Ammassi di galassie ad alto redshift. Una visione personale

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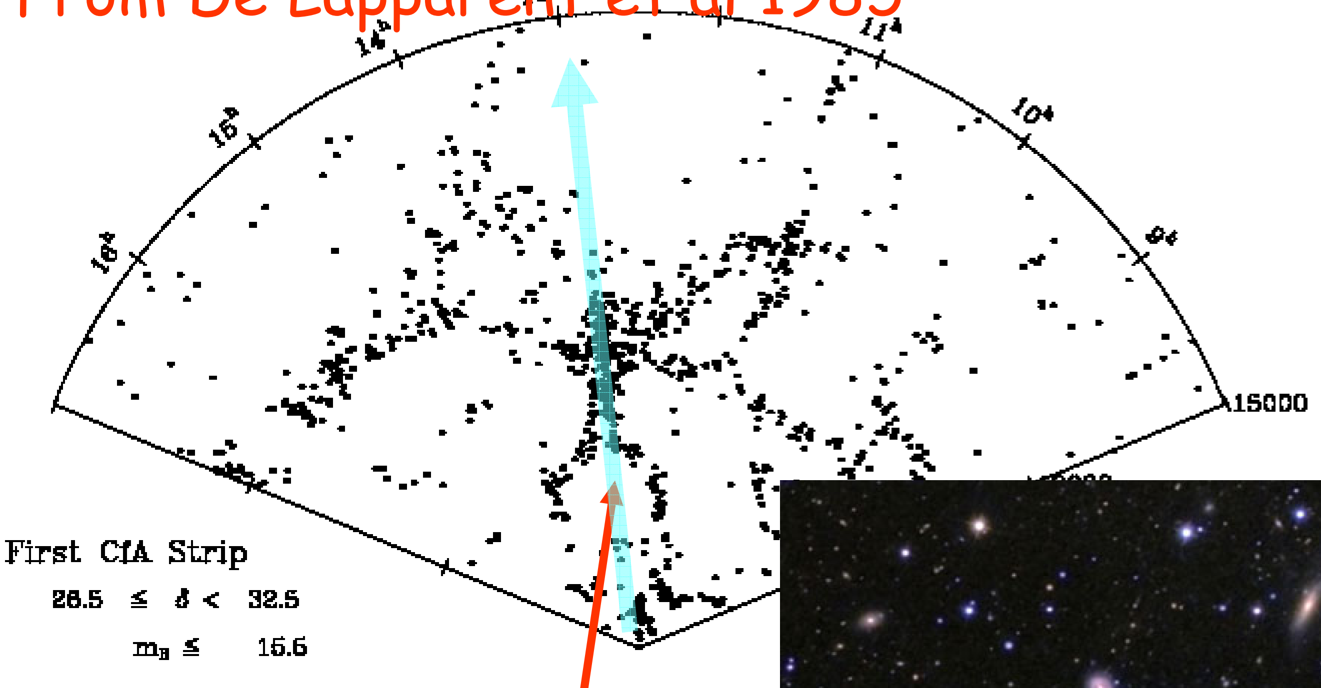
Based on:

Andreon, S., et al. 2014, A&A, in press (1311.4361)

Newman A., et al. 2014, ApJ, in press (1310.6754)

The data richness in “low” (z<1.2) redshift regime

From De Lapparent et al 1985

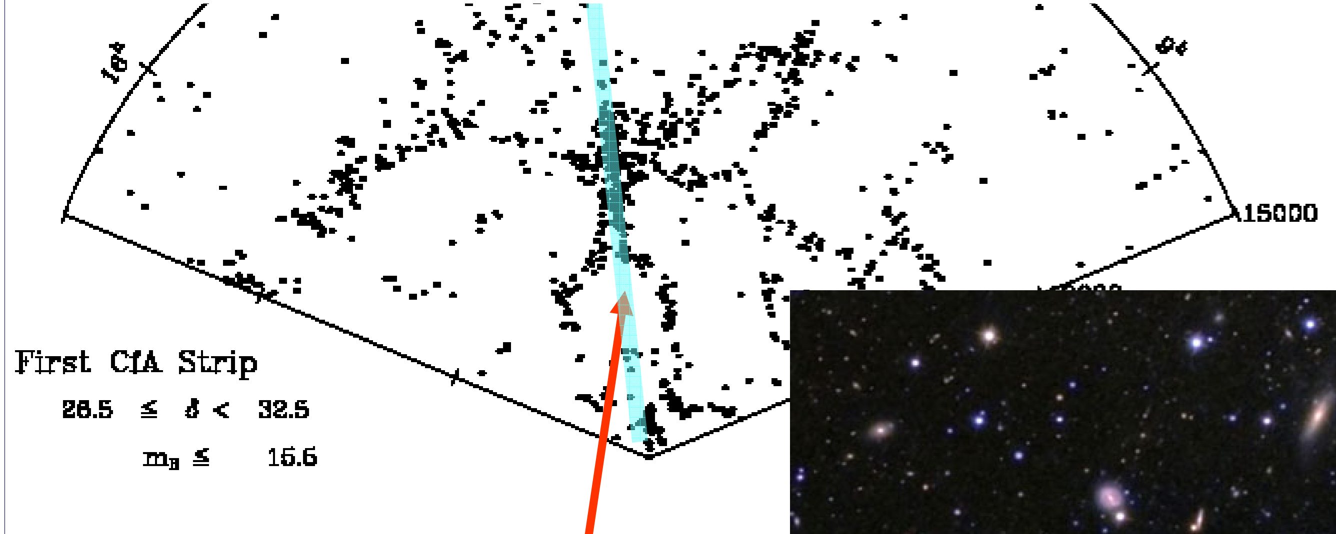


Redshift spike

Direct image

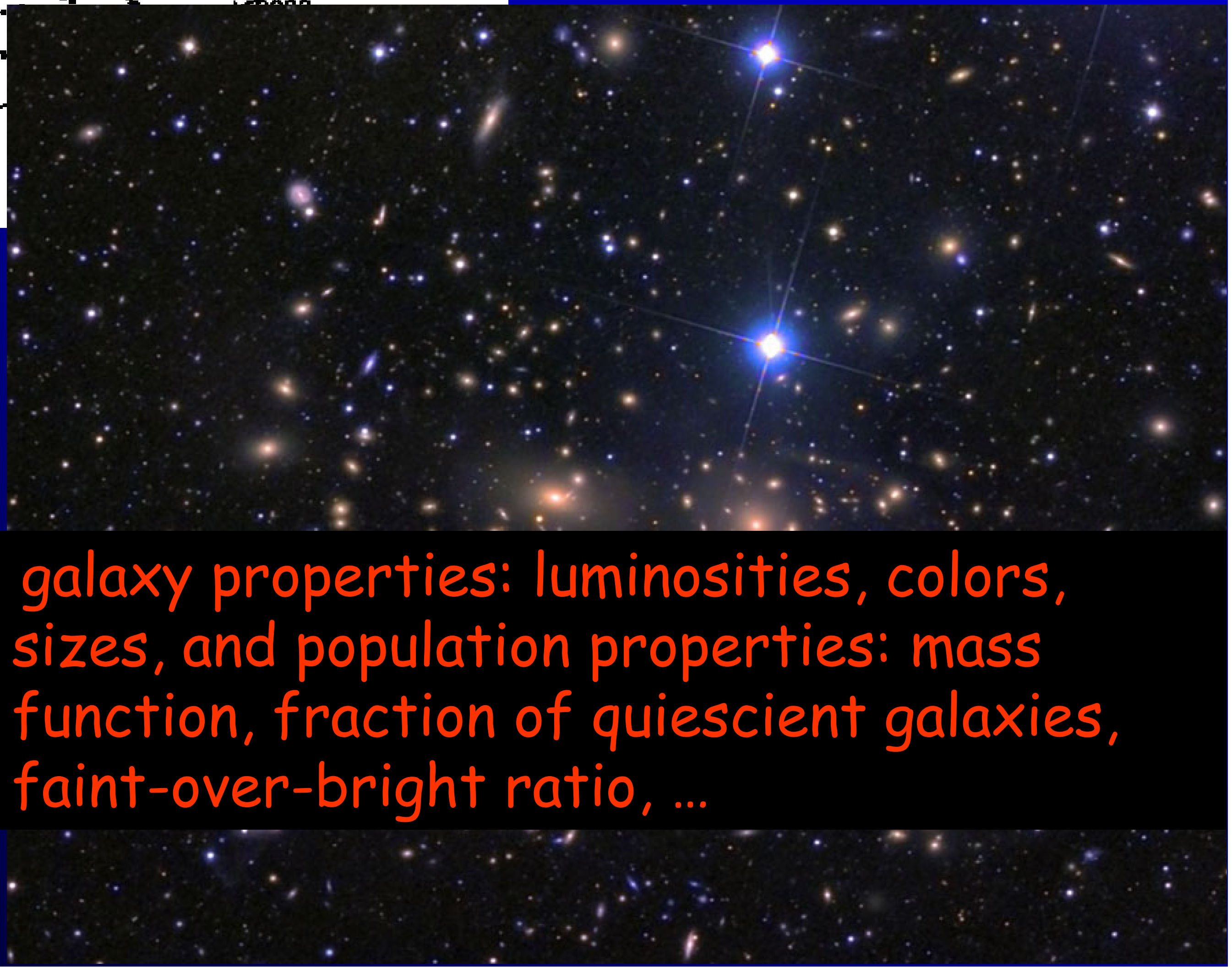
From Rowe, an amateur

velocity dispersion, spectroscopic-based galaxy properties (ages, star formation histories, masses, etc.)



Redshift spike

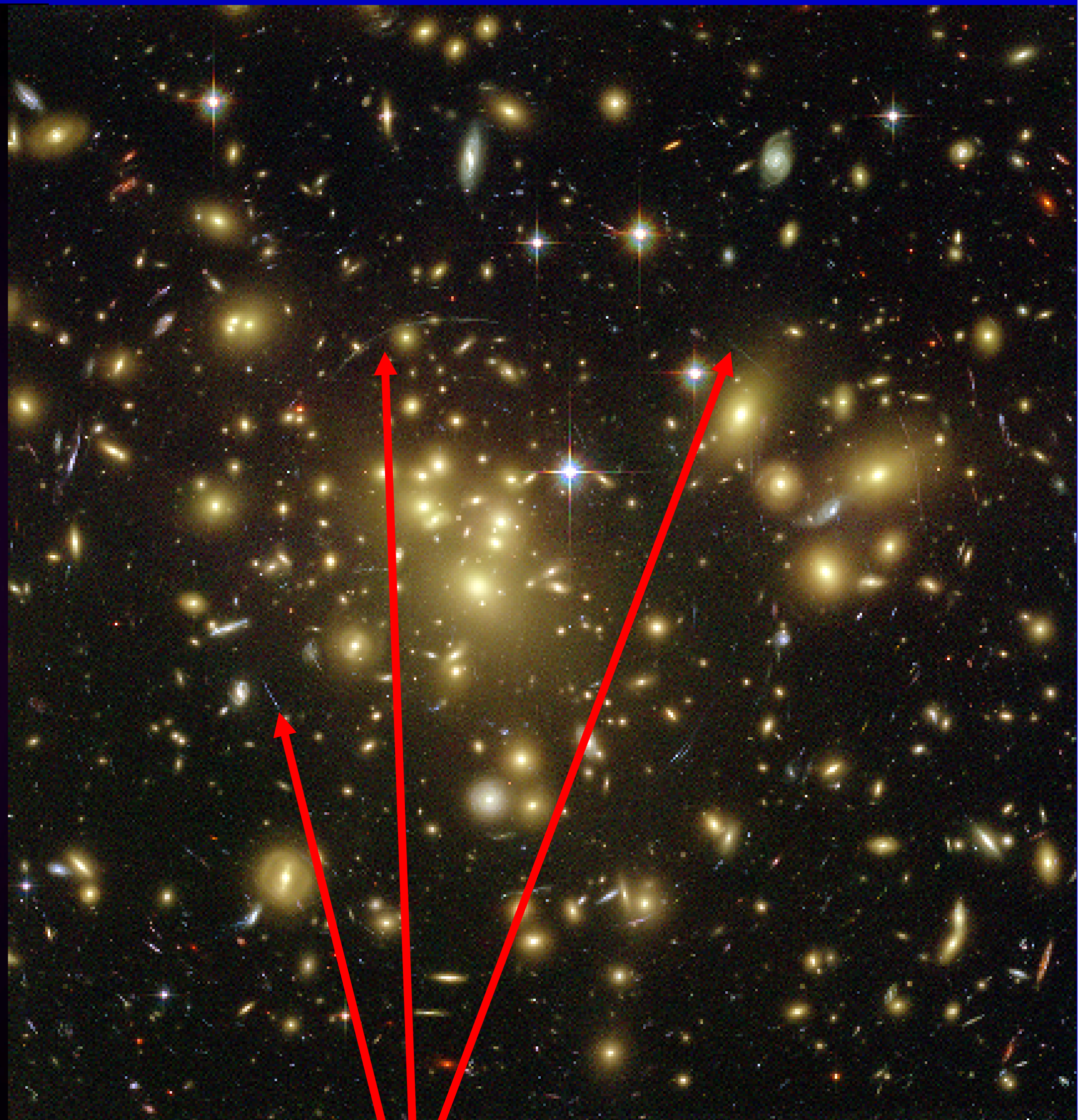
Direct image



galaxy properties: luminosities, colors, sizes, and population properties: mass function, fraction of quiescient galaxies, faint-over-bright ratio, …

X-ray / direct image

Chandra HST

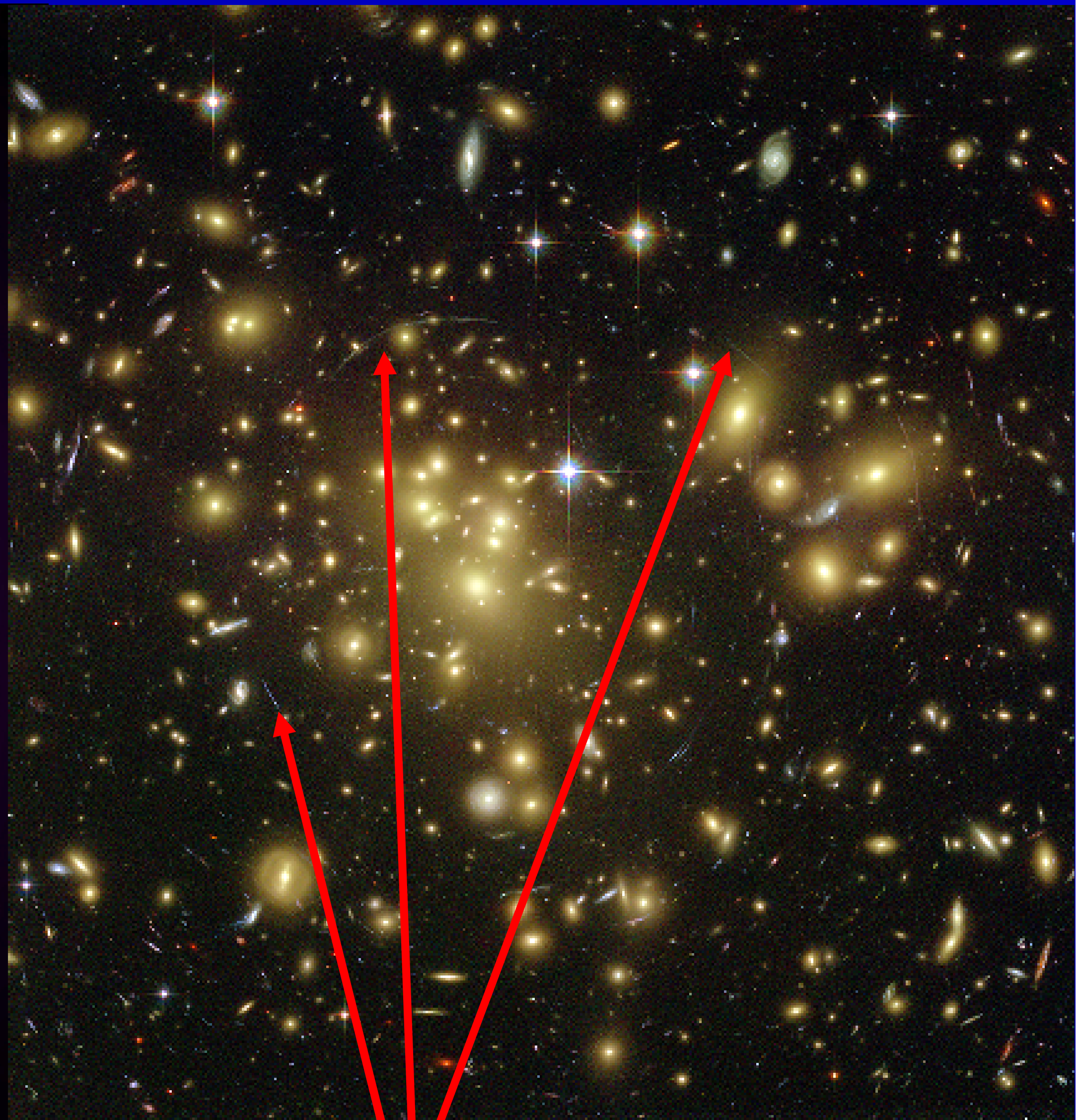


Arcs (lensing)

X-ray / direct image

ICM properties: T, P, ρ, ..

Direct Cluster Mass

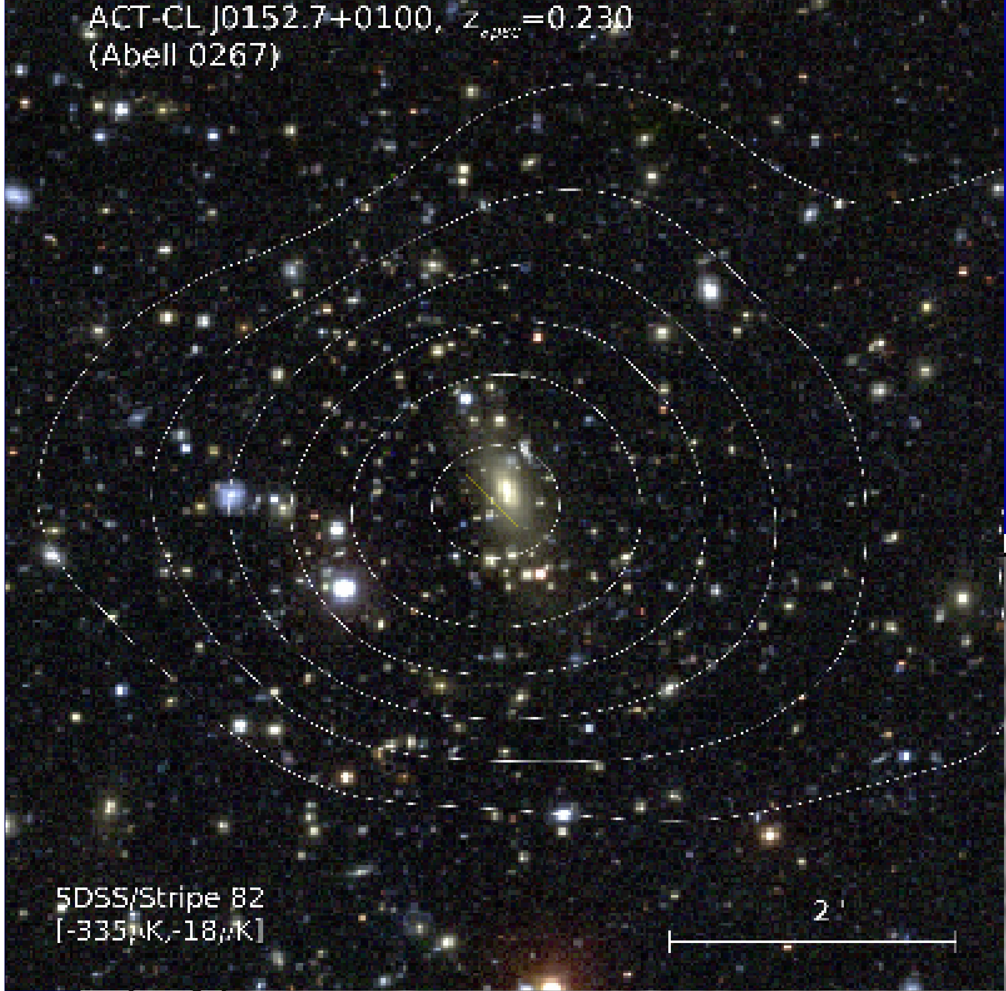


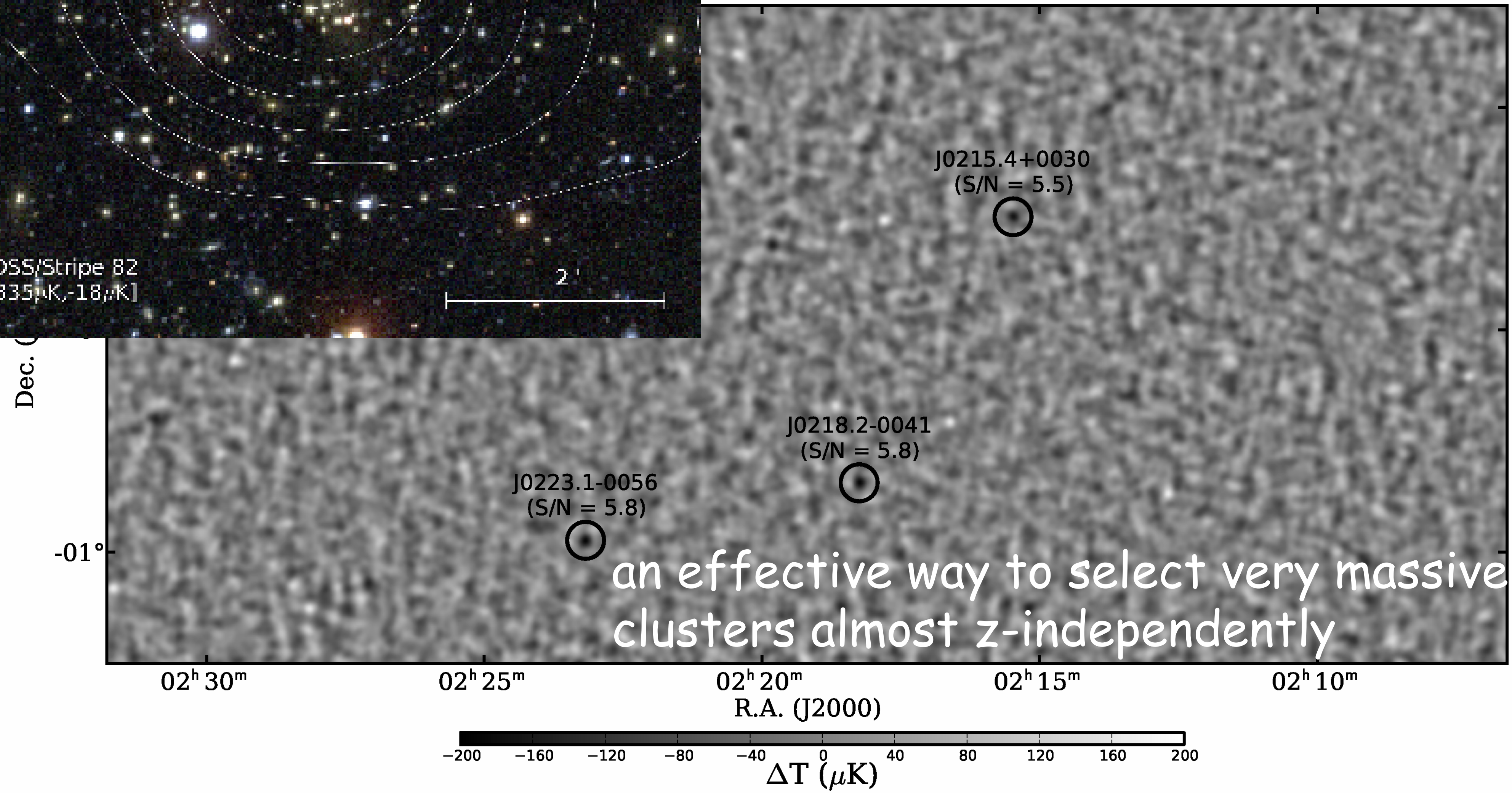
Arcs (lensing)

ACT direct image sky map

From Menanteau et al. 2013 &

Hassefield et al. 2014





an effective way to select very massive clusters almost z-independently

The data-desert at "high" (z>~1.5) redshift

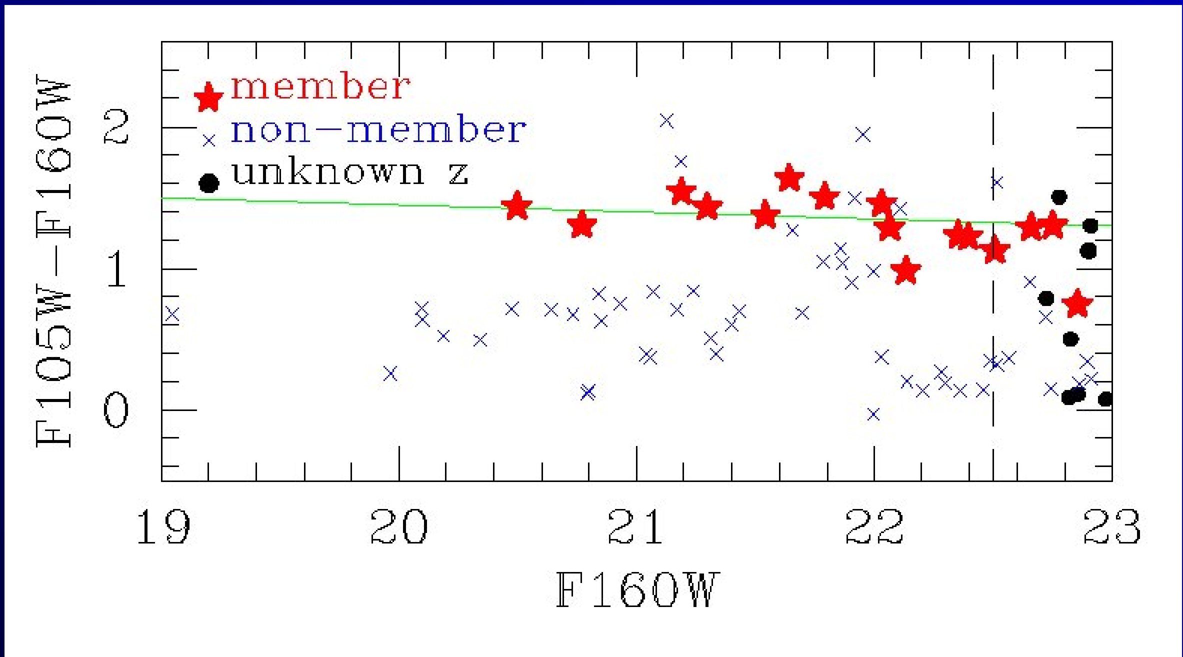
Several clusters or candidate clusters but …

1) No WL (i.e. direct) masses.
2) Severely incomplete (and biased toward star-forming galaxies) spectroscopic coverage.
3) Undetected in SZ.
4) Too faint in X-ray -> no characterization of the thermodynamical properties (e.g. ICM T)

Beware: faint XMM detections got non-confirmed with Chandra: Papovich et al. (2010) z=1.6 cluster (Pierre et al. 2012), now renamed proto-cluster (Papovich et al. 2012); Gobat et al. (2011) z=2.07 "mature" cluster, now a group at z=1.99, (Gobat et al. 2013);

Exceptions to 2 and 4: JKCS041, to 3: IDCS1422

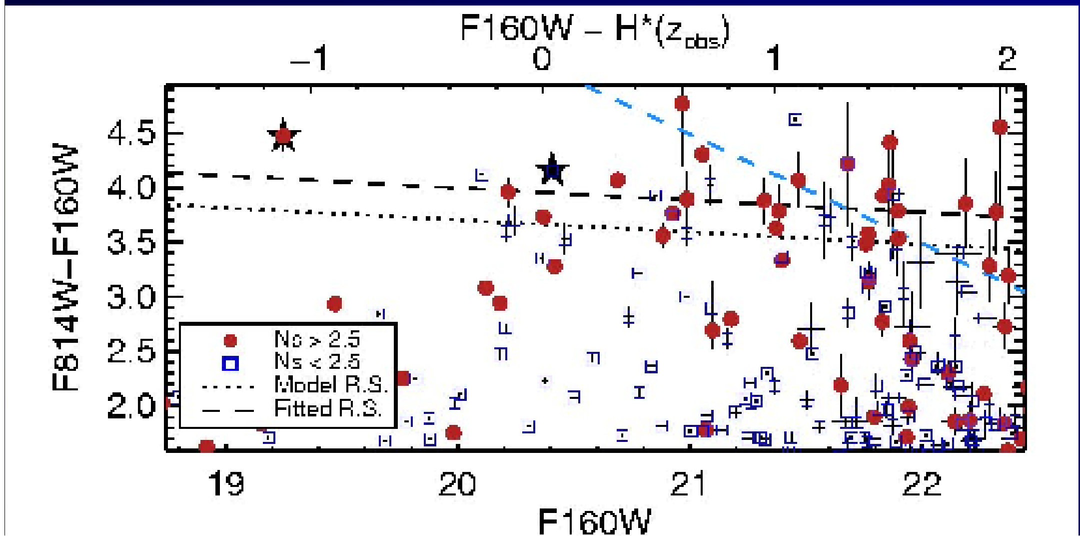
The unique JKCS041 spectroscopic coverage



The single exception:

JKCS041, z=1.803:

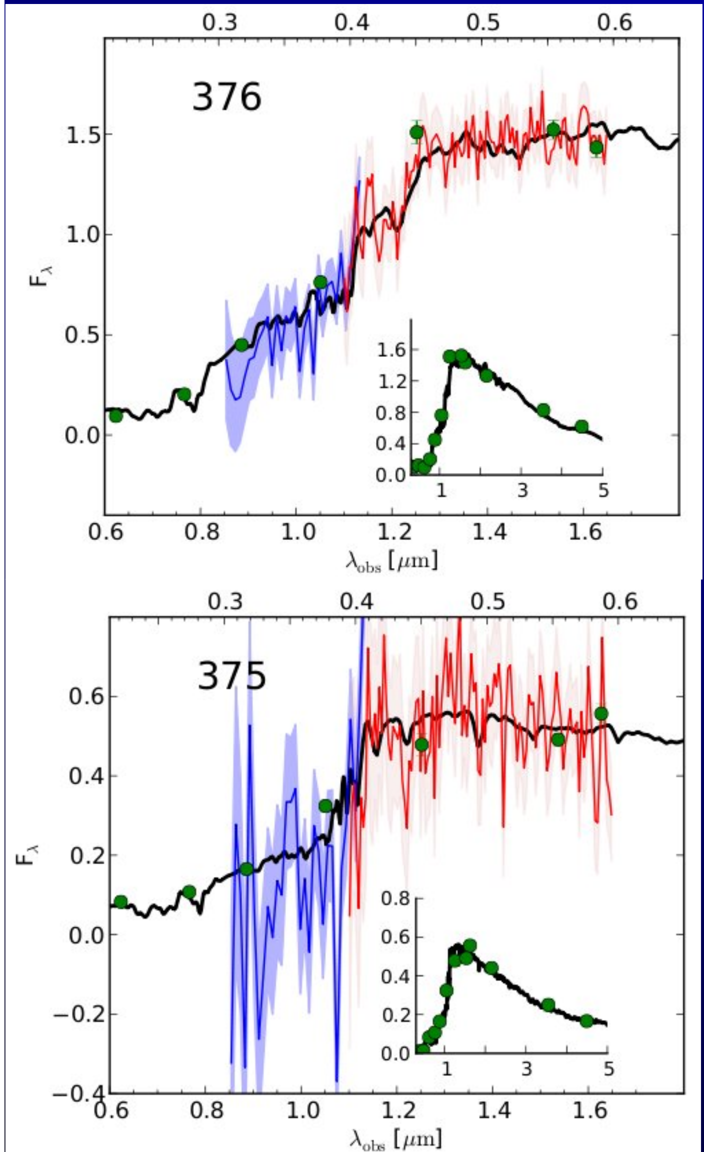
complete spectroscopic coverage down H=22.5, representative down to H=23.2 mag



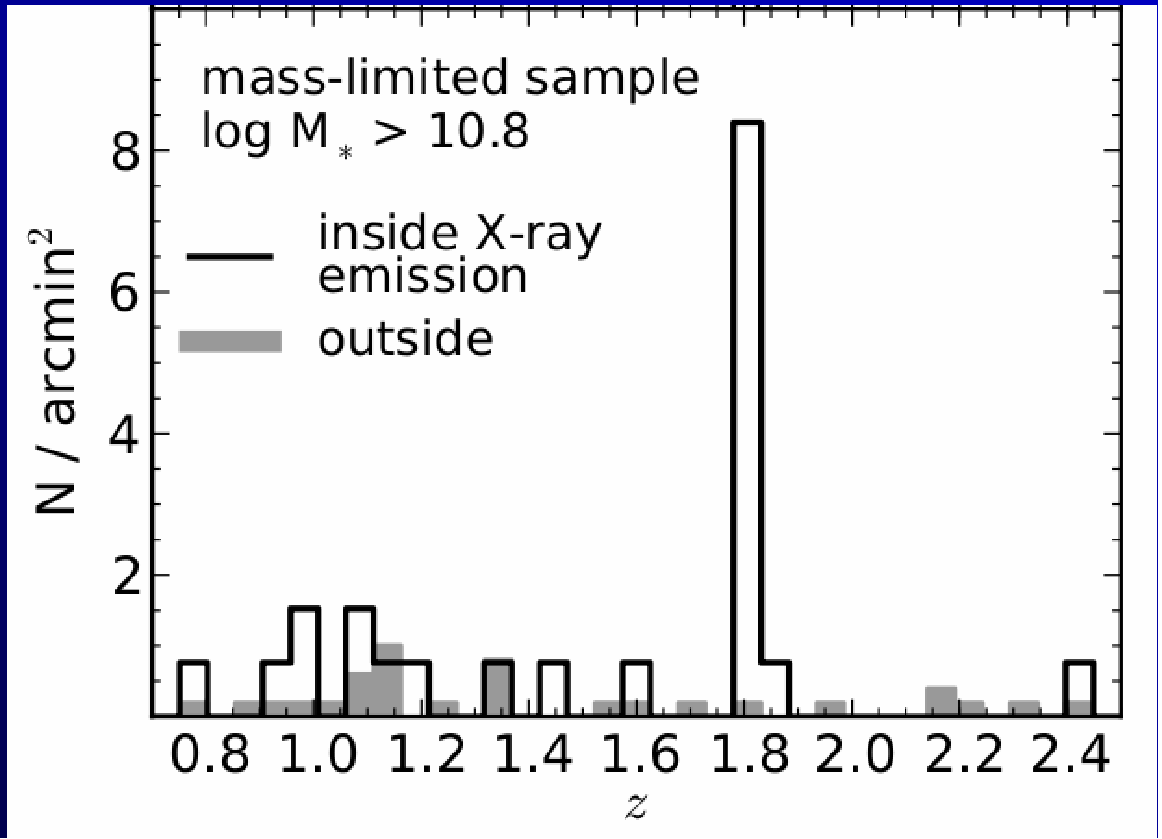
IDCS1422, z=1.75:

Common lack of complete spectroscopic coverage hampers galaxy evolutionary studies

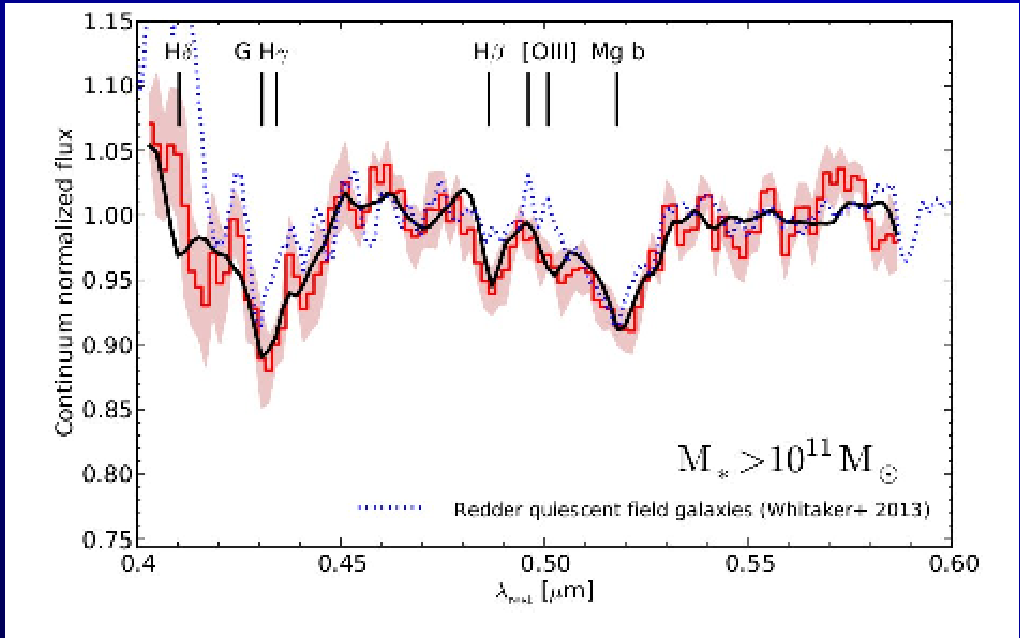
The spectroscopic richness of JKCS041

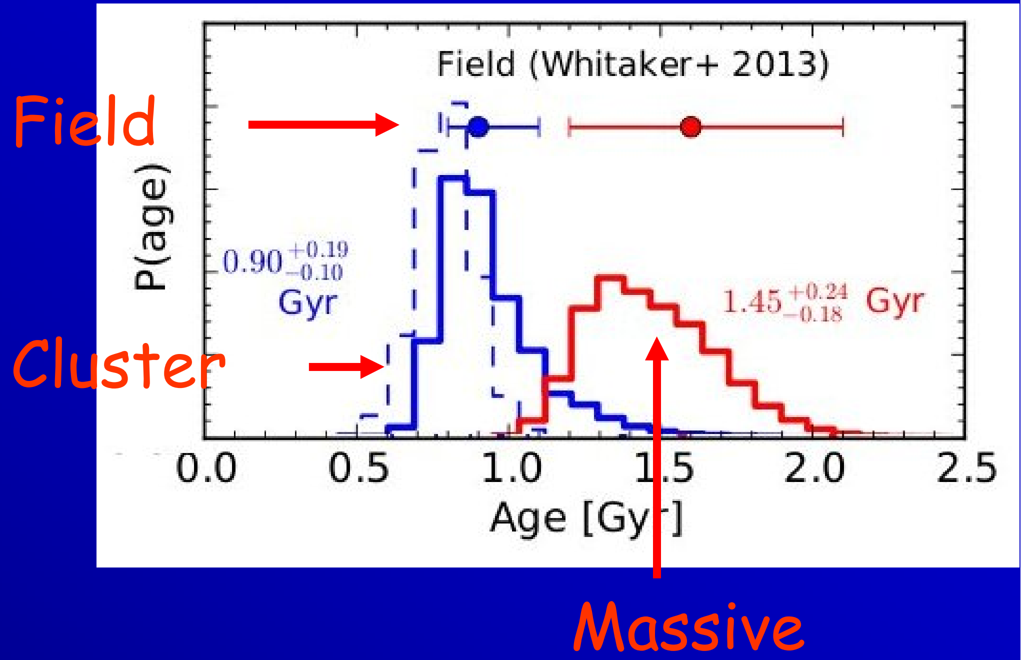


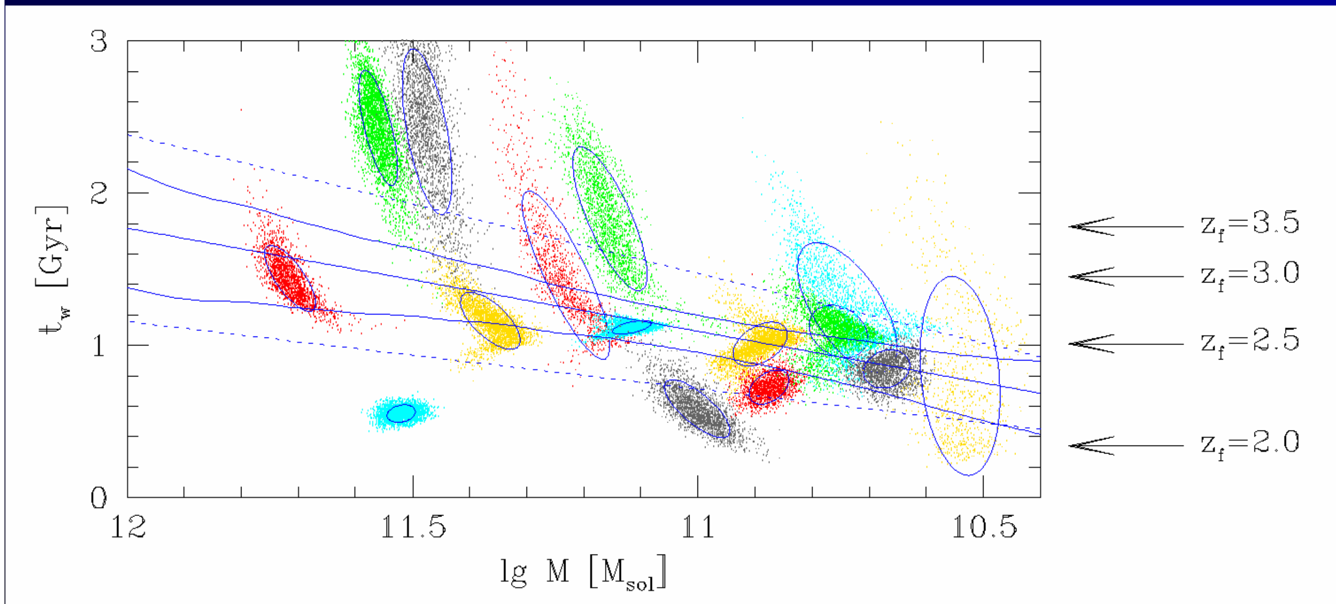
- 2° most (lgM=11.7) and 2° less (lgM=10.8) massive (Salp. IMF)
- from 3 orientation HST grism spectroscopy
- Many galaxies (19 members), a controlled sample, access to spectroscopic quantities (SFR, age, etc.)



Role of the environment

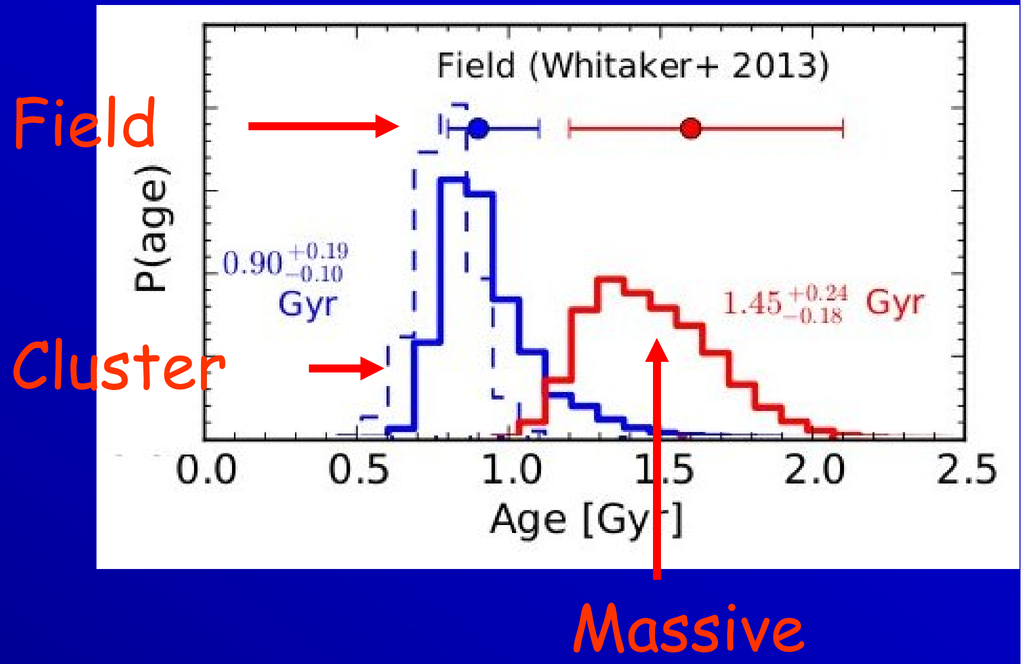


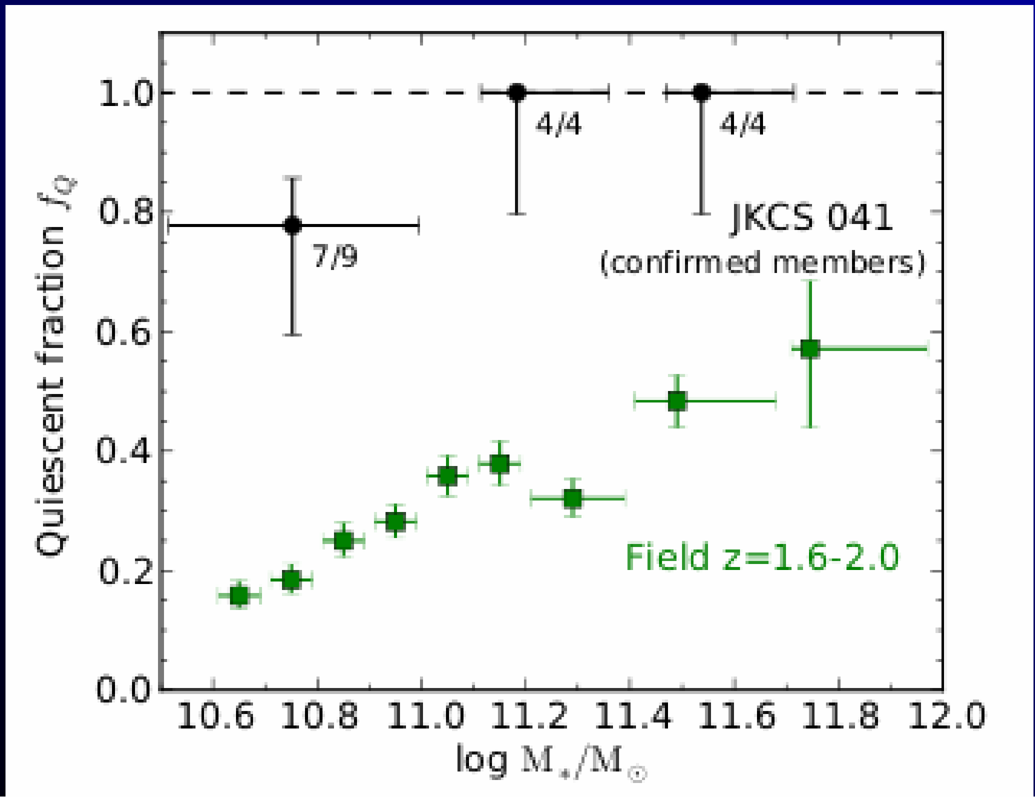




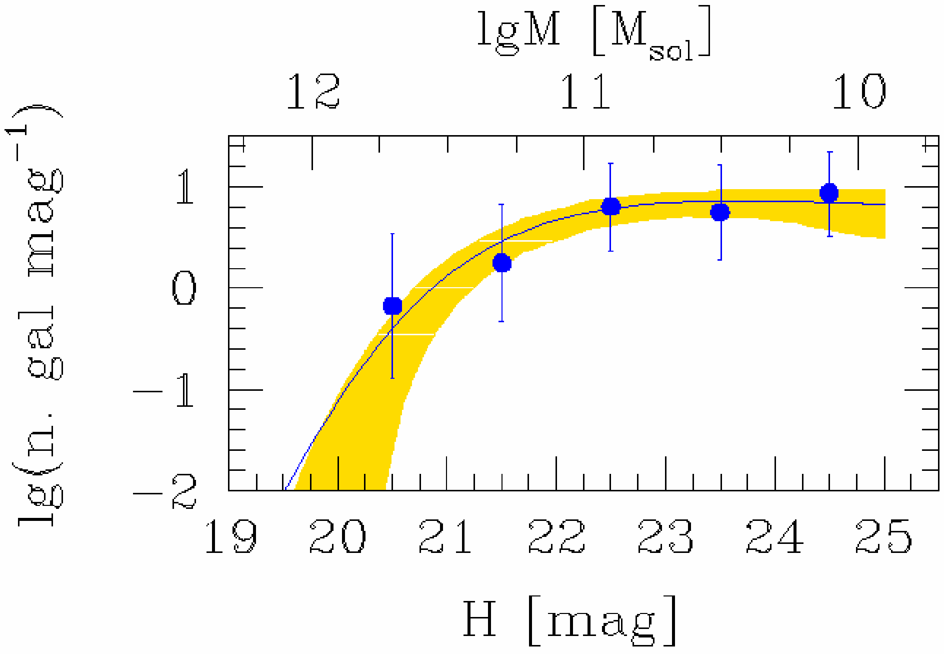
Age-mass relation: precisely-determined z_f , synchronous (380 Myr scatter)

Environmental quenching, at z=1.8, as a function of mass: about 50%

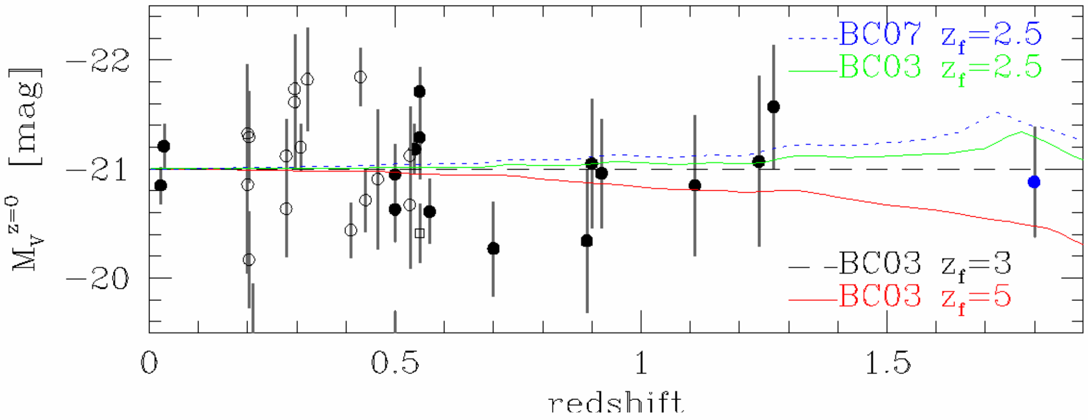


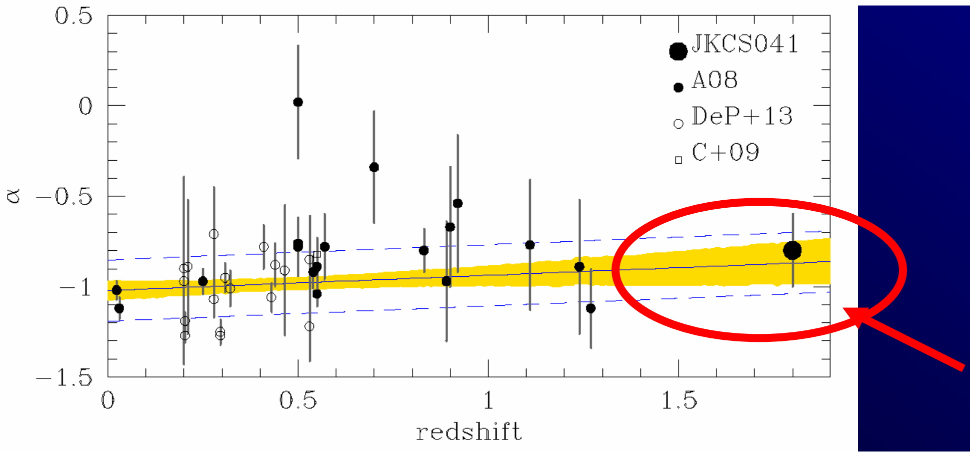


In cluster a larger fraction is quenched, but not quenched earlier!



Galaxy mass function

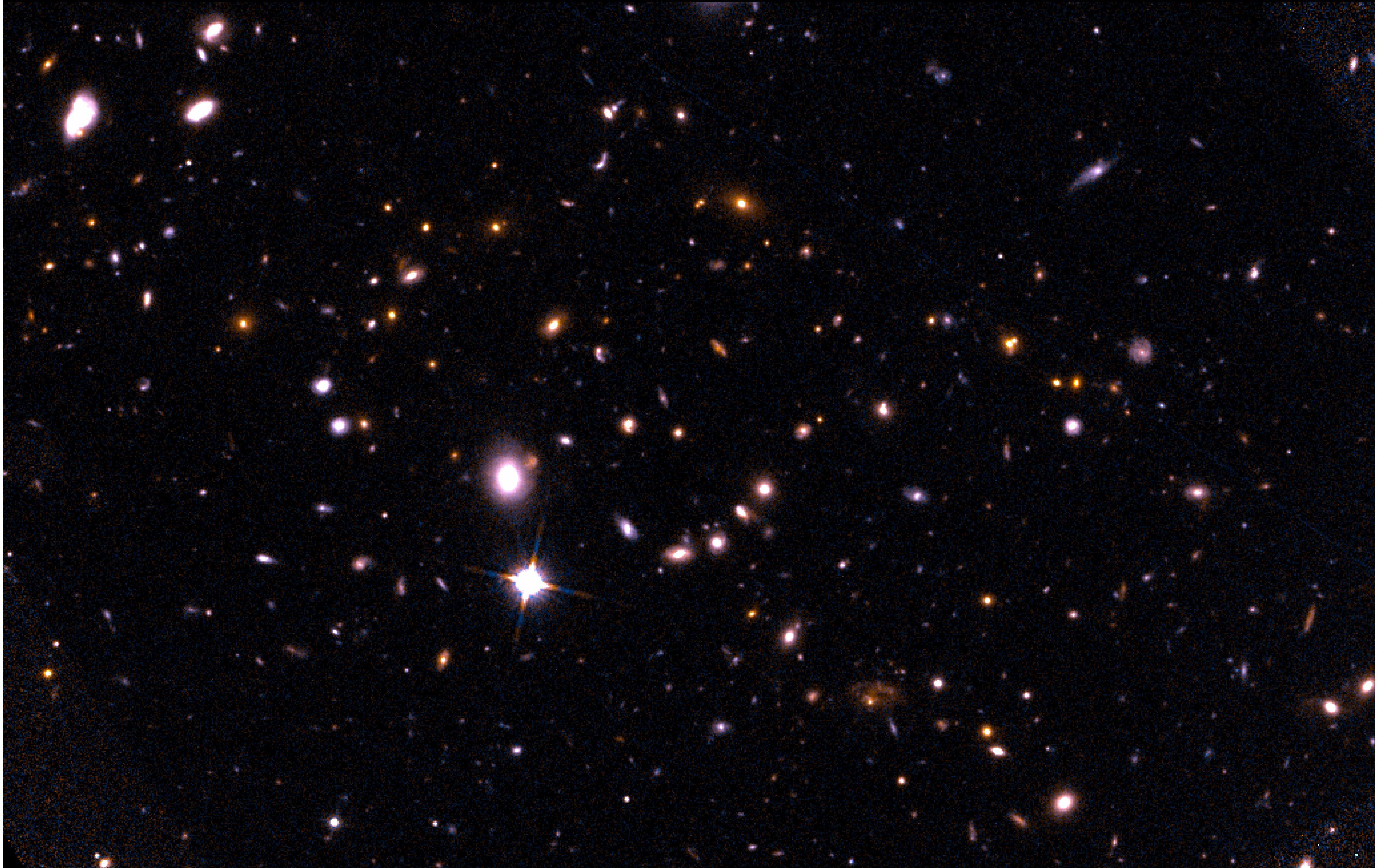




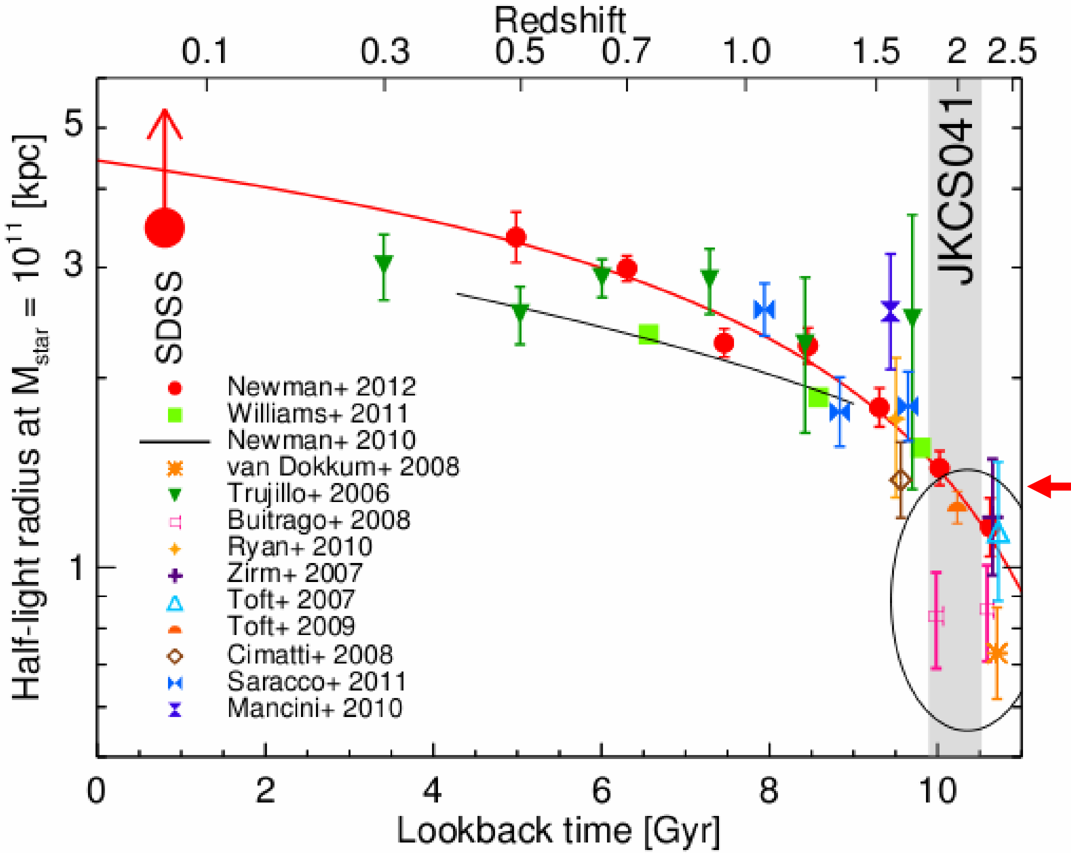
The insignificant evolution of the massive end and of the faint one (no faint-to-bright deficit among red sequence galaxies).

Unique because of the requested depth

HST F160W Image: i.e. sizes



Mass-size

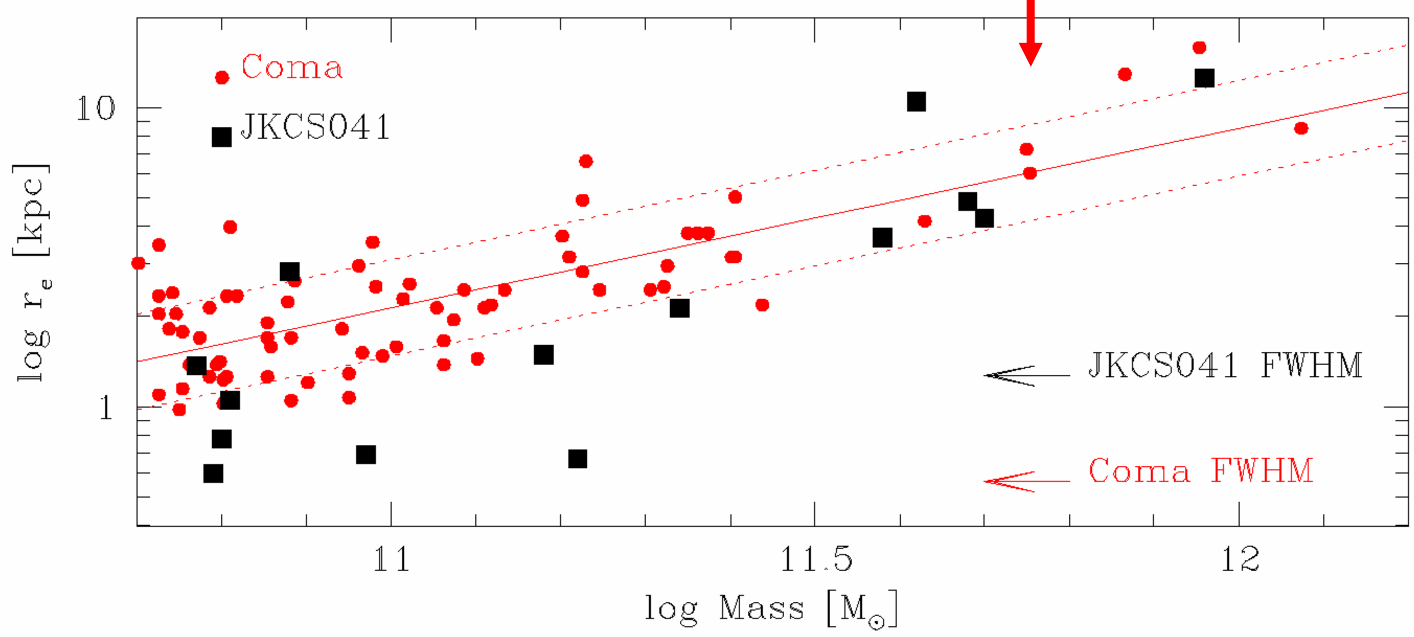


In the field, evolution is mostly at z>> 1. Need to go as close as possible to z=2!

0.4 dex per unit redshift change in field

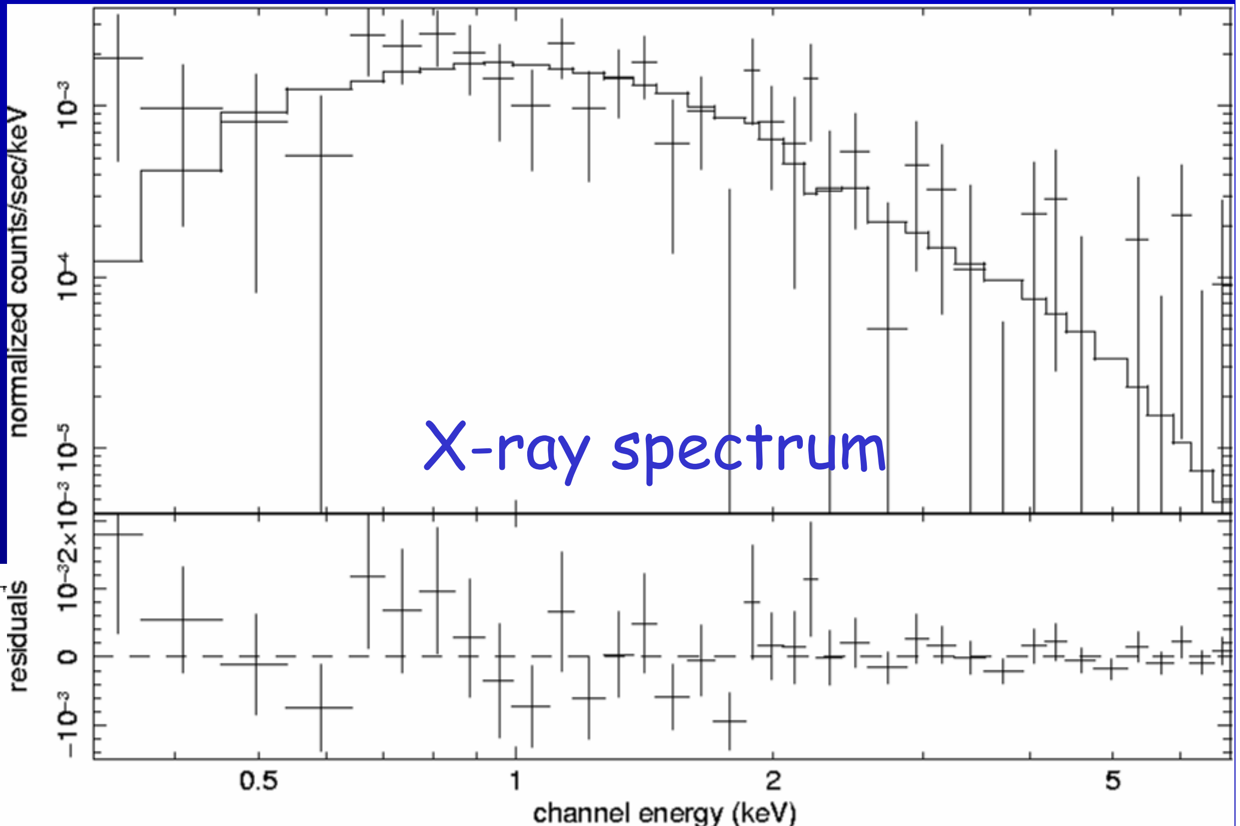
<0.11 dex (1σ) per unit redshift change in cluster

First preliminary indication that size evolution occurs earlier in clusters.



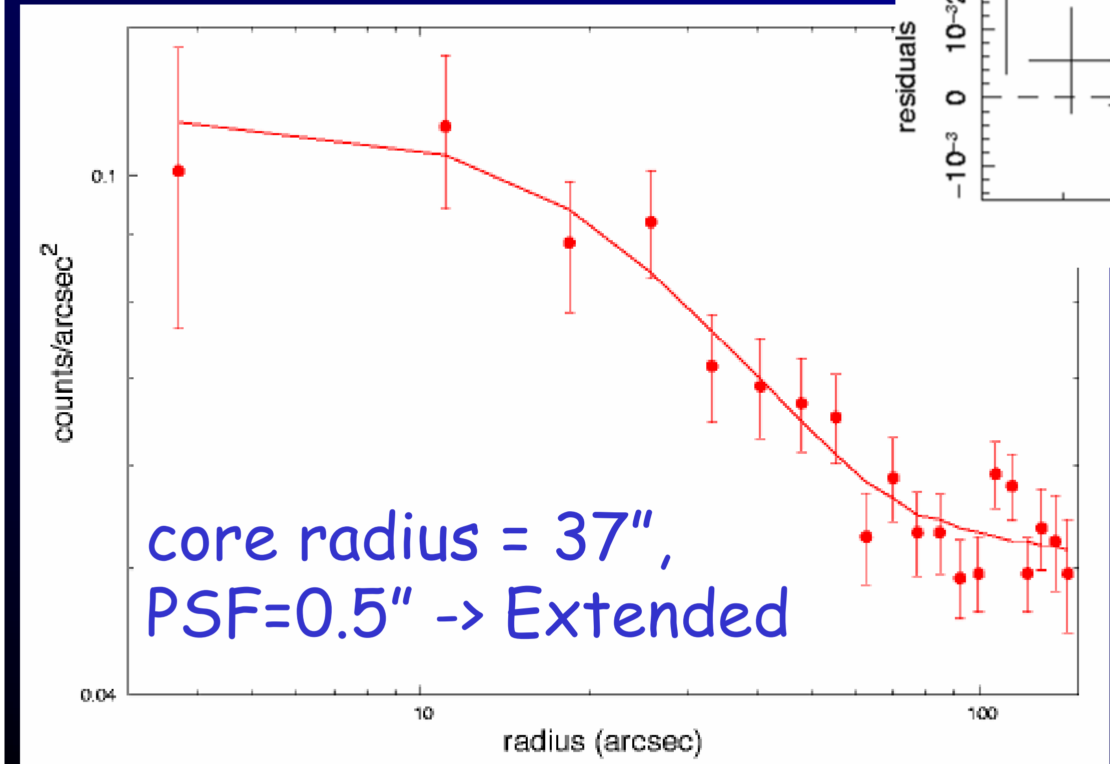
JKCS041 Chandra 80 ks exposure

Unique measurements of size and X-ray temperature at z>1.5



$T_X = 7.6^{+5.3}_{-3.3}$ keV

$L_X = 7.6 +/- 0.5\ 10^{44}$ erg cm^{-2} s^{-1}$_{l}$



Unique 4-ways mass determination

1) T_X-based: $\lg M_{200}$=14.6 ±0.5

2) L_X-based: $\lg M_{200}$=14.45 ± >0.2

- T_X- and L_X-based assume self-similar, but uncertain, evolution; L_X-based requires R_{500} from T_X

3) gas-fraction-based: $\lg M_{200}$=14.4 ±>0.1

- Firm lower limit $\lg M_{200}$=14.2

4) n200-based: $\lg M_{200}$=14.25 ± 0.29 almost free from assumptions about evolution

In reasonable agreement: a Coma cluster ancestor at z=1.803

General view at z=1.8

Almost everything in place at z=1.8:

Fully populated red sequence down to lgM=9.8, both at the high- and low-mass ends

Fully established color-density segregation, with minor star-forming component (once sample is mass-selected) within r500.

Age-mass as in nearby clusters, and the z=1.8 field.

Mass-size (almost) as in nearby clusters and in the field (after accounting for selection effects).

Cluster core radius as nearby clusters

but:

1) only 1 Gyr available to put everything in place and

2) should kept in place while the cluster mass (and its galaxy component) will grow by a factor about 3.

Possible Explication:

A) growth from material having "composition" and properties similar to already present "material"

B) not distributing itself in the cluster *randomly*

A quantitative model (simulation) appeared at the same time (Cen et al. 2014)

Conclusions

In the usual panorama of z>1.5 clusters, undetected by Chandra, with a scarce and biased spectroscopic coverage, JKCS041 stands out. Their data offer a unique view on many different topics of galaxy evolution and a four-ways cluster mass.

However, JKCS041 is a single cluster. It's time to add a second (and a third …) cluster with a comparable data-richness, to reduce the danger of generalizing from a single example.


Thanks
JKCS041 z=1.803