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Candidate High Redshift Clusters of Dusty Galaxies from *Herschel* and *Planck*

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Abstract. By examining *Herschel* images in the HerMES & H-ATLAS surveys at the position of *Planck* Catalog of Compact Source sources we are able to determine the nature of the *Planck* sources. Most are simply nearby, known, dusty galaxies, while others are foreground galactic 'cirrus' dust. About 11% of sources, though, appear to be groups or clumps of fainter *Herschel* objects. Followup of a number of these indicates that they are galaxy clusters or protoclusters at z ∼1-3 that contain a number of galaxies undergoing contemporaneous massive starbursts. These sources present challenges for current galaxy & cluster formation/evolution models.

Keywords. Galaxy clusters, Starburst Galaxies, Galaxy Formation

1. The Search for Dusty Clusters of Galaxies

The early history of galaxy clusters is currently a poorly constrained aspect of galaxy formation. Normal X-ray, optical/near-IR and Sunyaev-Zeldovich approaches to finding galaxy clusters generally become ineffective at redshifts >∼1.5. Theoretical models (eg. Granato *et al.*, 2015) suggest that galaxies in a forming cluster will undergo near-simultaneous massive bursts of star formation. Such objects will have significant far-IR & submm luminosities and thus might be detectable in large area *Herschel* surveys and in the *Planck* all sky surveys. Negrello *et al.* (2005), for example, suggested such objects would be detectable by *Planck* as compact sources which would break up into overdensities of individual objects when observed at the higher resolutions available to *Herschel*.

We searched for such objects by examining the H-ATLAS & HerMES *Herschel* surveys at positions matching those of compact sources in the *Planck* ERCSC and PCCS1 catalogs. We find that these objects divide easily into four classes: known sources (66%) such as IRAS galaxies; galactic cirrus (24%); protocluster candidates (7.5%); and lens candidates (2.5%).

Followup observations of our first candidates using a combination of optical, near-IR and submm data, using both archival and dedicated observations, have confirmed the cluster nature of the first four candidates found (Clements *et al.*, 2014). Followup observations of our larger sample continue. Further modelling of such objects using modern N-body/hydro codes combined with radiative transfer modelling to account for dust absorption and re-emission (Granato *et al.*, 2015) suggests that the observed number counts we are finding for these objects are higher than predicted.

References

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Granato, G. L., *et al.* 2015, *MNRAS*, 450, 1320
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