A local comparison sample for the EDisCS survey

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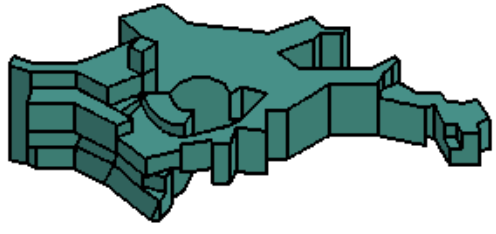
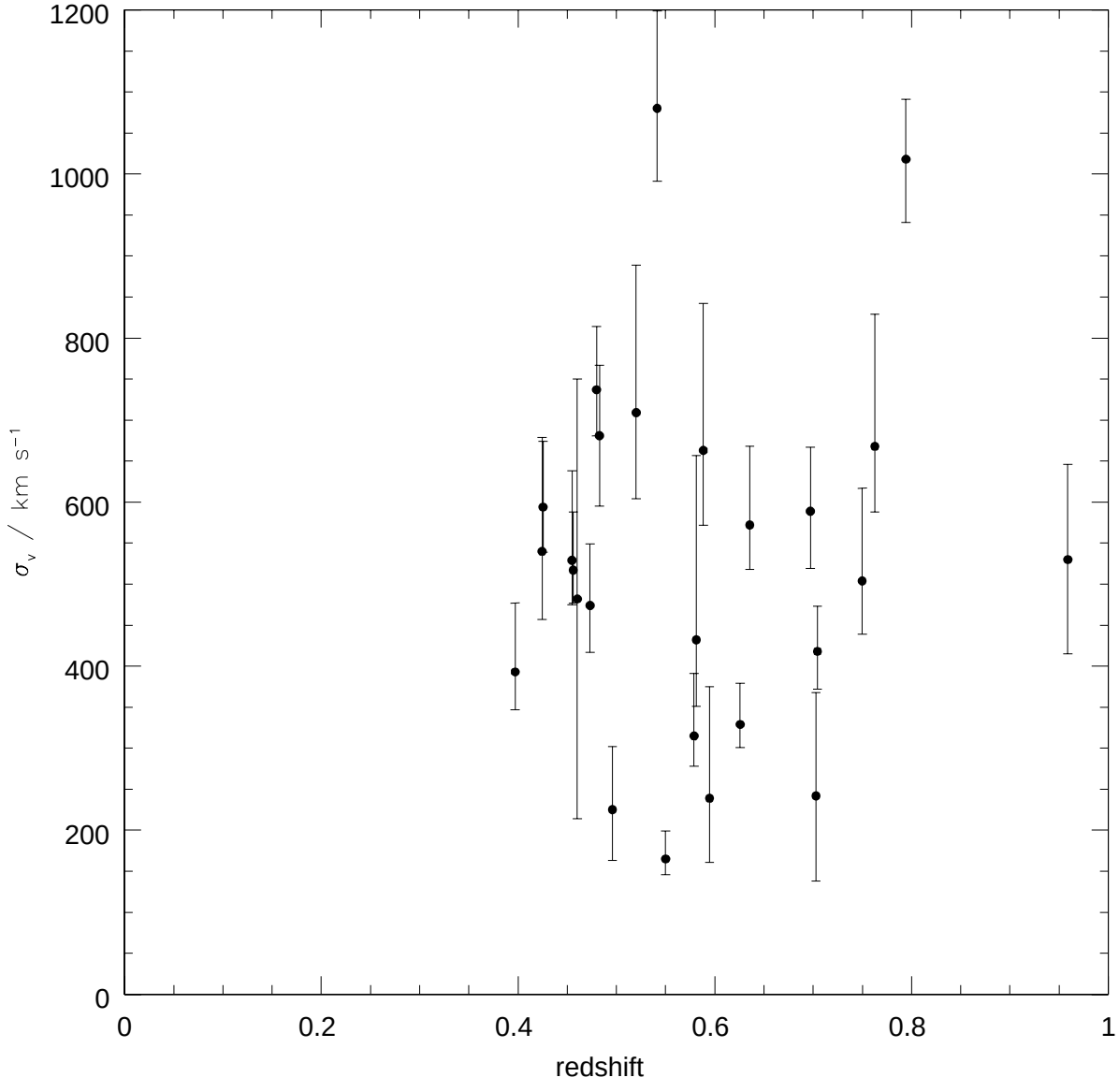


Simon White, Guinevere Kauffmann + EDisCS collaboration

The EDisCS Survey

- ESO Distant Cluster Survey
- one of the first optically selected high-redshift cluster samples
- based on Las Campanas Distant Cluster Survey (detected integrated cluster brightness)

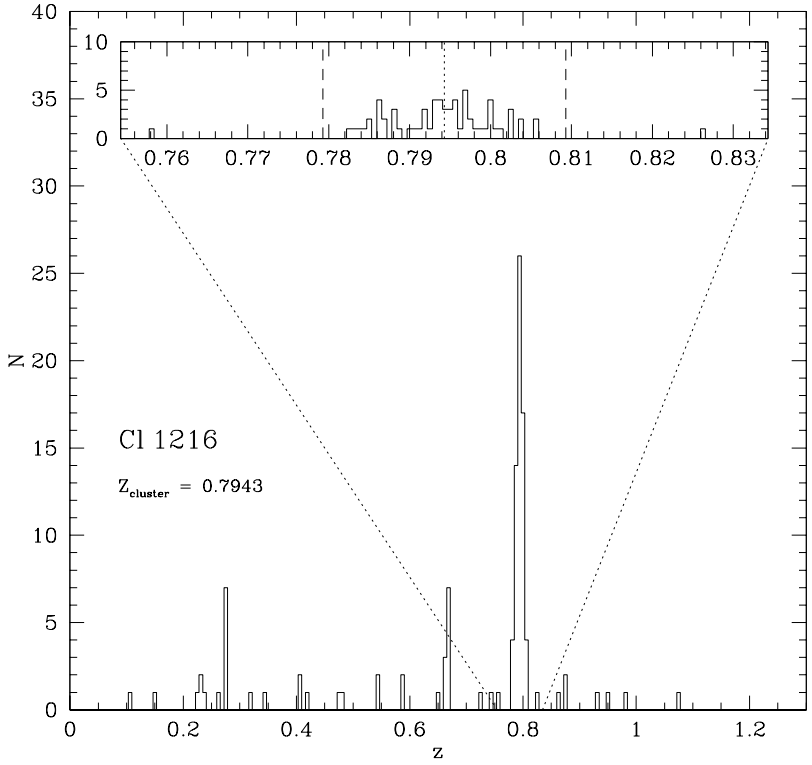
- 20 fields containing clusters with $0.4 \lesssim z \lesssim 1$
- deep optical photometry in B,V,I or V,R,I (FORS2)
- deep near-infrared photometry (SUSI)
- deep spectroscopy (FORS2)
- wide-field imaging (WFI)
- ACS mosaic imaging for 10 most distant clusters

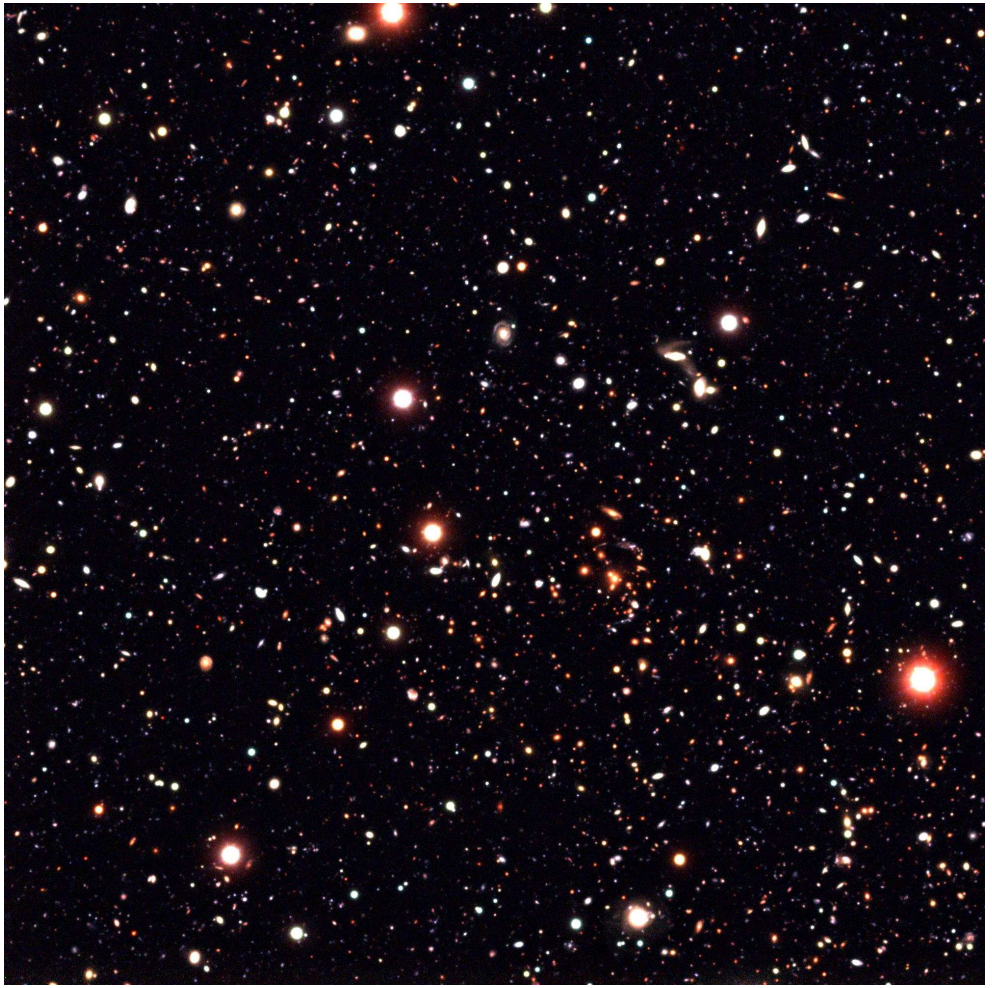

1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
redshift
σv / km s-1

Example: Cl1216

redshift: 0.794

velocity dispersion: (1018^{+73}_{-77}) km/s





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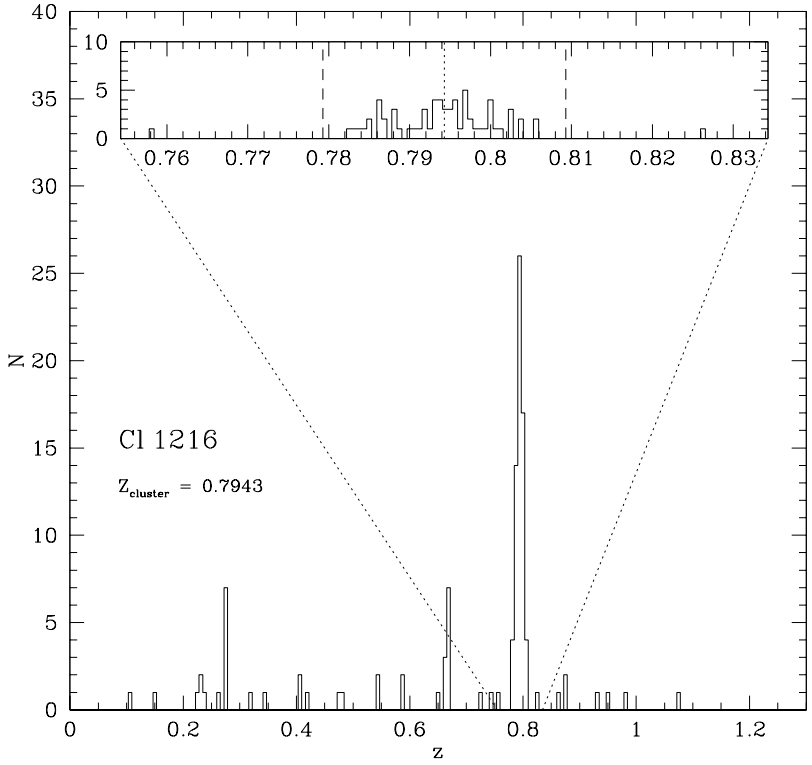

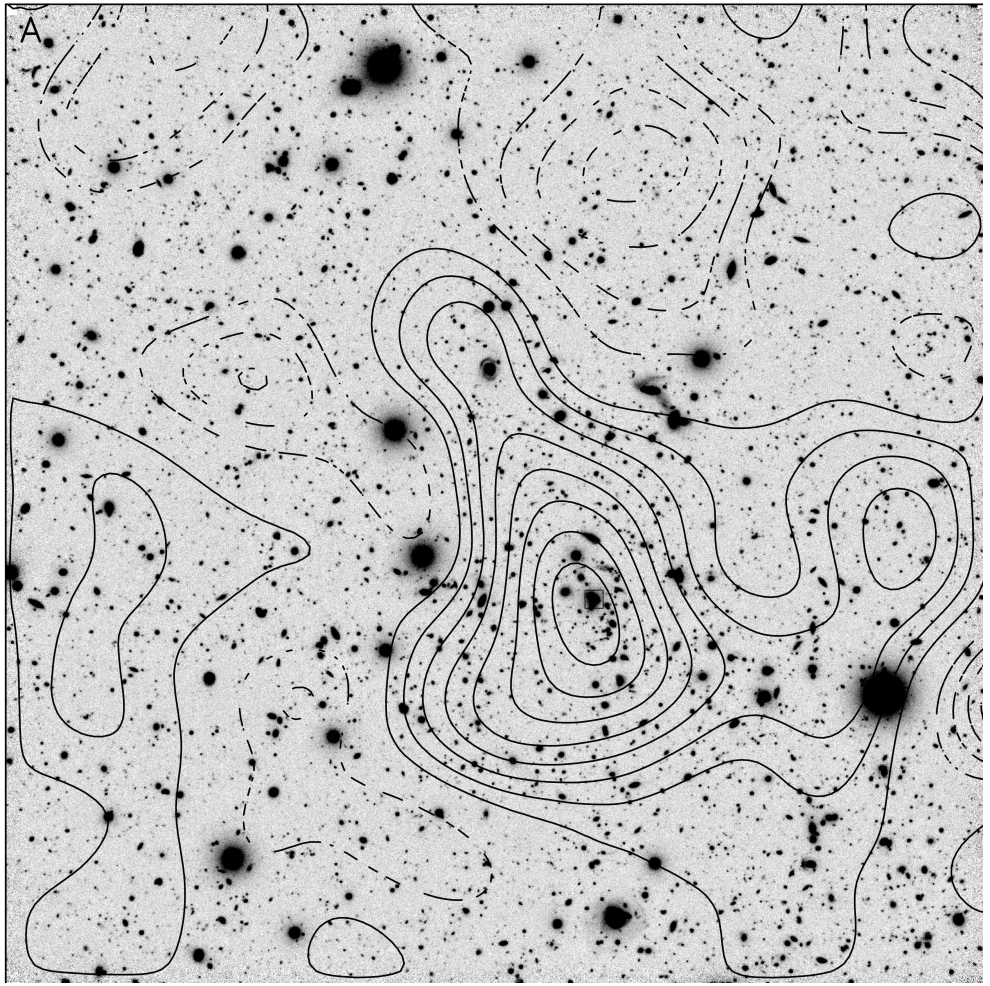

Local Comparison Sample

- need local sample for evolutionary studies!
  - morphology-density relation
  - star-formation activity
  - ...

$\Rightarrow$ draw sample from SDSS

$\longrightarrow$ detailed spectroscopic analysis by stellar population synthesis fitting (Kauffmann et al. 2003, Tremonti et al. 2004, Brinchmann et al. 2004)

(1) Abell clusters

(2) C4 clusters

Abell cluster sample

- optically selected
- (projected) galaxy overdensity $\simeq$ LCDCS light overdensity (?)

Abell cluster sample

- sample construction:
  - Struble & Rood (1991) compilation of properties of Abell clusters
    $\rightarrow$ select clusters with redshifts based on ≥ 2 galaxies (774 clusters)
  - select clusters with $0.04 \leq z \leq 0.085$ (226 clusters)
  - retain only clusters with ≥ 20 SDSS DR2 galaxies within Abell radius ($1\farcm7/z$) from cluster center (31 clusters)

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  - check for edge location (SDSS imaging, -3)
  - check for redshift peak at S&R redshift (-2)
  - identify BCG from SDSS imaging (-1)

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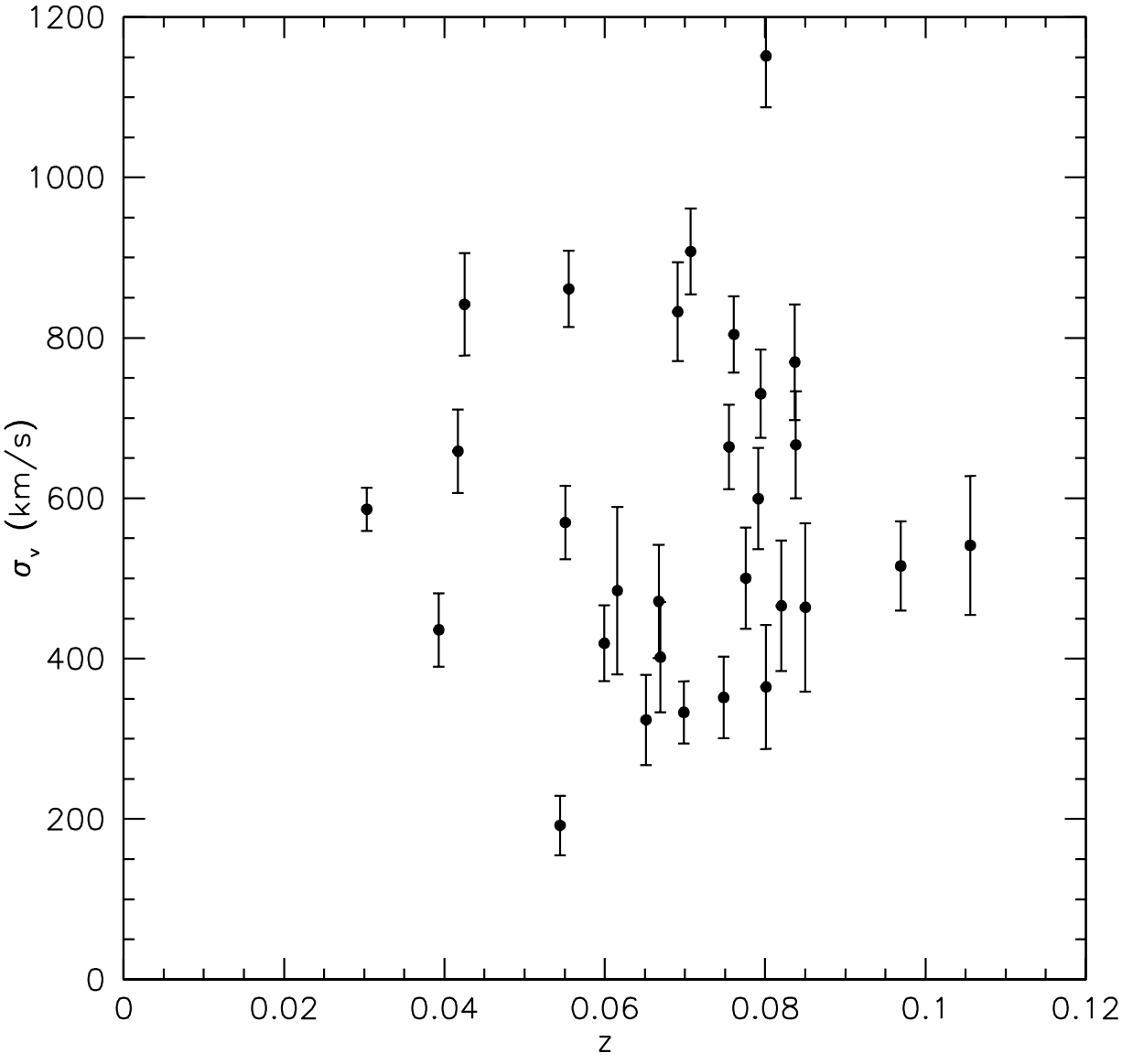
  - add 4 clusters outside redshift range ($\Rightarrow$ 29 clusters)

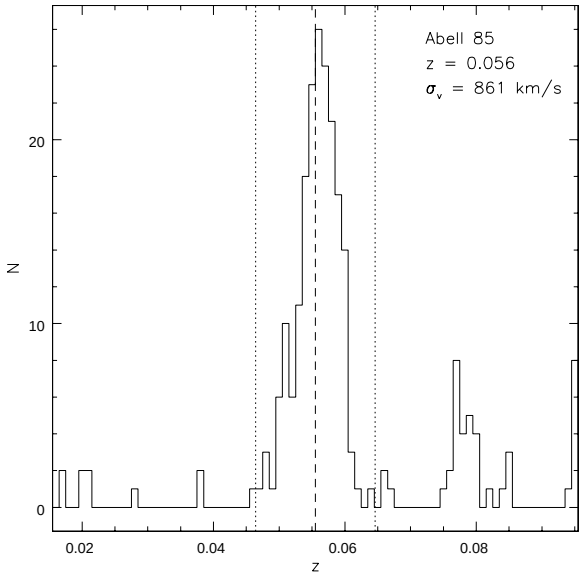
Velocity dispersions

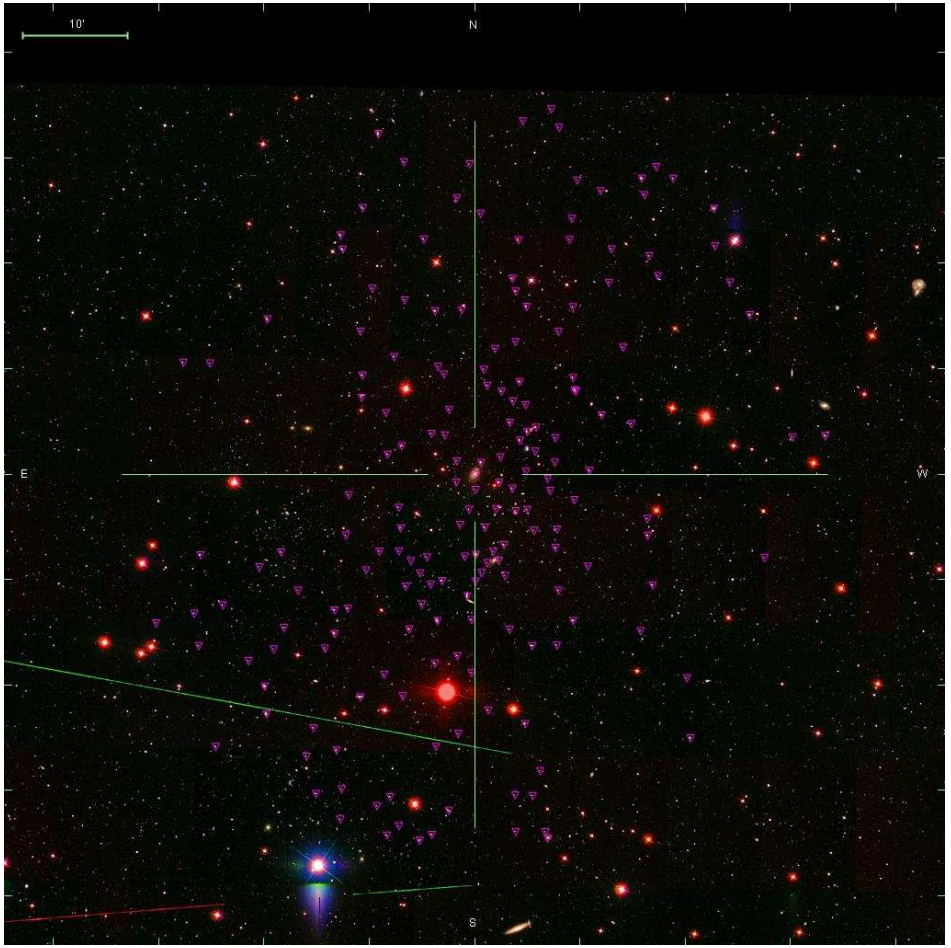
- iterative procedure to find cluster redshift and velocity dispersion from galaxies within $\pm 3\sigma_v$ and 1.2 R_{200} from BCG
- uses biweight estimator (Beers '90)
- first estimate constrained to $\sigma_v \lesssim 500$km/s; this is necessary to avoid contamination by LSS


1200
1000
800
600
400
200
0
σ_v (km/s)
0
0.02
0.04
0.06
0.08
0.1
0.12
z

Abell 85

R.A.:	$00^{\mathrm{h}}\,41^{\mathrm{m}}\,50^{\mathrm{s}}$
Dec:	$-09^{\circ}\,18'\,11''$
redshift:	0.056
velocity dispersion:	(861 ± 48) km/s
R_{200}:	$(2.071 \pm 0.115)\mathrm{Mpc}$
	$\hat{=}\ (0.499 \pm 0.028)^{\circ}$
	185 galaxies





The C4 catalog

- C. Miller et al., 2005
- based on SDSS DR2 spectroscopic catalog
- cluster identification in position, redshift, and color space
  $\longrightarrow$ assumption: cluster galaxies have similar colors
- 748 clusters, $0.02 < z < 0.17$

1. redshift limit $z \leq 0.1$ (522 clusters)
2. determine BCG (brightest cluster galaxy):
   - draw candidates (C4 BCG(s), bright E's in vicinity of cluster center)
   - eye-ball candidates, choose BCG
   - for 10% of clusters: closer inspection needed
3. identify clusters associated with identical BCG (477clusters)

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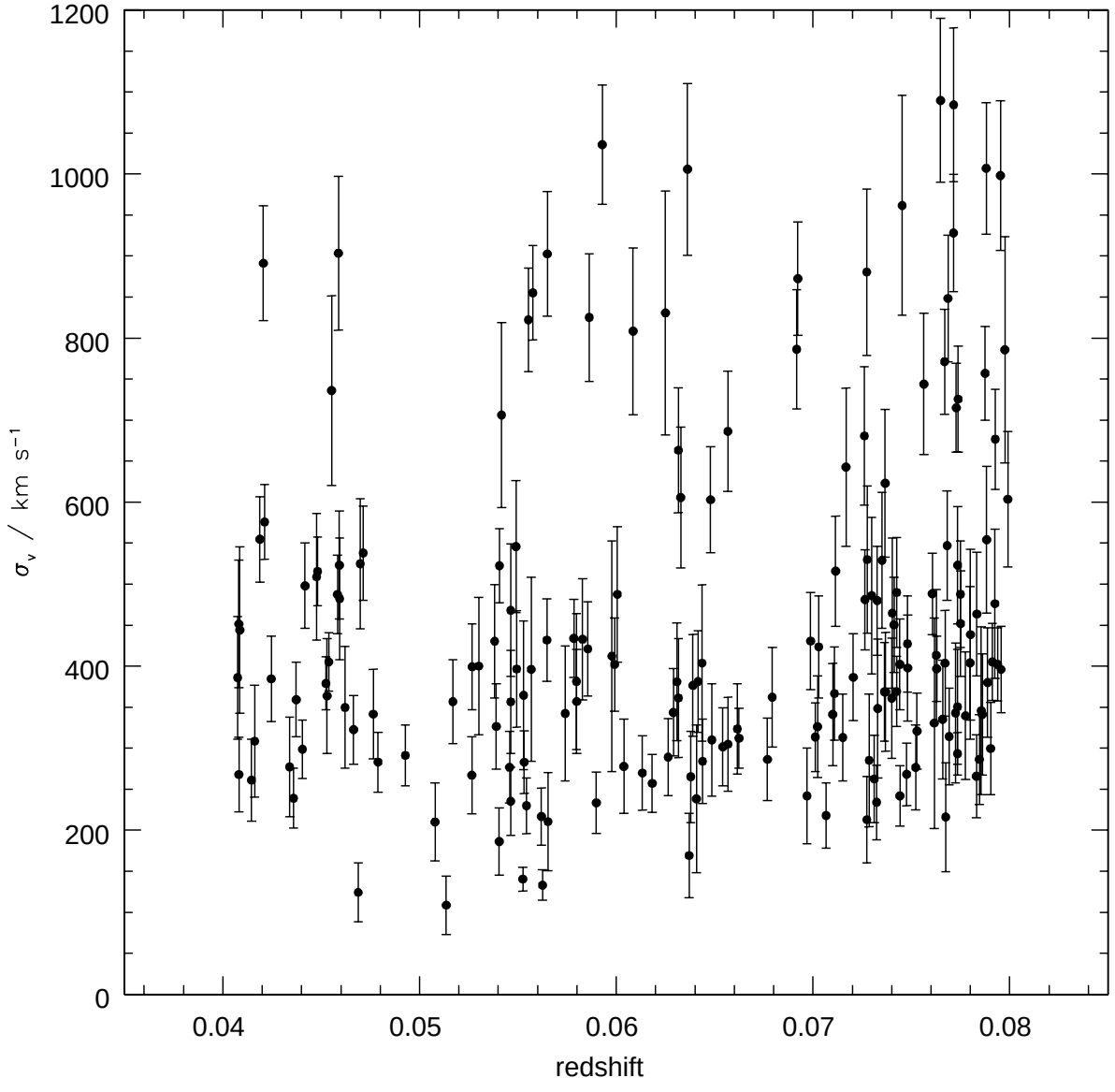
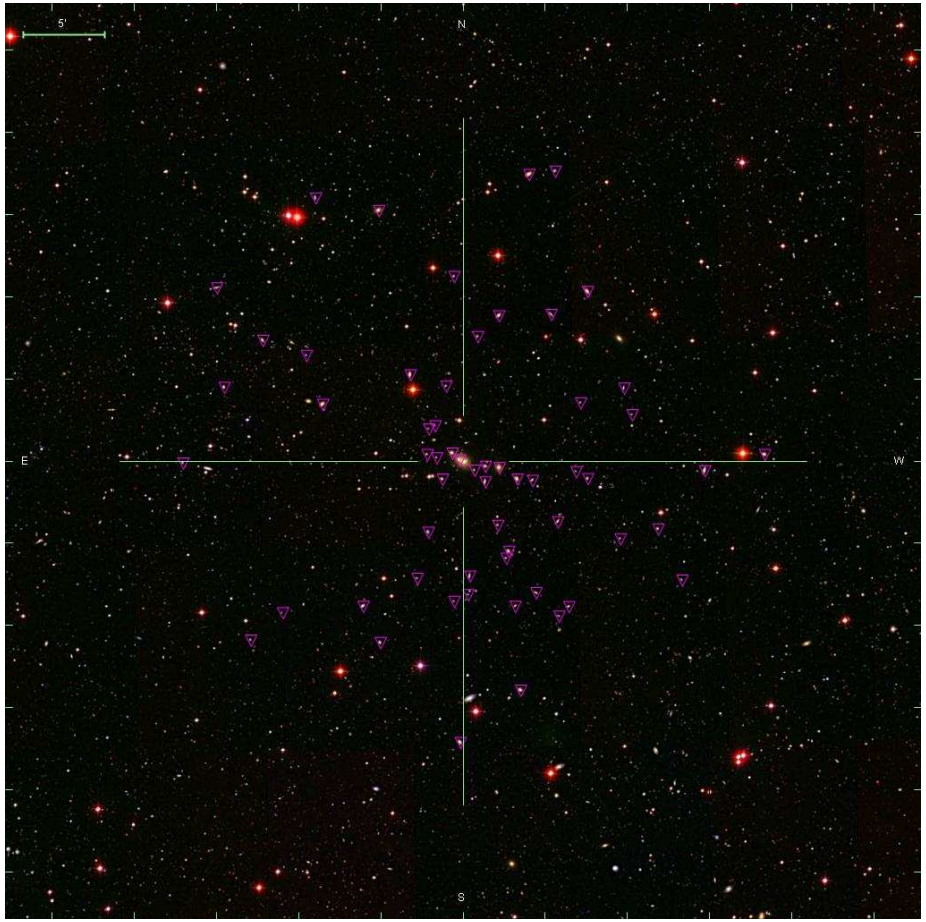
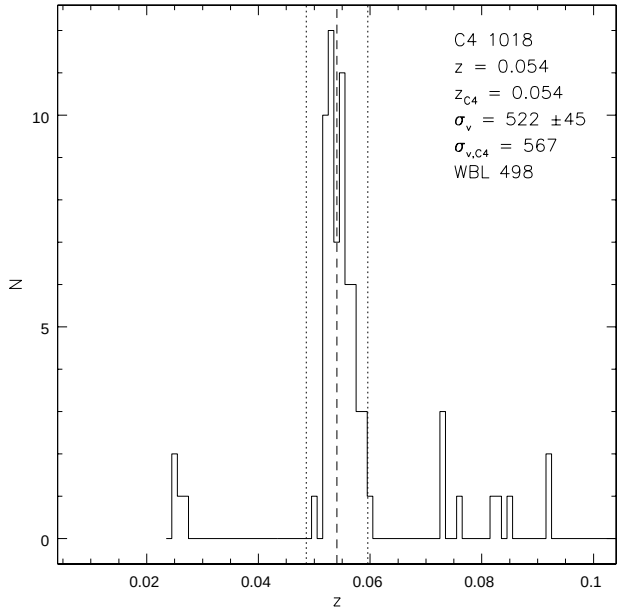
4. determine redshift, velocity dispersion σ_v, R_{200}, cluster members iteratively (449 clusters):
   - initial redshift as given by C4
   - initial $\sigma_v \leq 500$km/s
   - cluster members within $\pm 3\sigma_v$ and R_{200}
5. main sample: 232 clusters with $0.04 \leq z \leq 0.08$, $\sigma_v \leq 1500\,$km/s
6. no mergers: 188 clusters without overlap in R_{200}

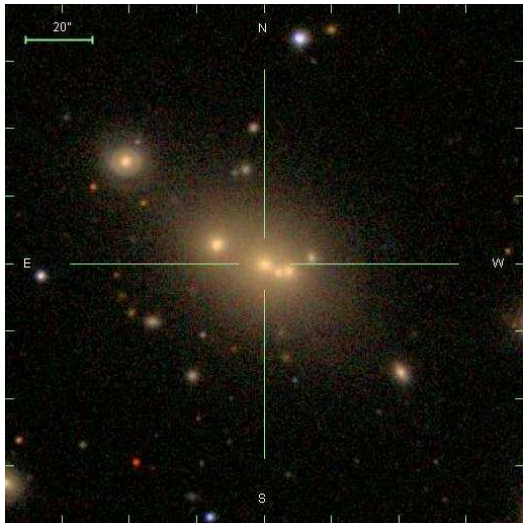

1200
1000
800
600
400
200
0
0.04
0.05
0.06
0.07
0.08
redshift
σ_v / km s^{-1}

C4 1018

redshift:	0.054
velocity dispersion:	(522 ± 45) km/s
R_{200}:	(1.259 ± 0.109)Mpc
	$\hat{=} (0.311 \pm 0.027)°$

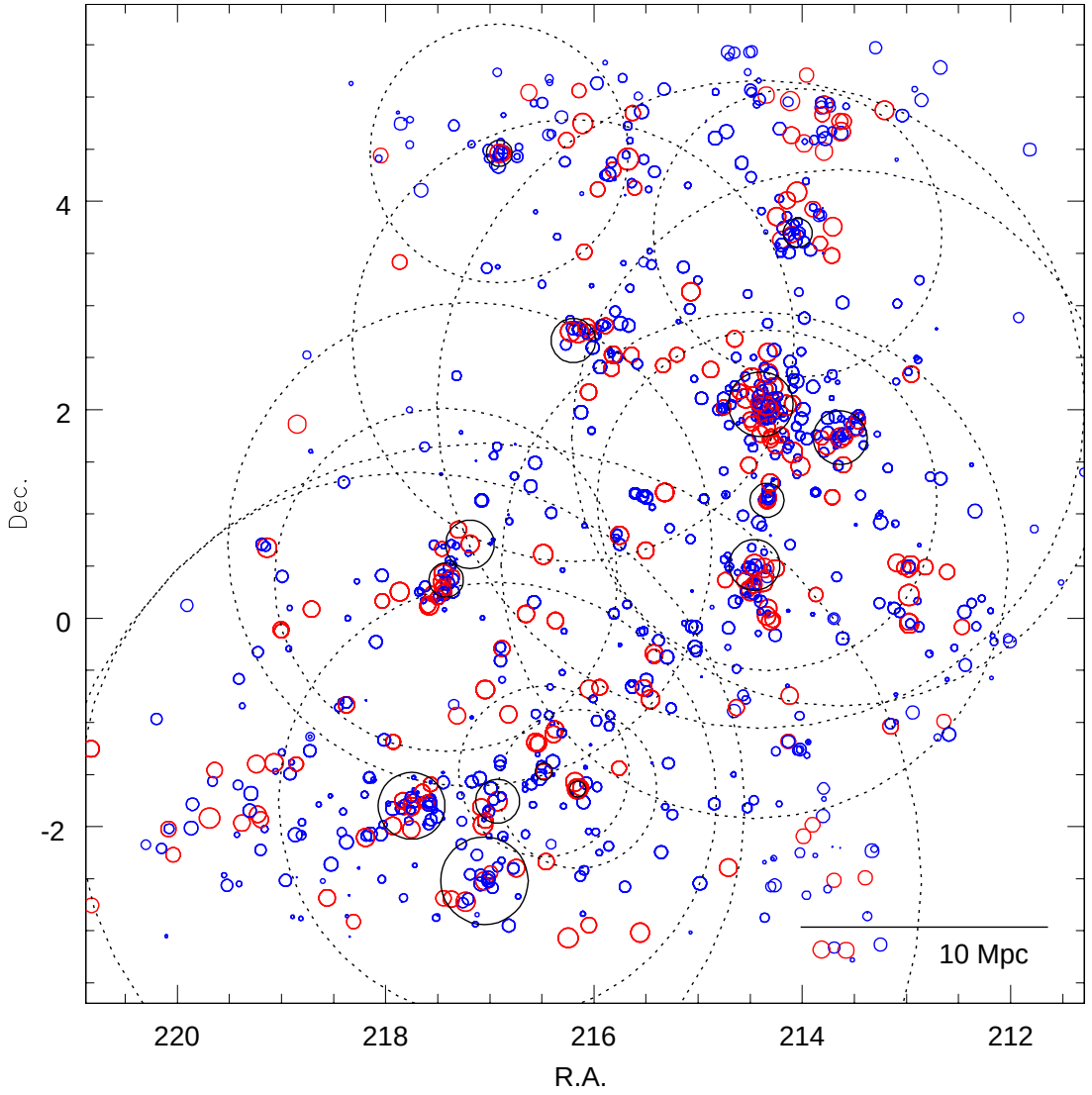






Cluster clustering

Cluster	redshift	σ_v[km/s]
C4_1248	0.056	217
C4_1229	0.055	235
C4_1162	0.055	364
C4_1018	0.054	522
C4_1037	0.054	431
C4_1079	0.055	277
C4_1361	0.055	397
C4_1116	0.053	400
C4_1133	0.055	283
C4_1294	0.055	140
C4_1255	0.056	133
C4_1300	0.055	357
C4_1141	0.055	546
C4_1089	0.054	706



First results

Radial trends in C4 sample

- clusters isolated within 3 Mpc and $\pm 5\sigma_v$
- galaxies within $\pm 1\sigma_v$ from cluster redshift
- galaxies brighter than $M_V < -19.4$
- two samples:

  $\sigma_v < 600$ km/s: 85 clusters, 4625 galaxies

  $\sigma_v > 600$ km/s: 28 clusters, 5213 galaxies

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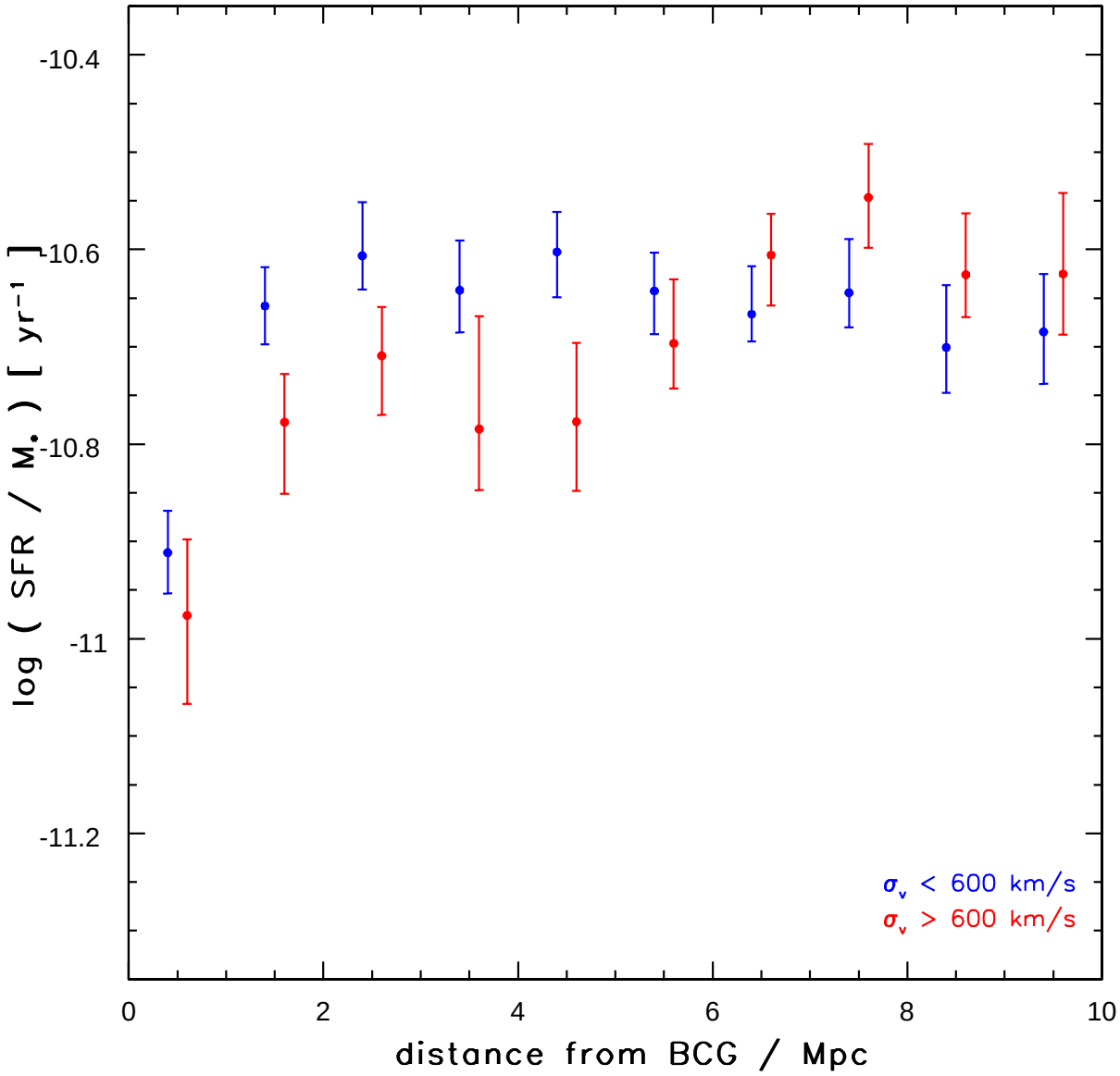
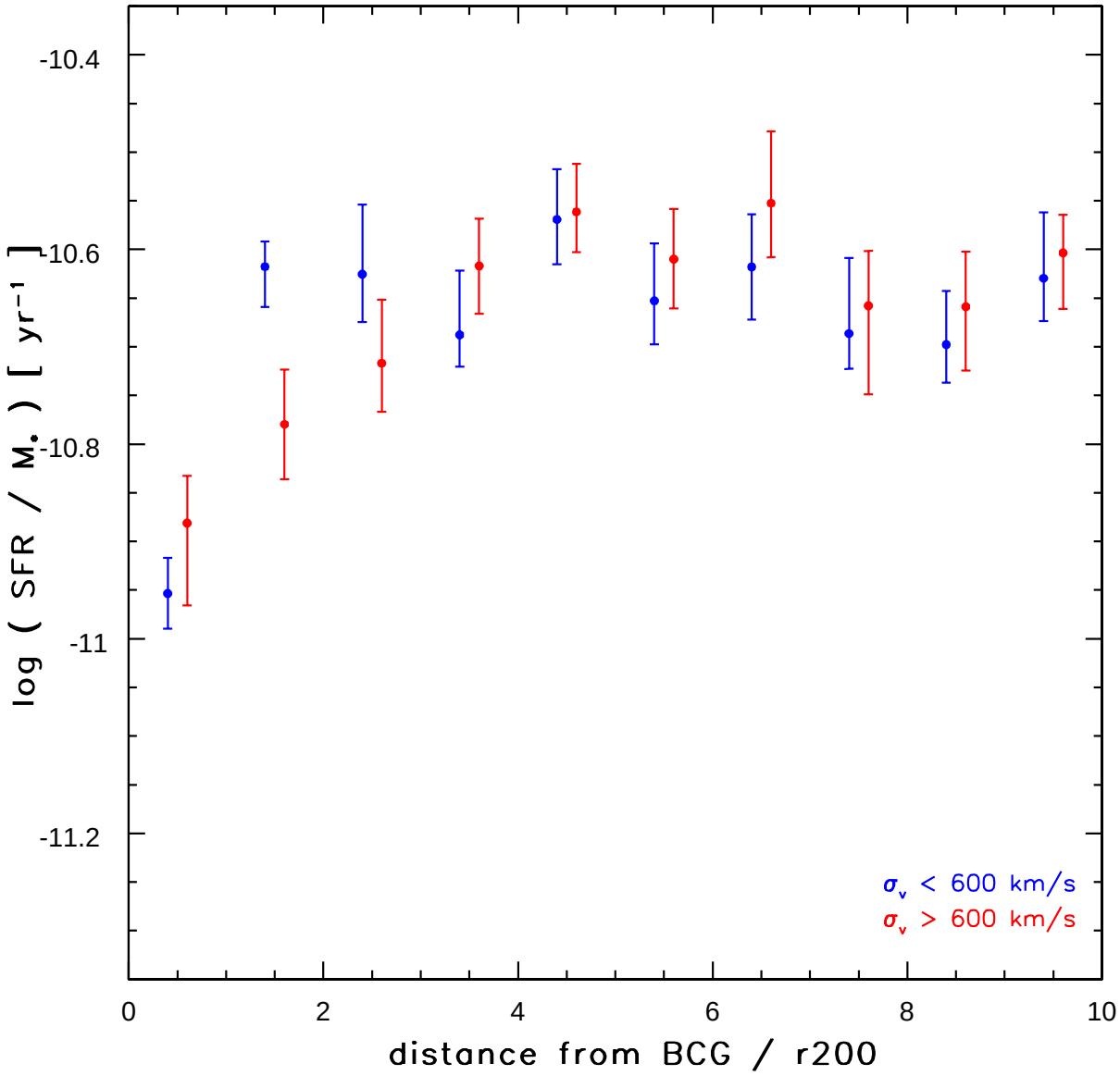
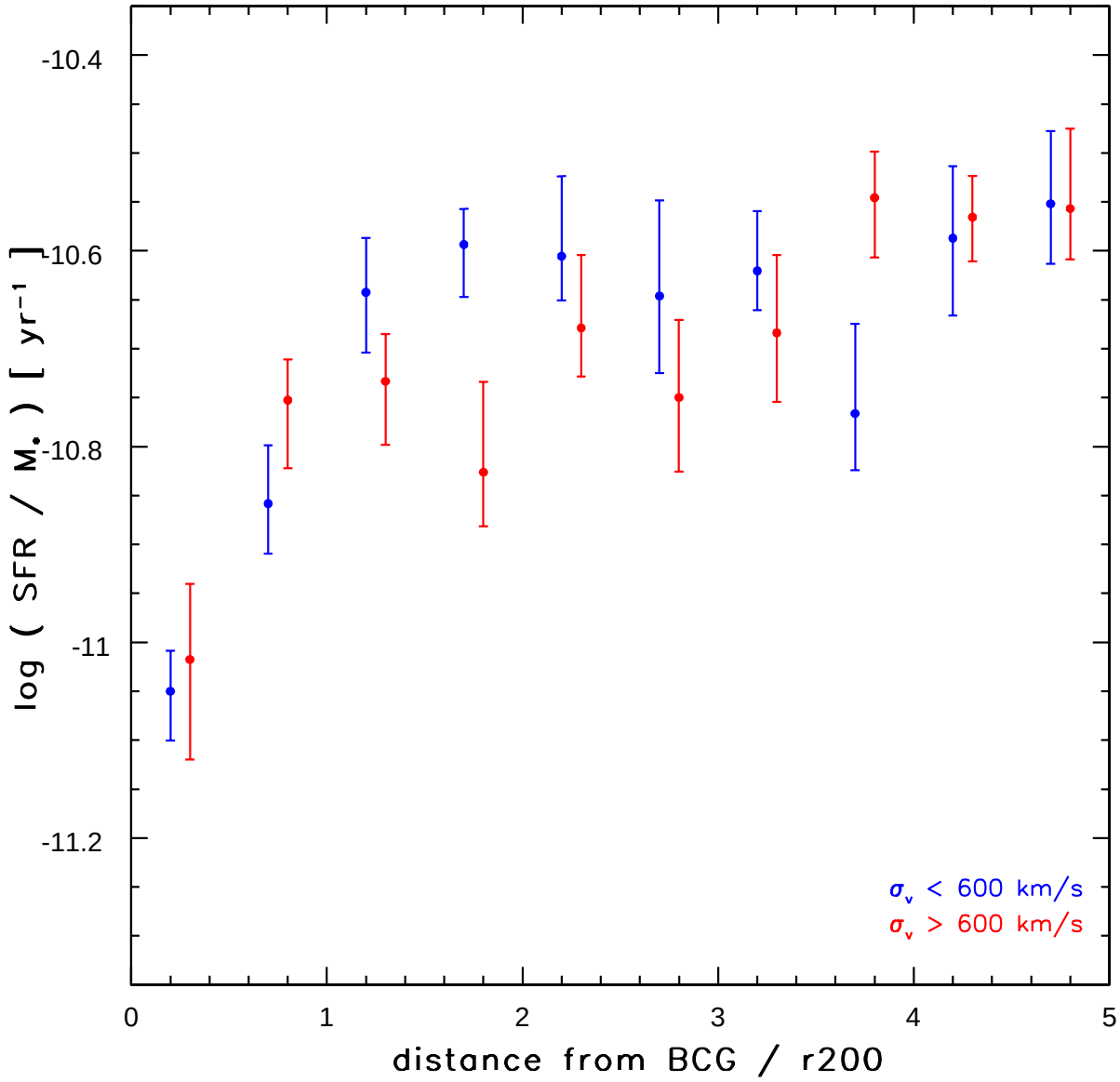
(1) specific star formation rate vs. clustocentric distance


-10.4
-10.6
-10.8
-11
-11.2
log (SFR / M•) [yr⁻¹]
0
2
4
6
8
10
distance from BCG / Mpc
σv < 600 km/s
σv > 600 km/s


-10.4
-10.6
-10.8
-11
-11.2
log (SFR / M•) [yr⁻¹]
0
2
4
6
8
10
distance from BCG / r200
σv < 600 km/s
σv > 600 km/s


-10.4
-10.6
-10.8
-11
-11.2
log (SFR / M•) [yr⁻¹]
0
1
2
3
4
5
distance from BCG / r200
σv < 600 km/s
σv > 600 km/s

Radial trends in C4 sample

(1) specific star formation rate vs. clustocentric distance

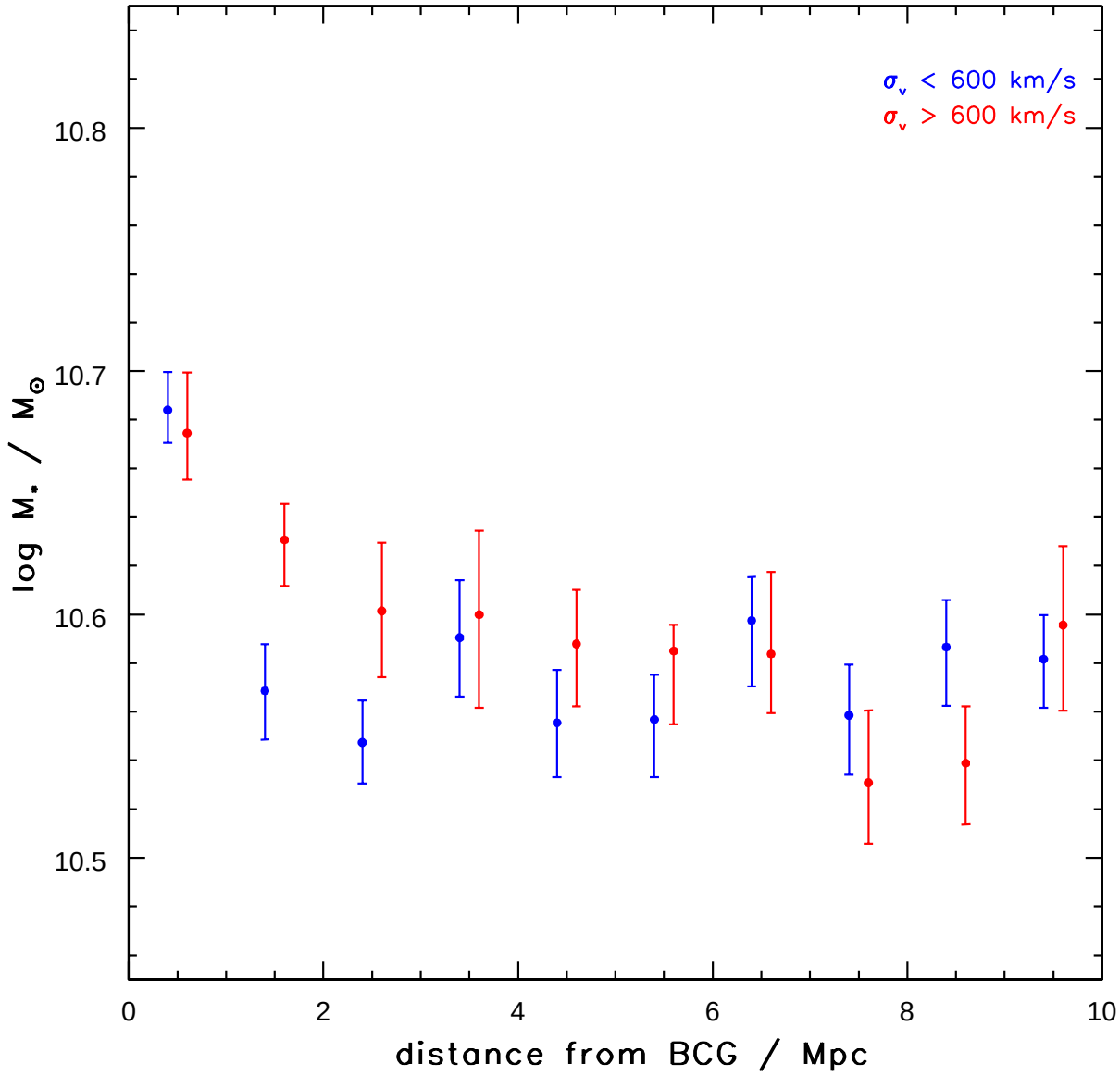
$\Longrightarrow$ SFR suppression within $\sim 2R_{200}$

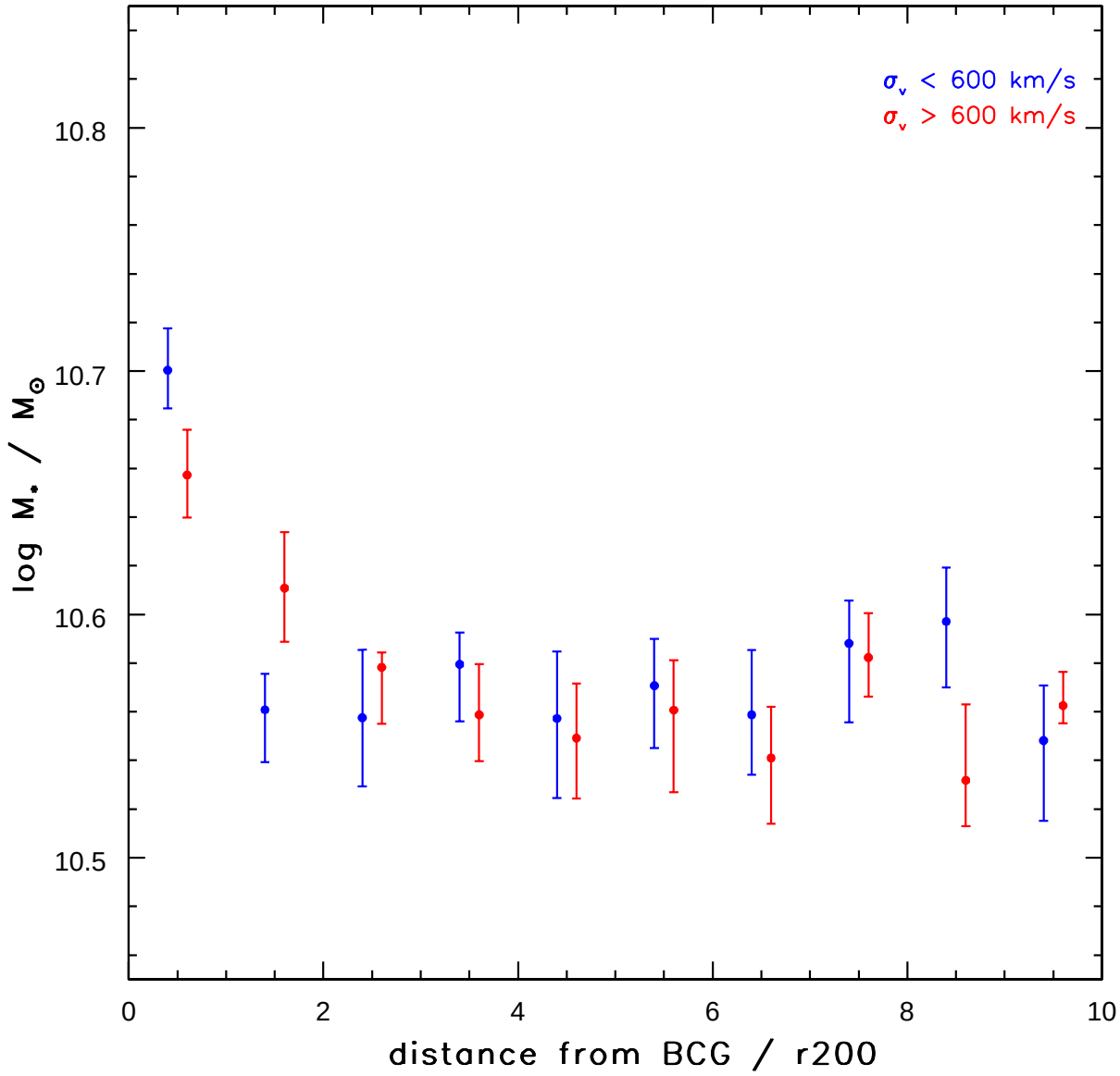
Radial trends in C4 sample

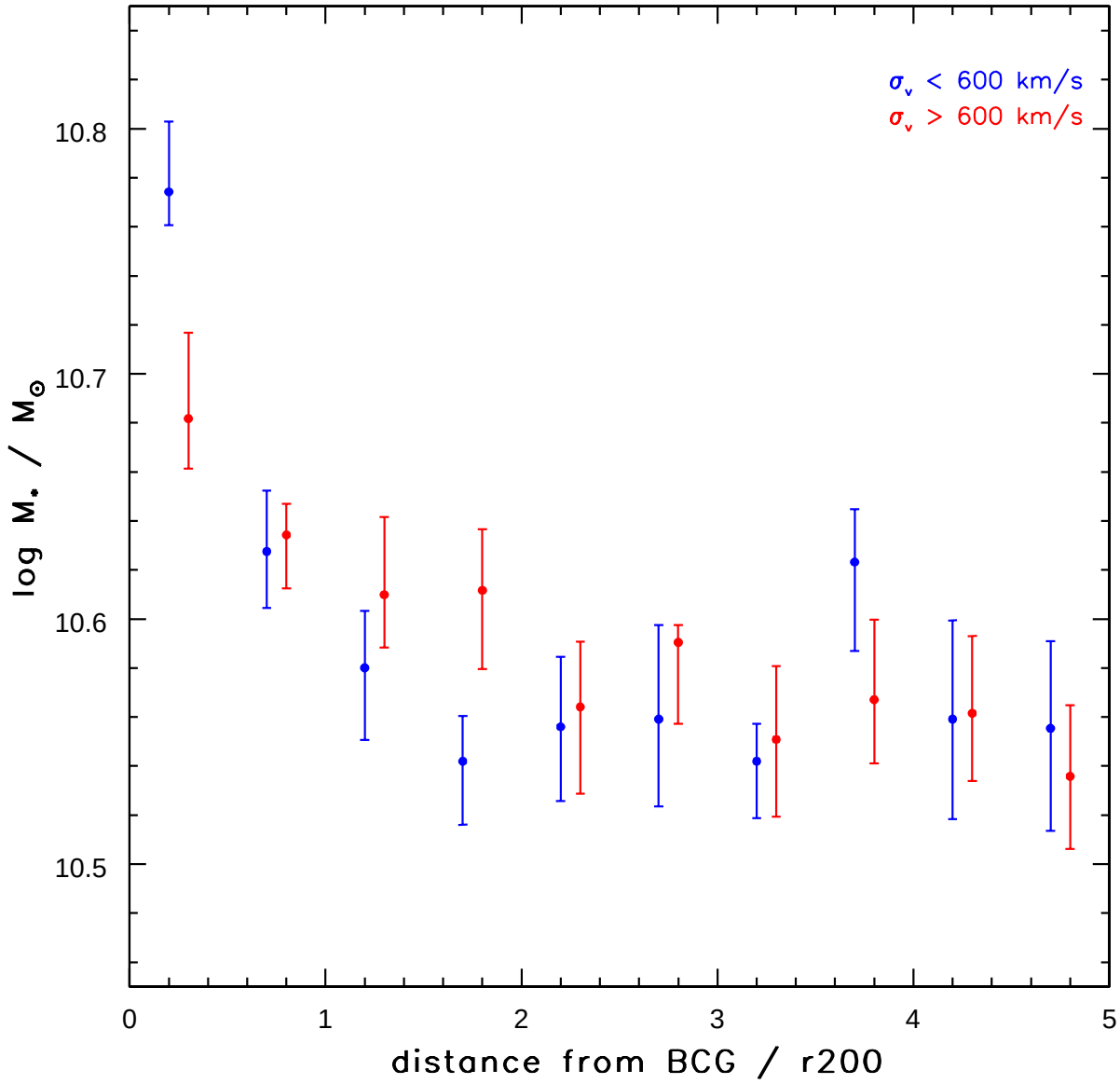
(1) specific star formation rate vs. clustocentric distance

$\Longrightarrow$ SFR suppression within $\sim 2R_{200}$

(2) stellar mass vs. clustocentric distance


σ_v < 600 km/s
σ_v > 600 km/s
10.8
10.7
10.6
10.5
log M* / M⊙
0
2
4
6
8
10
distance from BCG / Mpc


σv < 600 km/s
σv > 600 km/s
10.8
10.7
10.6
10.5
log M* / M⊙
0
2
4
6
8
10
distance from BCG / r200


σ_v < 600 km/s
σ_v > 600 km/s
log M* / M⊙
10.8
10.7
10.6
10.5
0
1
2
3
4
5
distance from BCG / r200

Radial trends in C4 sample

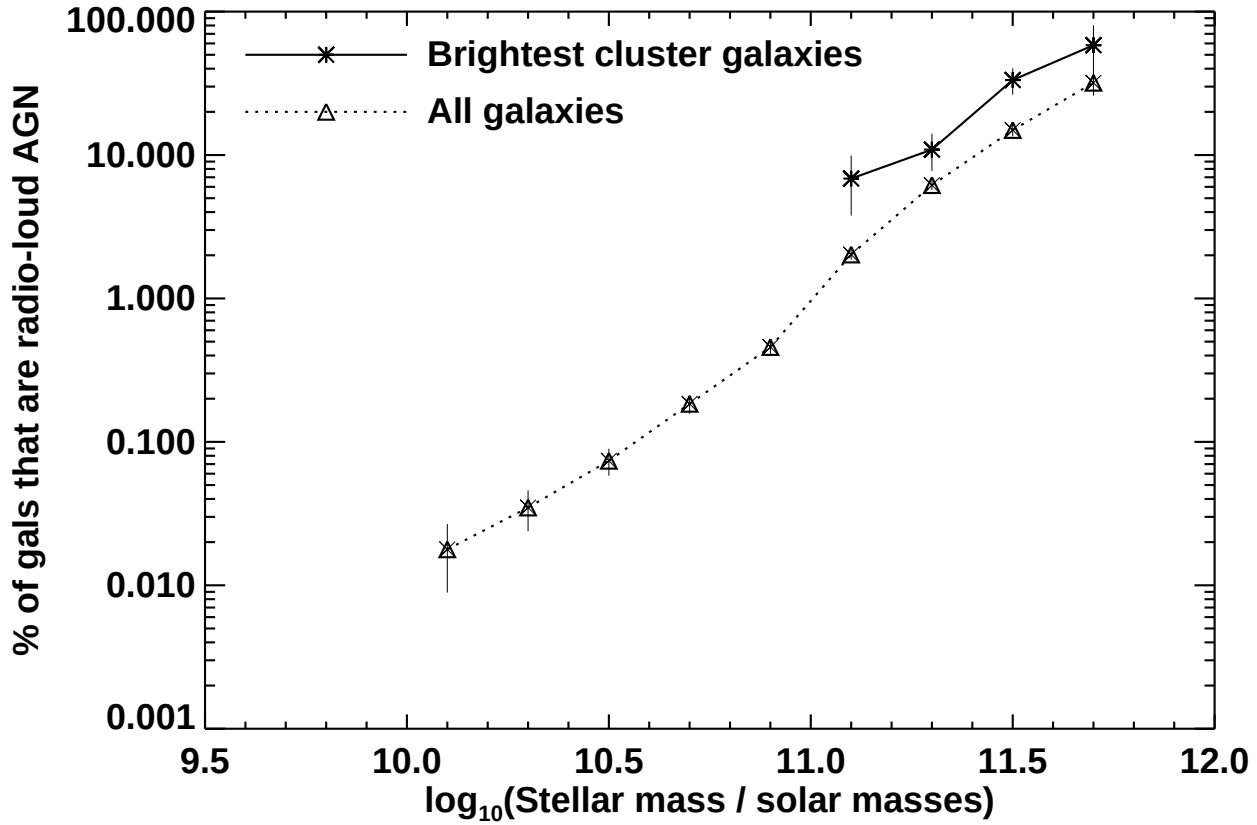
(1) specific star formation rate vs. clustocentric distance

$\Longrightarrow$ SFR suppression within $\sim 2R_{200}$

(2) stellar mass vs. clustocentric distance

$\longrightarrow$ increase within $\sim 2R_{200}$

Radio-loud BCGs



work in progress
with
Philip Best,
Guinevere
Kauffmann

$\Longrightarrow$ for a given stellar mass, probability to host radio-loud AGN twice as high if galaxy is BCG

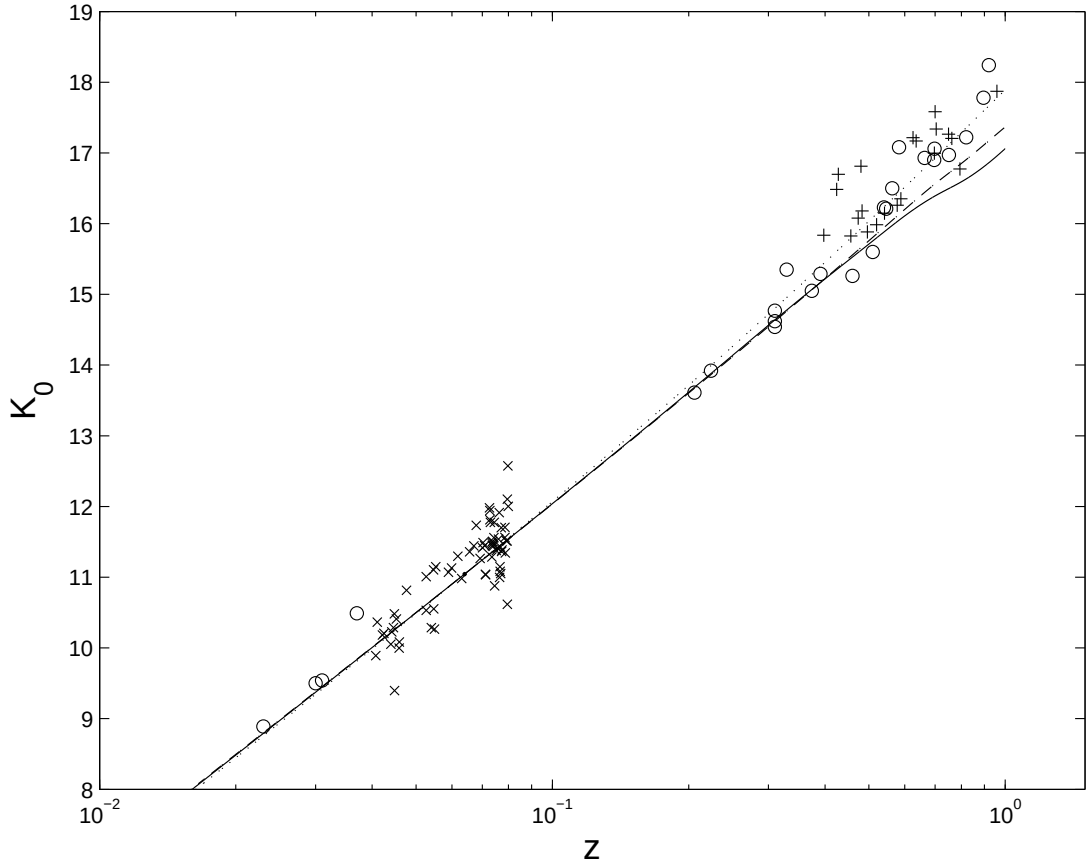
$\longrightarrow$ BCG's black hole refuelled by cooling flow

BCG Hubble diagram

$\cdots$ no evolution

- - $z_{\rm form} = 5$

— $z_{\rm form} = 2$



+ EDisCS BCGs

× C4 BCGs

work in progress with Ian Whiley, Alfonso Aragon-Salamanca

- constant luminosity requires doubling BCG mass since $z \sim 1$
- colors consistent with $z_{\rm form} = 2$

Star Formation in EDisCS vs. SDSS clusters

$\longrightarrow$ B. Poggianti's talk

Outlook

- update to DR4
- compare BCG positions to
  - luminosity centroid
  - X-ray and radio centroids
- apply population synthesis fitting to EDisCS spectra