Galaxy Groups in AEGIS Field

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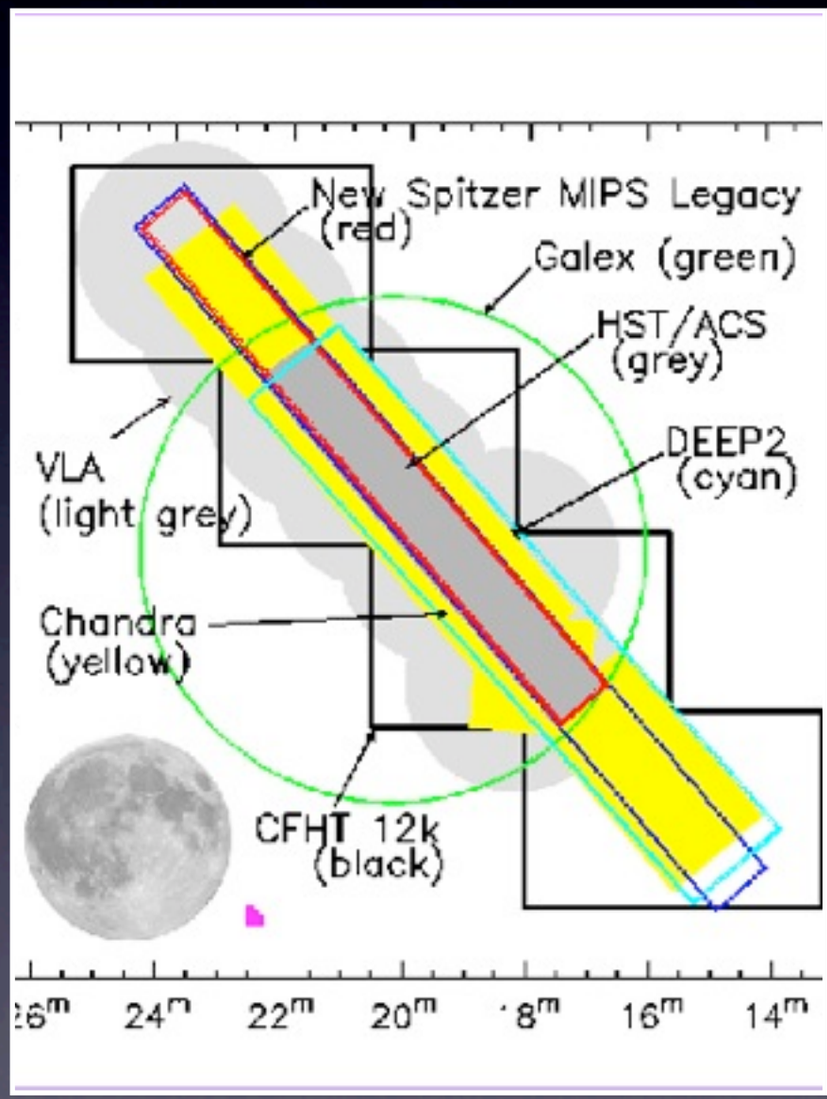
AEGIS

All-wavelength Extended Groth strip International Survey

- Targeted on a special area of the sky called the Extended Groth Strip (EGS) 0.5-1deg^2 : low extinction, low galactic infrared emission, good schedulability by space based observatories :Chandra/ACIS Xray, GALEX ultraviolet, CFHT/MegaCam Legacy Survey optical, CFHT/CFH12K optical, Hubble Space Telescope/ACS optical and NICMOS near infrared, Palomar/ WIRC near-infrared, Spitzer/IRAC mid-infrared, VLA radio continuum.

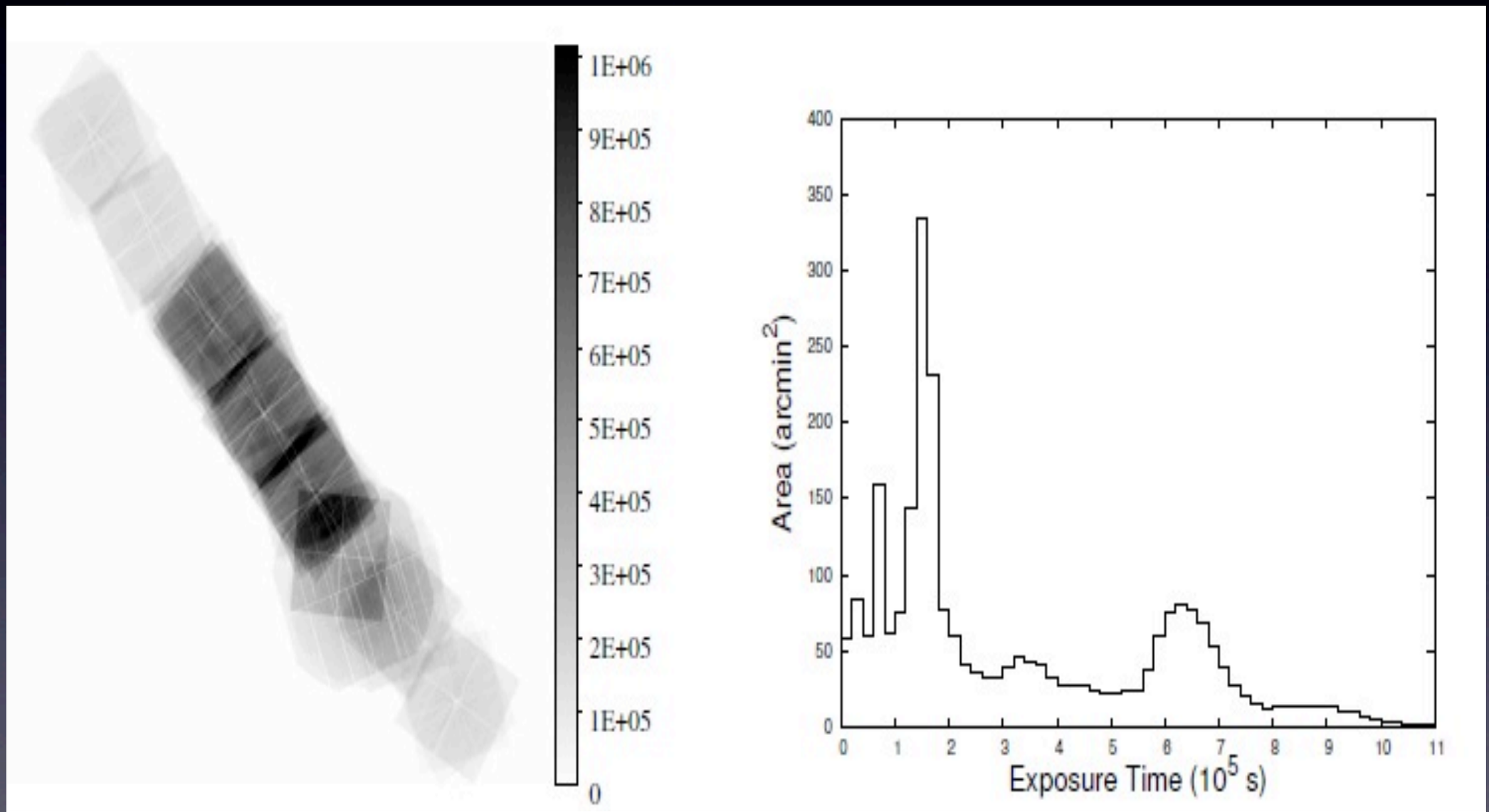
- This region of the sky has been targeted for extensive spectroscopy using the Deep Imaging Multi-Object Spectrograph (DEIMOS) on the Keck II 10 m telescope.



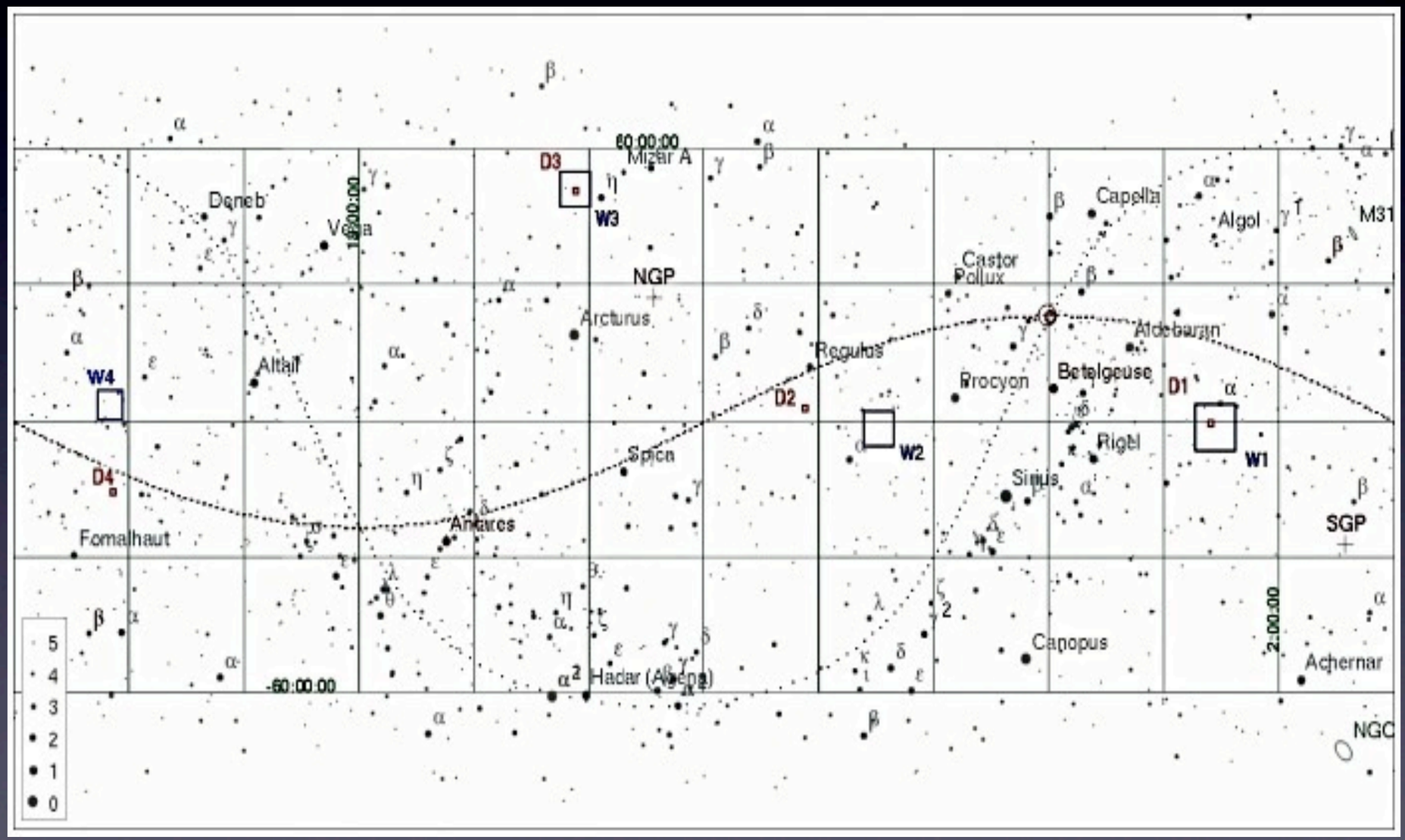
Data

- X-ray data → Chandra & XMM-Newton
- Spectroscopic data → DEEP2 & DEEP3, MMT & SDSS
- Photometric data → CFHTLS wide and deep fields

X-ray data


1E+06
9E+05
8E+05
7E+05
6E+05
5E+05
4E+05
3E+05
2E+05
1E+05
0
Area (arcmin^2)
Exposure Time (10^5 s)

Photometric data



Group Identification

- Using the initial redshift catalog, imaging data and X-ray extended sources we assigned a redshift to each X-ray source visually where the spatial distribution of galaxies in the sky coincide with the X-ray emission.

- Red-Sequence

For those groups which place in D3 field in CFHTLS :
0.0<z<0.3 : $u^* - r'$ color and r' magnitude
0.3<z<0.6 : $g' - i'$ color and i' magnitude
0.6<z<1.0 : $r' - z'$ color and z' magnitude
1.0<z<1.5 : $i' - J$ color and J magnitude
1.5<z<2.0 : $z' - Ks$ color and Ks magnitude

For those in W3 field:
0.0<z<0.3 : $u^* - r'$ color and r' magnitude
0.3<z<0.6 : $g' - i'$ color and i' magnitude
0.6<z : $r' - z'$ color and z' magnitude

Catalog

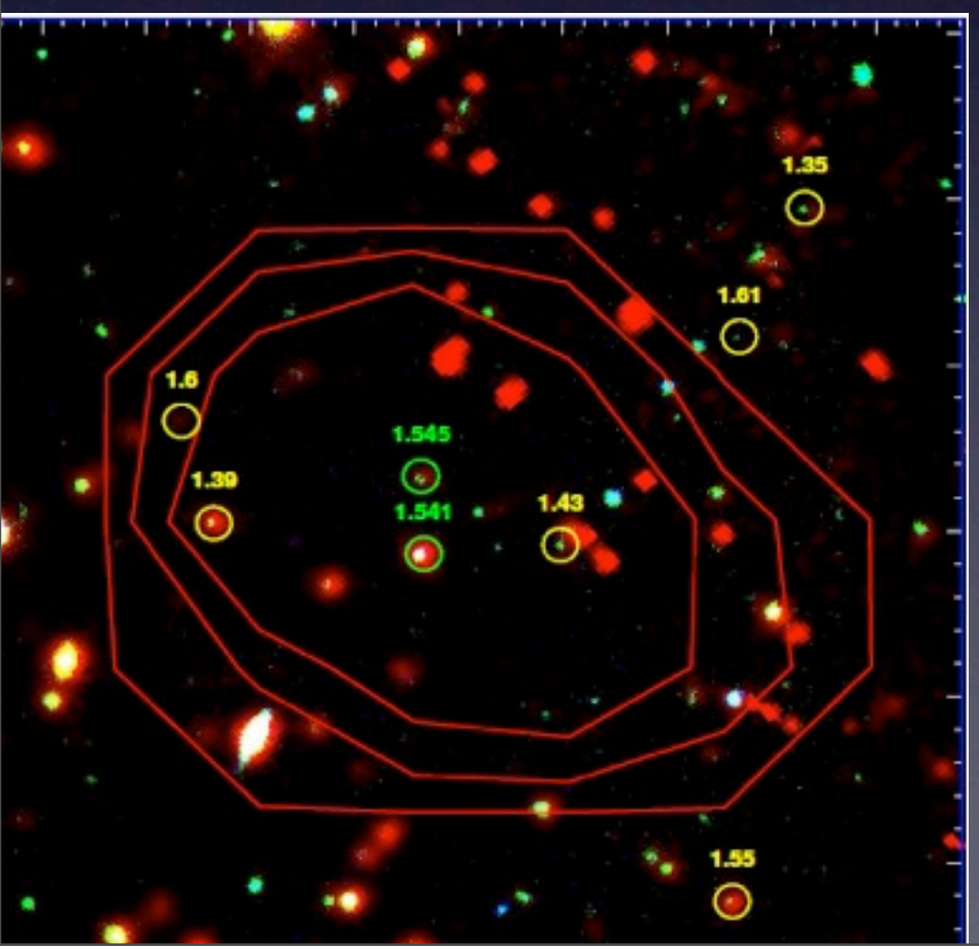
TABLE 2
X-RAY GROUP CATALOG:(1) X-RAY ID; (2) RA [DEG]; (3) DEC[DEG]; (4) z; (5) FLUX [$10^{-14} ergcm^{-2}s^{-1}$]; (6)$L_X(0.1-2.4keV)[10^{42}erg/s]$; (7) $M_{200}[10^{13}M_\odot]$; (8) r_{200}[ARCMIN]; (9) FLAG; (10) N(z); (11) FLUX SIGNIFICANCE; (12) VELOCITY DISPERSION FROM X-RAY LUMINOSITIES

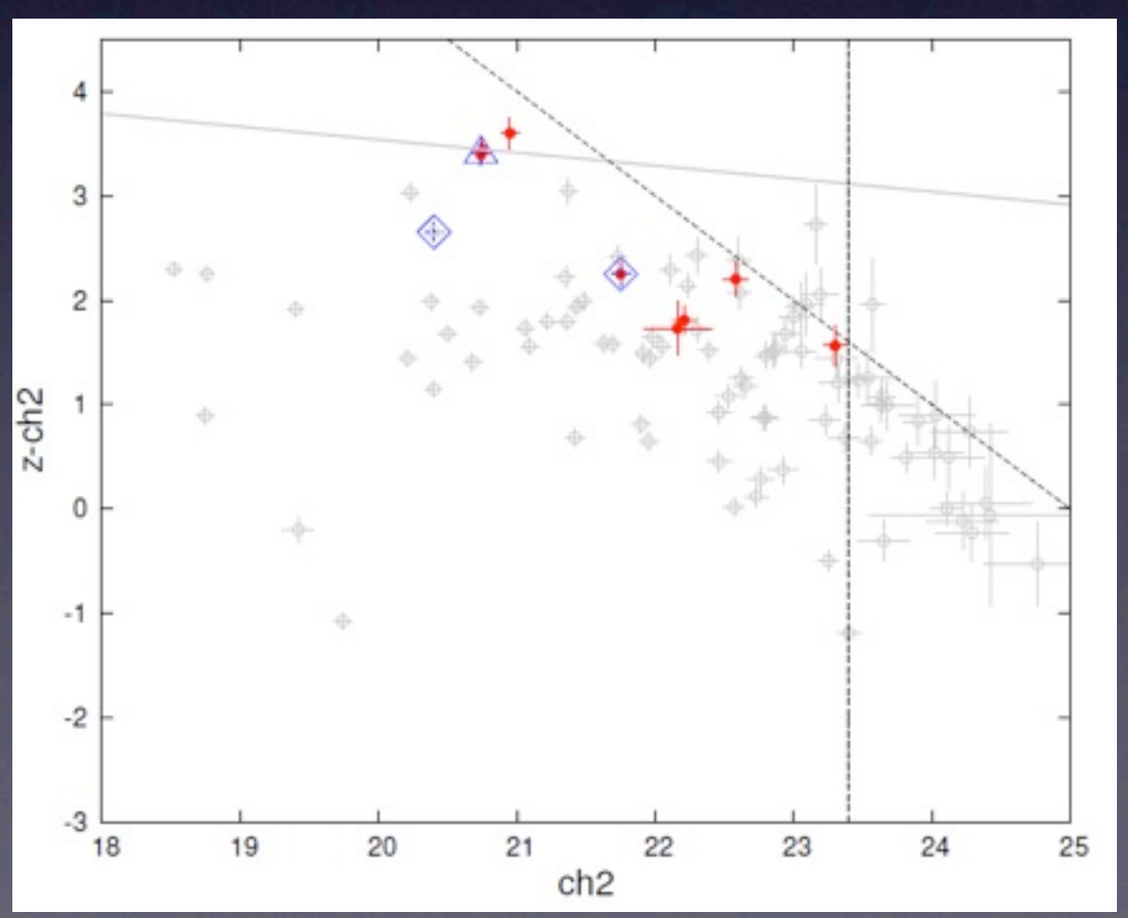
ID	RA	Dec	z	Flux	L_X	M_{200}	r_{200}	Flag	N(z_{spec})	Flux significance	σ_X
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
EGSXG J1414.8-5210	213.71657	52.16481	0.455	0.50±0.08	6.35±0.98	4.61±0.44	1.8	4	3	6.50	325
EGSXG J1414.9-5213	213.71946	52.21343	0.301	0.38±0.09	1.76±0.43	2.32±0.35	2.0	1	3	4.11	251
EGSXG J1415.0-5205†	213.76555	52.07685	0.074	2.77±0.33	0.56±0.07	1.34±0.10	5.7	1	34	8.49	202
EGSXG J1415.4-5220†	213.85106	52.34112	0.074	4.22±0.46	0.84±0.09	1.73±0.12	6.2	1	26	9.19	220
EGSXG J1415.6-5222	213.91018	52.36540	0.622	0.33±0.07	9.20±1.94	5.01±0.65	1.5	2	10	4.73	345
EGSXG J1416.0-5225	214.02791	52.41598	0.572	0.13±0.07	3.19±1.67	2.67±0.82	1.3	1	8	1.92	277
EGSXG J1416.3-5206†	214.07123	52.09987	0.832	0.91±0.13	46.87±6.79	11.68±1.06	1.6	2	1	6.90	475
EGSXG J1416.3-5214	214.07507	52.22752	0.641	0.12±0.04	4.02±1.46	2.90±0.64	1.2	2	7	2.76	288
EGSXG J1416.3-5230	214.07862	52.49943	0.356	0.36±0.08	2.46±0.55	2.74±0.38	1.8	1	9	4.44	268
EGSXG J1416.4-5214	214.08759	52.23544	0.366	0.25±0.06	1.83±0.43	2.25±0.32	1.7	2	10	4.27	251
EGSXG J1416.5-5227	214.12227	52.45173	0.837	0.30±0.06	17.81±3.26	6.26±0.71	1.3	1	10	5.46	386
EGSXG J1416.6-5229	214.15991	52.47882	0.812	0.09±0.04	5.94±2.34	3.17±0.75	1.1	1	5	2.54	307
EGSXG J1416.7-5222	214.17417	52.37189	0.510	0.15±0.04	2.63±0.79	2.50±0.45	1.4	1	5	3.35	267
EGSXG J1416.7-5229	214.17480	52.48355	0.238	0.33±0.09	0.87±0.23	1.56±0.25	2.1	4	6	3.82	218
EGSXG J1416.8-5211	214.20403	52.17700	0.900	1.04±0.15	63.55±8.95	13.33±1.17	1.6	3	0	7.10	503
EGSXG J1417.0-5227	214.25416	52.44758	1.023	0.08±0.02	10.89±2.90	3.85±0.63	1.0	1	5	3.75	340
EGSXG J1417.3-5215	214.31665	52.25140	0.470	0.20±0.05	2.82±0.72	2.71±0.42	1.5	3	0	3.95	273
EGSXG J1417.4-5236	214.34115	52.59349	0.236	0.27±0.05	0.73±0.14	1.39±0.17	2.1	1	14	5.07	210
EGSXG J1417.4-5238	214.37150	52.63047	0.355	0.39±0.05	2.66±0.34	2.88±0.23	1.9	2	15	7.72	273
EGSXG J1417.5-5238	214.38305	52.63655	0.717	0.29±0.06	11.61±2.36	5.32±0.67	1.4	2	14	4.93	358
EGSXG J1417.6-5232	214.38819	52.53527	0.985	0.25±0.03	22.59±2.87	6.35±0.51	1.2	1	8	7.87	399

Erfanianfar et al. In prep.

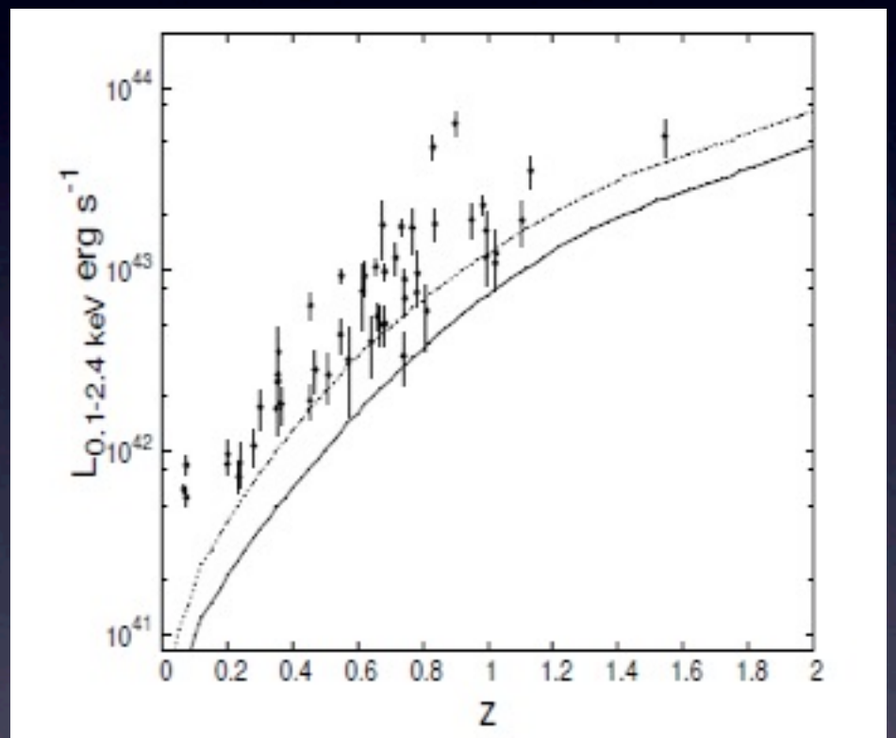
High-z galaxy group candidate at z=1.54

- The X-ray signal is measured with a significance of 4.16
- LX=5.4*10^43 erg/s , M200=6.18*10^13 Msun & r200 = 0.015degree





X-ray Luminosity and Mass



- Leathaud et al. 2010 used a sample of 206 X-ray detected galaxy groups to investigate the the scaling relation between total mass and X-ray lumoinosity

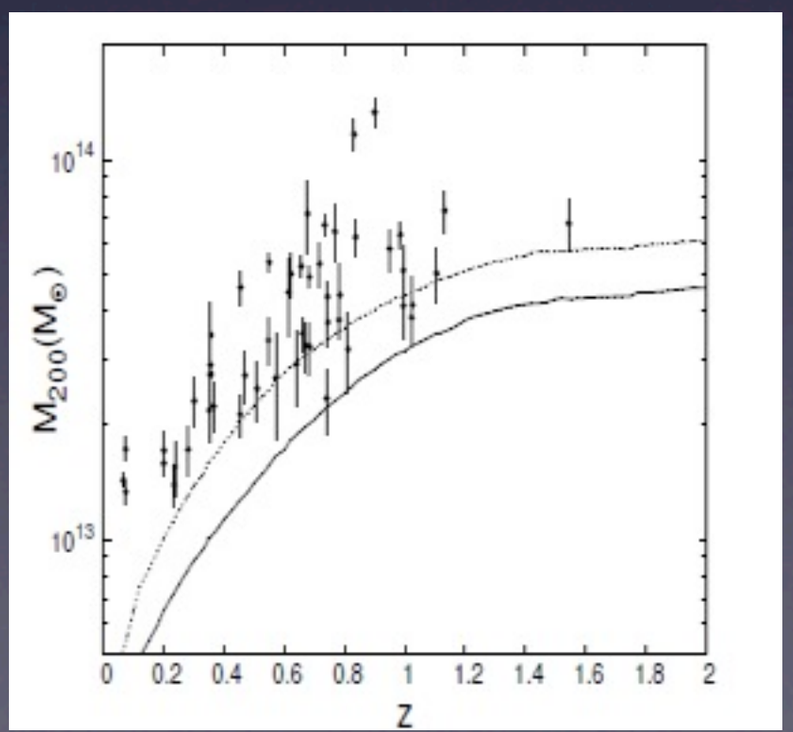
$$\frac{\langle M_{200} E(z) \rangle}{M_0} = A \left(\frac{\langle L_X E(z)^{-1} \rangle}{L_{X,0}} \right)^{\alpha}$$

$$M_0 = 10^{13.7}\ h_{72}^{-1}\ M_\odot$$

$$L_{X,0} = 10^{42.7}\ h_{72}^{-2}\ \text{erg s}^{-1}$$

$$\alpha = 0.64 \pm 0.03$$

$$\log_{10}(A) = 0.03 \pm 0.06$$

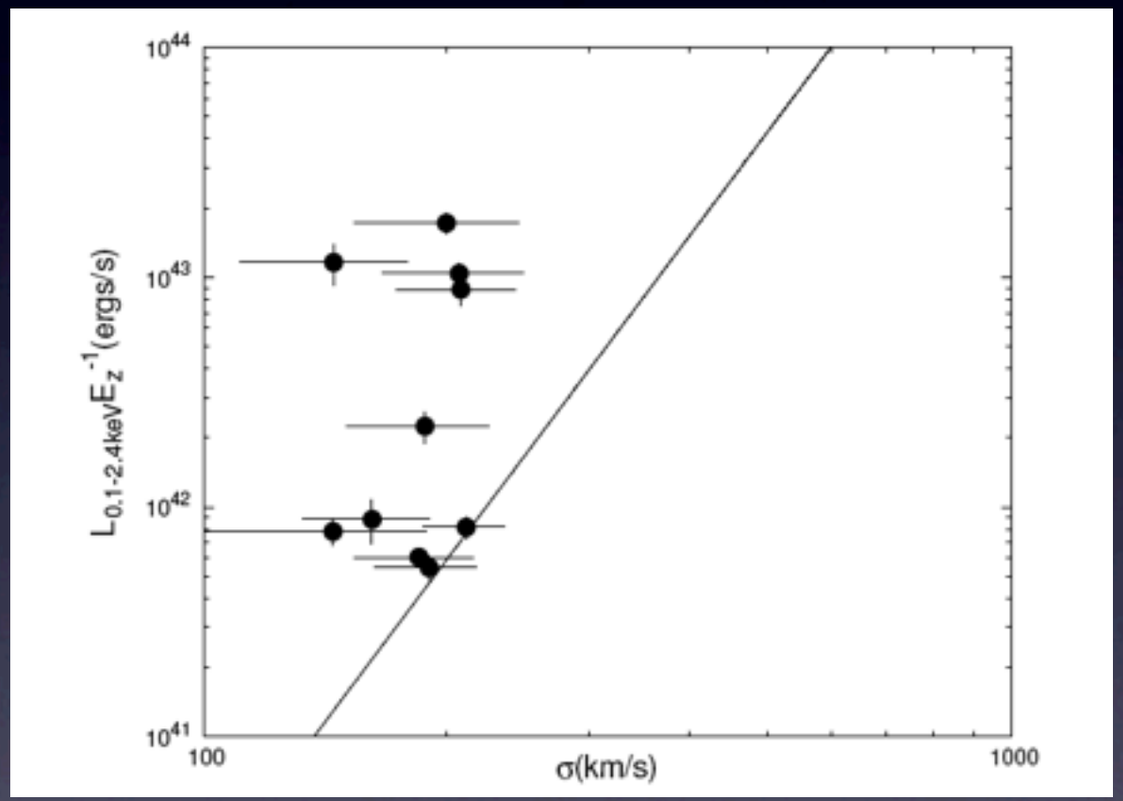


Spectroscopic member galaxies

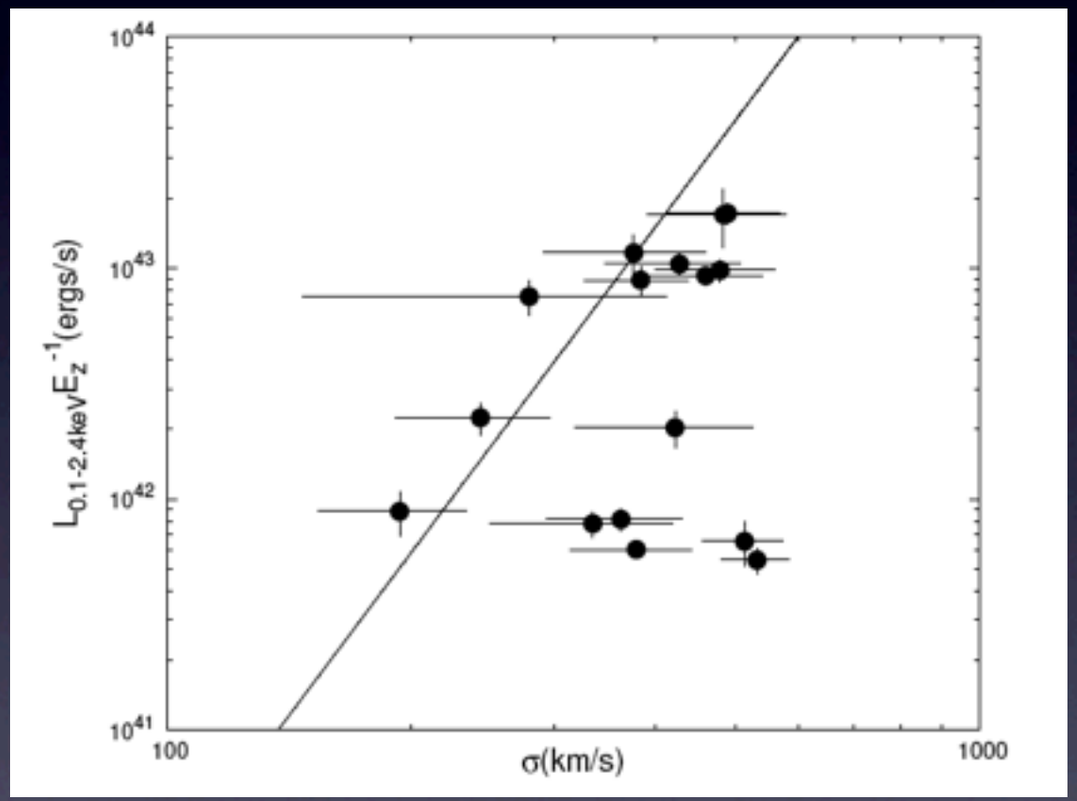
- X-ray selection
- Optically selection

Spectroscopic members from X-ray

- Their positions are within the r200 of the X-ray centers and their redshifts match to $c|z-z_g| < 2(1+z_g)\sigma$
- σ=150 km/s & σ=375 km/s



σ=150 km/s



σ=375 km/s

Optically selected spectroscopic members

$$\delta(z)_{max} = 2\frac{\sigma(v)_{obs}}{c}$$

$$\sigma(v)_{obs} = 1.135c \times \frac{\sqrt{\pi}}{N(N-1)} \sum_{i=1}^{n-1} \omega_i g_i$$

$$\delta(r)_{max} = \frac{c\delta(z)_{max}}{b.H_{71}(z)}$$

$$\sigma(v)_{rest} = \frac{\sigma(v)_{obs}}{1+z}$$

$$\delta(\theta)_{max} = 206265'' \frac{\delta(r)_{max}}{h_{71}^{-1}Mpc}.(\frac{D_\theta}{h_{71}^{-1}Mpc})^{-1}$$

$$\langle\Delta(v)\rangle^2 = \frac{1}{N}\sum_{i=1}^{N}\Delta(v)_i^2$$

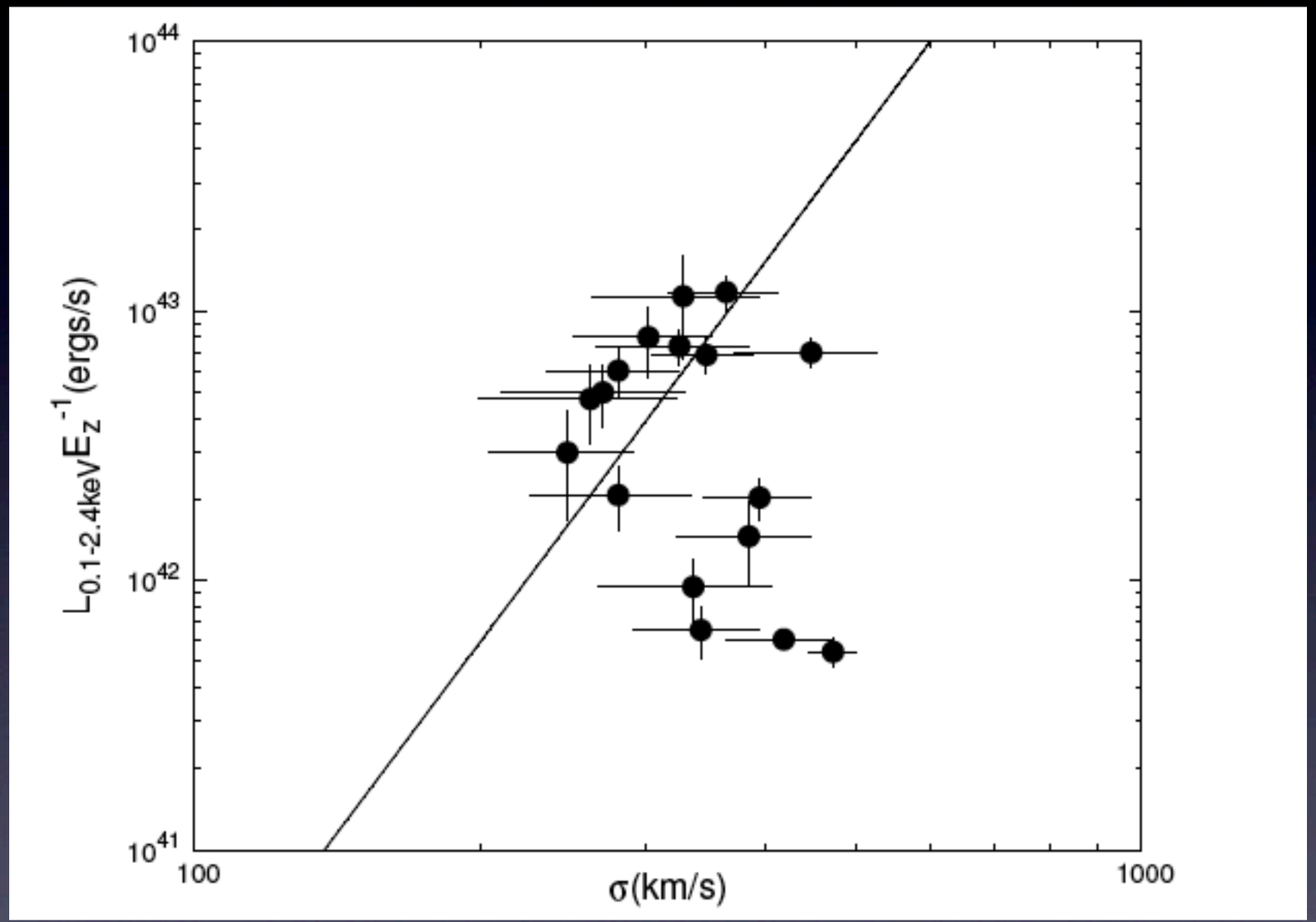
$$|z - z_{group}| < \delta(z)_{max}$$

$$\delta(\theta) < \delta(\theta)_{max}$$

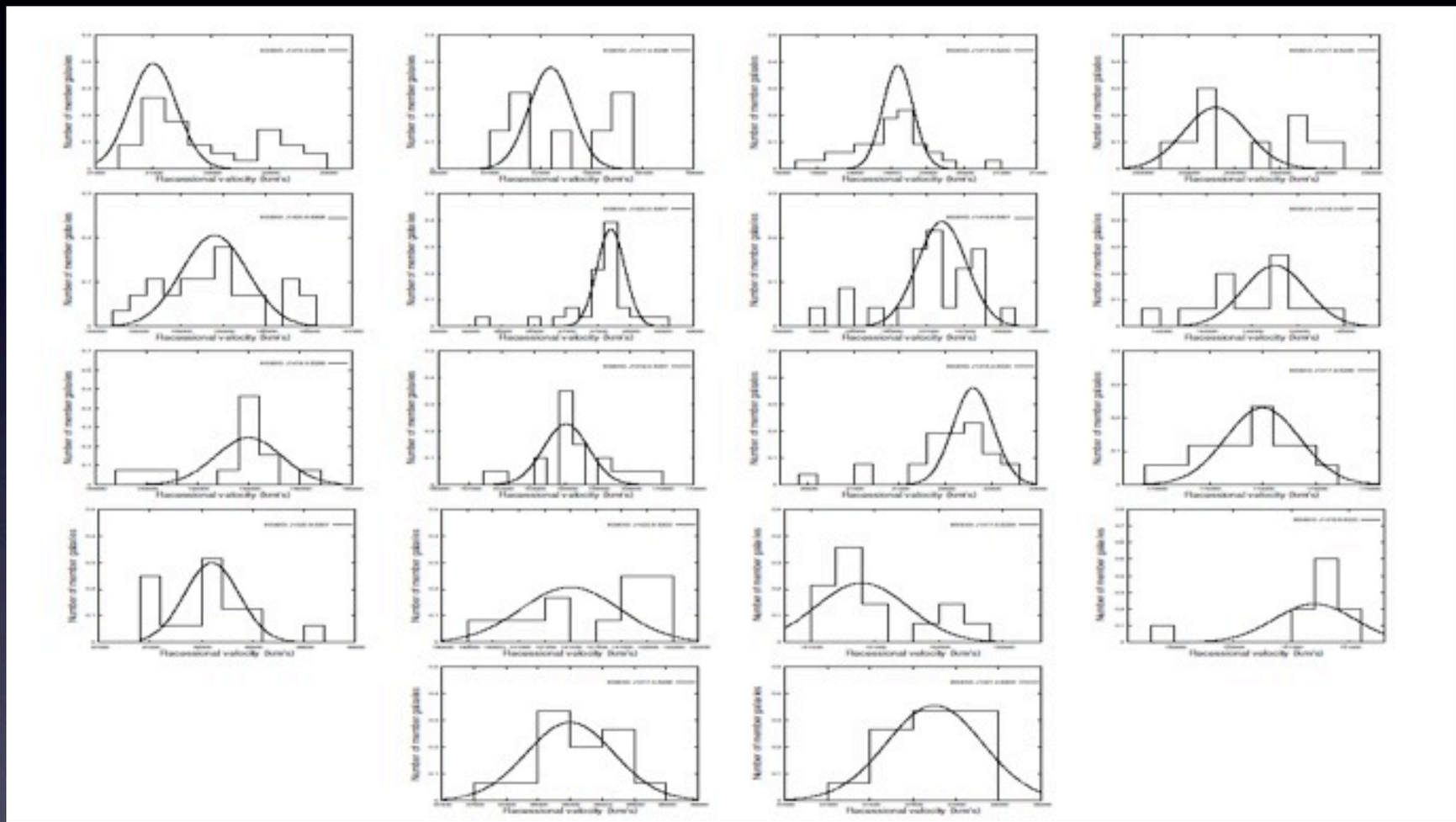
$$\sigma(v)_{intr}^2 = \sigma(v)_{rest}^2 - \langle\Delta(v)\rangle^2$$

Wilman et al. 2005

Beers et al .1990


10^{44}
10^{43}
10^{42}
10^{41}
$L_{0.1\text{-}2.4keV}E_z^{-1}$(ergs/s)
100
1000
σ(km/s)

Dynamical Complexity



- Anderson-Darling (A-D) test (Hou et al.2010)
- Dressler-Shectman (D-S) test. (Hou et al.2012)

D-S test

- Based on the deviations of the mean velocity and velocity dispersion for each member and a number of its nearby members from the mean velocity and velocity dispersion of the group.

$$\delta_i^2 = \left(\frac{N_{nn}+1}{\sigma^2}\right)[(\bar{v}_{local}^i - \bar{v})^2 + (\sigma_{local}^i - \sigma)^2]$$

$$\Delta = \sum_{i=1}^{N} \delta_i$$

A-D test

- Goodness of fit test that compares cumulative distribution function (CDF) of ordered data to a model empirical distribution function (EDF).

$$A^2 = -n - \frac{1}{n}\sum_{i=1}^{n}(2i-1)(\ln\Phi(x_i) + \ln(1-\Phi(x_{n+1-i})))$$

$$A^{2*} = A^2\left(1 + \frac{0.75}{n} + \frac{2.25}{n^2}\right)$$

$$\alpha = a\exp(-A^{2*}/b)$$

A-D & D-S test results

Optically selected

X-ray selected

AD	DS	AD	DS
$r_{200,\sigma}$	$r_{200,\sigma}$	$r_{200,X}$	$r_{200,X}$

8 of 17 6 of 17 6 of 14 in progress

Summery

- We have identified 52 X-ray galaxy groups in AEGIS field.
- A Group candidate at redshift z=1.54 with 3 spectroscopic counterparts and M200=6.18*10^13 solar masses.
- A constant redshift range for selecting spectroscopic member galaxies doesn't work well for a sample of galaxy groups with a wide range of X-ray luminosities.
- Dynamical complexity can inflate the velocity dispersion.

Thank You!

Dynamical Mass

$$\sigma(v)_{obs} = 1.135c \times \frac{\sqrt{\pi}}{N(N-1)} \sum_{i=1}^{n-1} \omega_i g_i$$

$$\sigma(v)_{rest} = \frac{\sigma(v)_{obs}}{1+z}$$

$$\langle \Delta(v) \rangle^2 = \frac{1}{N} \sum_{i=1}^{N} \Delta(v)_i^2$$

$$\sigma(v)^2_{intr} = \sigma(v)^2_{rest} - \langle \Delta(v) \rangle^2$$

$$r_{200} = \frac{\sqrt{3}\sigma_{intr}}{10H(z)}$$

$$H(z) = H_0 E(z)$$

$$M_{dyn} = \frac{3}{G}\sigma^2 r_{200}$$