Planck high-z sources observed by *Herschel*-SPIRE

D.Guéry (david.guery@ias.u-psud.fr), H.Dole, N.Nesvadba, L.Montier, I.Flores-Cacho, N.Aghanim, A.Beelen, M.Béthermin, R.-R.Chary, K.Dassas, G.De Zotti, M.Douspis, B.Frye, M.Giard, J.Gonzalez-Nuevo, E.Le Floc'h, G.Lagache, C.Martinache, M.Negrello, A.Omont, E.Pointecouteau, J.-L.Puget, D.Scott, J.Vieira, N.Welikala.

Introduction

How evolve the star formation at redshift > 2 ?
To answer we look for cold sources of CIB. Those have a dust emission peak around 350 μm because of redshift between 2 and 4. *Planck* satellite is well design to detect those sources over all sky [7][4][5].We extract from *Planck* all-sky data hundreds of candidates.
We expect that those sources were clusters in their intense star-forming phase, bright strongly gravitationnaly lensed sources or chance alignment. Here we focus on the 228 sources followed-up by *Herschel*-SPIRE [6].

I. Sample

228 sources were observed with *Herschel*-SPIRE at 250, 350 and 500 μm. A sub-sample of 40 sources were observed with *Spitzer*-IRAC [10]. We perform a photometric analysis (number count, color analysis) to classify sources : galaxy overdensities or lensed source candidates.

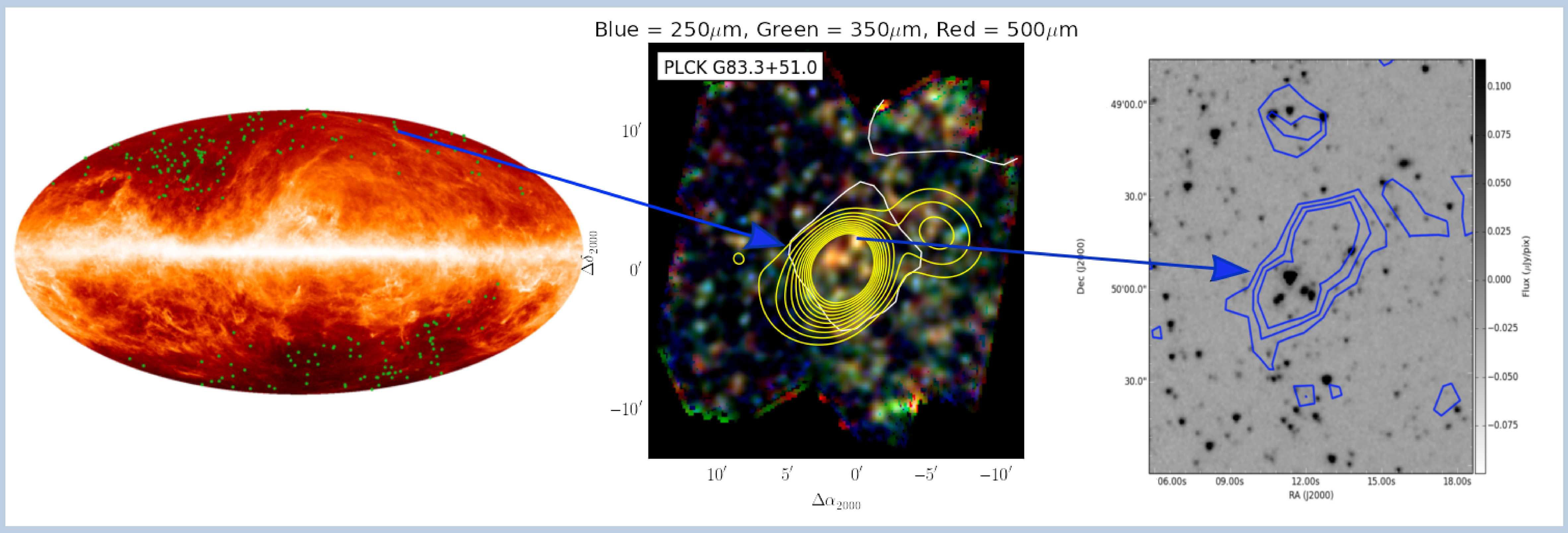

Figure 1: from left to right : *Planck* all sky, green dots trace *Herschel* follow-up. *Herschel*-SPIRE 350μm and 3 color images *Herschel*-SPIRE, white contour traces the *Planck* source at 550μm delimiting the IN and OUT *Planck* region, yellow lines are iso-overdensity contours. *Spitzer* 3.6μm, blue contours are *Herschel* 350μm data.

We identified **14 lensed sources with spectroscopic redshift between 2.2 and 3.5 [9], and 214 overdensity candidates** with overdensity significance around 5 sigma.

II. Excess of red sources

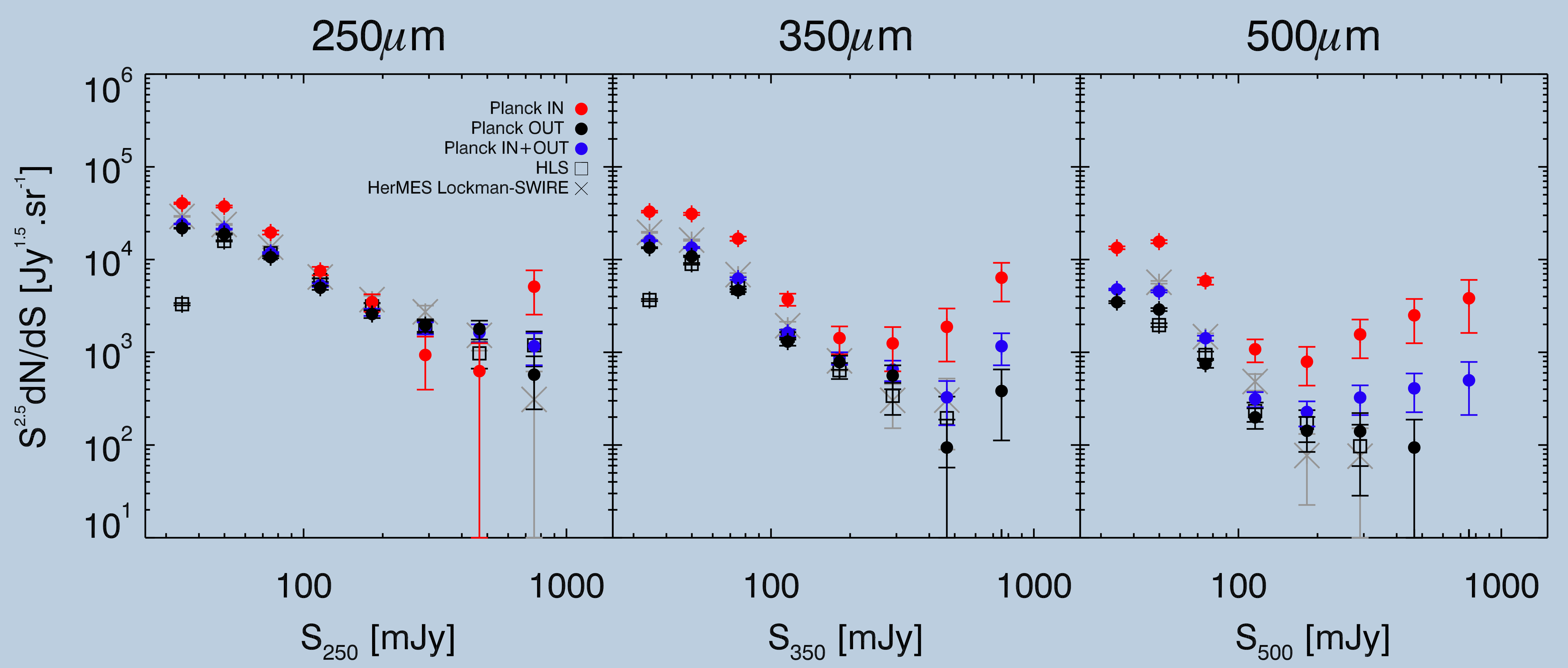

Figure 2: *From left to right* : Sources number count at 250, 350 and 500 μm. Inside *Planck* contours (red dots), outside (black dots), entire *Herschel*-SPIRE fields (blue dots), HLS (Herschel Lens Survey) fields (black squares), Hermes Lockman-SWIRE field (grey cross).

We see an excess of sources at 350 and 500 μm inside the *Planck* beam compared to HerMES and HLS. For $S_{500} > 400$ mJy, sources are candidate lensed galaxies ; for $50 < S_{500} < 200$ mJy sources are candidate overdensities.

III. Redshift and dust temperature

The color-color diagram is obtained by matching the 350 μm catalogue with the 250 and 500 μm catalogues (black dots). The background in the color-color diagram shows the average redshift or temperature for 10^6 randomly generated modified black-body SED (following [1]).with parameter in $T = [10, 60]$, $z = [0, 5]$, $\beta = [0, 2]$ and a gaussian noise of 10% added on fluxes.

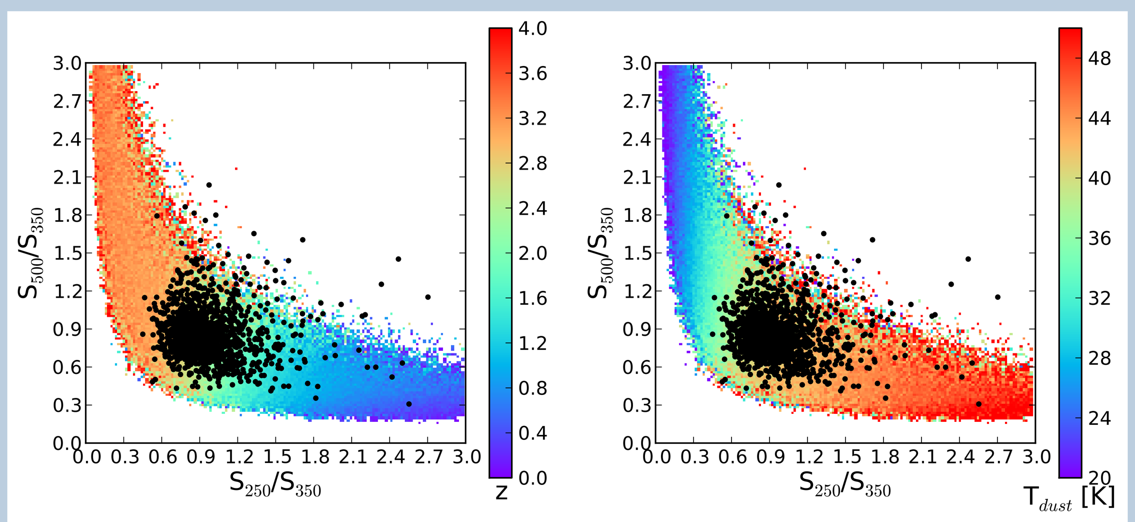

Figure 4: Color-color diagram of the sample inside *Planck* sources (*black dots*) over the mean redshift distribution (*left*) and the mean dust temperature distribution (*right*).

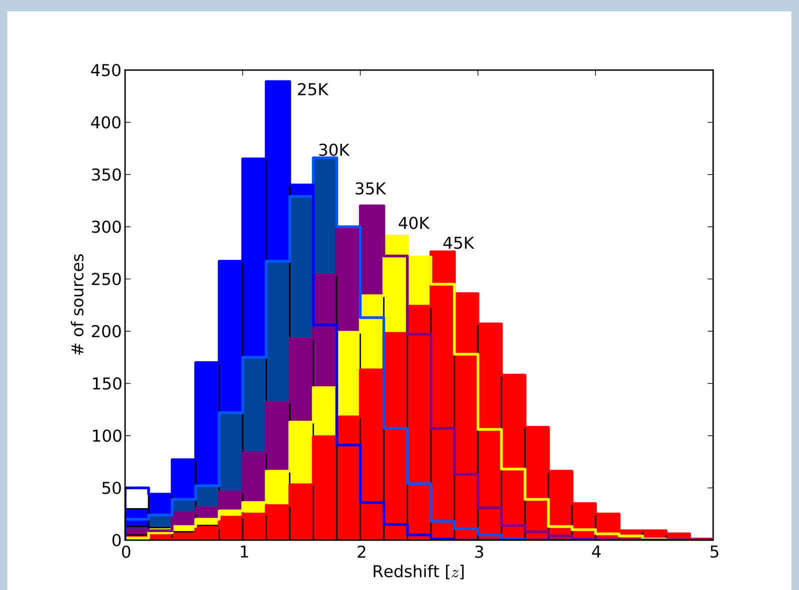

Figure 5: Photometric redshift distribution of the SPIRE sample assuming different dust temperature.

Fig.4 suggest redshifts between 1.5 and 3. Fig.5 suggest dust temperature of 35K [3][8][2]to have a redshift distribution between 2 and 4.

IV. Red sources overdensities

We perform *Herschel*-SPIRE stacking analysis.

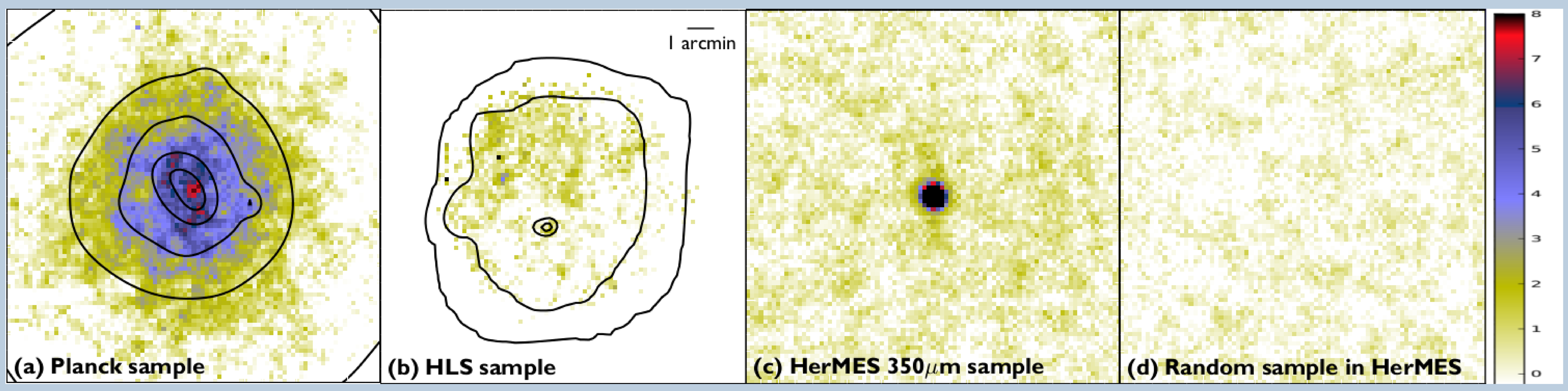

Figure 3: *Planck* selected Herschel fields stacking (a), HLS field stacking (low redshift clusters) (b), red sources stacking in HerMES Lockman-SWIRE (c) and random stacking in HerMES Lockman-SWIRE (d). Black lines trace the overdensity contours of SPIRE red sources

The stacking of different sample show that our sample is unique and not consistent with low redshift cluster (z<1), red isolated sources or random. We denote the signature of red ($\frac{S_{250}}{S_{350}} < 1.4$ and $\frac{S_{500}}{S_{350}} > 0.6$) significant overdensities that should be galaxy clusters.

Conclusion

Cold sources of the CIB are promising for the study at redshift > 2. *Herschel* show a lot of them as overdensity of sources with photometric redshift > 2. Assuming $T_d = 35$K each SPIRE sources have an average IR luminosity of $4 \times 10^{12} L_\odot$. Around 10 sources are detected per assumed structure. Leading to an average IR luminosity of $4 \times 10^{13} L_\odot$ and a total star-formation rate of $7 \times 10^3 M_\odot yr^{-1}$ for a structure. Some may be proto-cluster in their intense star-formation phase. Further spectroscopic analysis is on-going.

References

[1] Amblard, A., et al. 2010, A&A, 518, L9 • [2] Greve, T. R., et al. 2012, ApJ, 756, 101 • [3] Magdis, G. E., et al. 2010, MNRAS, 409, 22 • [4] Montier, L. A., et al. 2010, A&A, 522, 83 • [5] Planck Collaboration, . 2015, in prep • [6] Planck Collaboration, 2014, PIP XXVII, subm. to A&A • [7] Planck Collaboration XXVIII. 2013, ArXiv : 1303.5088 • [8] Symeonidis, M., et al. 2013, arXiv:1302.4895 [astro-ph] • [9] Cañameras, R., et al., 2014, in prep. • [10] Martinache, C., et al., 2014, in prep.