Optical follow-up for Planck clusters in SDSS area using photometric redshift

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Work done with J. Bartlett (APC) and S. Mei (GEPI)
Planck: The new all-sky cluster survey

|b| > 15 deg

Fiducial Model
S/N = 3

Chamballu et al. 2010

SZ only
Direction + M(z)

SZ + optical
M + z

Redshifts for these new Objects?
• Imaging surveys: photo-z
• Need model for cluster SZ-galaxies (optical/IR) relation

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Observations

Brightest Cluster Galaxy (BCG)

SZ observation

X-ray observation

Need direction (SZ) and redshift (optical) to direct a X-ray laboratory

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Conditional Luminosity Function (Yang, Mo and Van den Bosch 2008)

Galaxy population for a local cluster of given mass range in the SDSS R band

4 parameters: \( L_c \Phi * \alpha * \sigma_c \)

\[
\begin{align*}
\phi_s(L|M) dL &= \phi_s(M) \left( \frac{L}{L_s(M)} \right)^{\alpha_s(M)+1} e^{-\left(\frac{L}{L_s(M)}\right)^2} d(\log L) \\
\phi_c(L|M) dL &= \frac{A(M)}{\sqrt{2\pi\sigma_c(M)}} e^{-\left(\frac{\log^2(L) - \log^2(L_c(M))}{2\sigma_c^2(M)}\right)} d(\log L)
\end{align*}
\]

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CLF dependence on redshift and cluster mass

Redshift dependence of the CLF according to the following assumptions:

- Passive evolution for early type galaxies since $z = 1$ (Mei et al 2009, Brown 2008)
- All Planck clusters host a BCG
- Galaxy single burst formation at $z=7$ and spectra provided by the “Bruzual and Charlot simulation” (2003)
Comparison between our model and Johnston et al 2007 results

Our model prevision at redshift=0.25 in the SDSS I band

MaxBCG is a self-consistent optical method to find clusters (talk E. Rozo)

Cluster masses:
MaxBCG => weak-lensing
Yang => Luminosity reconstruction

SDSS MaxBCG catalog
Weak lensing masses

L>0.4L* 99%

Planck

(MaxBCG: Koester et al 2007)
Completeness in SDSS at $5\sigma$ (for 10 satellite red galaxies)

We need to detect the galaxy in three bands: G, R and I

The G band is first of the 3 which loose the detection => the G band represents the lower limit

![Graph showing number of Planck cluster + SDSS G band](image)

- SDSS field = 8000 deg$^2$
- Planck field = 31000 deg$^2$

- 8000 deg$^2$ → 430 clusters
- 5% Dedicated telescope

- 95%

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* SDSS field = 8000 deg$^2$  Planck field = 31000 deg$^2$
Tools for the optical clusters identification

PLANCK SZ flux

SDSS data bands and position for galaxies

Potential Clusters

Cluster Mass for SZ cluster @ optical redshift

Given mass and probability existence for each one

Best Cluster in combine SZ-Optical observations

We validate our method with Rosat data

SZ cluster model

Optical cluster model + CLF prior

sdss request (bands, ra, dec)

photo-z Identification algorithm
Selection of potential BCG in the ridgeline

$L > 0.4L^*$

+ cut in color
Tools for the optical clusters identification

PLANCK SZ flux

SDSS data bands and position for galaxies

Potential Clusters

Cluster Mass for SZ cluster @ optical redshift

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Several CLF in direction of Abell 963
Illustration with well-known cluster: Abell 963

PLANCK S/N=5 conservative
Illustration with well-known cluster: Abell 963

Our mass $M_{200} = 4 \times 10^{14} M_\odot$

X-ray* mass $M_{200} = 5 \times 10^{14} M_\odot$

Johnston mass $M_{200} = 3.5 \times 10^{14} M_\odot$

Our photometric $z=0.19$  spectroscopic $z=0.20$

*Zhang et al 2008 (LOCUSS)
Conclusion

- Model based on CLF
- Evolution in good agreement with observations
- We have an algorithm to identify the optical/NIR counterparts for PLANCK clusters with photometric redshift
- We are currently applying this algorithm on the PLANCK cluster candidates (WG5)
CLF parameters evolution
SDSS survey in galactic coordinates

8000 deg$^2$
First results for good reconstruction

We have a good agreement between the X-Ray mass and the optical mass when the redshift correspond.
Number of galaxies detected at $5\sigma$ in G band for Planck clusters at mass limit ($3\sigma$)

Number of red galaxies

$L > 0.4L^*$ in the CLF