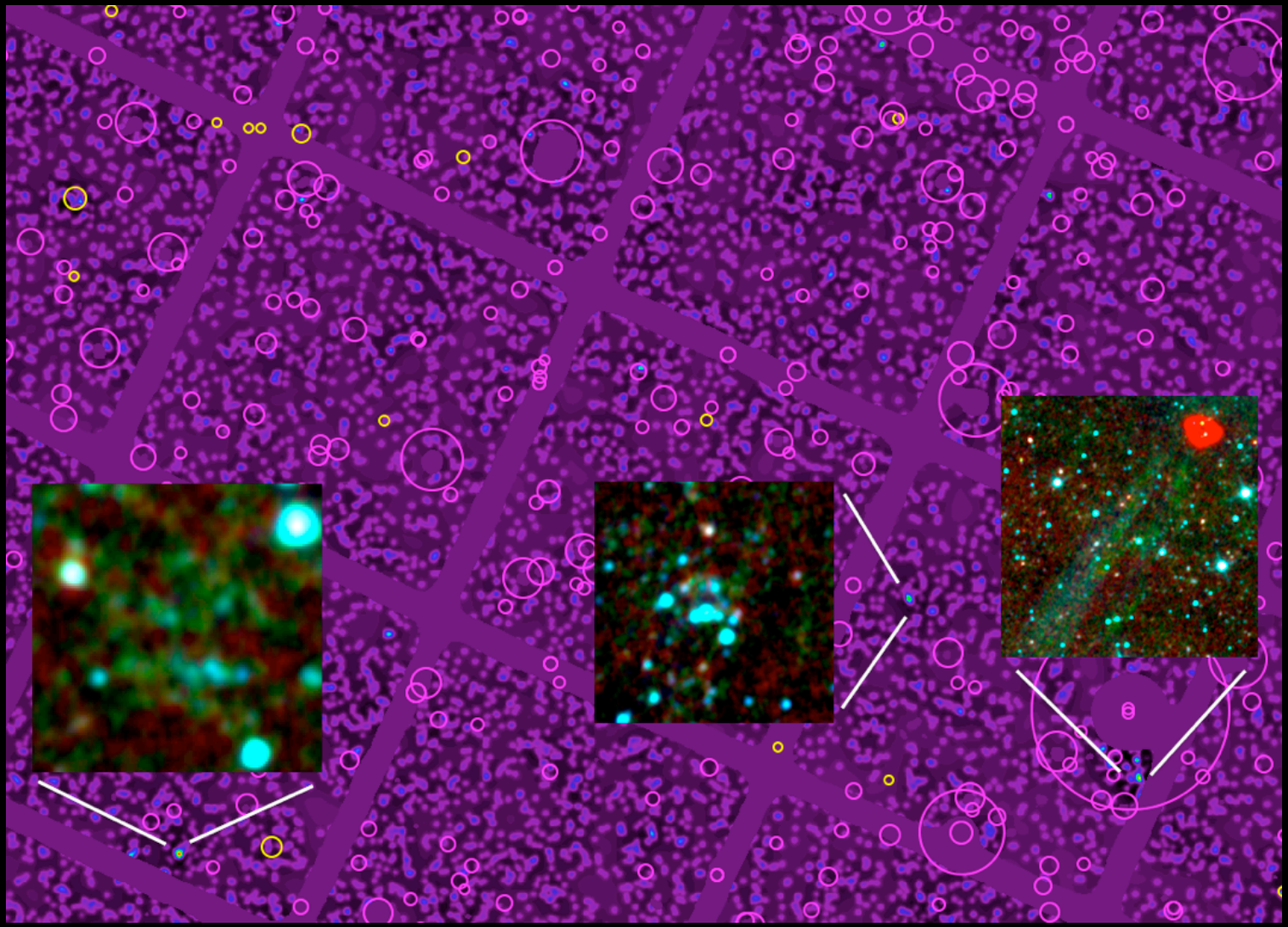
2MASS Extended Source

A WISE View of Galaxy Clusters

at high redshift



MaDCoWS

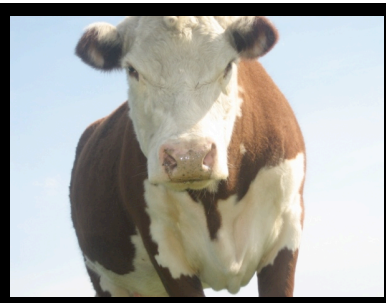


Smooth Detection Map

Additional rejection

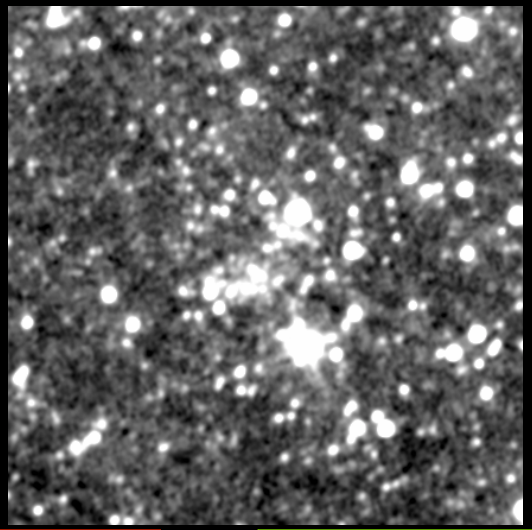
A WISE View of Galaxy Clusters

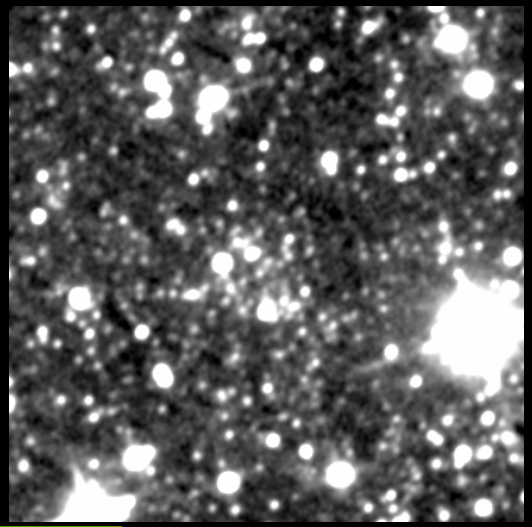
at high redshift



MaDCoWS

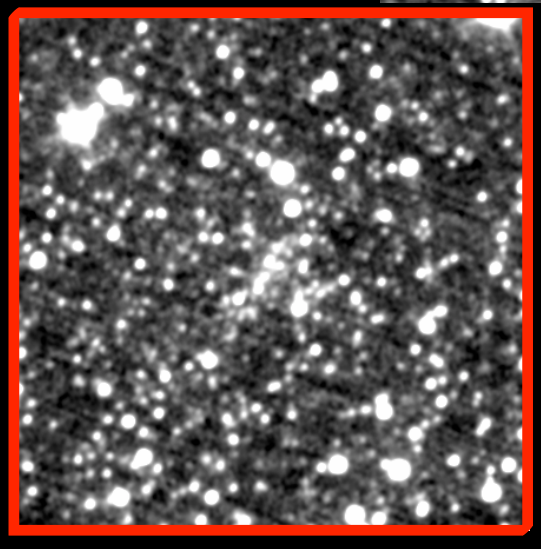
MaDCoWS Candidates
& SPT-CL J2106-5844

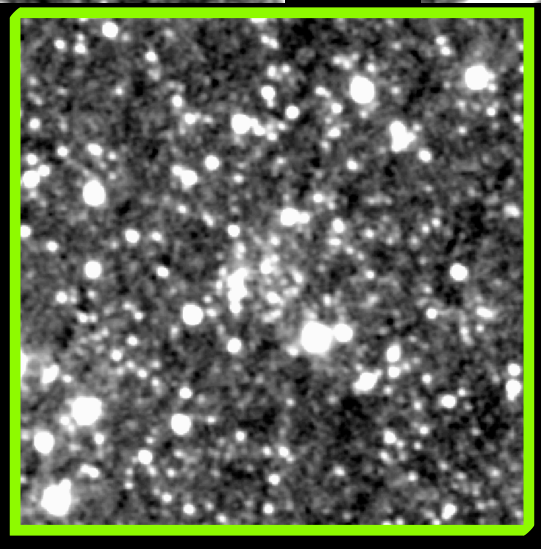


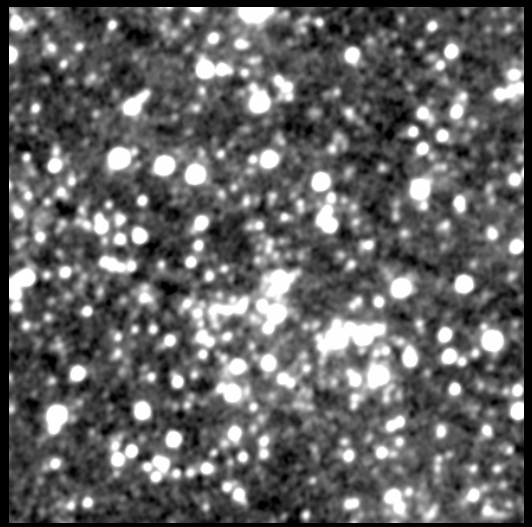


10′x10′

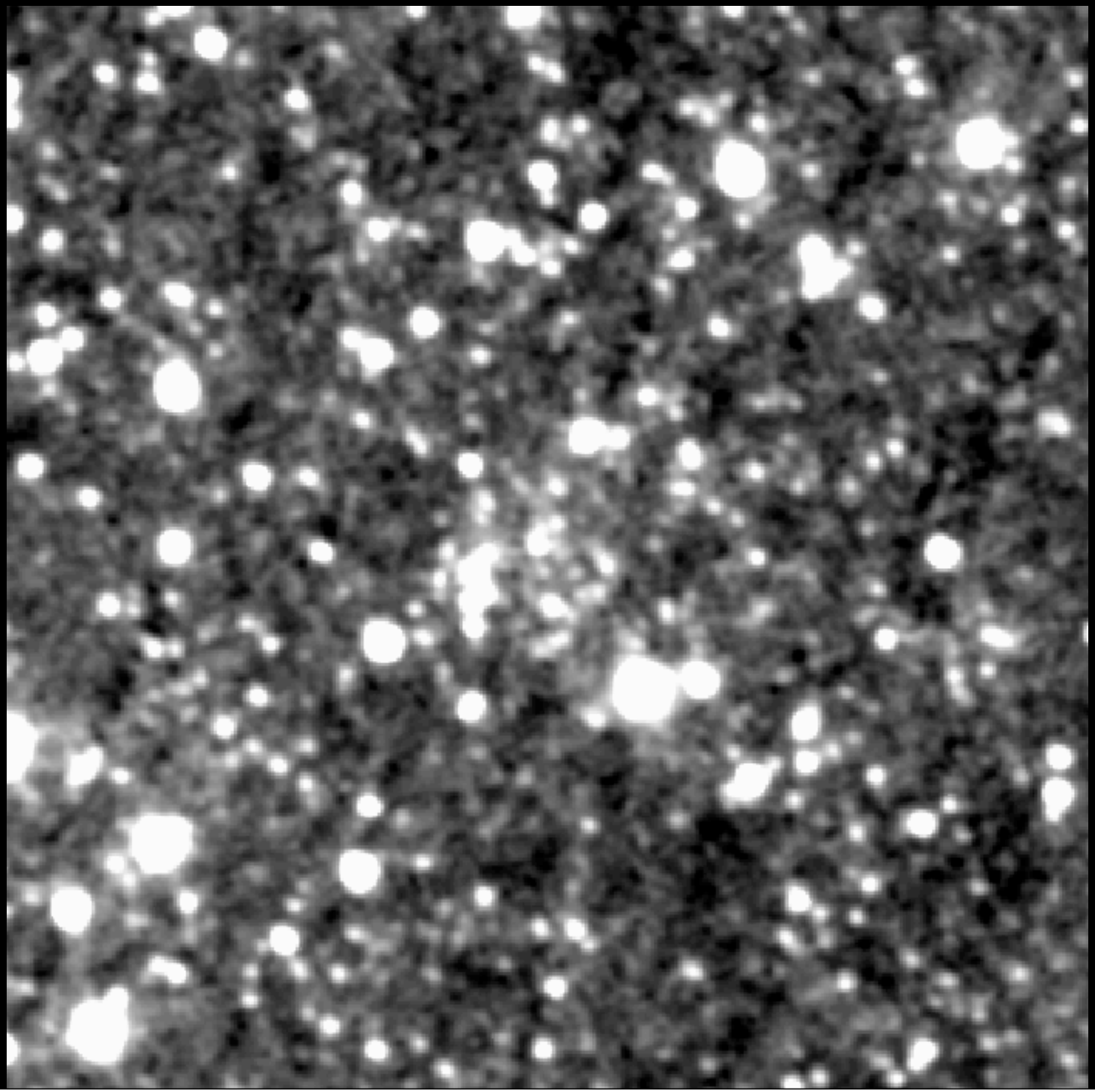
SPT ($M=1.7 \times 10^{15}\ M_{\odot}$)







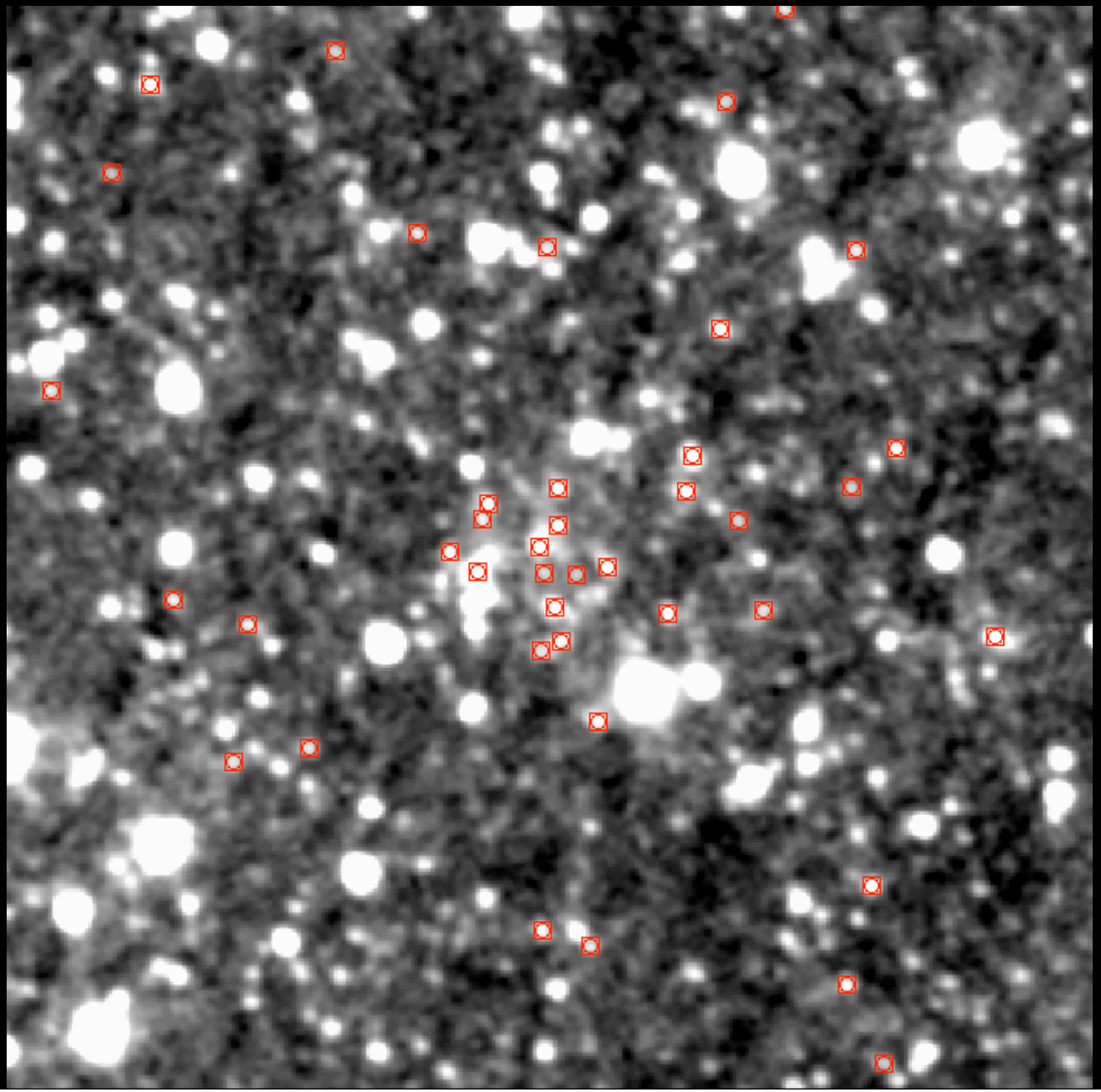
Bessie



WISE W1

10′x10′

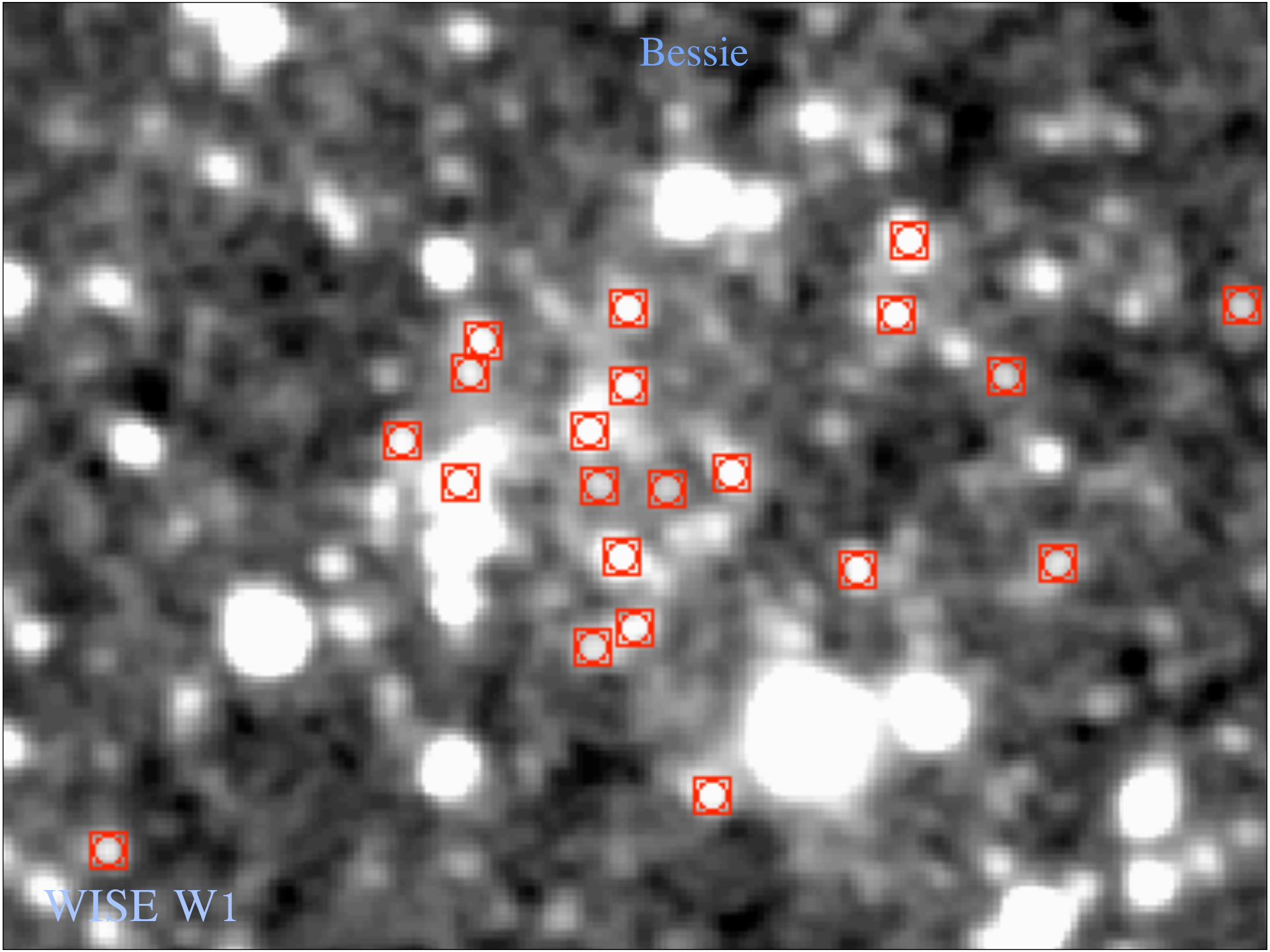
Bessie



W1-W2=0.55 (z~1.3)

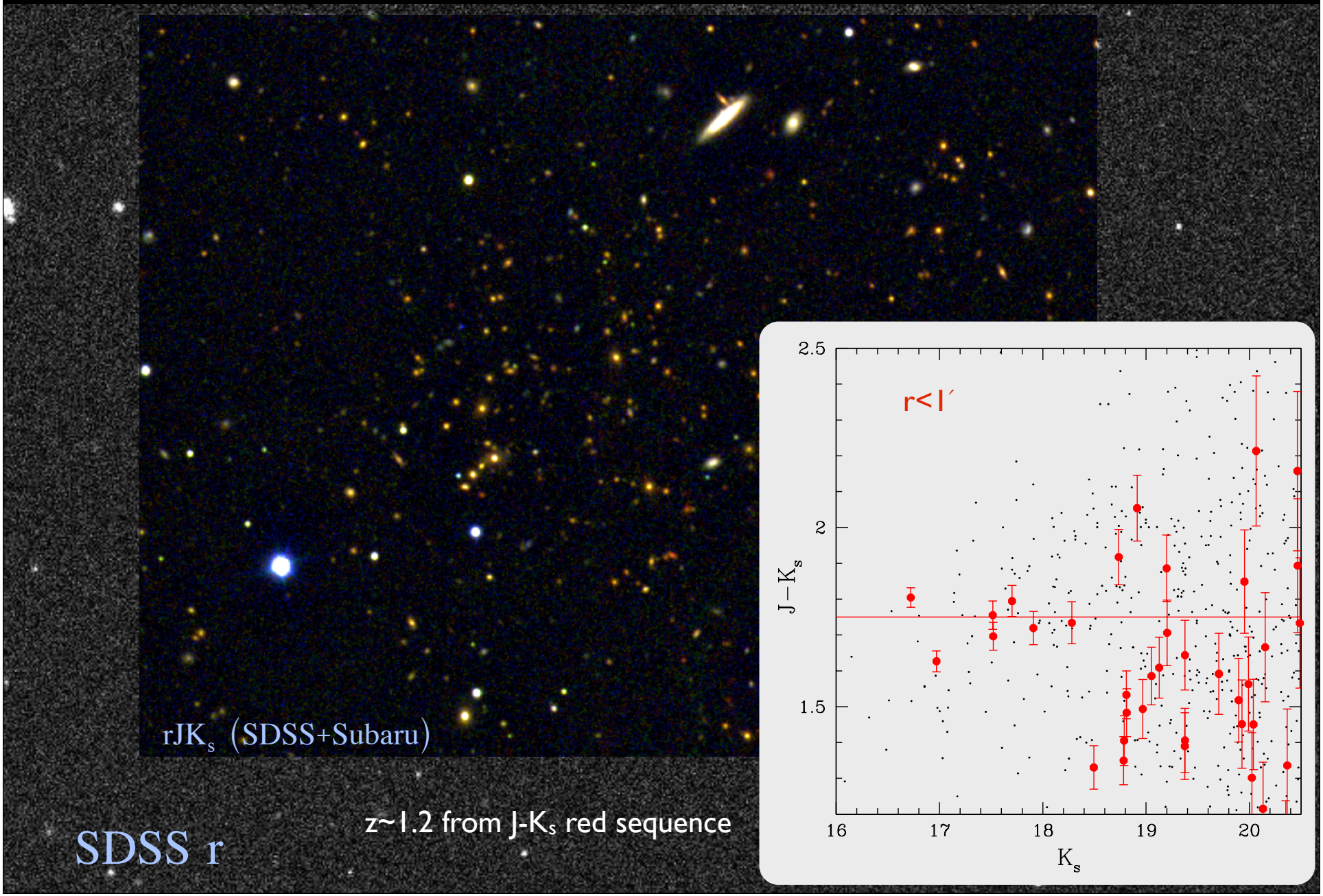
WISE W1

10′x10′


Bessie
WISE W1

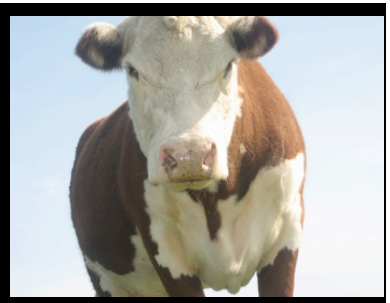
Bessie

Bessie


rJK$_s$ (SDSS+Subaru)
SDSS r
z~1.2 from J-K$_s$ red sequence
r<1′
J−K$_s$
K$_s$
2.5
2
1.5
16
17
18
19
20

A WISE View of Galaxy Clusters

at high redshift



MaDCoWS

Phase 1: Cluster detection in WISE

Phase 2: Confirmation imaging

1. Clear confirmation and identification of best clusters
2. Photometric redshifts for top 100 candidates from i-Ks CMDs

Timescale: 2011B-2012A

Fall 2011 upcoming runs: Optical & NIR imaging with WIYN, SOAR, MMT, GTC

Phase 3: Redshifts, mass determinations, cosmology

Spectroscopy, SZ, X-ray

A WISE View of Galaxy Clusters

Summary

Star Formation at low redshift

- Strong radial dependence of specific star formation rate
- Depressed star formation relative to field even at $3r_{200}$
- No significant mass dependence on specific star formation rate

MaDCoWS at high redshift

- First all-sky survey for z>1 clusters
- Efficient detection of massive clusters at z≈1.1-1.5
- Search complete, follow-up underway
- Stay tuned.