Hundreds of distant clusters in the CFHTLS Wide fields and in the SDSS Stripe 82

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Main collaborators

CFHTLS

- Sophie Maurogordato

- Christophe Adami
- Alberto Cappi
- Christophe Benoist
- Jean Coupon
- Olivier Ilbert
- Isabel Márquez
- Alain Mazure
- Cédric Mezrag and Thierry M. Edorh

Stripe 82

- Melville Ulmer
- Jiangjiang Hao

Papers

- Mazure, Adami, Pierre et al. 2007, A&A 467, 49 (M07)
- Adami, Durret, Benoist, Coupon, Mazure, Meneux, Ilbert, Blaizot et al. 2010, A&A 509, 81 (A10)
- Durret, Adami, Cappi, Maurogordato, Márquez, Ilbert, Coupon et al. 2011, A&A 535, 65 (D11)
- Maurogordato, Durret, Cappi et al. in preparation (CFHTLS)
- Durret, Adami, Hao, Ulmer et al. in preparation (Stripe 82)

CFHTLS data

- CFHTLS u, g, r, i or y, z bands
- M07: Deep 1 field
- A10:
  - Deep fields: Deep 2, Deep 3 and Deep 4
  - Wide fields: Wide 1, Wide 3 and Wide 4 from data release 4
- D11:
  - Wide fields: Wide 1, Wide 3 and Wide 4 from data release 6

Areas covered by CFHTLS

CFHTLS

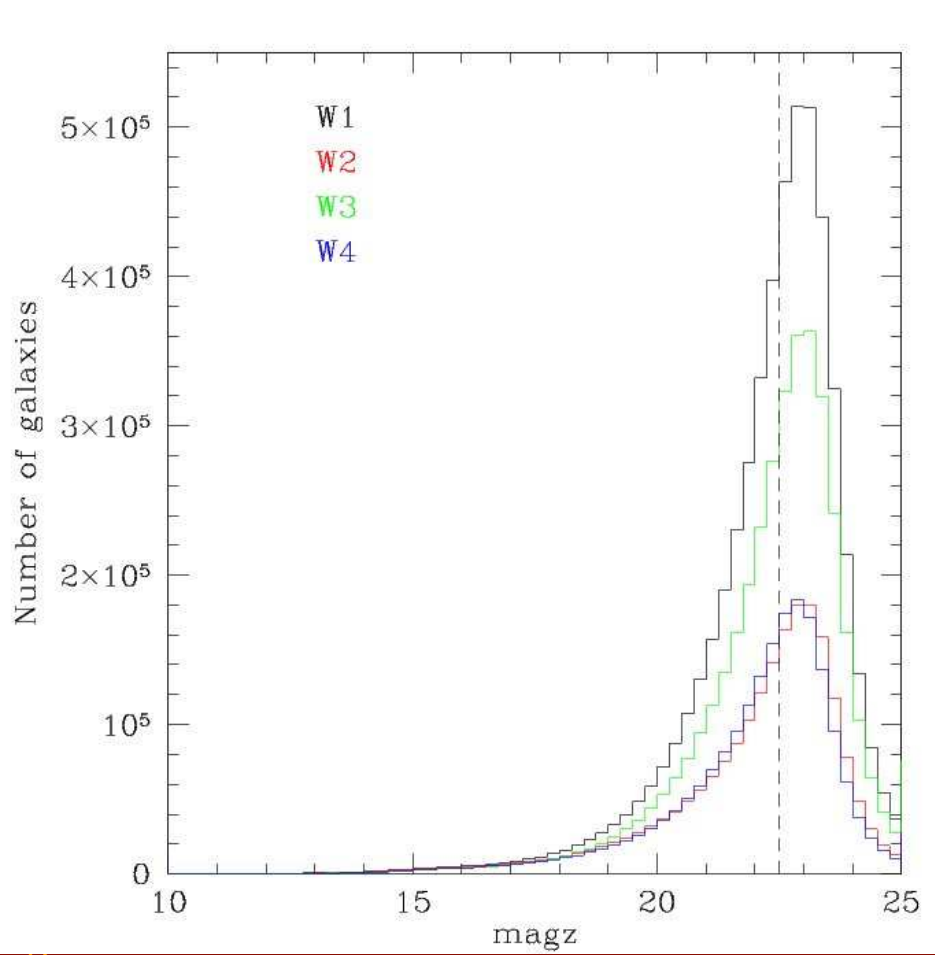
- Deep fields: 1x1 deg^2 each

- Wide fields:

  A10 34 deg^2

  D11 154 deg^2

CFHTLS: completeness



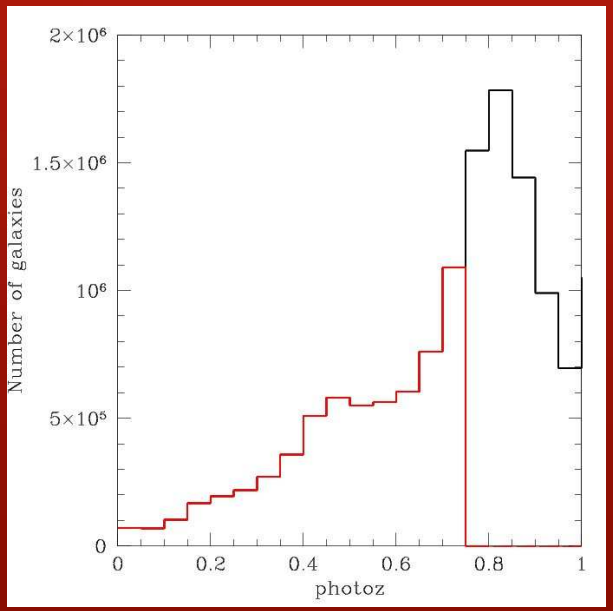
z' magnitude histogram

Cut at z'=22.5
to avoid
incompleteness
effects

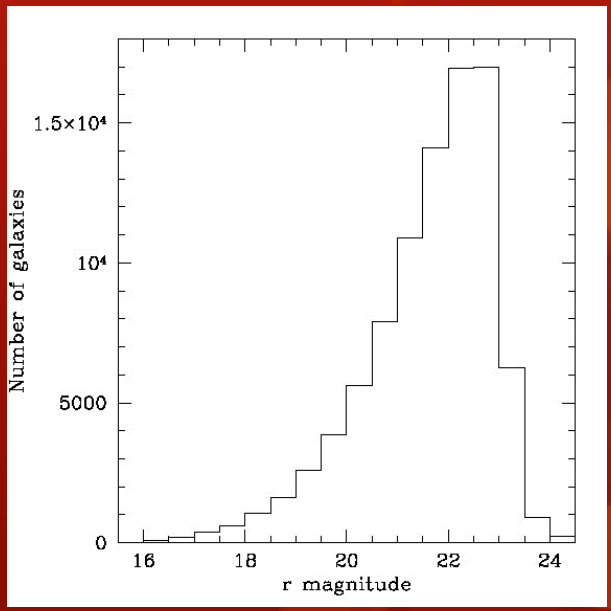
z'=22.5 corresponds to
$M_{z'}$ = -19.2 at z=0.4
- 21.0 at z=0.8

SDSS Stripe 82 data

- Zone of about 270 deg^2
- Photozs for 13.6 10^6 galaxies
- Cut at photoz ≤ 0.75 gives 5.4 10^6 galaxies



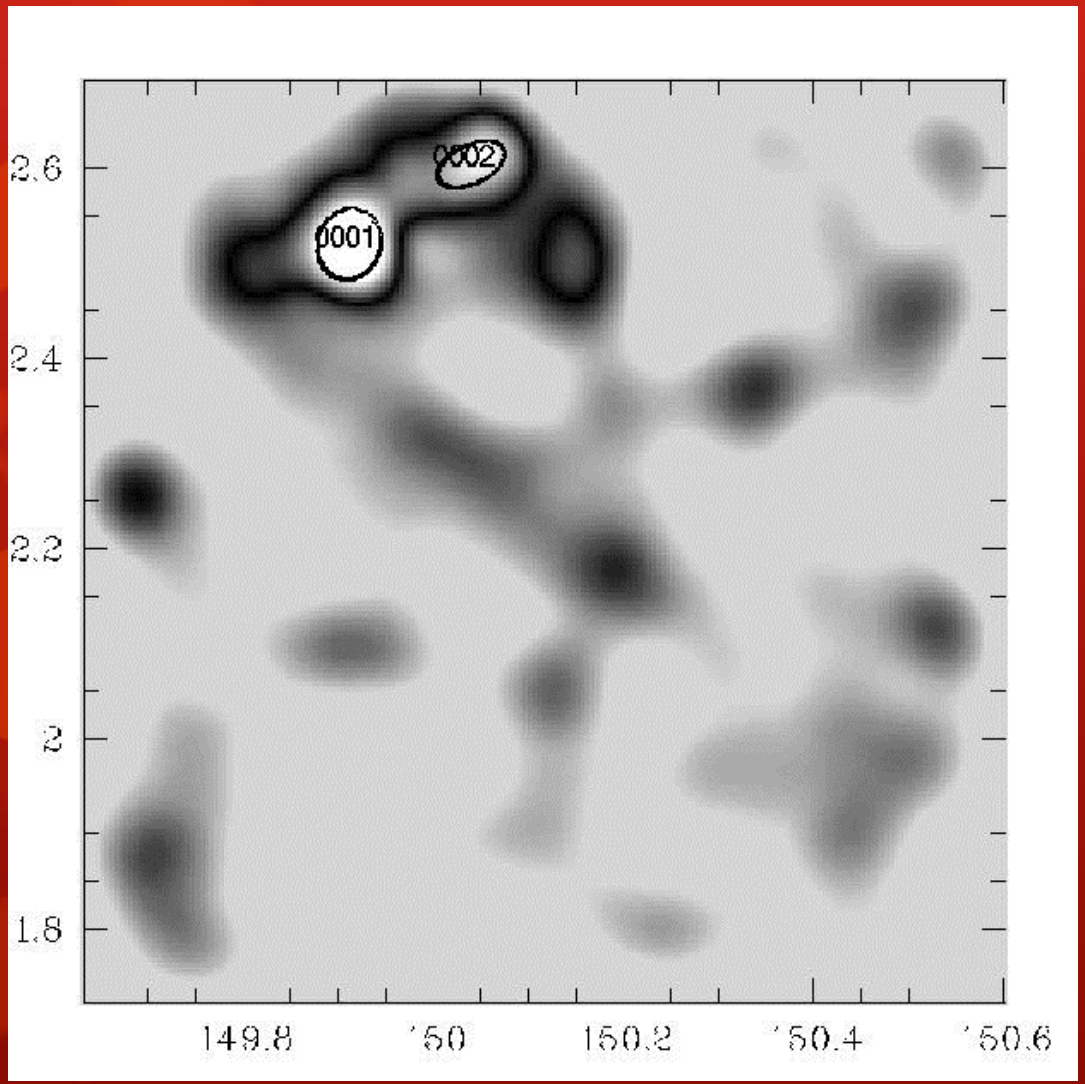
photoz histogram



r magnitude histogram

Method

- Apply magnitude limits to galaxy catalogues
  - i<25 for the Deep fields
  - i<23 in A10, z<22.5 in D11 for the Wide fields
- Estimate photometric redshifts for all galaxies with LePhare (O. Ilbert)
- Build galaxy density maps in photo-z bins of 0.1 incremented by 0.05 based on an adaptive kernel technique
- Detect structures in these maps with SExtractor at a chosen significance level (2σ, 3σ, 4σ, 5σ, 6σ, 9σ)
- Assemble the structures detected with a friends-of-friends algorithm (minimal spanning tree)



Example of a density map:

Deep 2 field in the]0.65-0.75] redshift bin

two candidate clusters detected at 6σ

Validation on Millennium simulation

- Validate method by applying same procedure to the Millennium simulation (modified to be comparable to our CFHTLS data)
- Estimate masses as a function of detection threshold for Deep and Wide fields separately
- Estimate percentages of fake detections as a function of redshift and of detection threshold
- Estimate errors on cluster positions

Results for Adami et al. (2010)

- 1200 cluster candidates

- Cluster candidates at $z \geq 1$
- 141 at 3σ
- 79 at 4σ
- 46 at 5σ
- 31 at 6σ

- Optical followup of two candidate clusters with Gemini (collaboration E. Cypriano & L. Sodré)

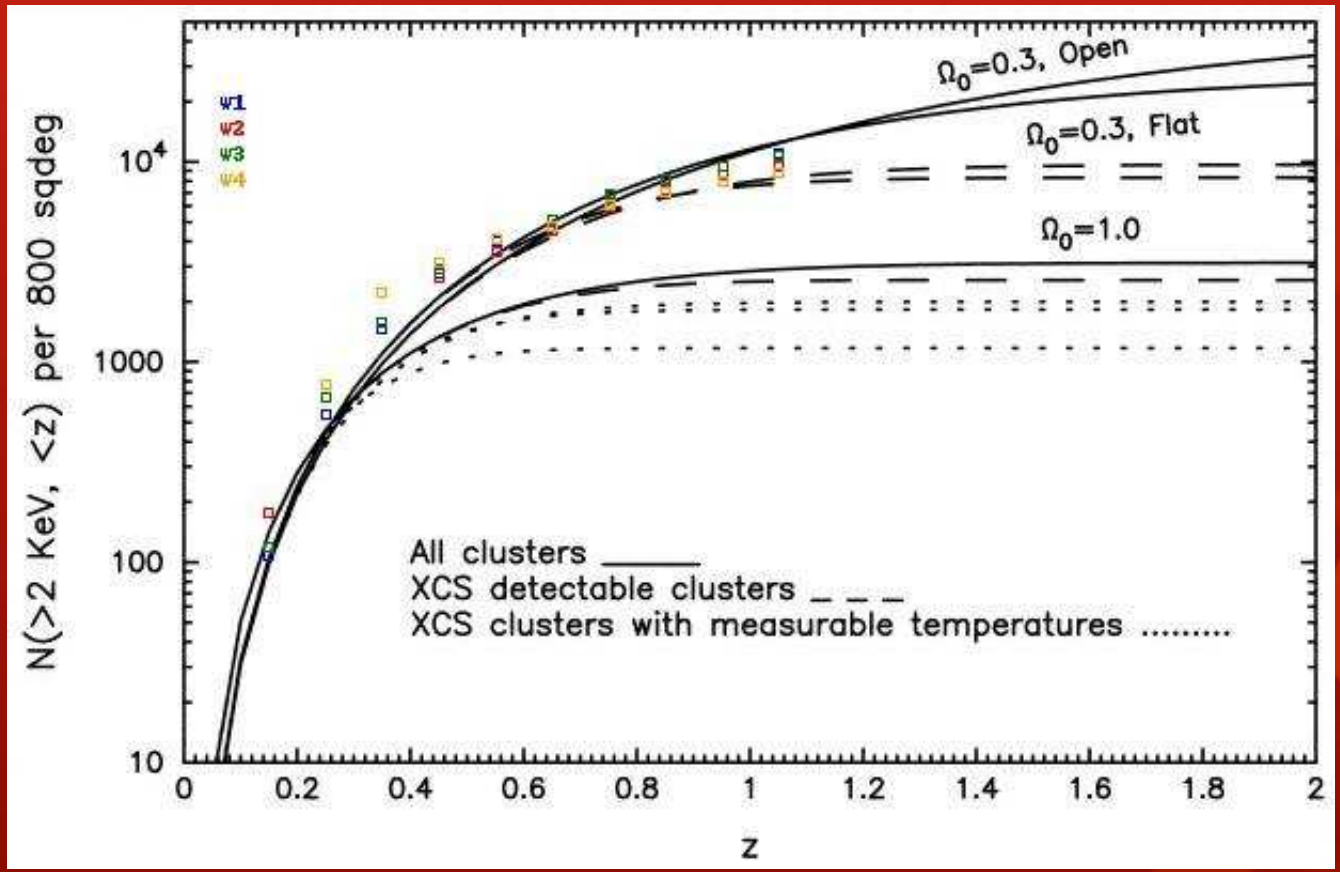
Results for Durret et al. (2011)

- 4061 cluster candidates detected at ≥ 3σ in the four Wide fields
  - redshift range $0.2<z<1.15$
  - masses between $1.3\ 10^{14}$ and $12.6\ 10^{14}\ M_{solar}$

- Cluster candidates at $z \geq 1$
- 821 at 3σ
- 226 at 4σ
- 84 at 5σ
- 32 at 6σ

- These cluster candidates have typical cluster properties (colour-magnitude relation, luminosity function)

Redshift distribution of the clusters detected at ≥ 4sigma in all the Wide fields

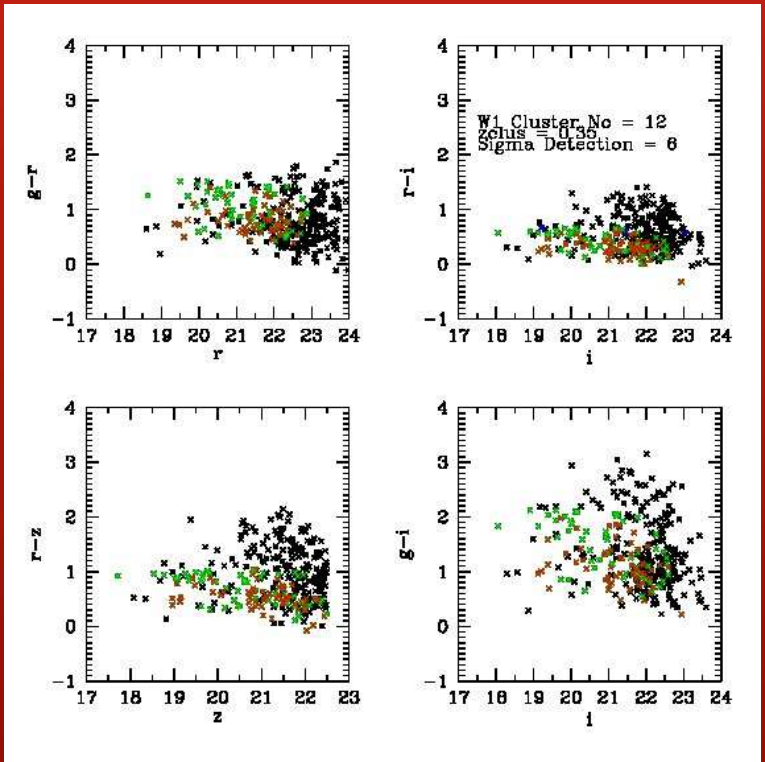


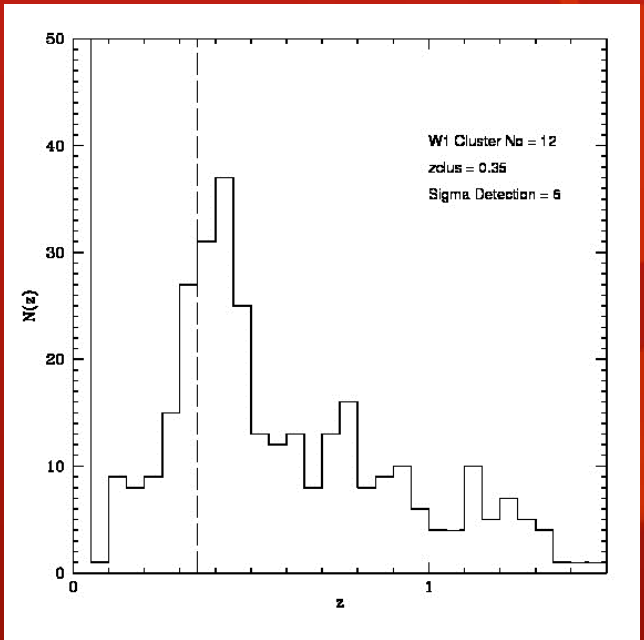
Romer et al. 2001, ApJ 547, 594

In progress: full analysis of all the CFHTLS candidate clusters

- Full analysis of all the clusters: individual colour-magnitude relations, galaxy luminosity functions and Schechter function fits
- Properties of candidate clusters stacked by redshift or mass intervals (for example)
- Large scale structure around candidate clusters

Example of a cluster at z=0.35



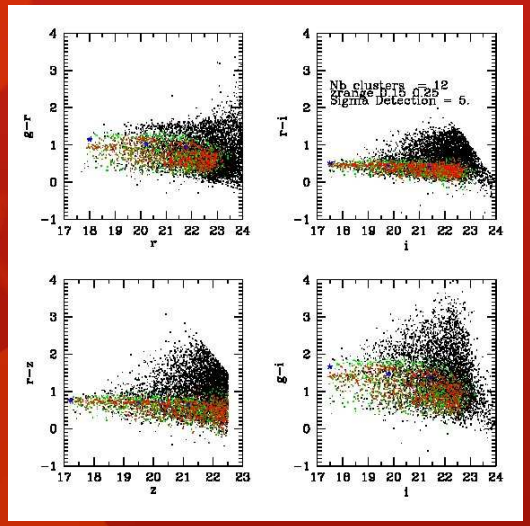


Black: all galaxies within 1 Mpc radius

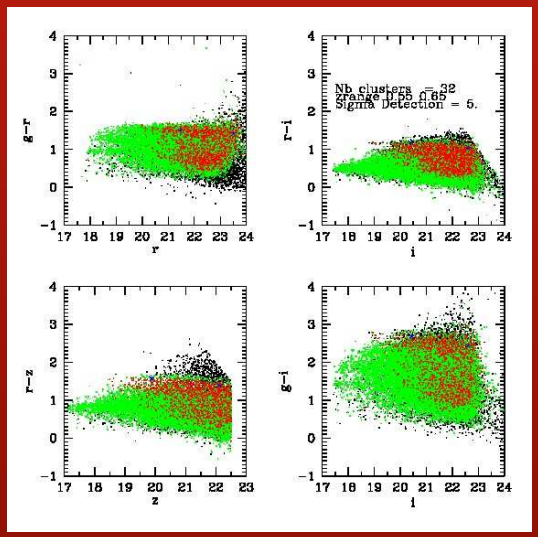
Green: galaxies within 1 Mpc and z cluster ± 0.1

Red: : galaxies within 1 Mpc and z cluster ± 0.05

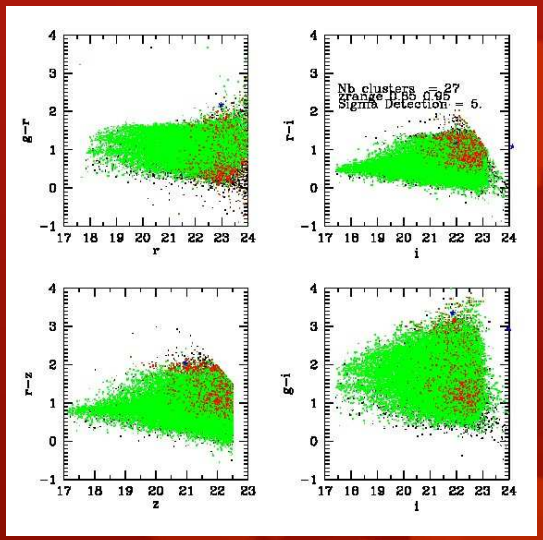
Colour-magnitude diagrams: cluster stacks in redshift bins in Wide 1 (clusters detected at 5σ and above)



0.15 ≤ zphot ≤ 0.25



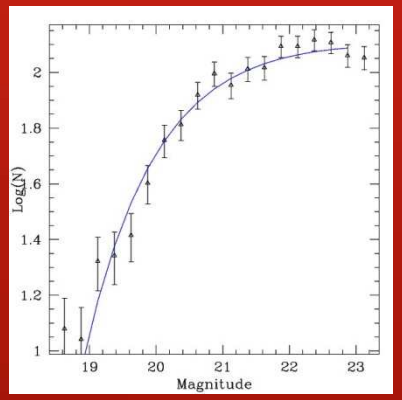
0.55 ≤ zphot ≤ 0.65



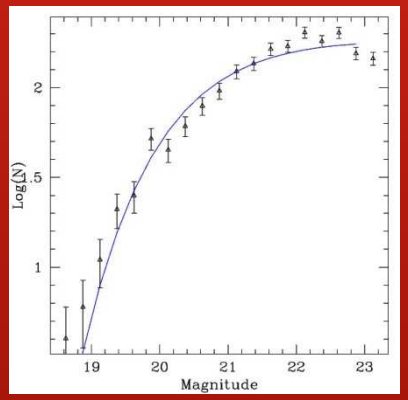
0.85 ≤ zphot ≤ 0.95

Blue points = Bruzual & Charlot (2003) model

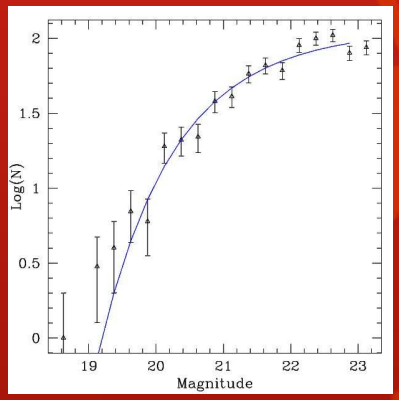
r band galaxy luminosity functions: clusters stacked in redshift bins



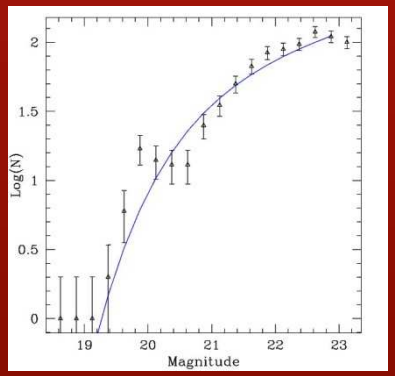
0.35<z<0.45



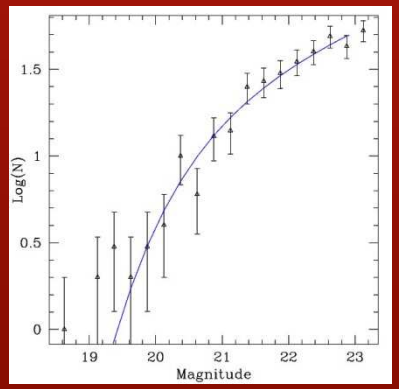
0.45<z<0.55



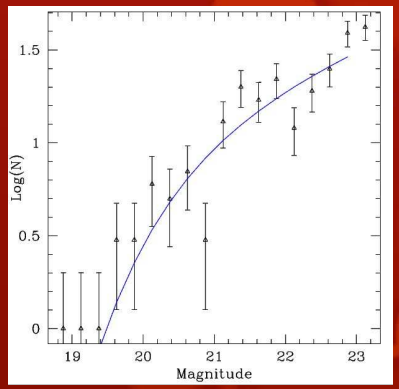
0.55<z<0.65



0.65<z<0.75



0.75<z<0.85



0.85<z<0.95

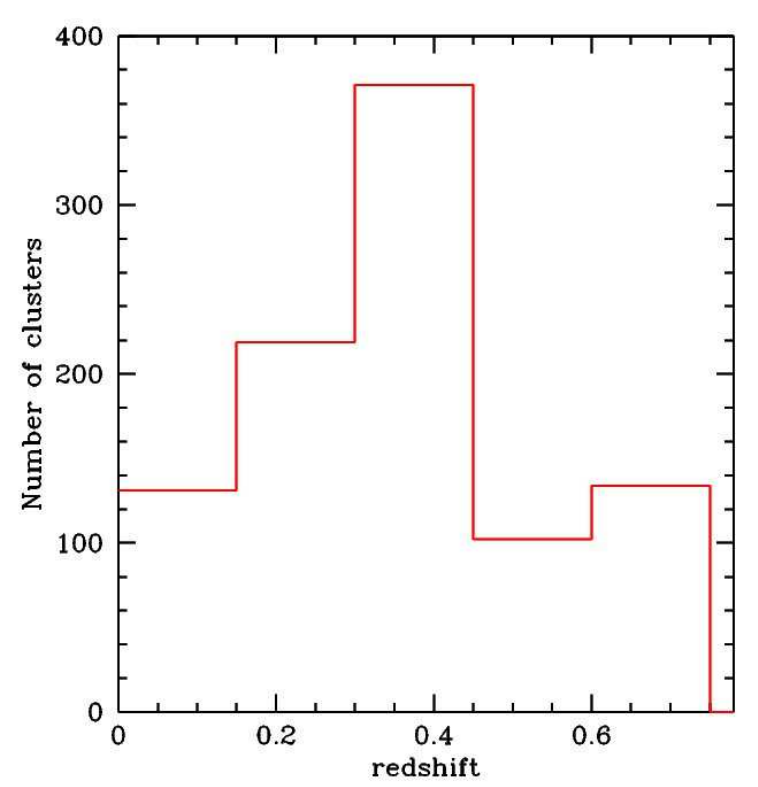
Luminosity functions: preliminary results

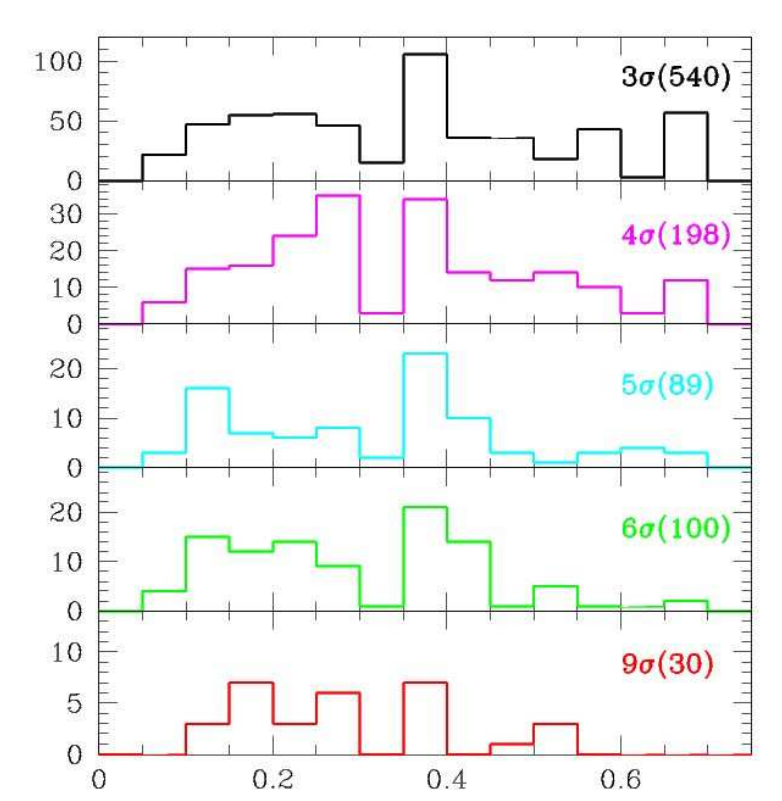
Redshift bin	M*	alpha
0.35 < z < 0.45	20.00	-0.98
0.45 < z < 0.55	20.45	-0.95
0.55 < z < 0.65	20.85	-1.04
0.65 < z < 0.75	20.75	-1.29
0.75 < z < 0.85	20.55	-1.38
0.85 < z < 0.95	20.35	-1.40

Steeper alpha for high z?

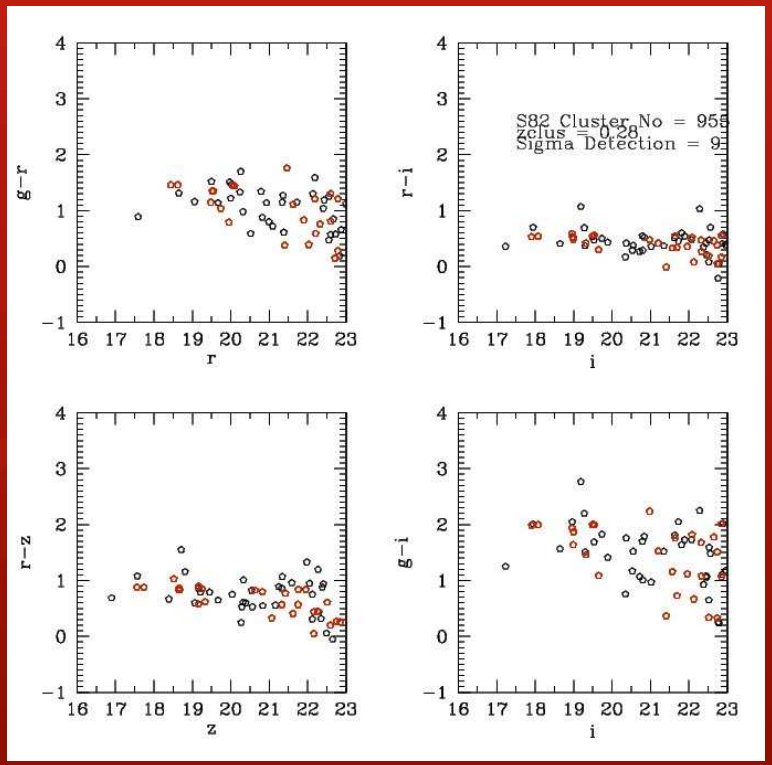
(background subtraction effect?)

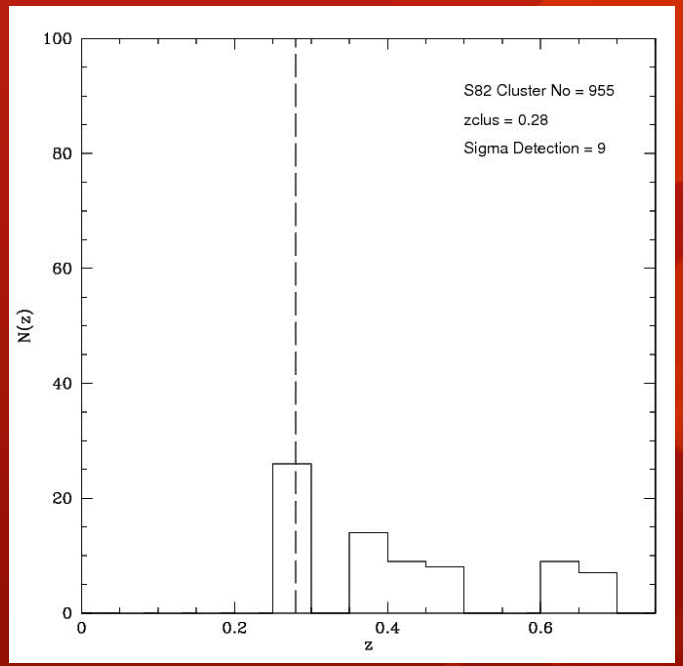
SDSS Stripe 82: 957 candidate clusters



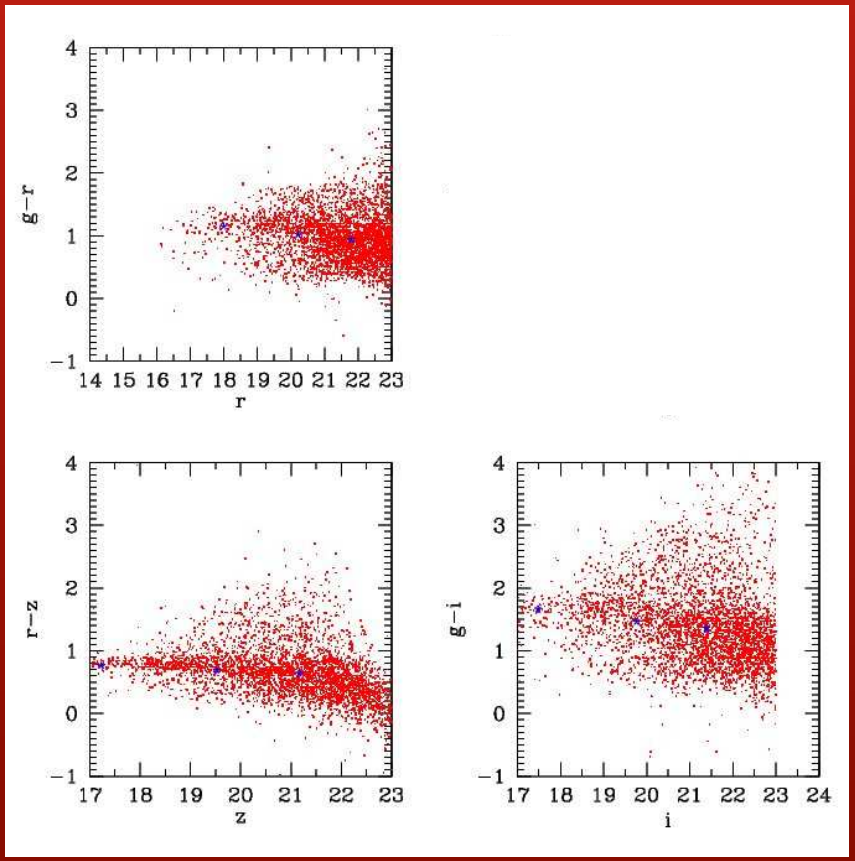


Example of a cluster at z=0.28





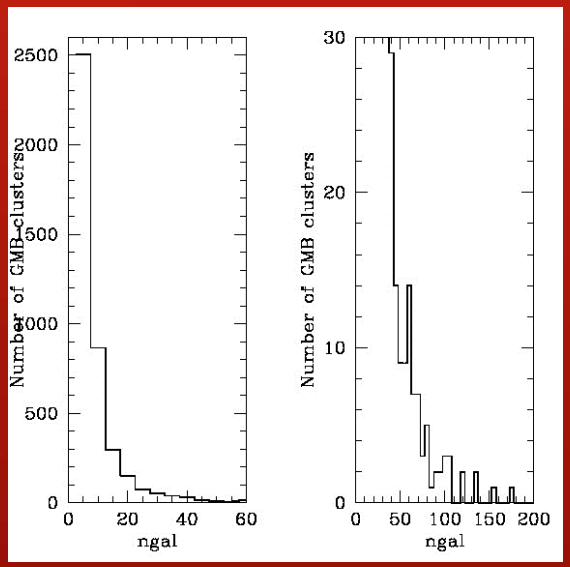
Colour-magnitude diagrams: cluster stacks in redshift bins

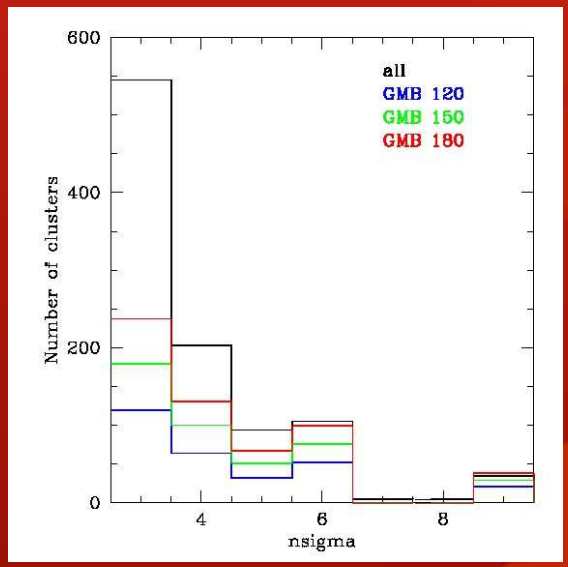


First attempt

$0.15 \leq \text{zphot} \leq 0.25$

Comparison with clusters detected by Geach et al. (2011)





GMB : 4098 clusters with ≥ 5 galaxies, 358 with more than 20 galaxies

572 of our clusters are also detected by GMB (3 arcmin match)

GMB = Geach, Murphy & Bower (2011), MNRAS 413, 3059

Conclusions

- Comparison with clusters detected by other methods in the same fields shows that an important fraction of our candidate clusters must be real clusters
- There may be variations of the galaxy luminosity function with redshift, but more work is needed
- Analysis of other properties is under way
- Correlate with X-ray data
- Our cluster catalogs are publicly available: please use them: followups at all wavelengths are welcome!