Probing Merging Galaxies and Active Galactic Nuclei

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OUTLINE

Hyperz

- Using hyperZ to fit redshift of merging galaxies

Examine Galaxy cluster

- Doing some statistic to prove the existence of a starforming galaxy group

Introduction -- Database

RCS2 Morphology Selected galaxies

- Our galaxy samples are from CFHT's RCS2.
- It's a wide field, deep exposure survey (compared with SDSS).
- But it has coordinate error, due to the wide field camera, thus I took the catalog fixed in **Huang & Hwang 2011**, in Elais N1 (few in other sky regions).

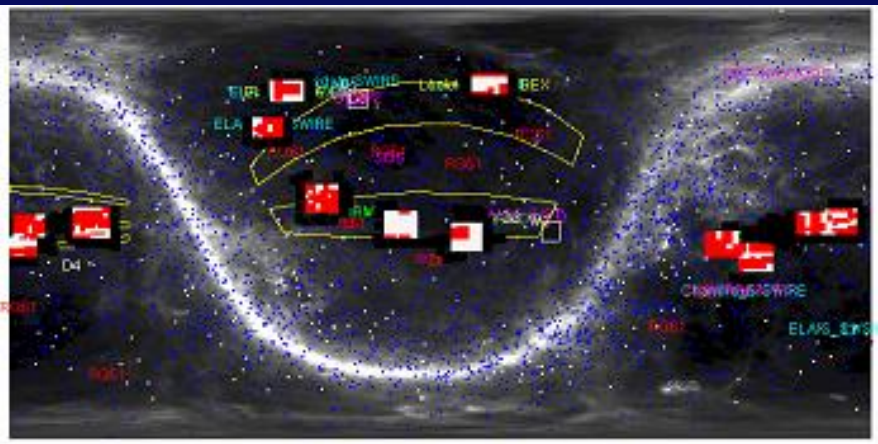


Figure 2.4: Red patches in white boxes are 422 sq. degrees images that we downloaded.

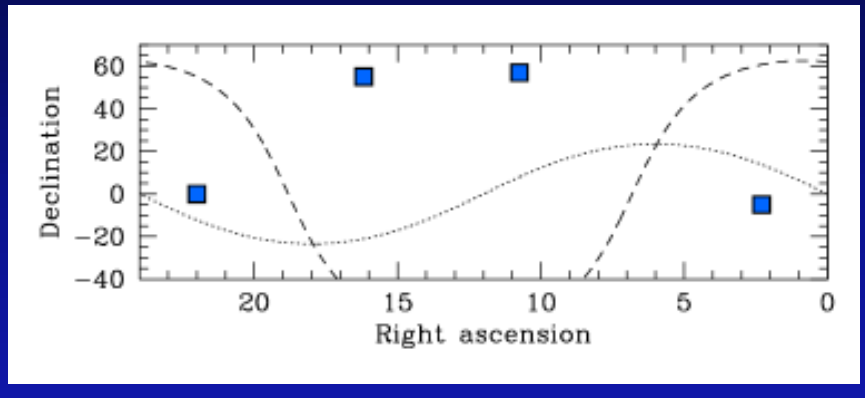
Table 1
SWIRE Fields Overlapped with RCS2

Field	Center Coordinate (J2000)		Area (deg^2)
	R.A.	Decl.	
ELAIS N1	$16^h11^m00^s$	$+55^d00^m00^s$	9.00
ELAIS N2	$16^h36^m48^s$	$+41^d01^m45^s$	4.45
Lockman Hole	$10^h45^m00^s$	$+58^d00^m00^s$	14.32

Introduction -- Database

SDSS & UKIDSS photometry

- It is better to have more bands to do the photometric redshift, since it will make the observed SED(Spectral Energy Distribution) more complete.
- We take SDSS u', g z' bands, and com with UKIDSS J, K

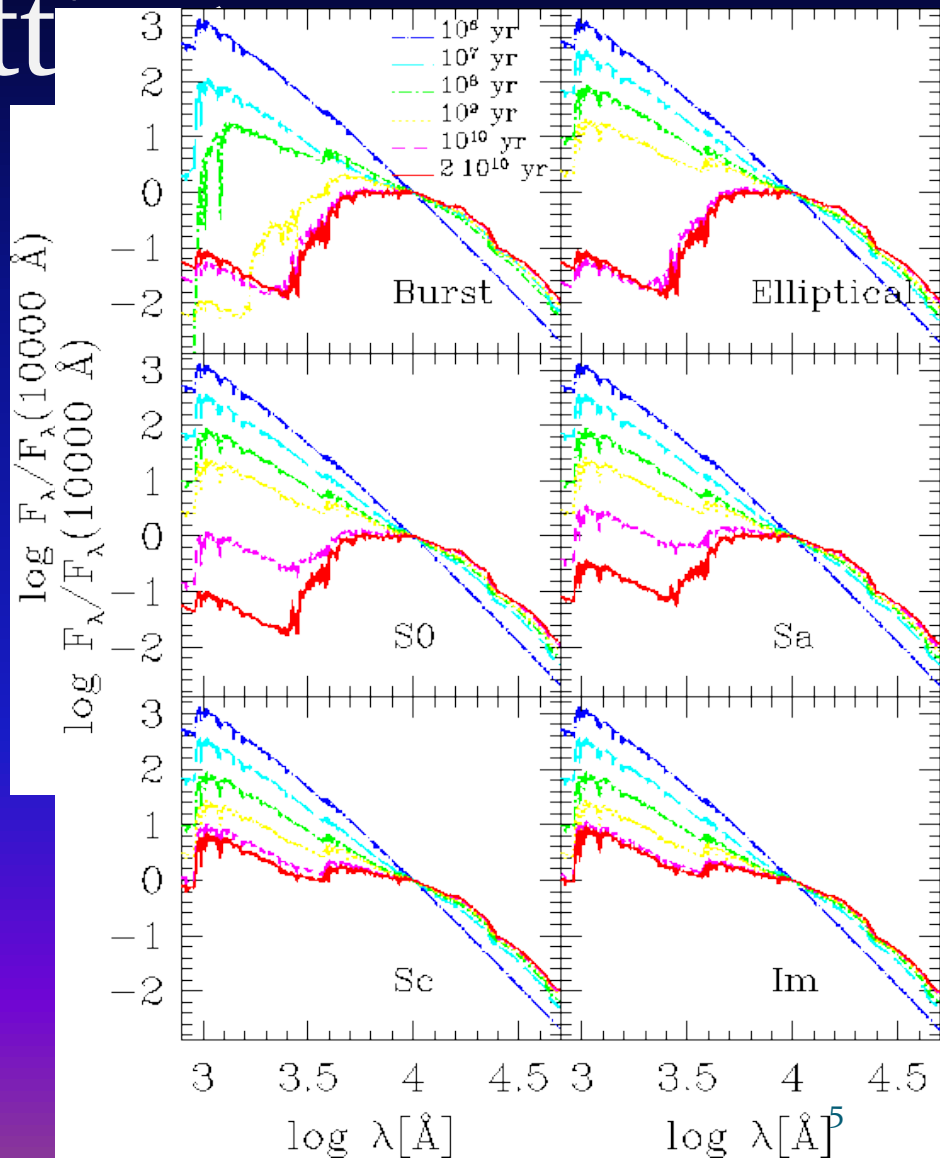


Name		Area sq. degs	RA J2000	Dec	
7-year plan	Filter	Area sq. degs	Mag. limit (Vega)	t(exp.)	t(total)	Nights
Deep Extragalactic Survey DXS	J	35	22.5	2.1h	415h	118
	H	5	22.0	4.4h	124h	
	K	35	21.0	1.5h	287h	

Introduction -- Hyperz

Galaxies SED fitti

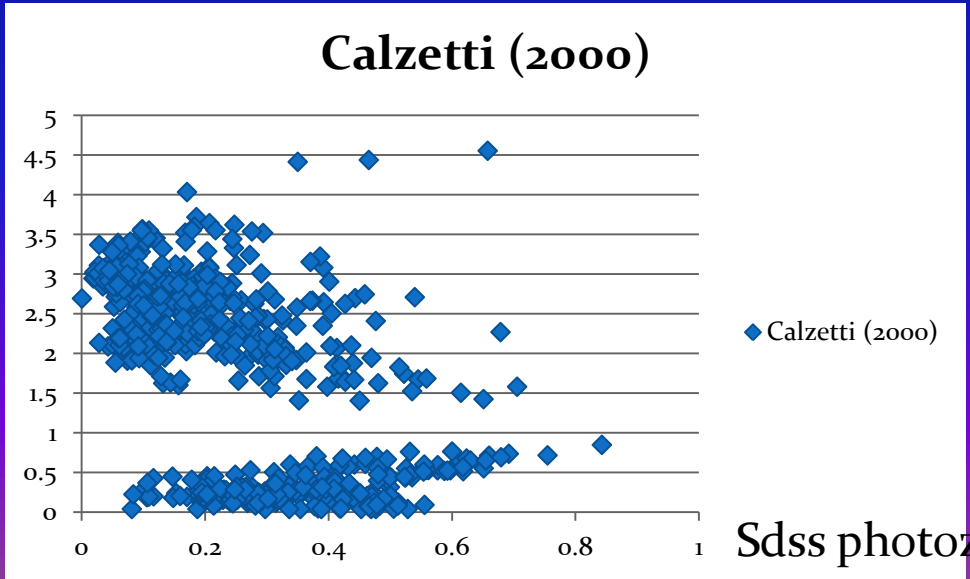
- HyperZ provided both observed SEDs and spectral synthesis models in order to get estimate redshifts.
- Evolution of the SEDs of different spectral types computed using the spectral evolutionary models of Bruzual & Charlot (1993), with Miller & Scalo IMF, solar metallicity and characteristics of the SFR as shown in Table 1.



HyperZ problem

- The observed SED of a given galaxy is compared to a set of template spectra:

$$\chi^2(z) = \sum_{i=1}^{N_{\text{filters}}} \left[\frac{F_{\text{obs},i} - b \times F_{\text{temp},i}(z)}{\sigma_i} \right]^2 ,$$



Constraint Free paramerers

- Constraints z value <1.5
- Templates adopted

Examine with redshift known galaxies

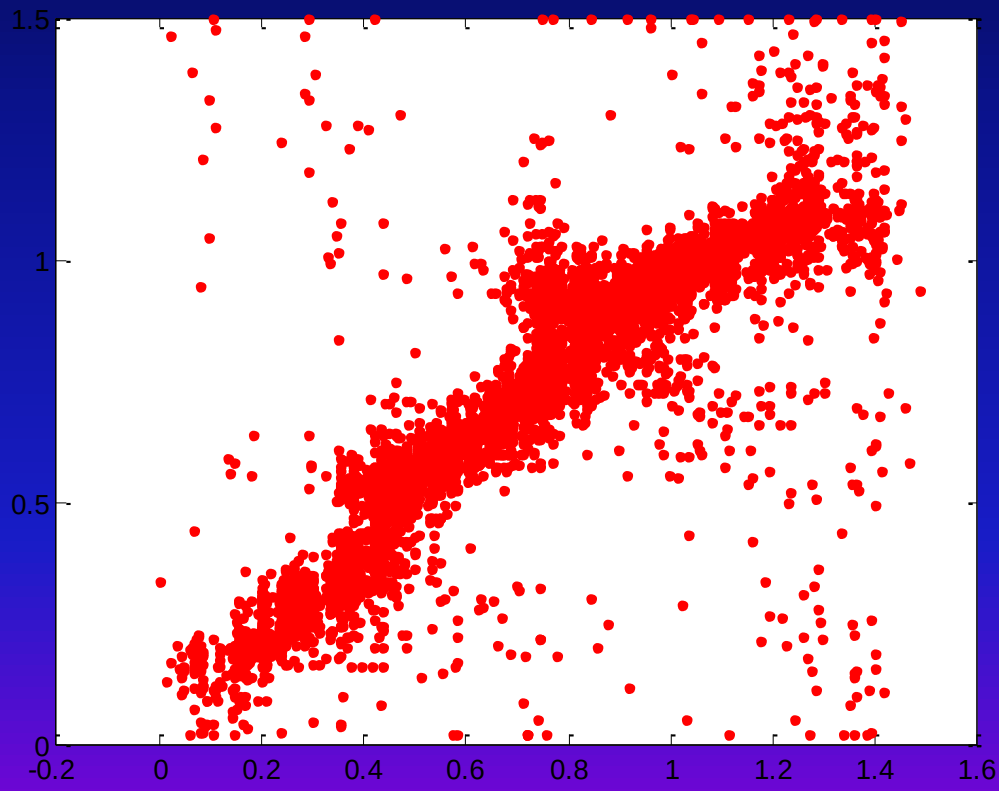
- EGS galaxies, selected by photometry.
- **Lin et al. 2009**

Zero-point fixed

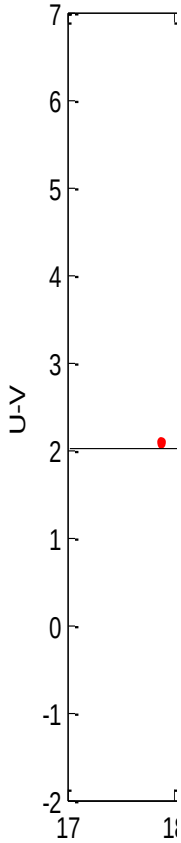
- *Median error
- Linear Regression

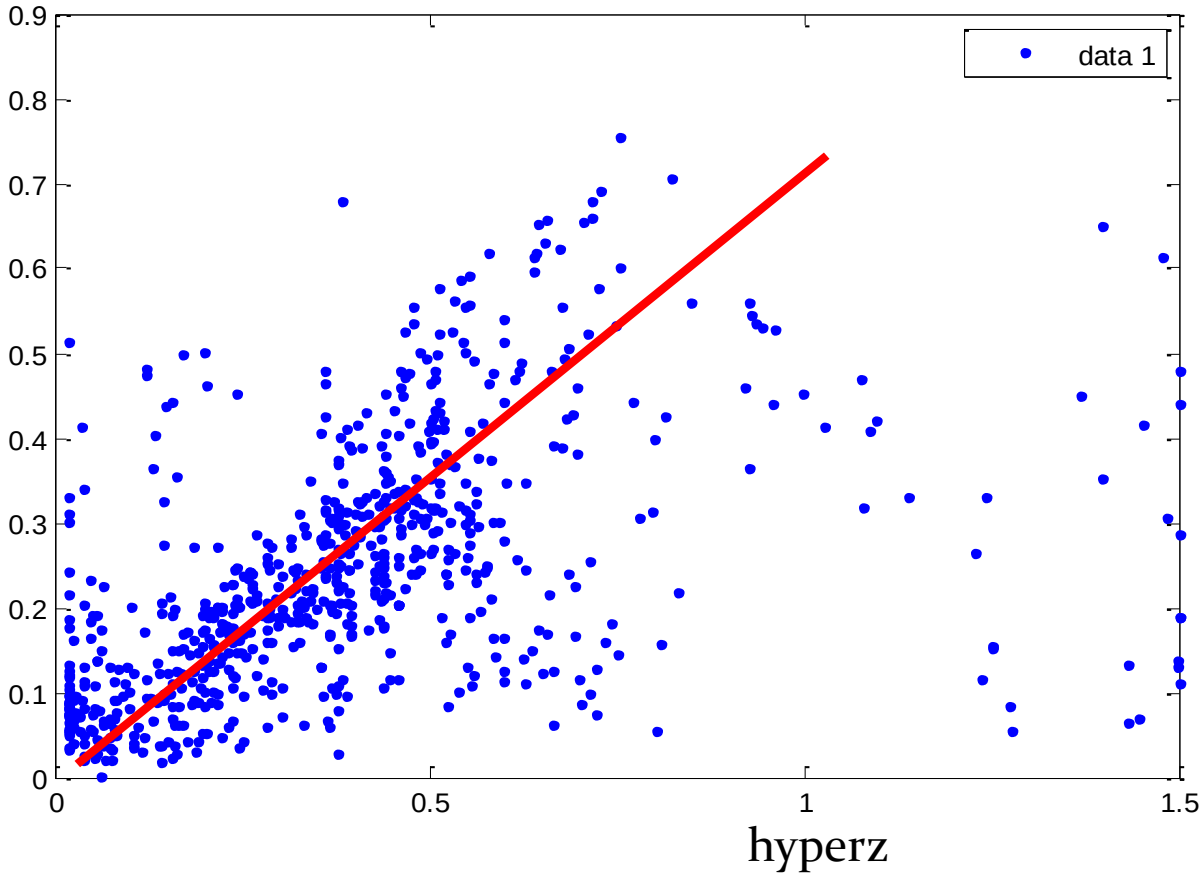
After Zero point fixed

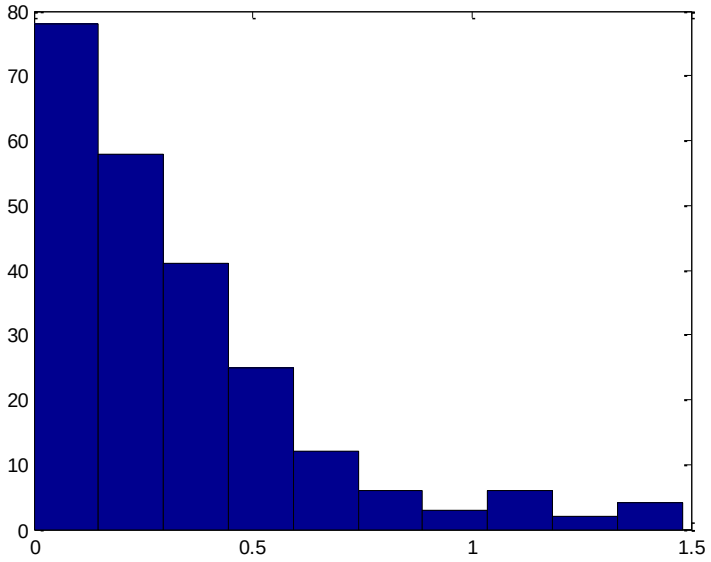
- I use egs galaxies with Burst template, those z_err~0.04. (Best template)
- Use the template output SED (it will gives the value of magnitude calculated)
- Do the linear regression and **median** of error, to fix systematic error.



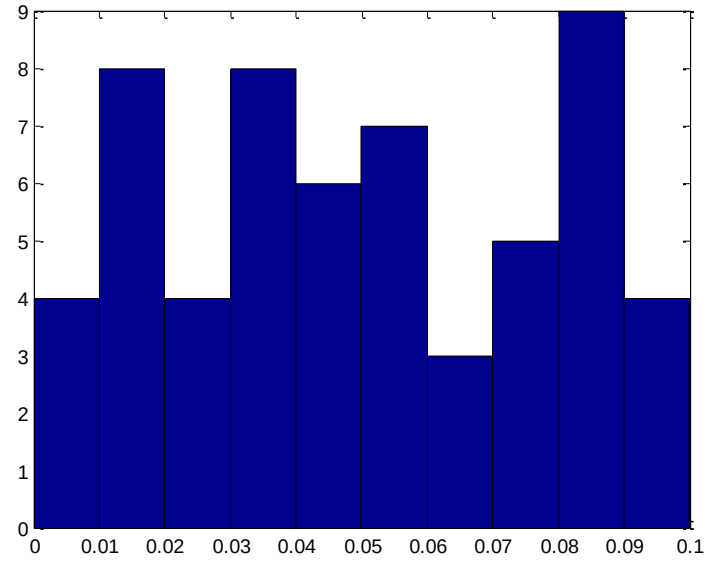
Reproduce the process





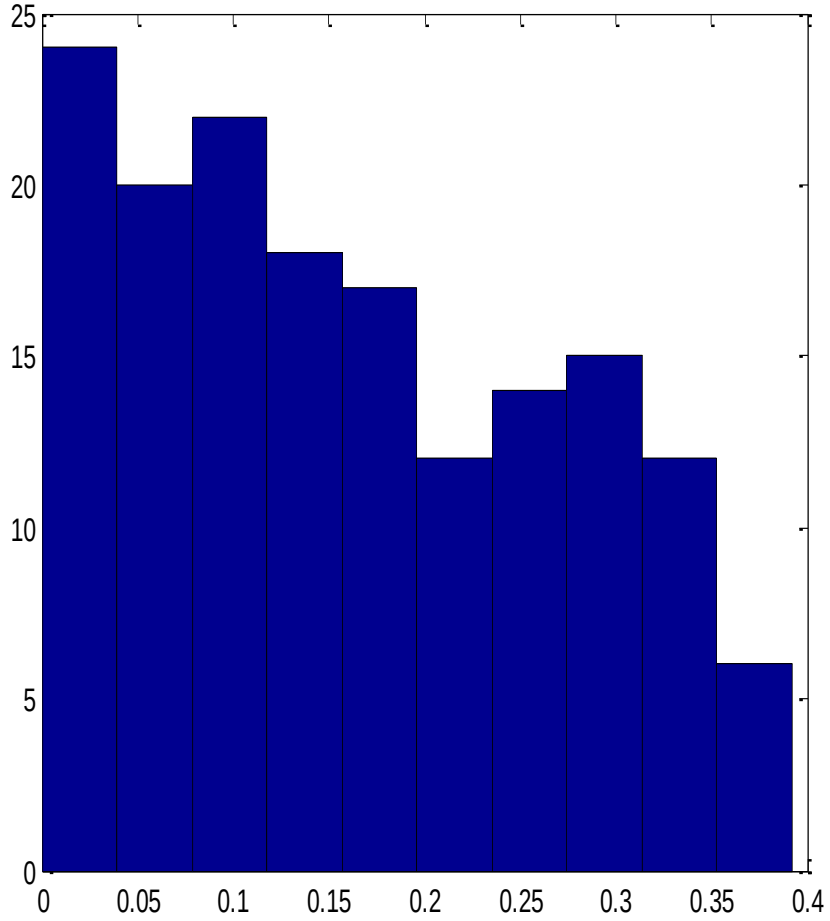


Close-pair z difference



- Since we can not guarantee our result to be very accurate, we can only take the result of **close-pairs.**
- If the difference of redshift in close-pair is smaller than 0.05, we consider it should be the real redshift, since it **is less likely** to be just a **coincidence**! (From EGS statistic, a half of the hyperZ is in accuracy better than 0.05)

Take Close-pair result



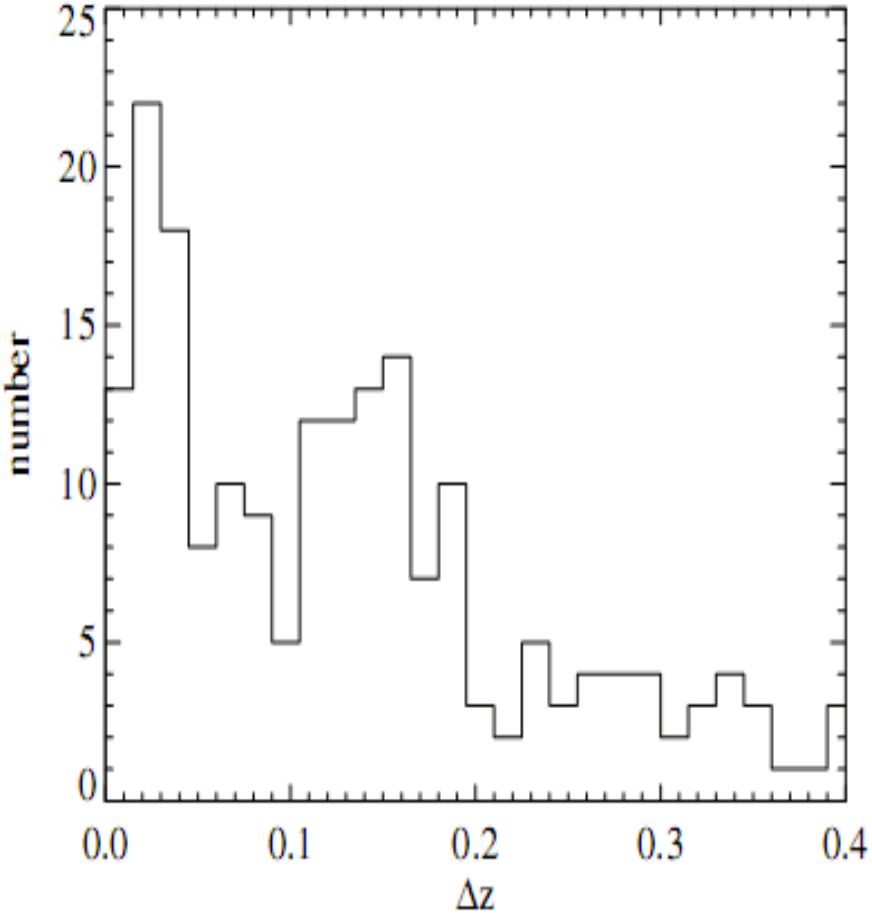


Figure 3. Distribution of redshift difference for galaxy pairs.

OUTLINE

HyperZ

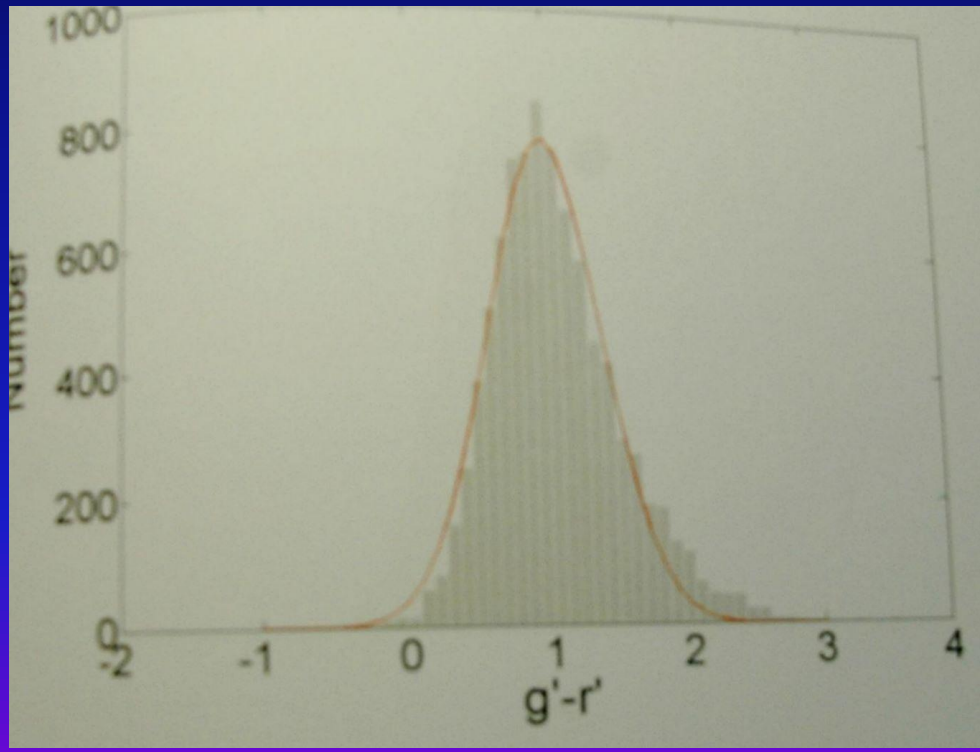
- Using hyperZ to fit redshift of merging galaxies

Examine Galaxy cluster

- Doing some statistic to prove the existence of a starforming galaxy group

Introduction -- OVRGs

- To investigate the properties of the red galaxies, it was selected by optical band with RCS2 data (Red Sequence Cluster Survey 2).
- With g'-r'>2.2 or r'-z'>1.8, about 3σ level in statistic.
- Combined with SWIRE (Spitzer Wide-area InfraRed Extragalactic databese).



***Wei-Fang Liu et al.**

OVRGs Spacial Distribution

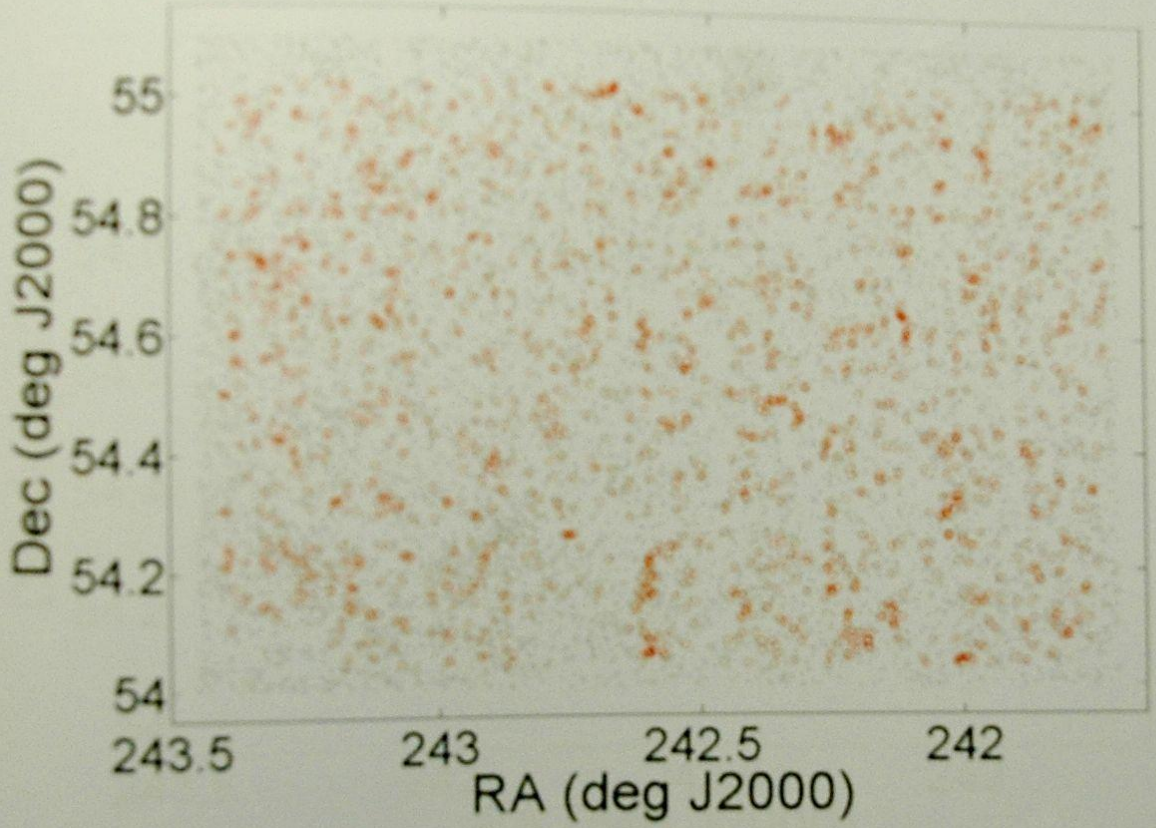


Figure 4.5: Spatial distribution of the OVRGs and other galaxies detected at the SWIRE 3.6 μm. The OVRGs are shown as red circles, and the other galaxies are shown as gray dots. There is an obvious line structure at around RA=242.575 deg and dec=+54.2 deg (J2000).

OVRGs

- It is considered OVRGs might be elliptical-like galaxies or dusty starforming galaxies as EROs
- OVRGs with detectable 24μm detection have lower 8μm emission than normal spiral-like galaxies.

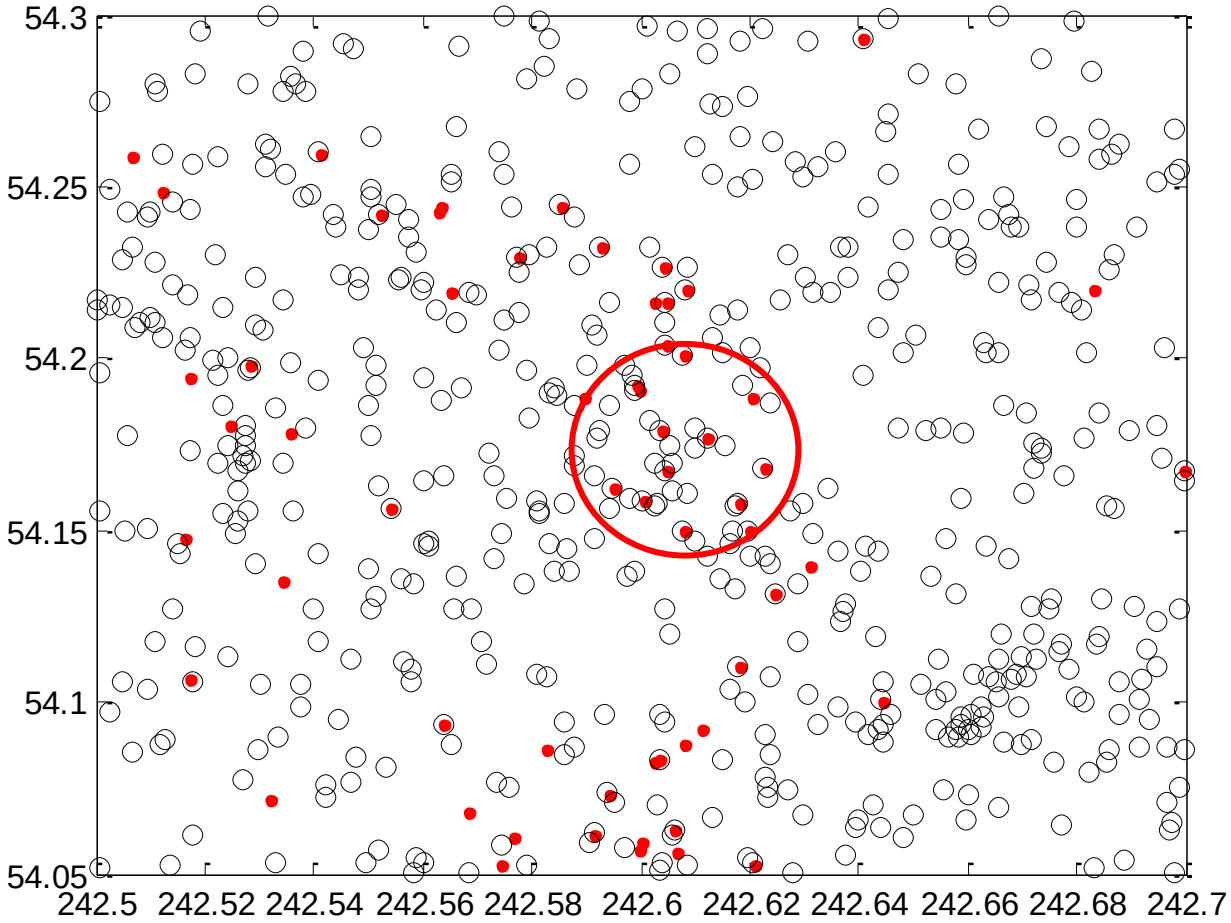
⇒They are new star-forming galaxies with very young ISM contain little or no PAH molecules

⇒Or very luminous starforming galaxies at high redshifts.

(Wei-Fang Liu et al.)

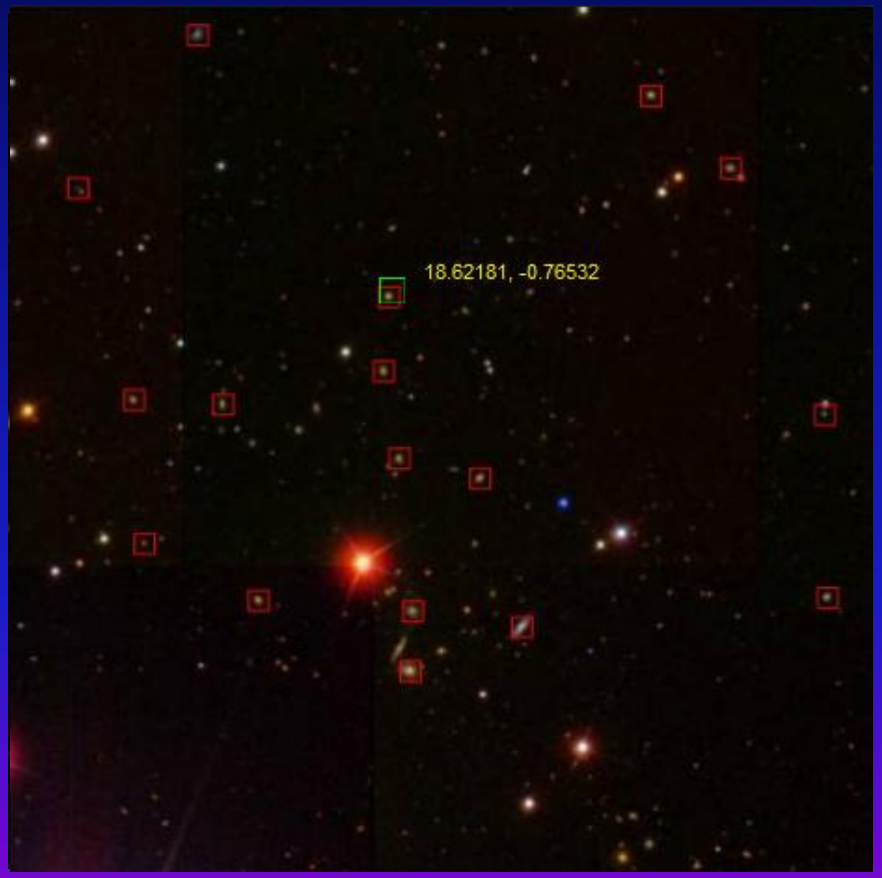
Which is our filament structure? Let's check it!

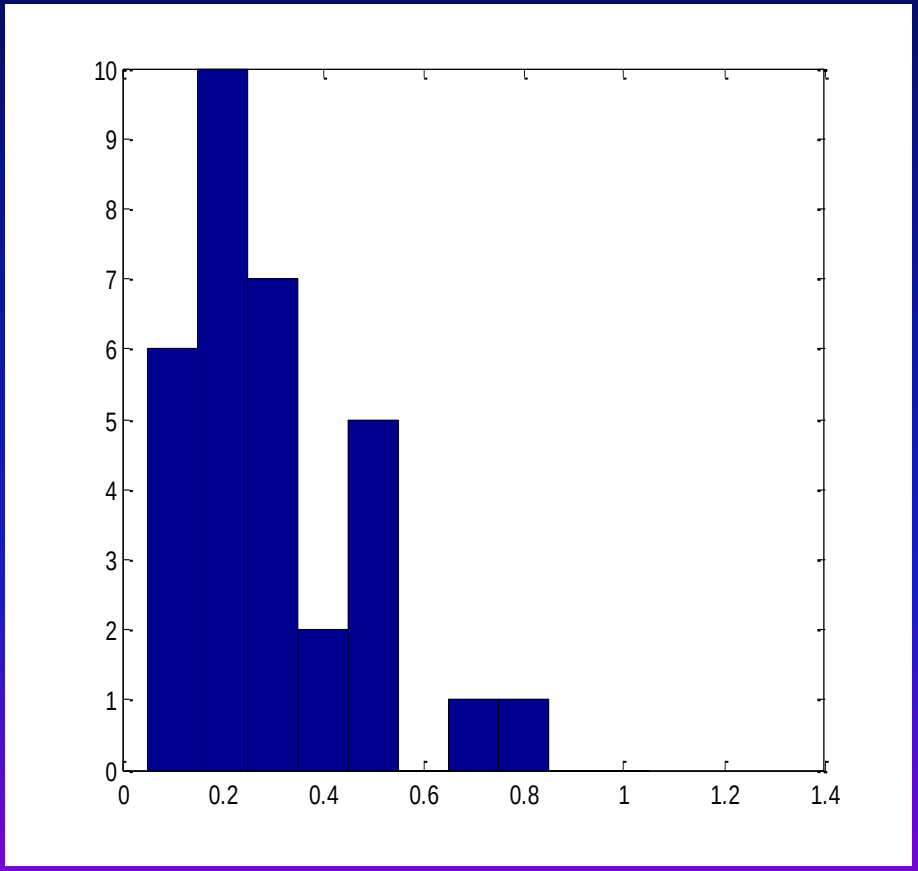
Clusterlike Structure?



- Red dot: OVRGs
- Black circle: SDSS galaxies
- If most of the OVRGs were elliptical, it is expected to find OVRGs in some clustering structure, considering elliptical are mainly in clusters.

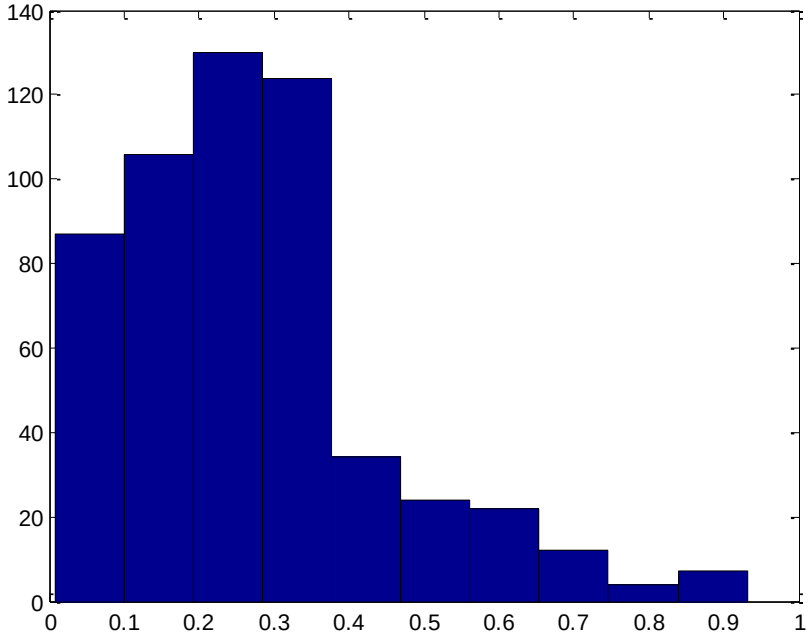
No Spectrum available…

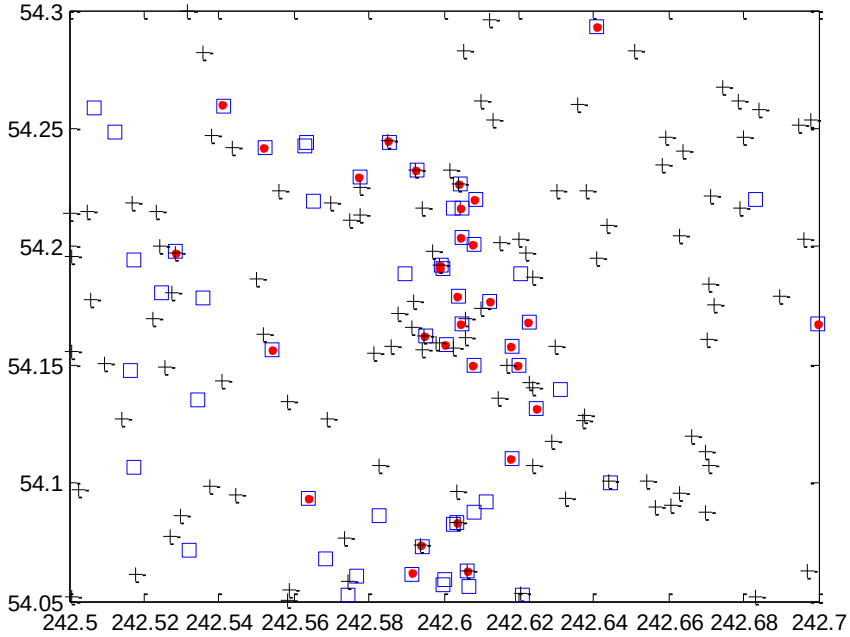




Distribution of OVRGs, has SDSS counterparts

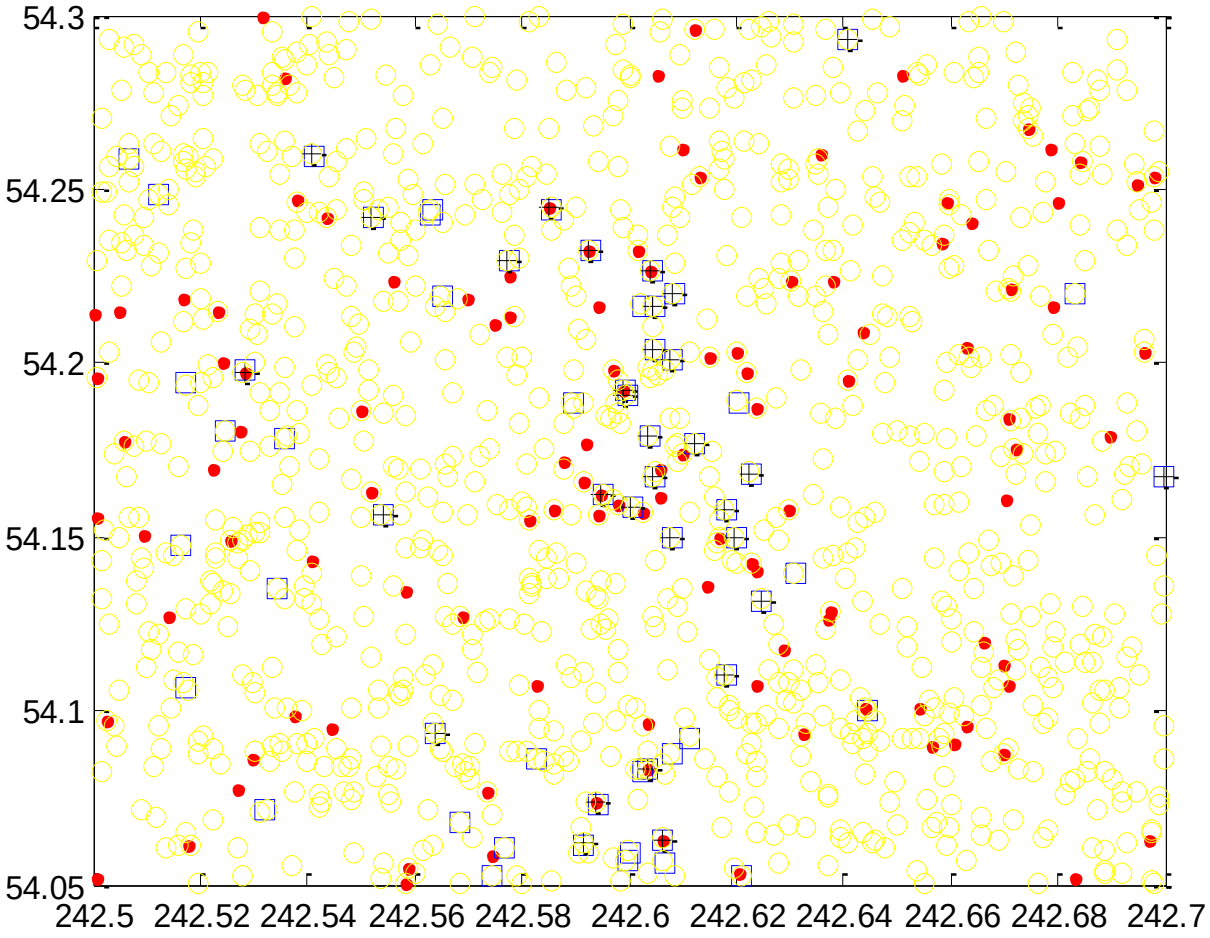
Filament structure z~0.2-0.3



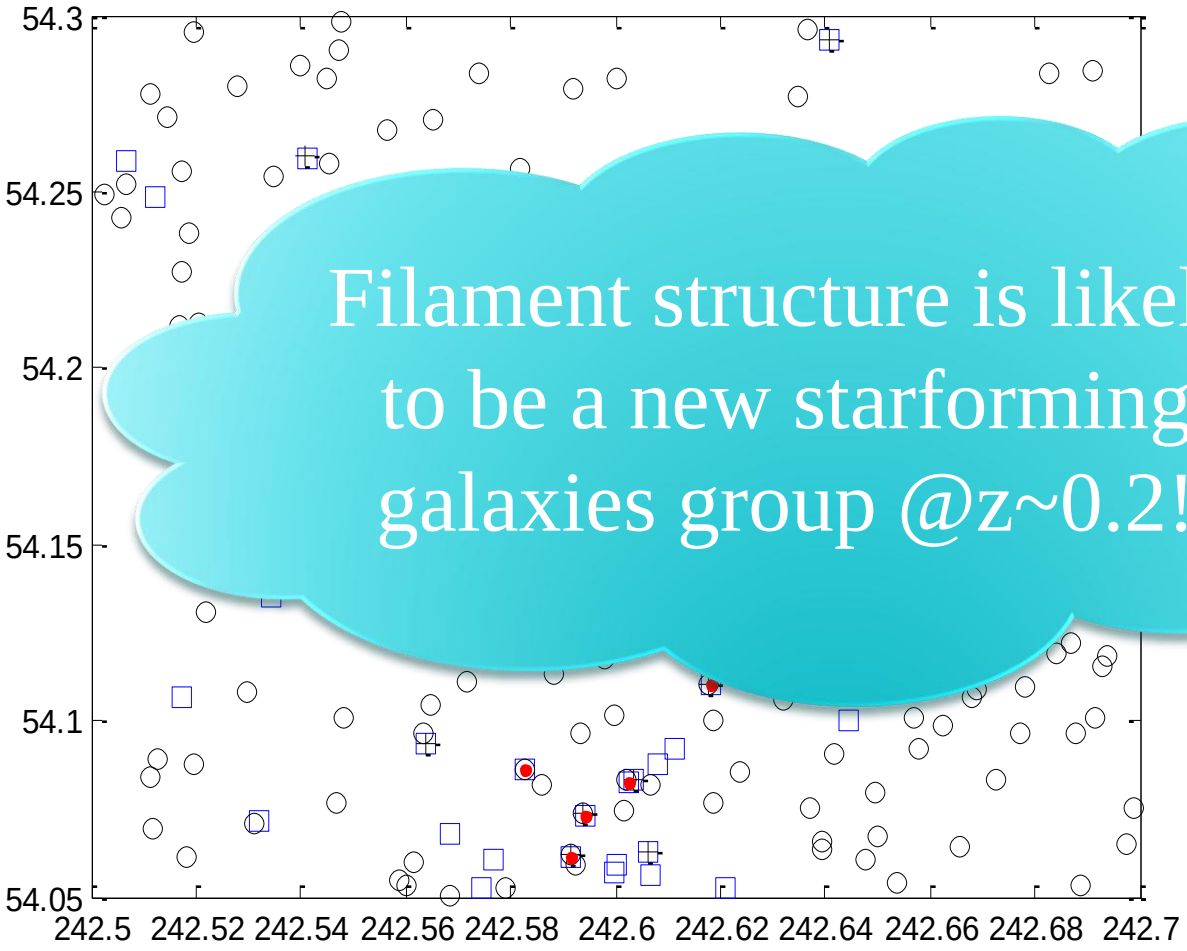


SDSS galaxies photoZ distribution

Blue square: OVRGs
Red dot: OVRGs with SDSS counterparts
Cross mark: SDSS galaxies p.z=0.2~0.3



Red dot: SDSS galaxies, z=0.2~0.3
Blue square: OVRGs
Cross mark: OVRGs with SDSS counterparts
Yellow circle: SWIRE 3.6 micron detection



Filament structure is likely to be a new starforming galaxies group @z~0.2!

…rcle: SWIRE 8
…etection
…OVRGs with
…nicron
…arts.
…ue square: OVRGs
Cross mark: OVRGs with SDSS counterparts

Few of OVRGs have 24 μm detection

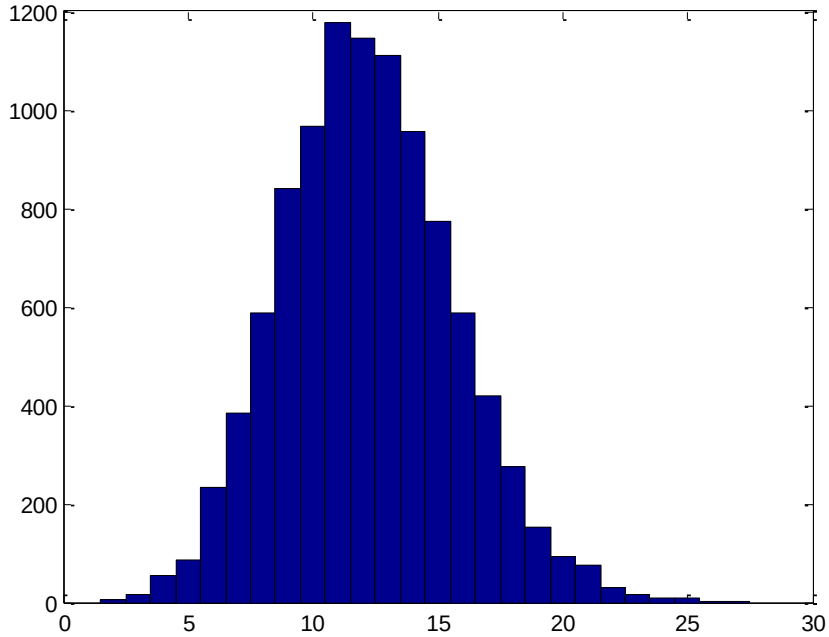
Further Examination (I)

- What if it's probability of it to be a coincidence?
- Examine with random distribution test

⇒For SDSS 550 galaxies, the probability for any 2*2 arcmin-qaure region to host >24 galaxies is smaller than 0.0012

(With 10000 times random trials)

=> Expect cluster number:1.4400

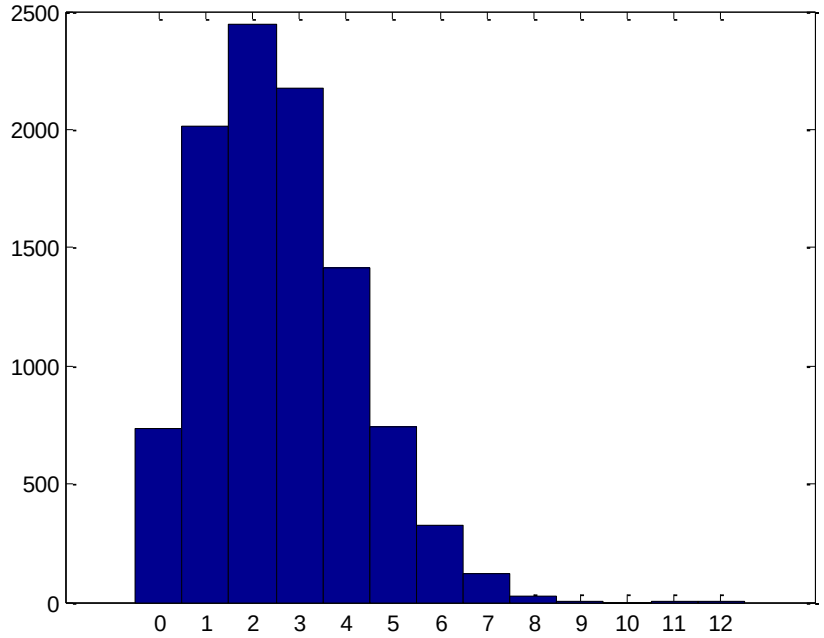


Further Examination (II)

⇒For SDSS 116 galaxies@ z=0.2-0.3, the probability for any 2*2 arcmin-qaure region to host >9 galaxies is 2.0000e-004

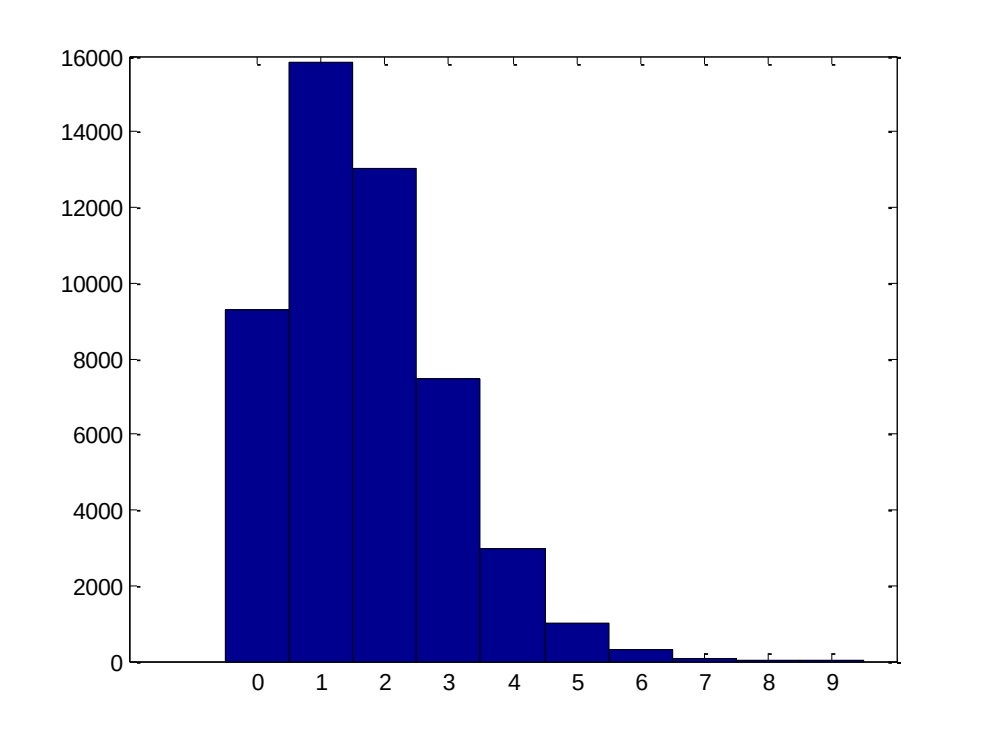
(With 10000 times random trials)

=> Expect cluster number:0.2400



Further Examination (III)

- Test the Origin group of OVRGs~3000 in 2 square degree.
- probability =
- 1.2000e-004
- exp =
- 0.1440
- OVRGs are considered to be a special group of galaxies, thus it is more likely to be real structure.



Conclusion

- From above examination, we conclude it's a real filament structure at z=0.2~0.3 (adopted SDSS photoz), though ROSAT doesn't observe any X-ray emission
- They are likely to be a new starforming galaxy group, with size~ 4 arcmin square.
- From redshift-angularsize relation:
- If it is a structure located around z=0.2

It's diameter should be 400 kpc

- If it is a structure located around z=0.3

It's diameter should be 550 kpc

- It is consistent with size of galaxy group, as the shape of OVRGs, which looks like filament structure.

Future Work

- **SMA observation for good photoZ close-pairs. (Radio observation need to know Z.)**
- **SMA observation for galaxy cluster (OVRGs)**
- **Precise redshift check, by large telescope observation**
- **Reproduce the method to find clusterlike structure to other sky region, find candidates for ALMA follow up.**
- **OVRGs properties check, we can reproduce it to other sky region with SDSS data. (but not as deep as RCS2)**