Radio Galaxies in Dense Environments

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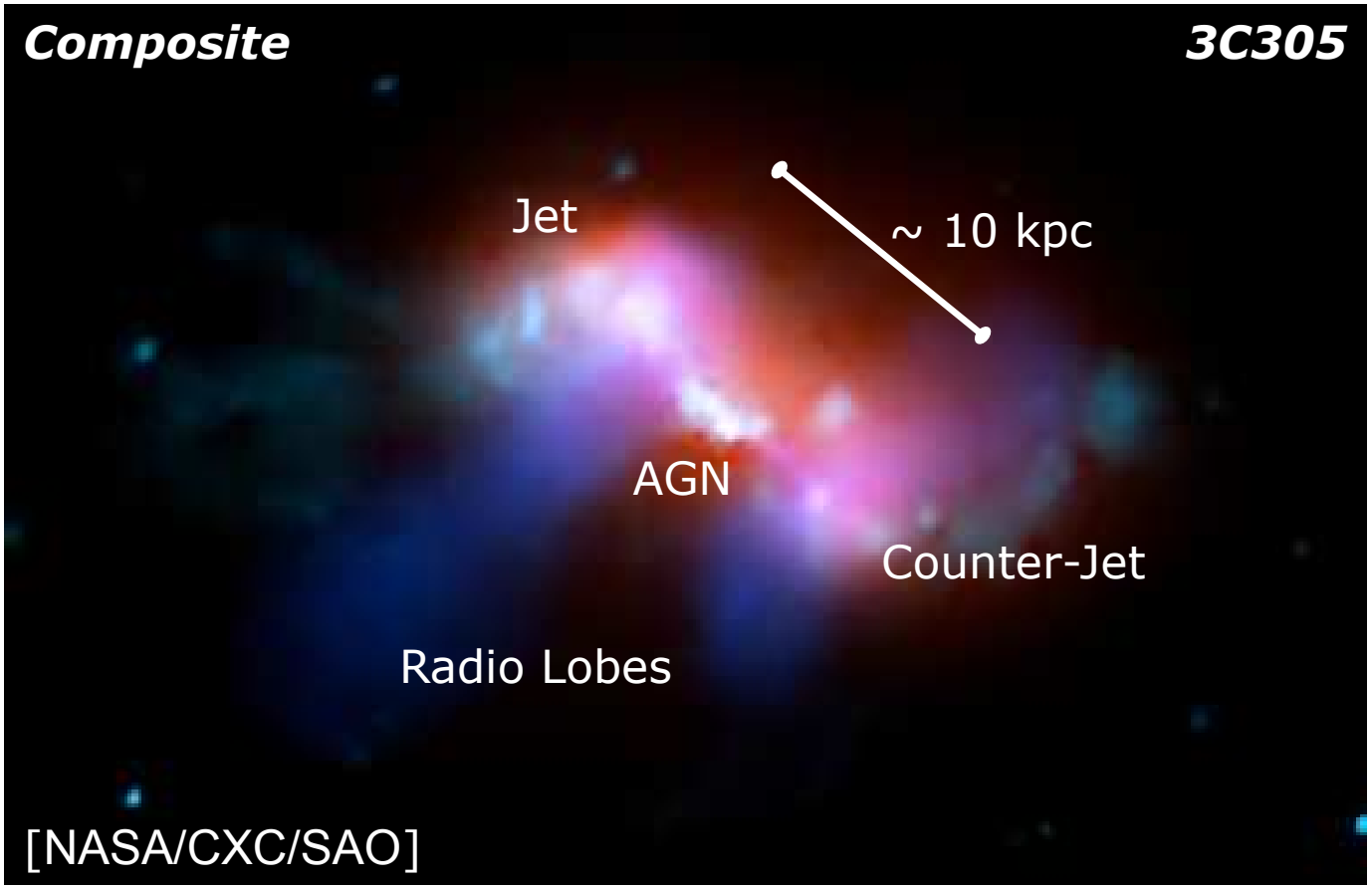
Outline

- Background – Radio Galaxies & Clusters
- Applications/Motivation
- Surveys (data collection) – FIRST/SDSS
- Main Results
- Conclusions
- Relating to LOFAR

Galaxies – Multi wavelength



- AGN/Starburst
- Synchrotron
- Observable for ~10^8 yrs

'Dense' Environments

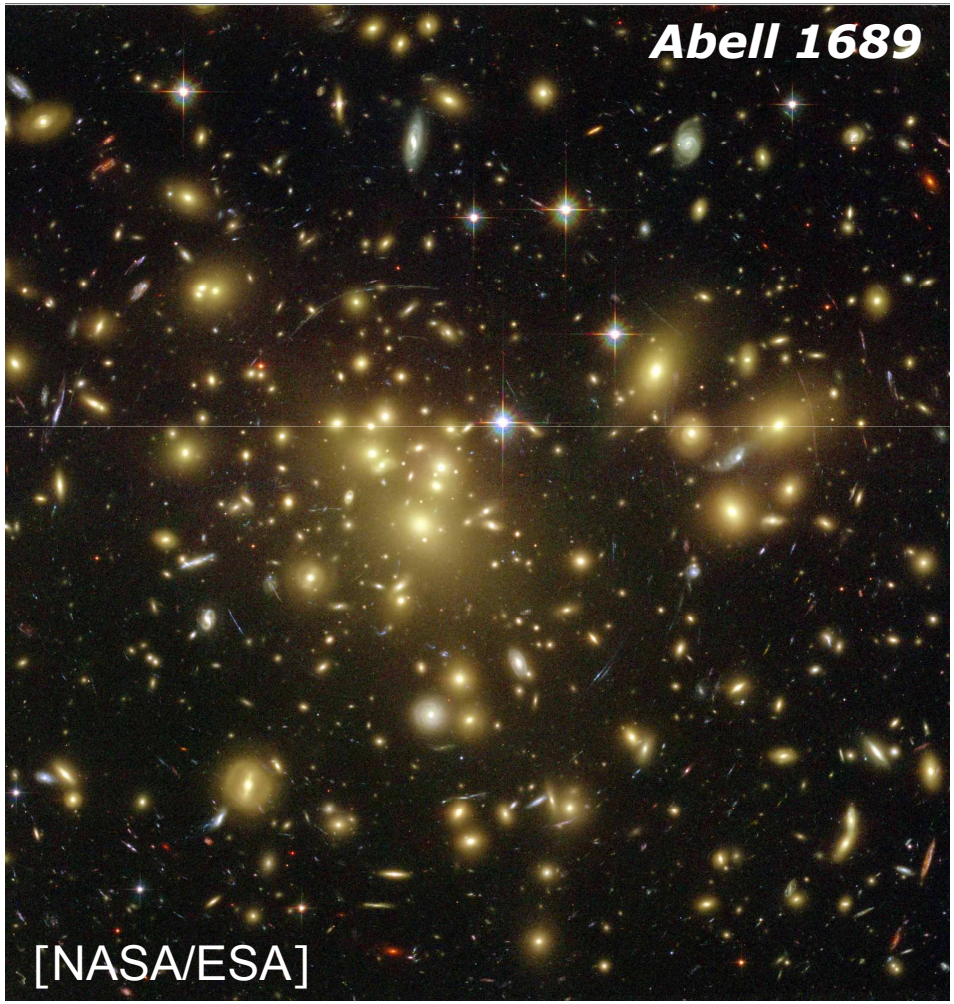
RADIO:

- 6-8 X more likely [Lin & Mohr 2007]
- Bright Central Galaxy (BCG) ~ AGN
- ICM ~100 x more dense

OPTICAL:

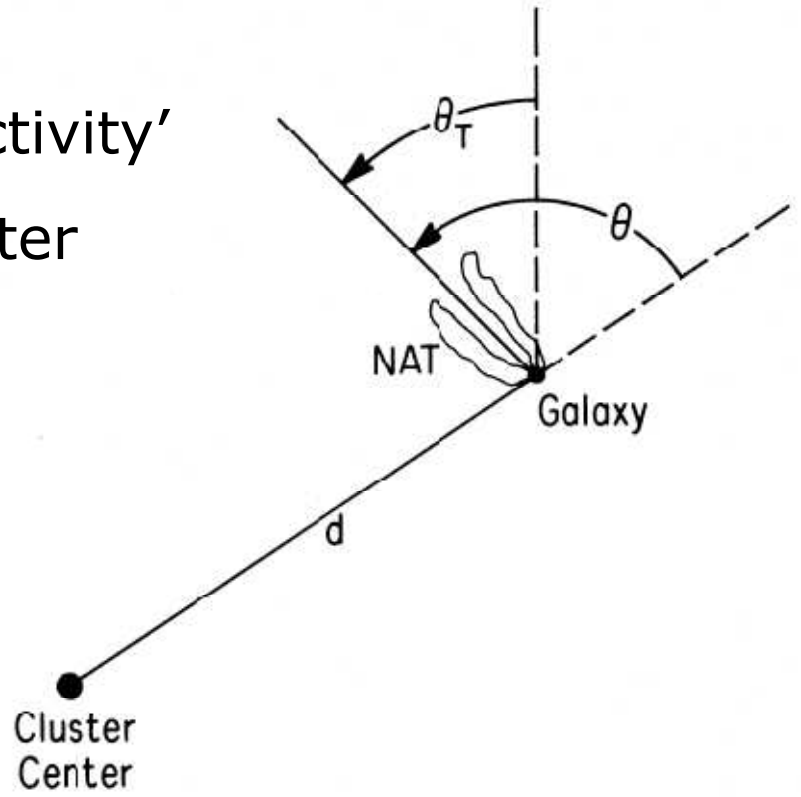
Abell Catalogue [1989]

4073 Clusters, 2712 Northern



Motivation – Unique Environment

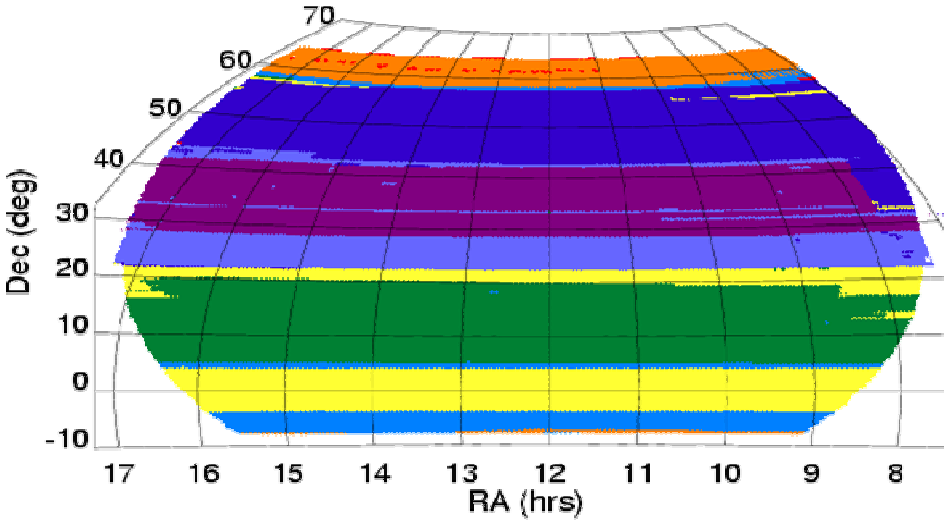
- Luminosity Functions:
  - Most systematic approach - 'activity'
  - Comparison between field/cluster
  - Future Surveys
- Orbital distributions
  - Cluster / galaxy formation
- Galaxy – ICM relation:
  - AGN feedback/accretion
  - Star Formation History

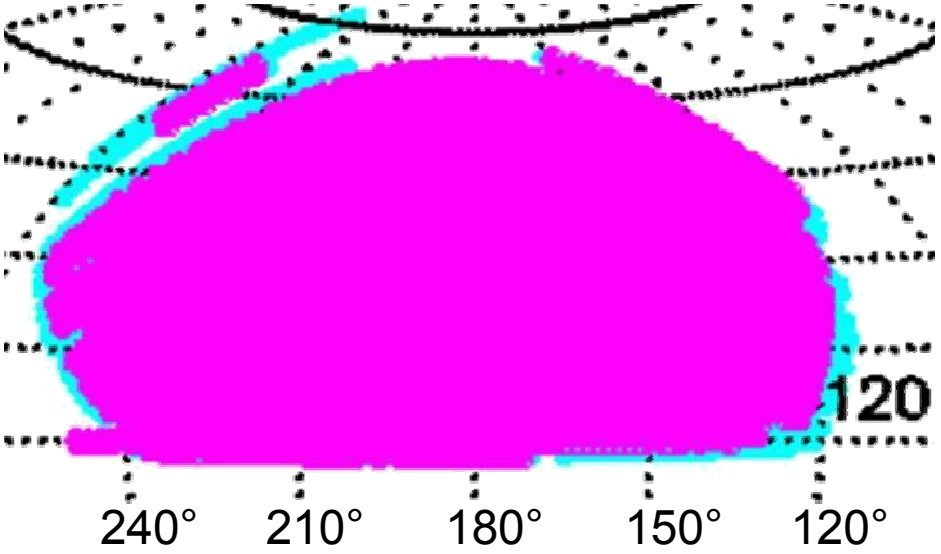


[O'Dea et al 1987]

Surveys

- Radio – VLA FIRST
- 1365/1435 MHz
- Optical – SDSS DR6
- Spectro – SDSS DR7





Sky Area	*9055 deg²*	*9,380 deg²*
Objects	*816,331*	*357x10⁶ / 1,640,960*

Radio Sources Sampled

- 1361 Abell clusters
  - z ~ 0.0201 – 0.4069
- 124 988 objects
  - within 1800” / 2100” radius of Abell centres
  - >47000 with SDSS optical magnitudes
  - ~9000 with SDSS redshifts

✓ Large sample size

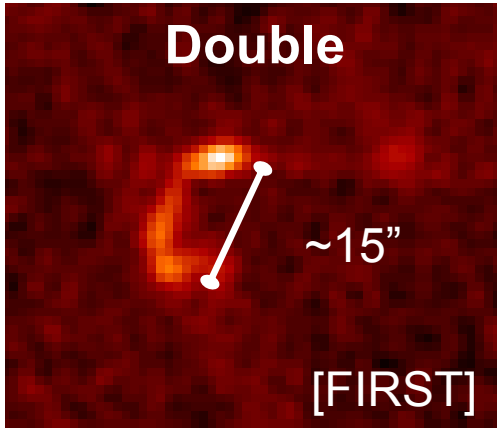
✓ Radio, Optical, Spec^c data

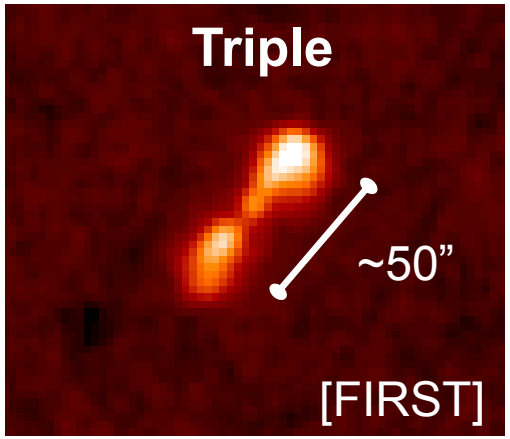
- Objects per cluster (with cuts - sidelobes, *):
  - Mean 57 Max 125 Min 12 σ=11.5

Grouping Associated Objects

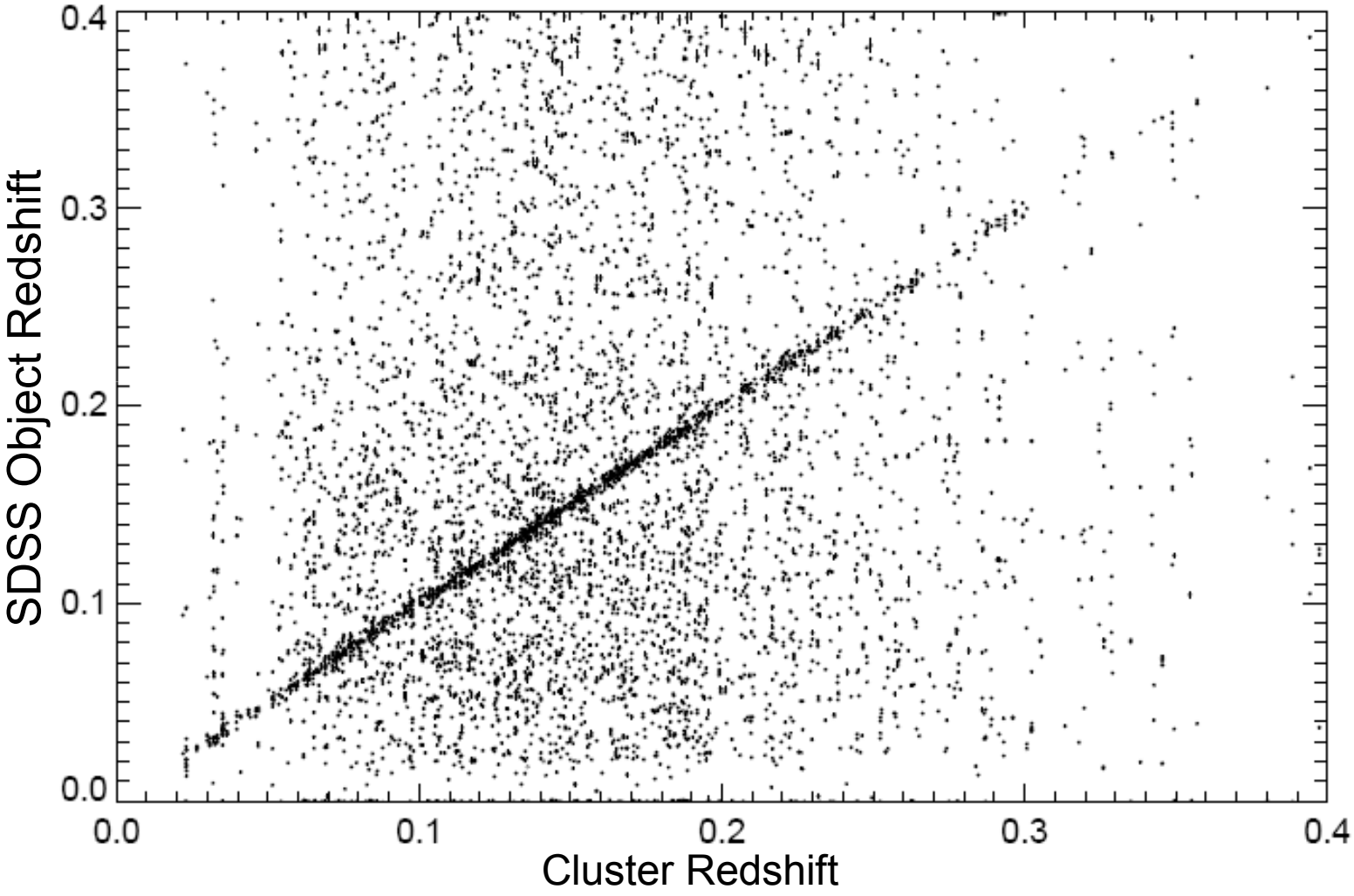
- Resolution of FIRST survey ~ 5”
- Extended sources may be listed multiple times
- Group double, triple, quadruple sources ~ <50” separation

Double = 8699 Triple = 950 Quadruple = 1184

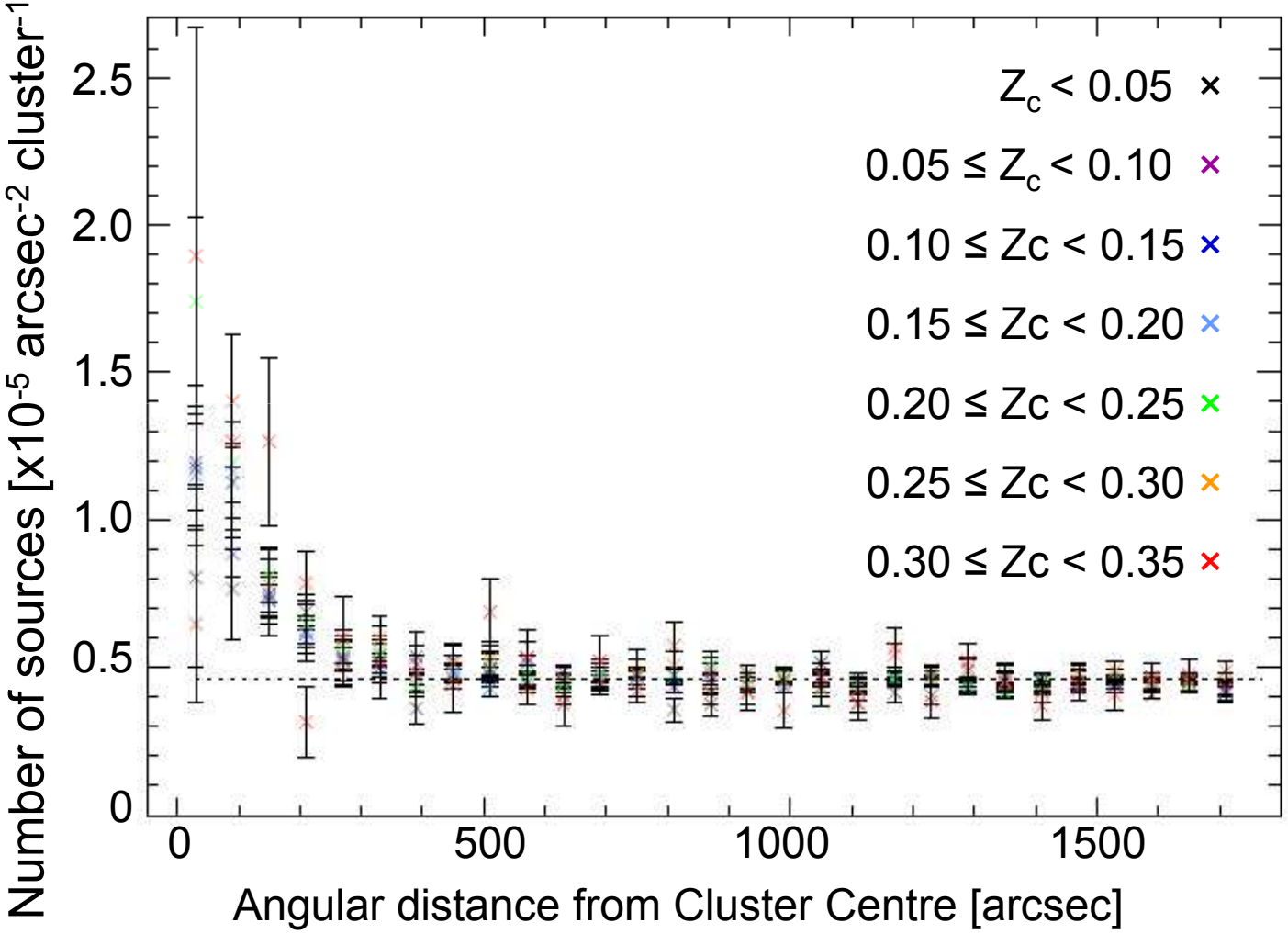




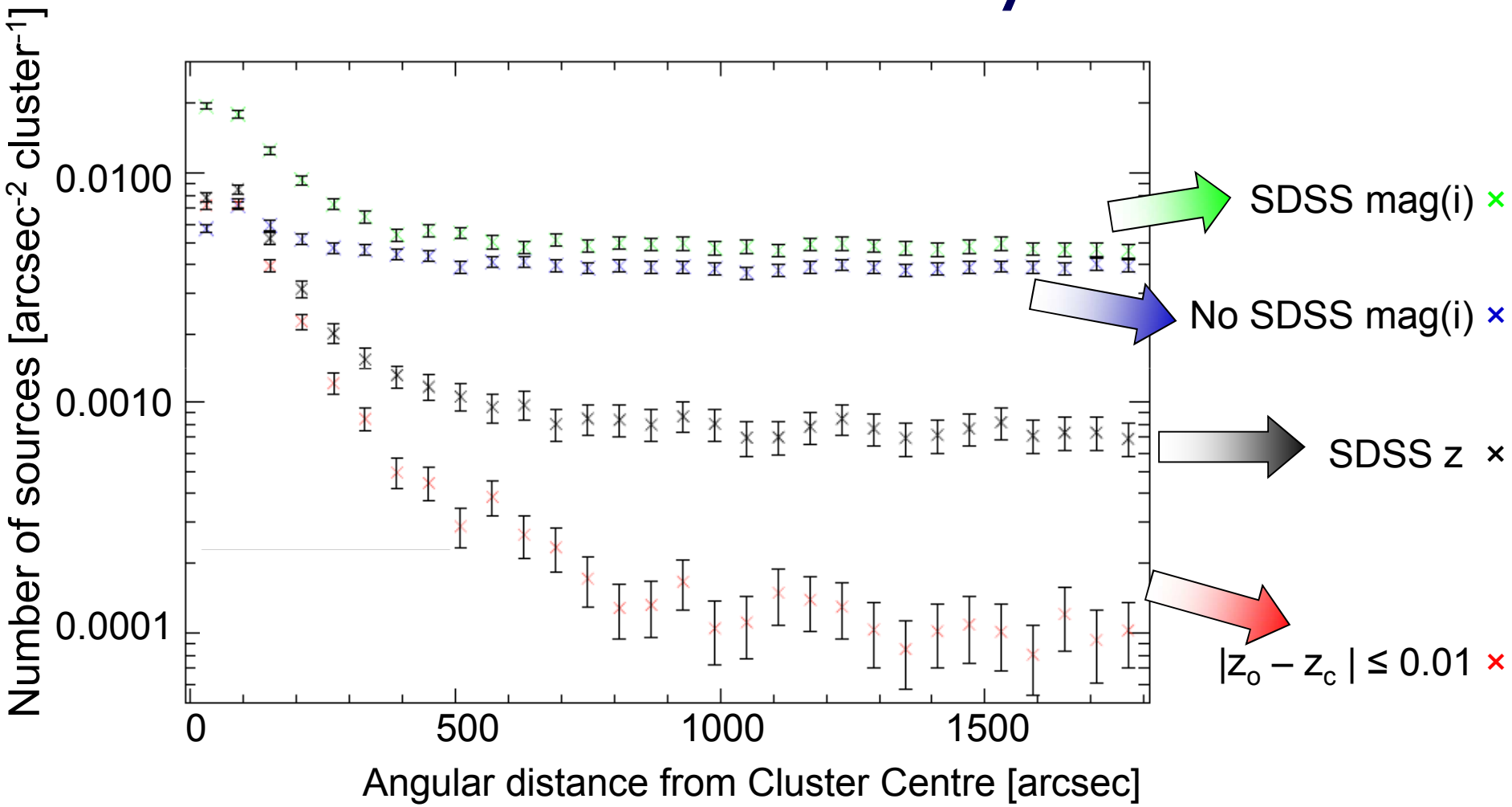
Cluster – Object Redshifts



Surface Density of Sources I

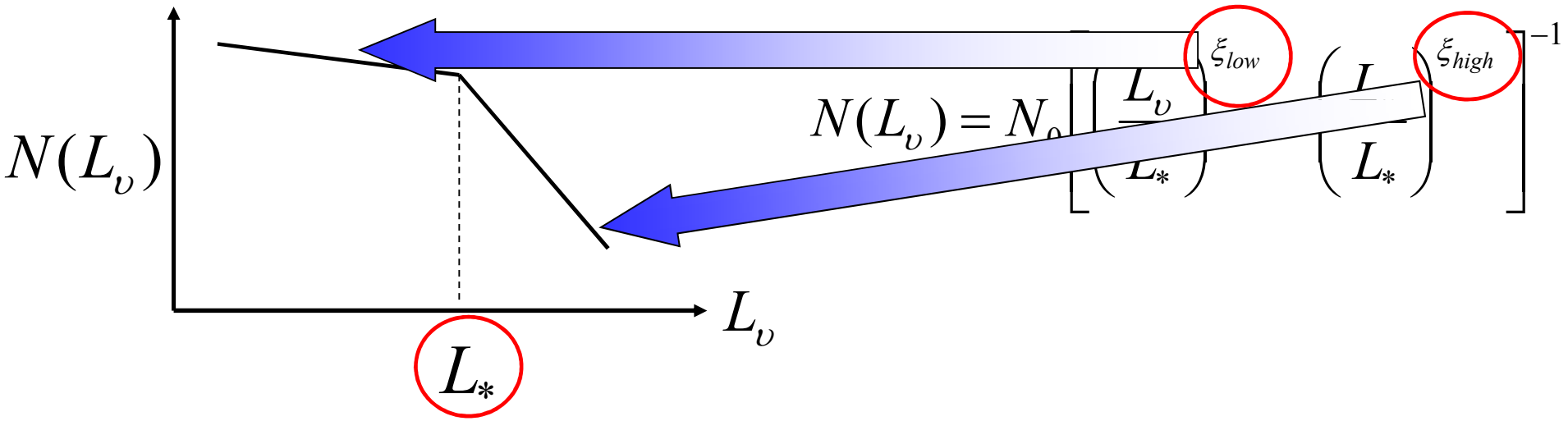


Surface Density II

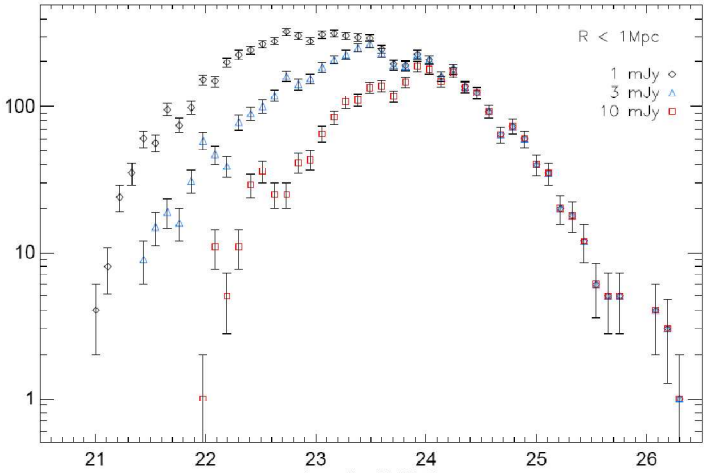


Radio Luminosity Function

$$= \frac{\text{Cluster Sources (R≤1Mpc) – Background Sources (R>2Mpc)}}{\text{Number of clusters}}$$



Radio Luminosity Function



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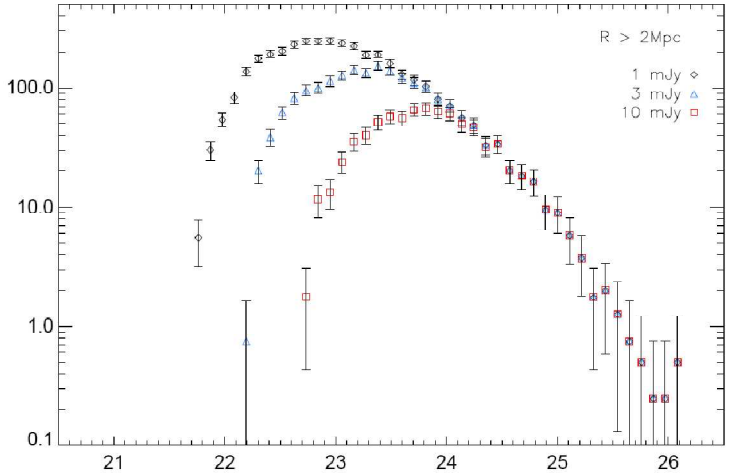

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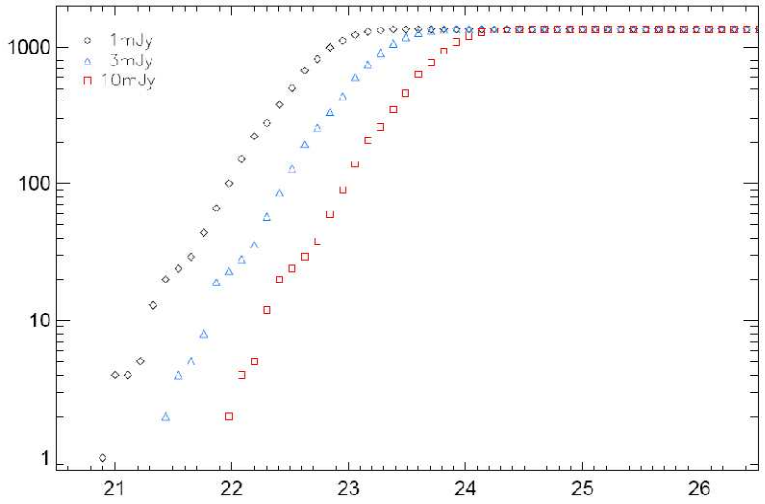
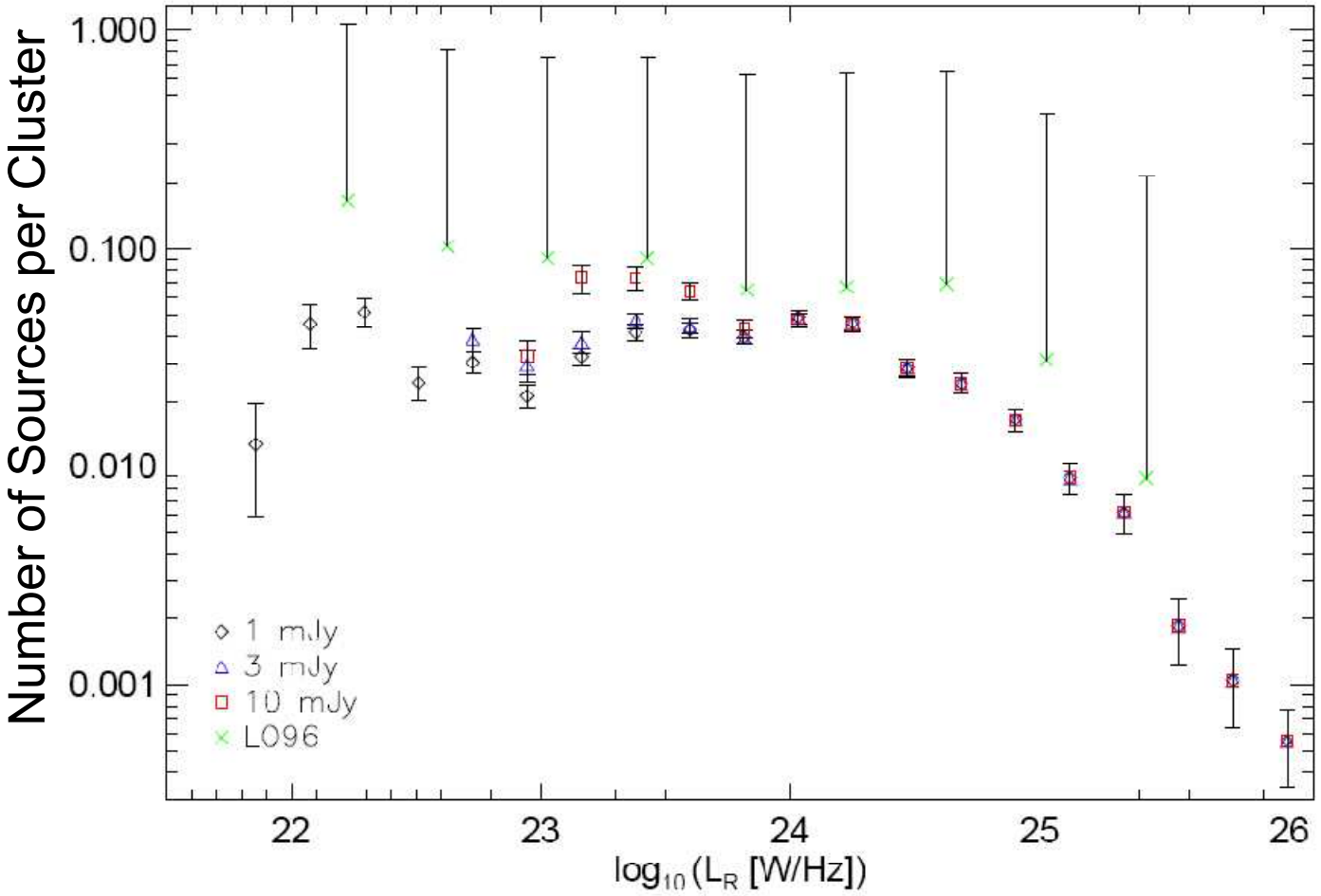


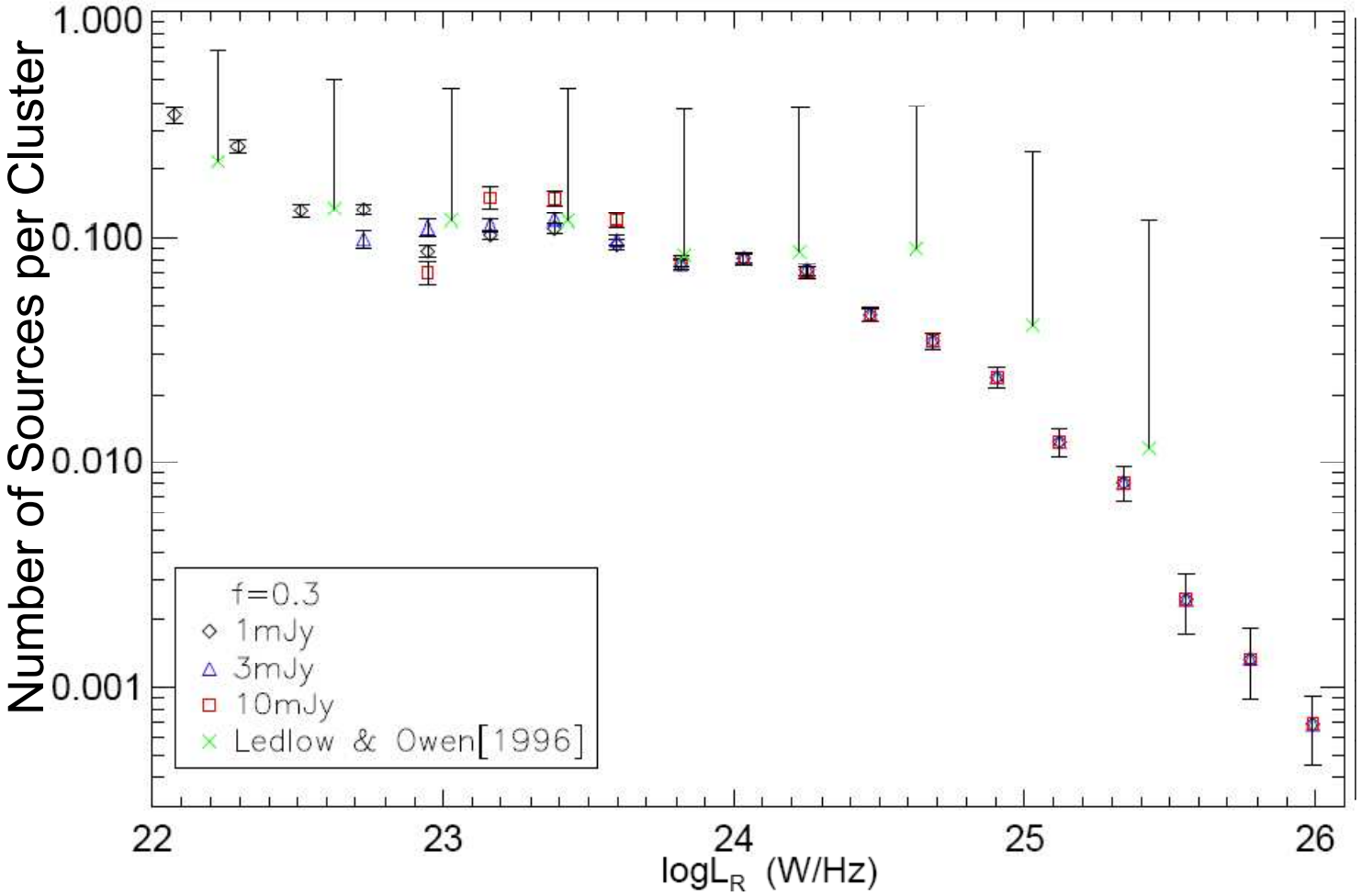
Number of Clusters Number of Sources

Radio Power [log(W Hz^{-1})]

Radio Luminosity Function I



Radio Luminosity Function II



Project Conclusions

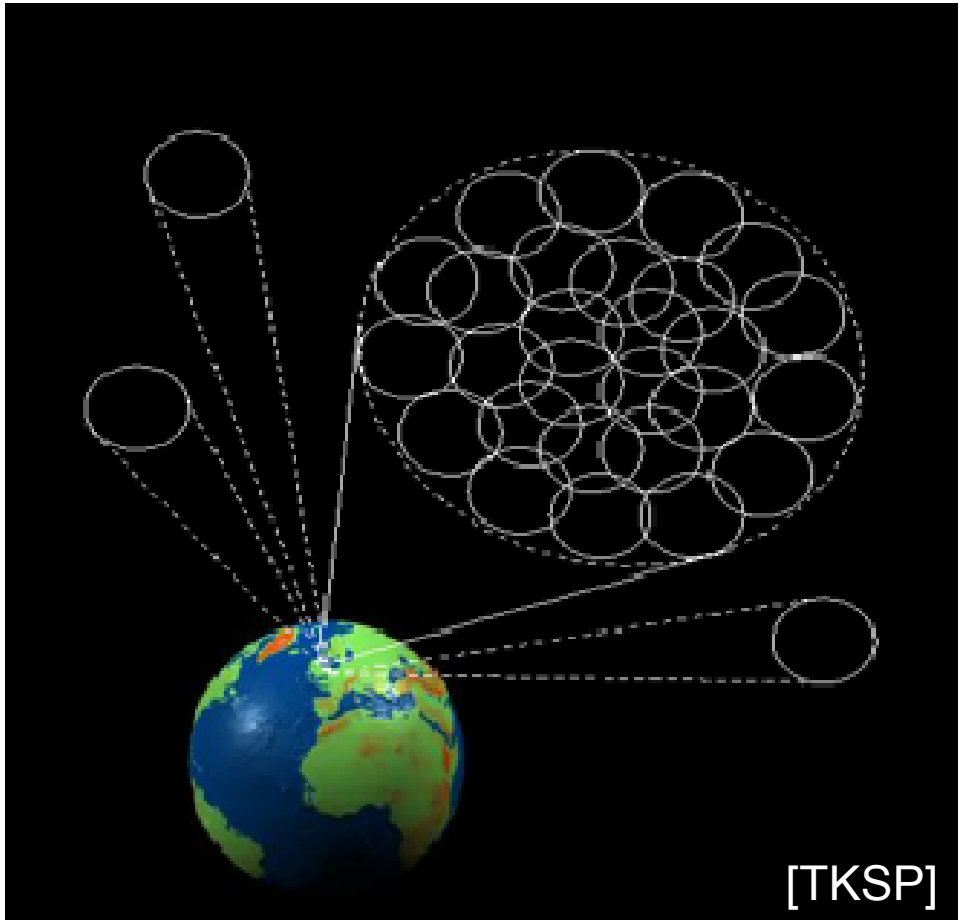
- Conclusions – Successful!...
  - Radio, optical, spectroscopic data for 1361 clusters
  - Cluster to background ratio and parameters
  - Significant overdensity noted in angular scale -> R≤1Mpc
  - RLF evaluated
    - Reduced errors, 0.3-0.6 b/g subtraction promising
- Extensions… including…
  - X-ray data for cluster centres
  - BCG inspection (using SDSS)

...LOFAR: Survey KSP

- Survey KSP
- Survey *entire* sky

  @ 15, 30, 60, 120 MHz

- Obtain large number of extragalactic sources
- Compare…



LOFAR: Magnetism/Transients KSP

- Moving on…

From the large (clusters)…

to the slightly smaller… Pulsars!

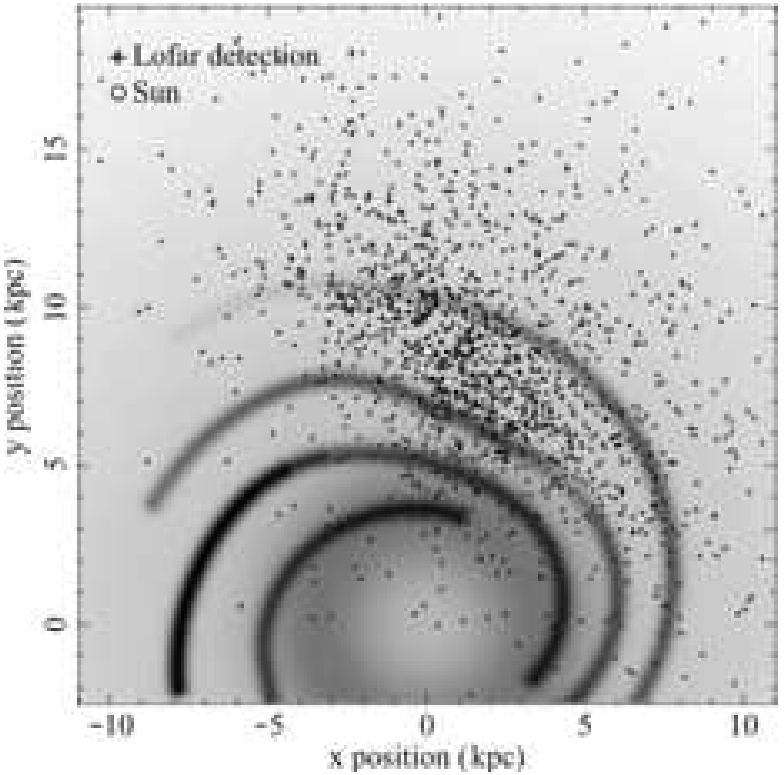
- Transients:

"detect all pulsars within 3 kpc" ~ 1000 new discoveries!

- Magnetism:

Use Faraday Rotation Measures

See Aris' talk tomorrow….



Simulation of pulsar discoveries with 60-day LOFAR all-sky survey

[van Leeuwen & Stappers (2008)]

Thanks for listening!!