Clustering around 3C 270.1

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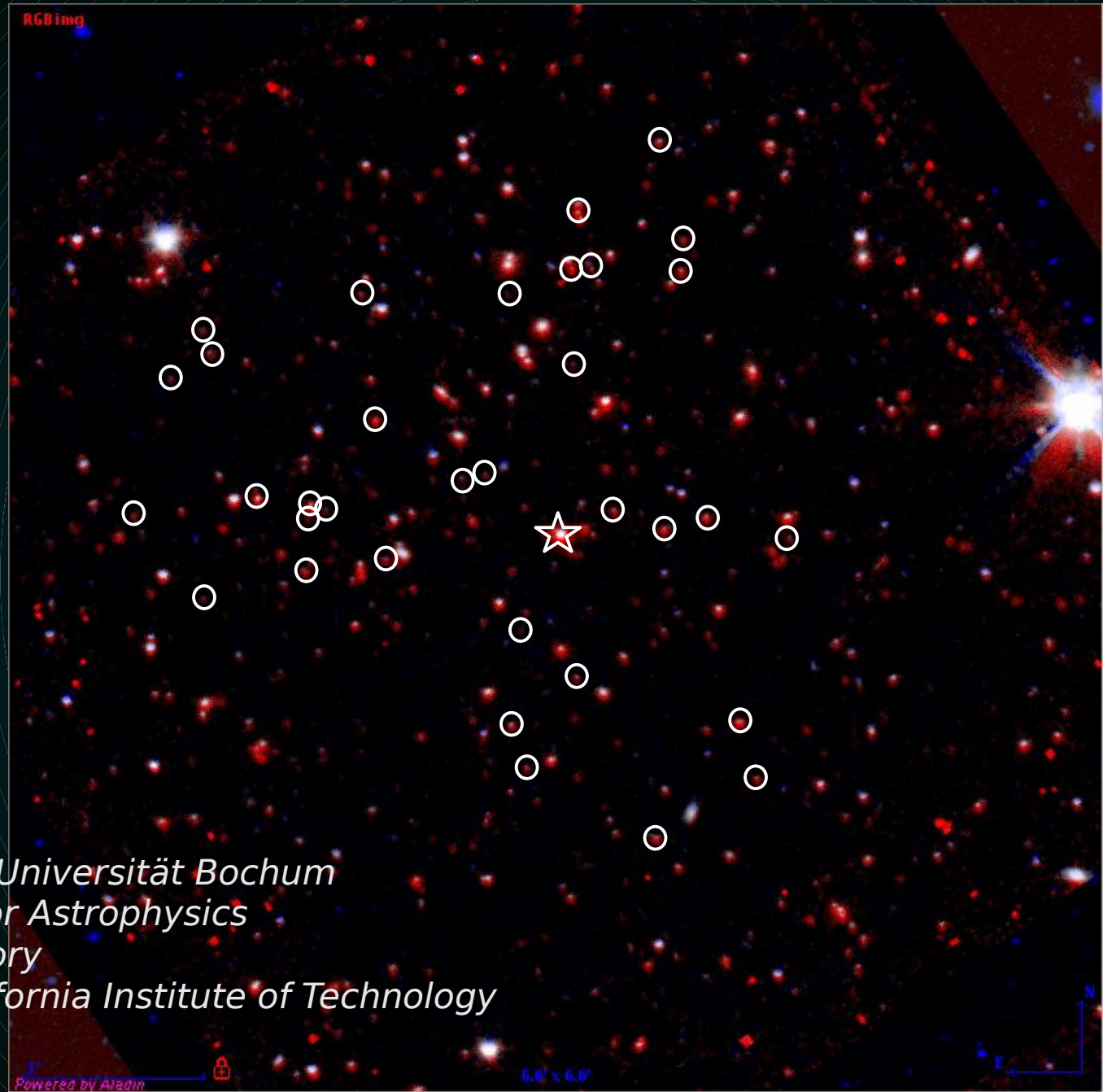Matt Ashby[2]
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Outline

- Motivation for high redshift cluster search

- Data (Spitzer / MMT / Chandra / HST)

- Finding cluster galaxies

- Results 3C 270.1 (Quasar z=1.53)

- Results 3C 437 (Radio Galaxy z=1.48)

- Conclusion

Motivation for high-z cluster search

- Largest bound structures in the universe
- Extreme in mass, size, ...
- Low redshift z<1: clusters around radio galaxies with elliptical cluster members (Zwicky,Abell, ...)
- High redshift 1<z<2: large multiwaveband studies (Best,Stanford,Eisenhardt)
- Very high redshift z>2: Lyman α protoclusters found (Miley et al.)

Motivation for high-z cluster search

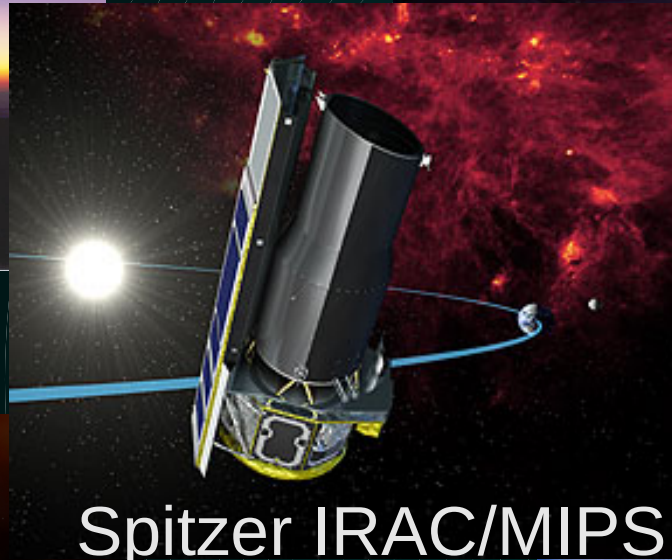- When did the first elliptical galaxies occur?
- How common is a cluster at z ~ 1.5 ?

- Spitzer study around high-z radio sources
- IRAC ideal for finding high redshift clusters
- MIPS possibility to distinguish elliptical and dusty starburst
- MEGACAM z' / SWIRC Y encompass 4000Å break at z=1.5

Data: observatories
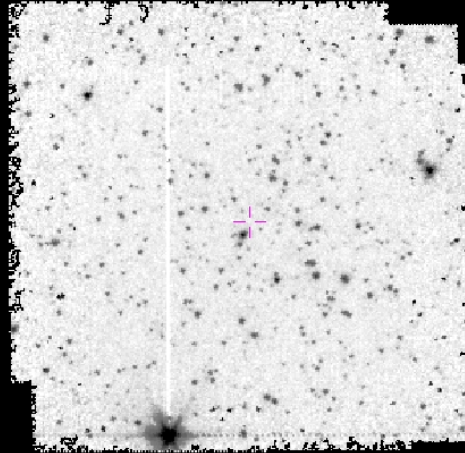
MMT Megacam/SWIRC
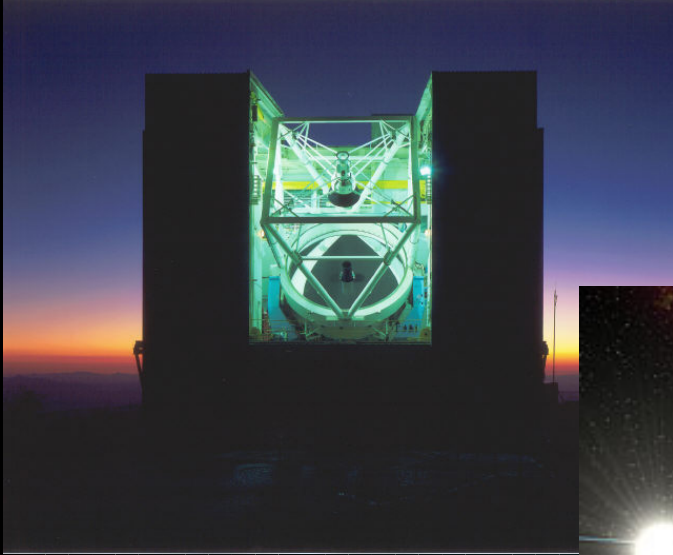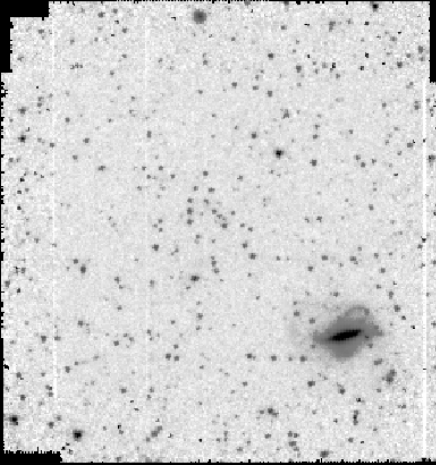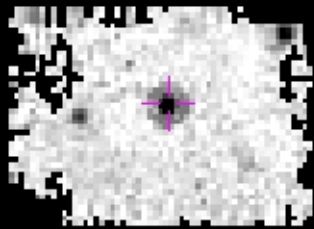
VLT HAWK-I
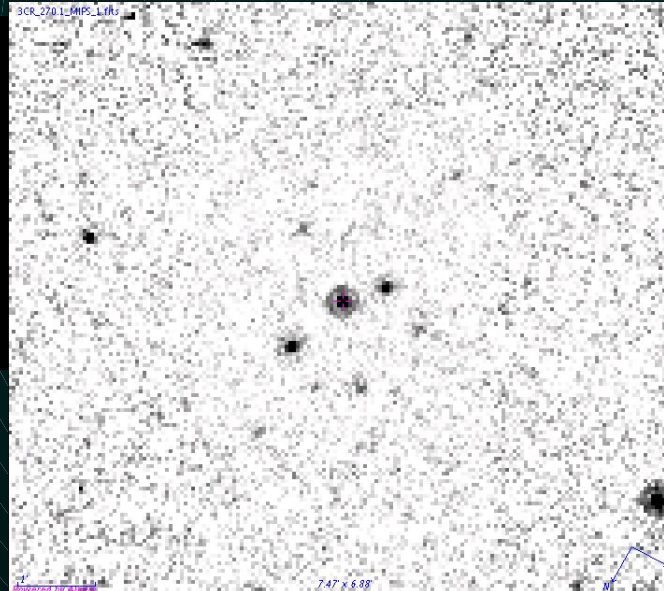
Spitzer IRAC/MIPS

Chandra snap-shot

Archival HST image

Data: Spitzer IRAC/IRS/MIPS

Spitzer IRAC (infra-red array camera)
• GTO by G. G. Fazio
• center frame with 3.6 4.5 5.8 and 8.0 micron
• control fields with 3.6/5.8 left and 4.5/8.0 right
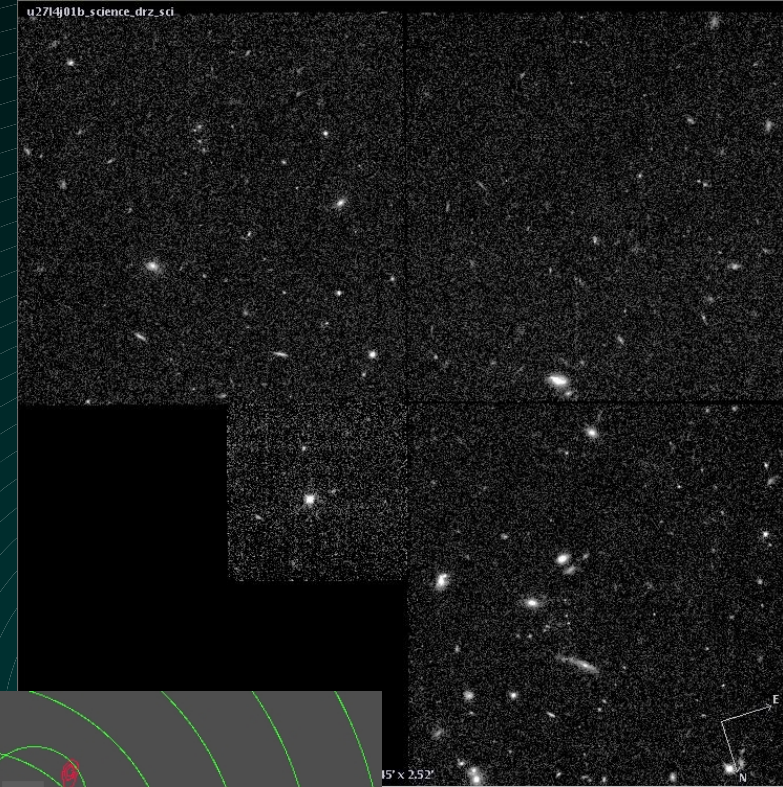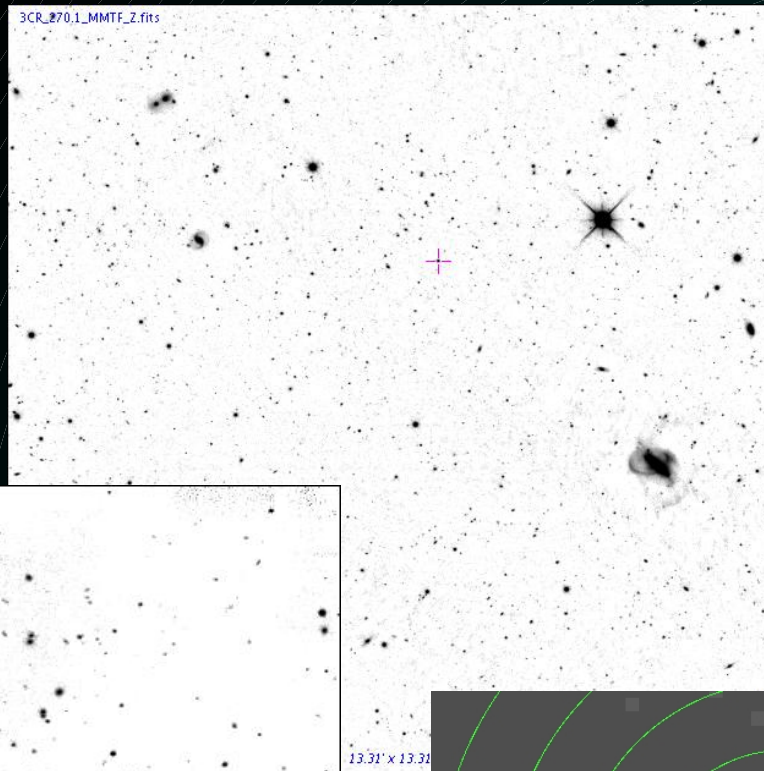• 3.6 micron peak of SED at redshift z=1.5

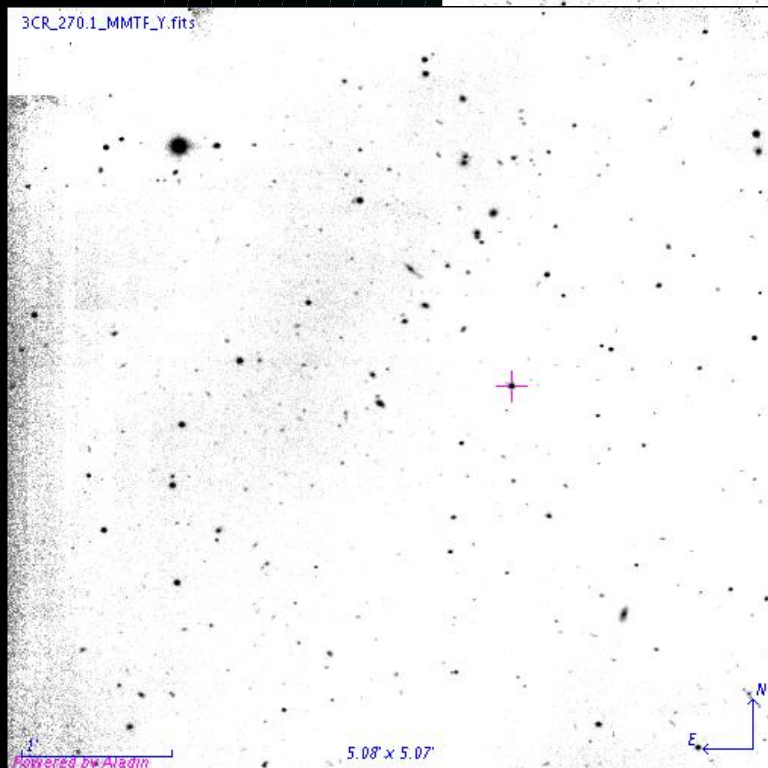Spitzer IRS blue peakup small size (only 3C source) 5..150mJy

Spitzer MIPS
• 5.4 x 5.4 arcmin^2
• 128x128 Pixel
• limit 110μJy
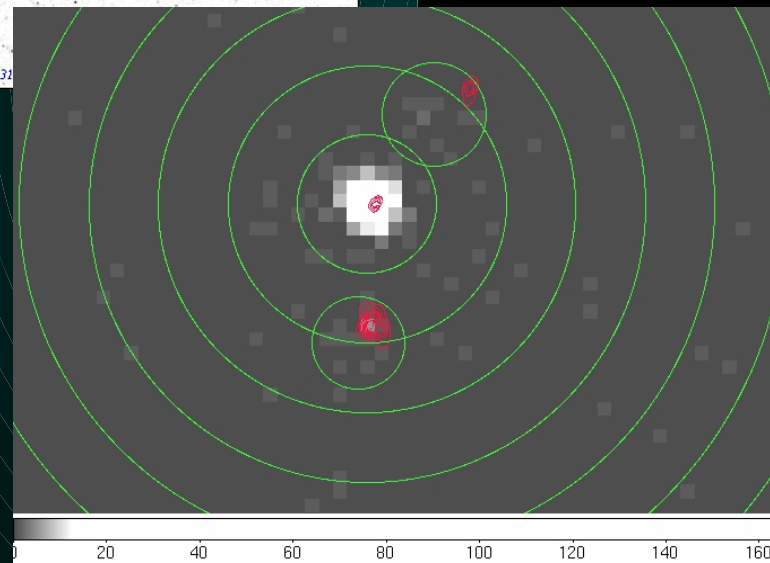• Dusty starbursts

Data: MMT / HST / Chandra

Megacam z'
image


SWIRC Y image

Archival
HST
image

Chandra image of 3C
270.1 (5ks)

Finding Cluster Galaxies

- Data set was designed to study the radio source
  - Also useful for cluster study
- Tracer: Quasar 3C 270.1 at z=1.53
  - Hosts of radio sources are massive
  - Know that radio sources are located in clusters
  - Use high z radio source as signpost for cluster
- Candidates with the same redshift as for 3C 270.1

Finding Cluster Galaxies

- ## Three different templates
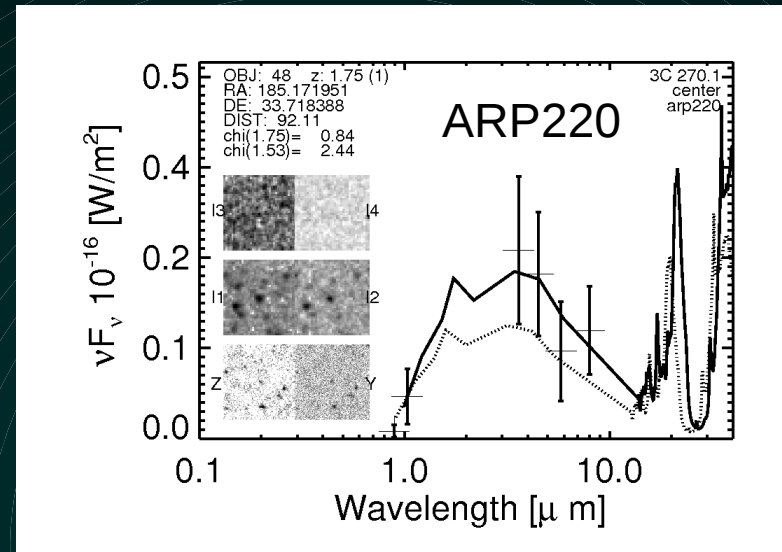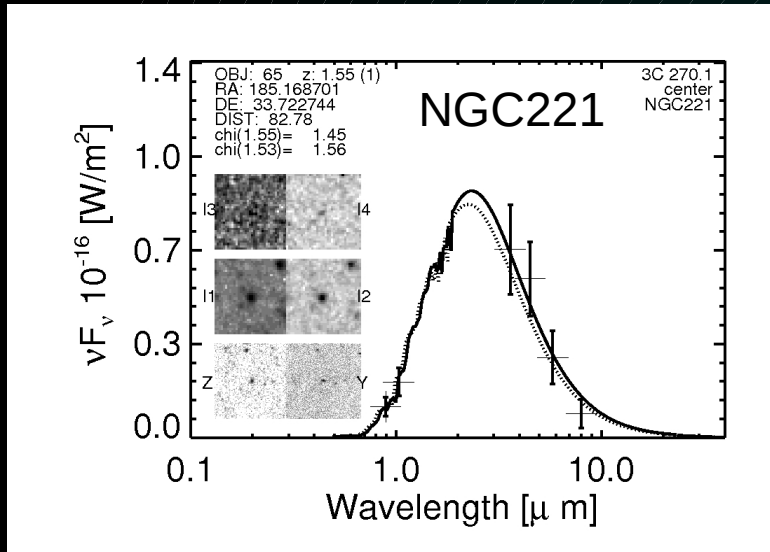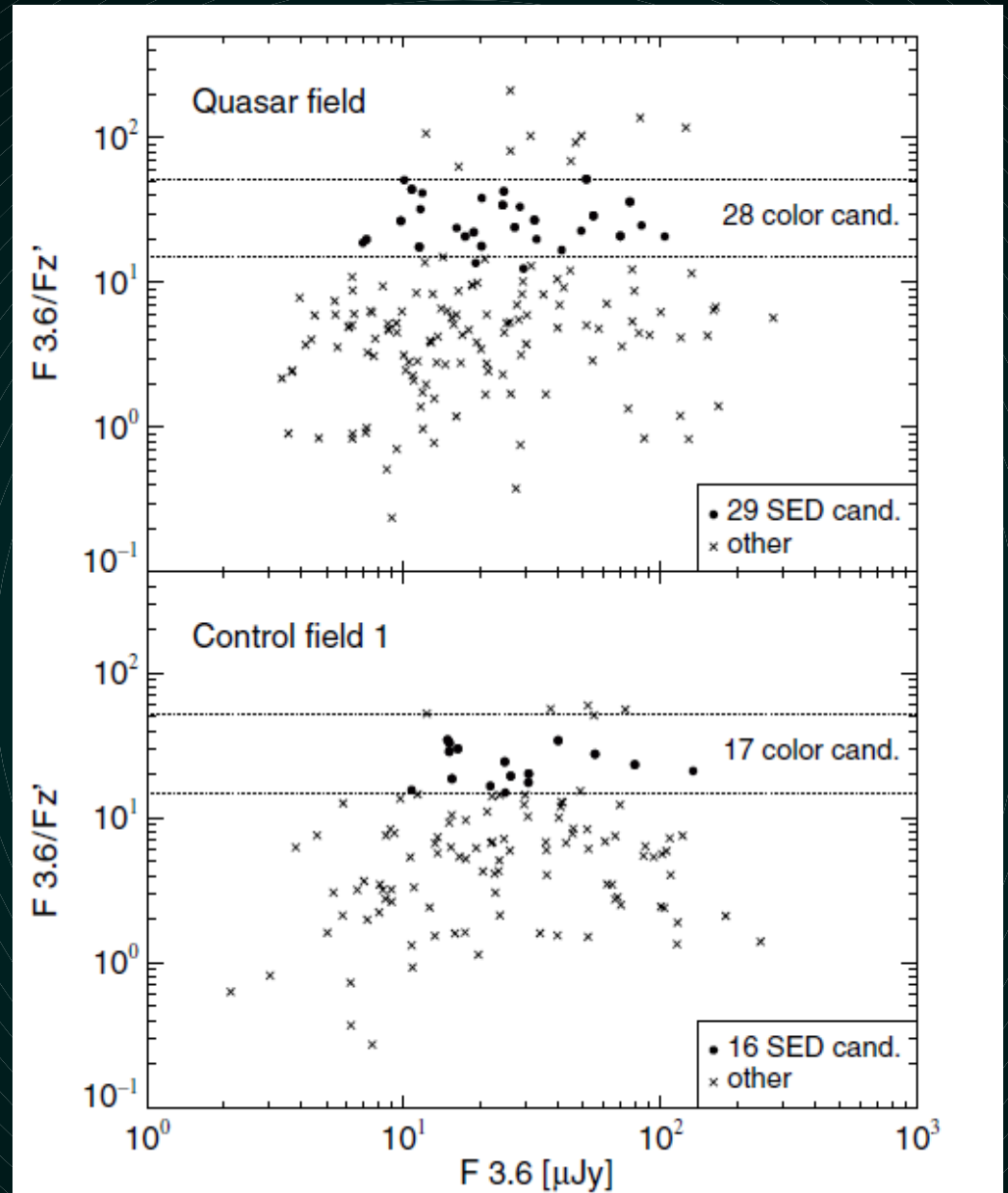

- ## NGC221
  - – elliptical template
- ## M82
  - – dusty starforming
- ## ARP220
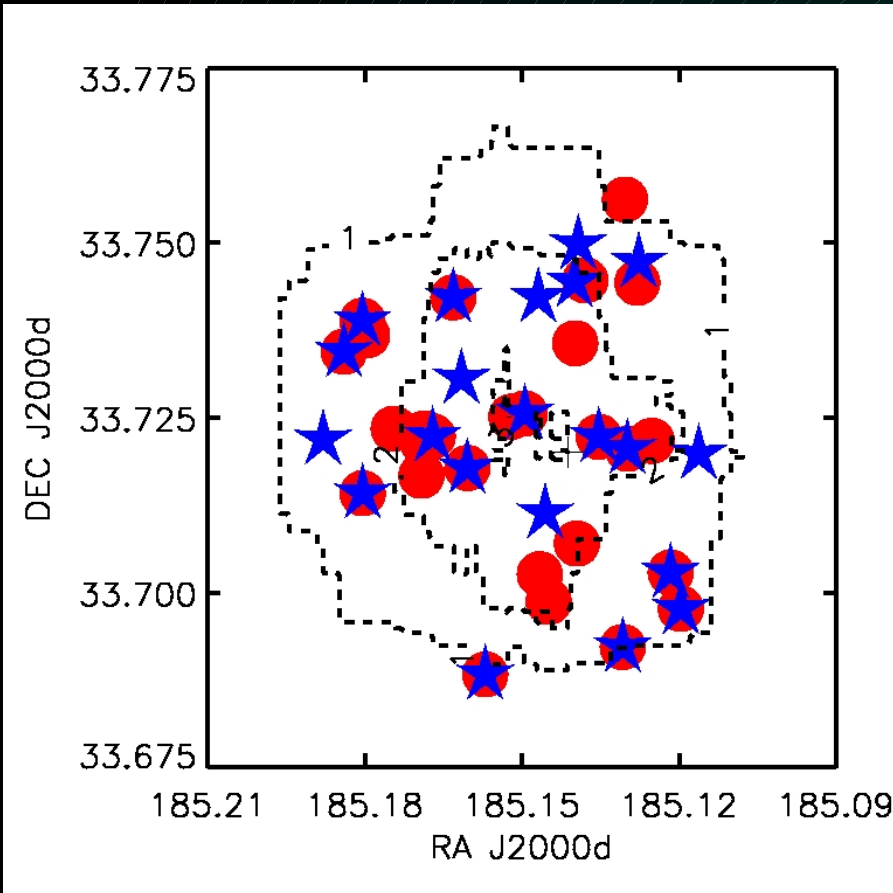 - – ULIRG
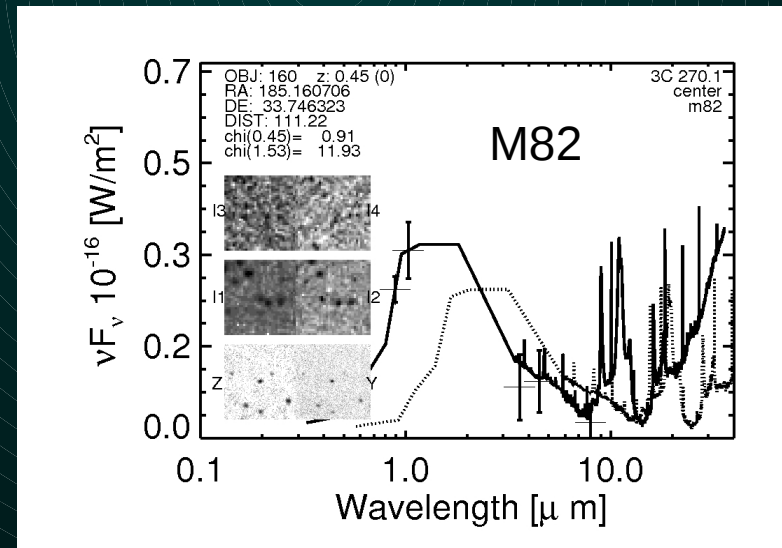
Color – magnitude diagram

- The numbers
- Center:
    - 29 SED
    - 28 color
    - 279
- Control Field
    - 16 SED
    - 17 color
    - 180

Results 3C 270.1

- Sky plot of cluster candidates around 3C 270.1
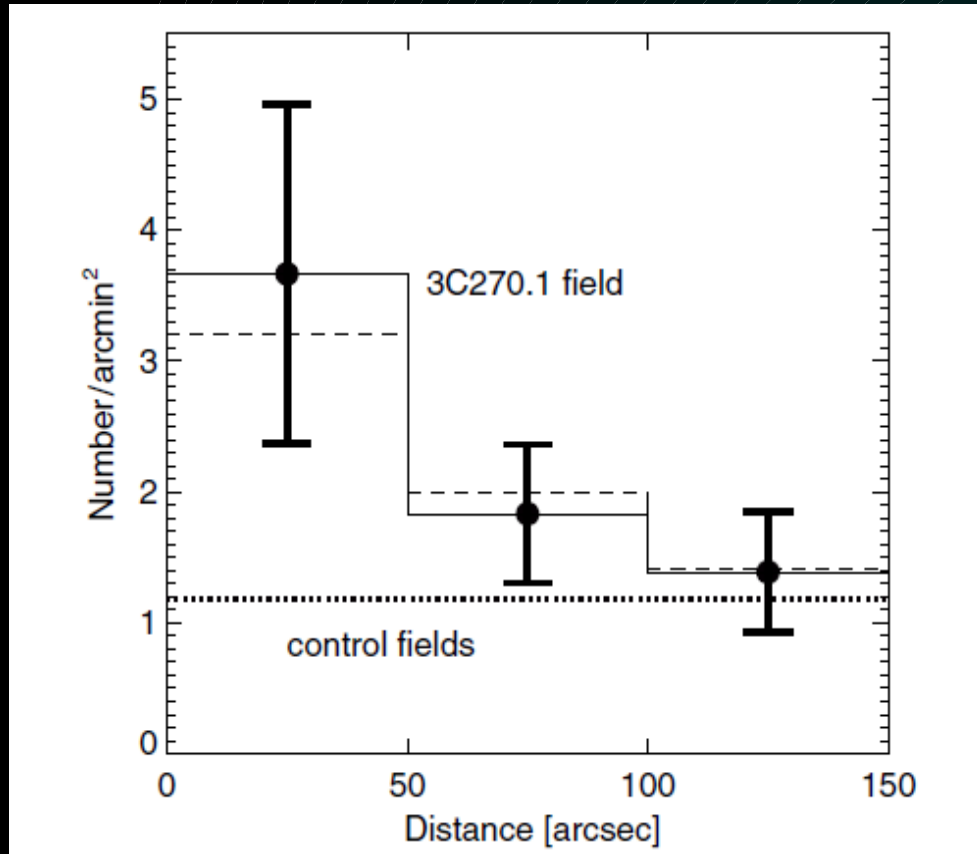

- Visual evidence for clustering of cadidates
- Overdensity of z=1.53 objects compared with control fields

Sky distribution of galaxies at redshift z=1.5± 0.2. ellipticals(red), starbursts(blue), smoothed number density(dashed line)

Results 3C 270.1

- Radial clustering

Radial plot with Poisson error bars
Solid line centroid as 0
Dashed line Radio source as 0
Dotted line control fields

– Evidence for clustering around single z=1.53 quasar

– No clustering in control fields

Results 3C 270.1 Properties of the candidates

- Elliptical galaxies
    - 90% elliptical candidates
    - More luminous than L* galaxy at z=1.5
    - Top of the iceberg
- Starforming galaxies
    - At z=1.5 silicate absorption feature at 24 micron
    - MIPS not deep enough (110 μJy)
    - Only one object is irregular on MMT/HST
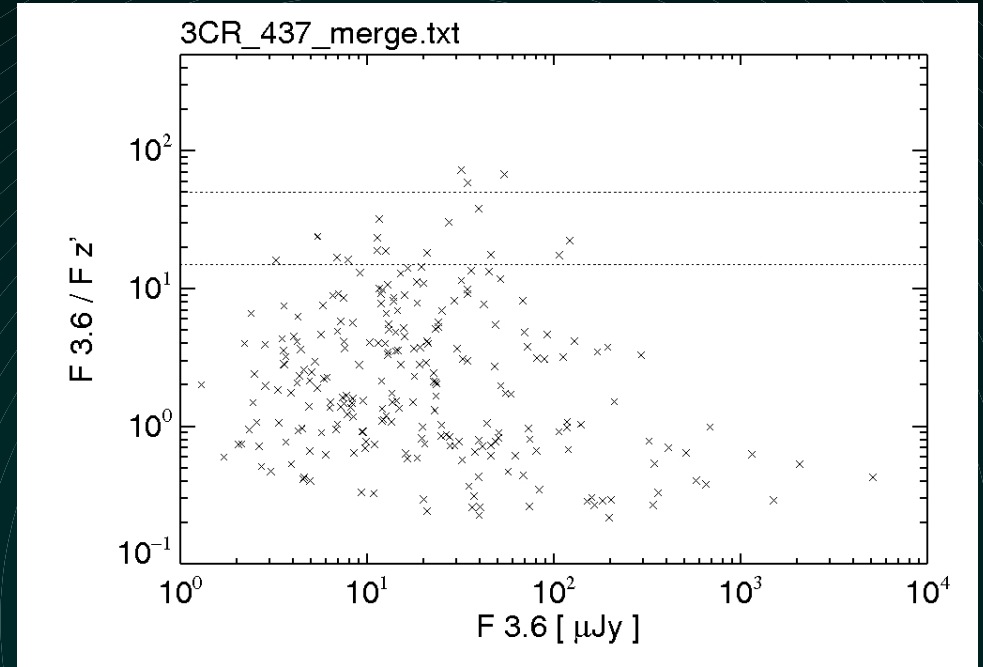   - 3 times more luminous than ULIRG ARP220

Results 3C 437
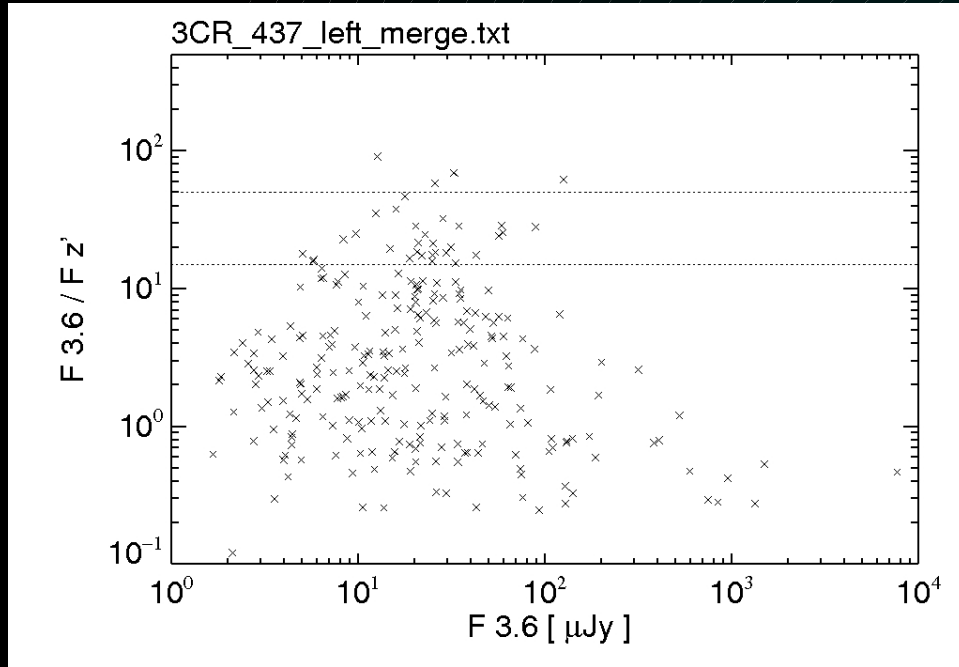
	Left	
Total number:		361
Candidates:		29

	Center	
Total number:		328
Candidates:		14

Conclusion

- Spitzer/MMT study of high-z radio source environment

  - Comparison with control fields support clustering

    - Number counts: left: 19 center: 36 right: 14
      - Sky plot and Chandra Image favors a cluster
      - Radius plot support the cluster
      - Elliptical Galaxys in clusters as early as z=1.5

- No evidence for clustering around the radio galaxy 3C 437 at redshift 1.48