

Candidate High Redshift Clusters of Dusty Galaxies from Herschel & Planck

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Abstract

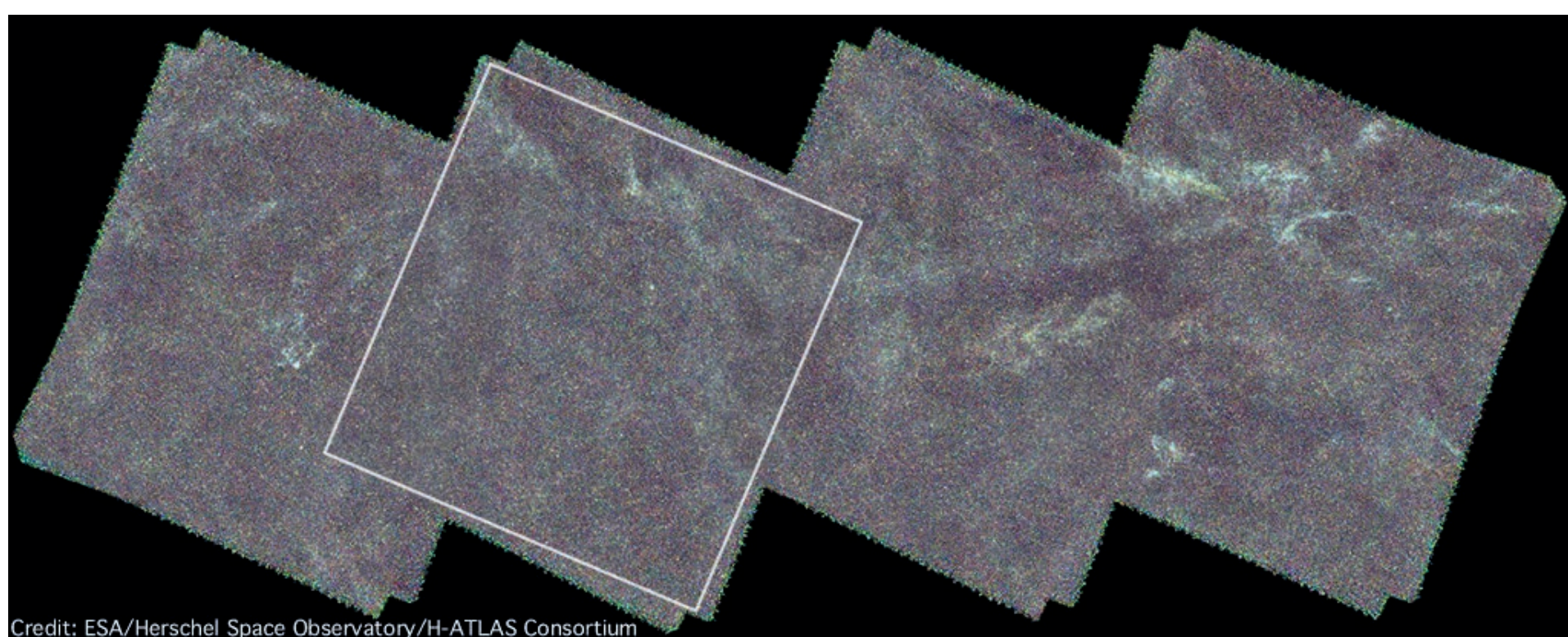
By examining the Herschel images in the HerMES & H-ATLAS surveys at the position of Planck Compact Source Catalog sources we are able to determine the nature of the Planck sources. Most are simply nearby, known, dusty galaxies, while others are foreground galactic 'cirrus' dust. About 11% of sources,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

The Surveys

Planck ERCSC and PCCS1 cover entire sky, including ~ 7000 857GHz (350 μm) high galactic latitude sources (Planck Consortium 2013).

Planck maps have $\sim 5'$ resolution.

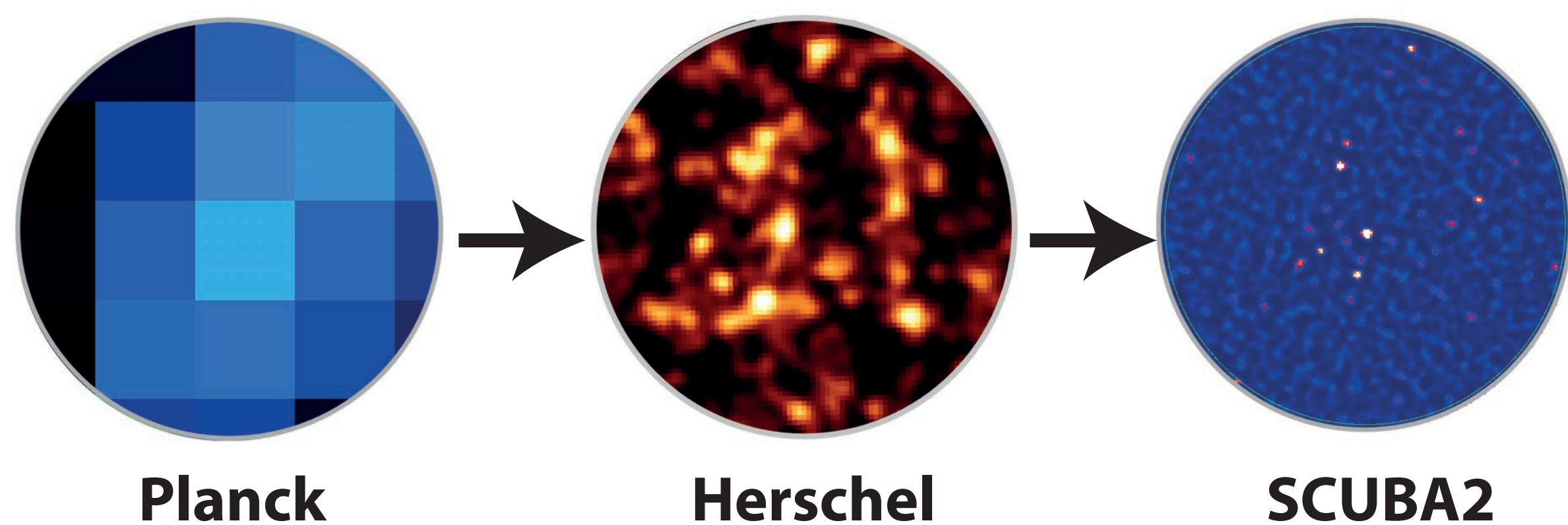
Herschel images from HerMES & H-ATLAS projects cover ~ 1000 sq. deg. at high latitude, with $18''$ beam at 250 μm .



Credit: ESA/Herschel Space Observatory/H-ATLAS Consortium

The Followup

Followup observations from radio to optical are underway, including optical/IR imaging to search for associated red sequence galaxies, submm imaging to improve far-IR SED fits & photo-z, redshift measurements using CO and optical/IR spectroscopy. Modelling of these systems is also underway (Granato et al. 2015), which shows these sources are difficult to reproduce with the current assumptions in physical models of galaxy/structure formation.



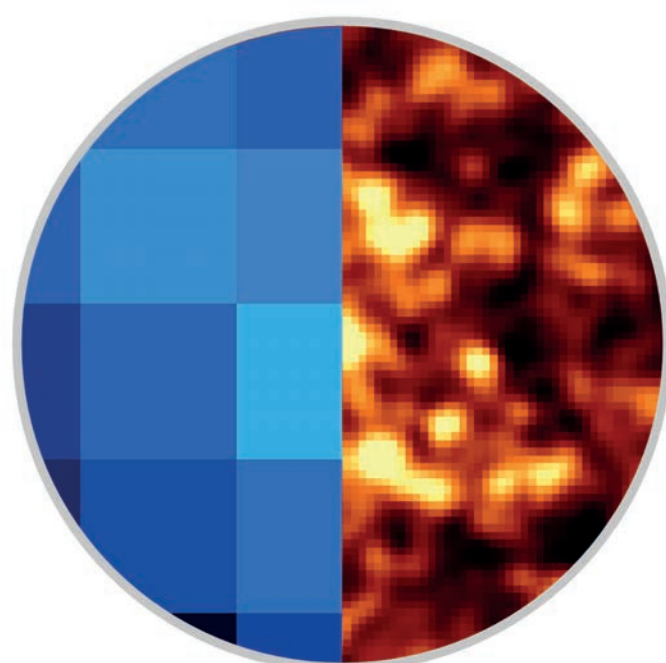
Planck

Herschel

SCUBA2

Selection

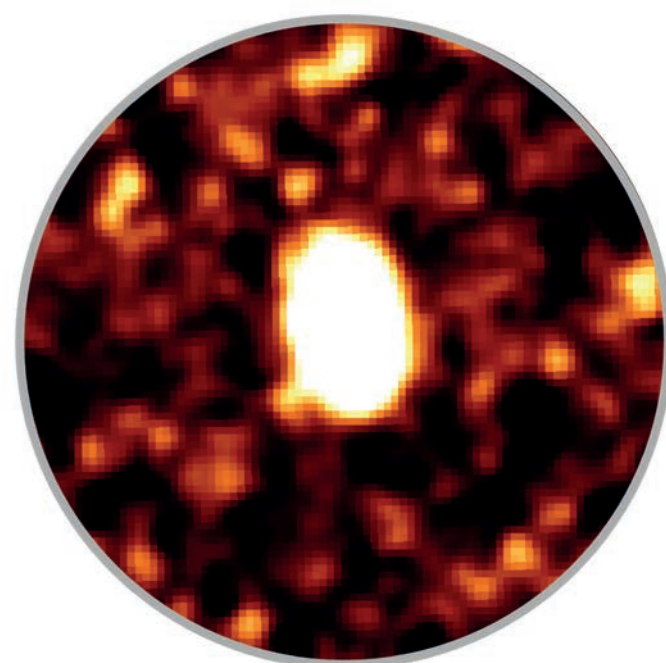
Examination of Herschel images of Planck 350 μm allows the nature of the sources to be determined. We use the pre-existing high galactic latitude Herschel survey fields from HerMES (Oliver et al., 2012) and H-ATLAS (Eales et al., 2010) for this purpose. We find that Planck sources fall into three categories.



Known Sources:

57%

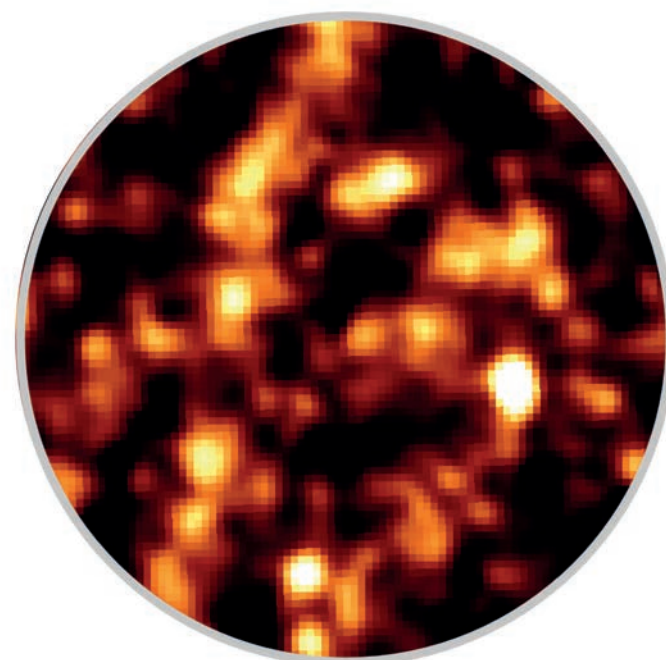
Largely known local galaxies such as NGC5012 shown here. Identifiable by resolved emission in Herschel and cross matches to catalogues.



Galactic Cirrus:

32%

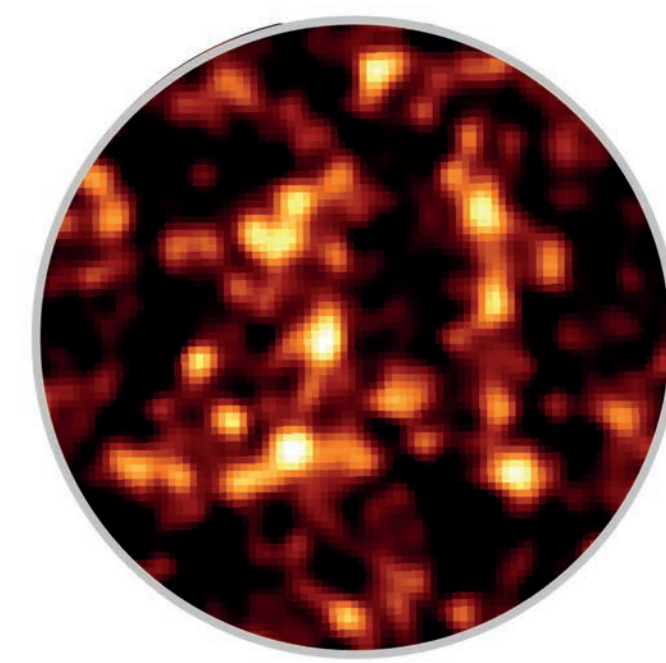
Identifiable through extended emission in Herschel & IRAS, absence of known cataloged sources.



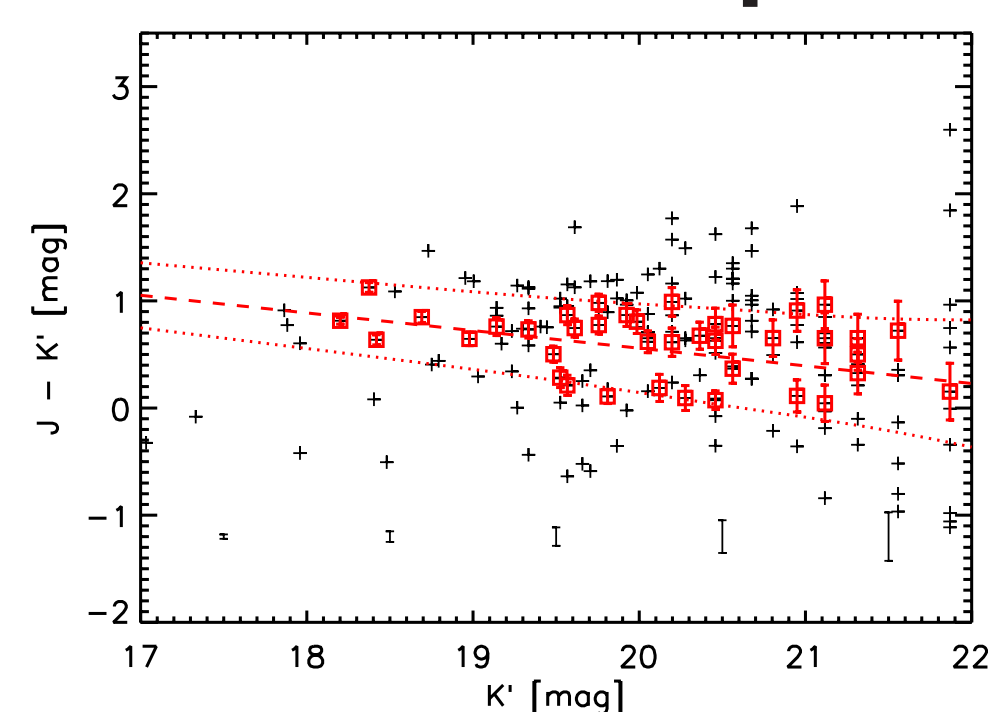
Protocluster Candidates:

11%

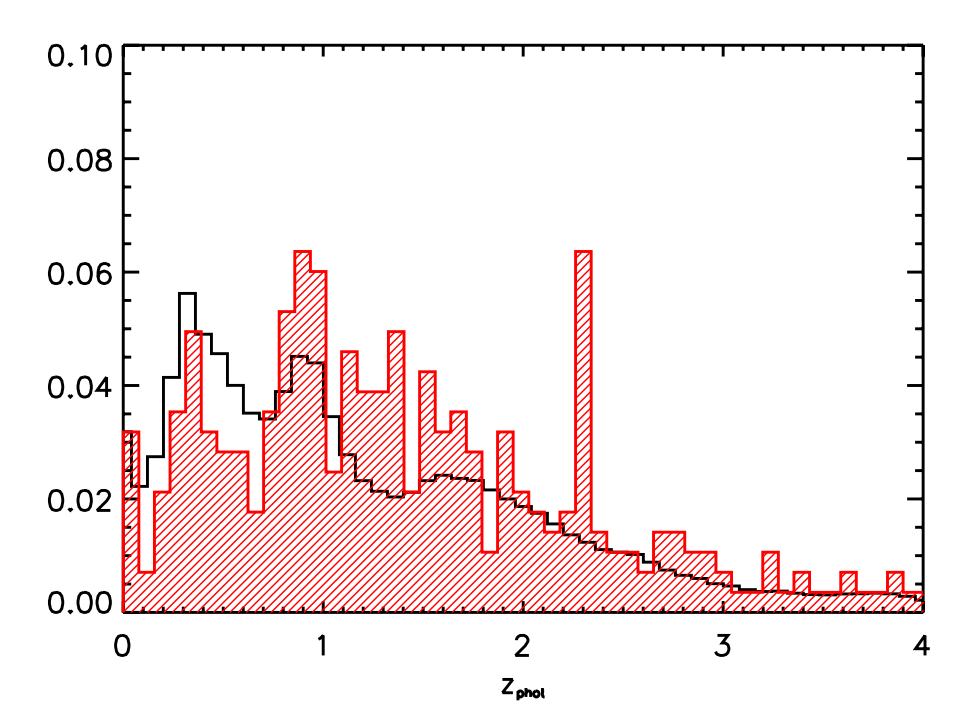
Overdensities of Herschel sources, no extended emission, no extant identification, no extended IRAS emission. Details in Greenslade et al., in prep



Optical & Near IR

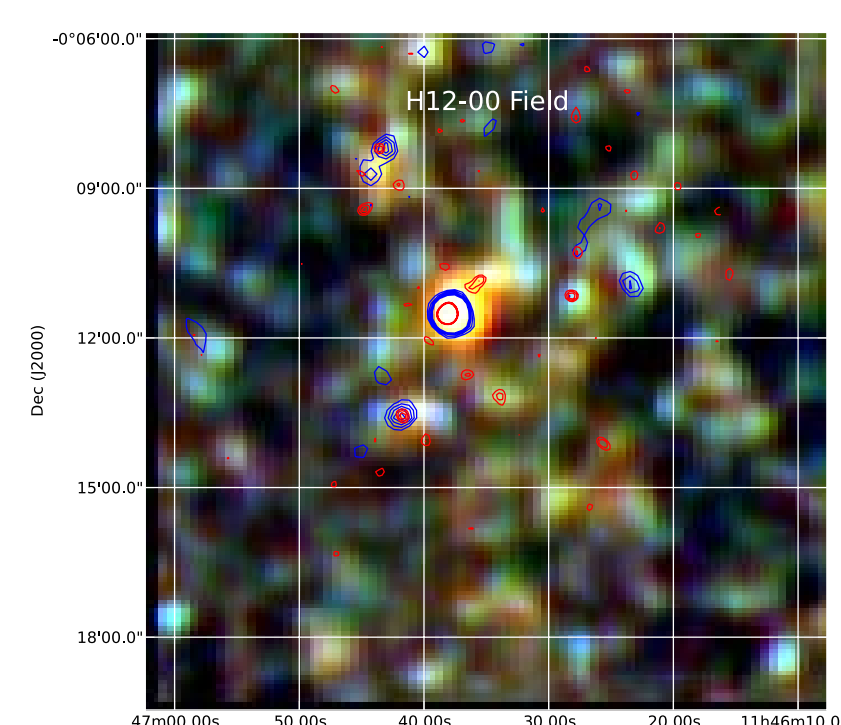


Red sequence seen in near-IR for EGS clump; implies presence of underlying cluster population and redshift of ~ 0.8



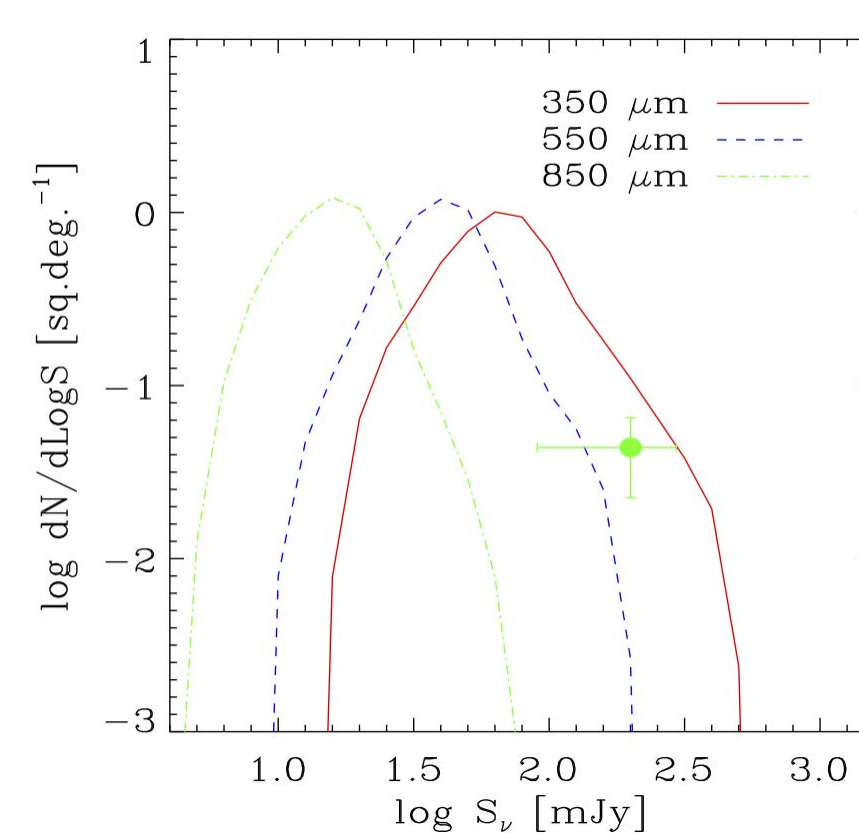
Optical-near-IR photoz for Boots clump region; spike in photo-z at $z \sim 2.3$ indicates redshift of clump. Details in Clements et al., 2014.

Submm: SCUBA2 & LABOCA

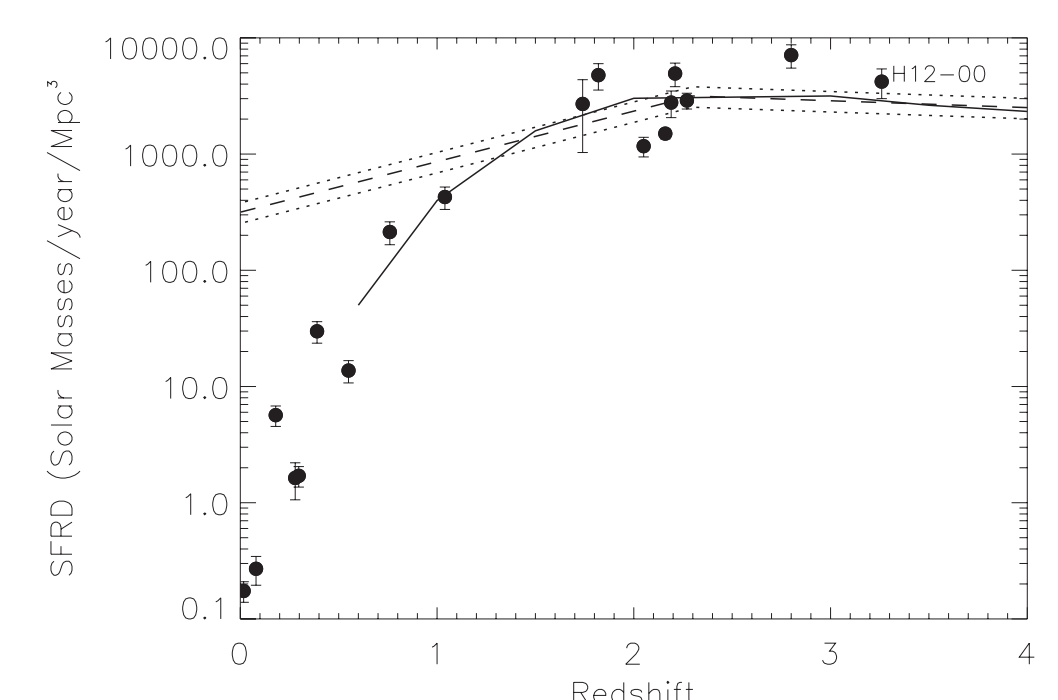


Herschel 3-colour image of H12-00 clump with submm 850 μm contours from SCUBA2 (red) and LABOCA (blue) overlaid. Photo-z using SPIRE & submm fluxes suggests submm detected sources at same z as the lensed object at centre: $z=3.26$. Details in Clements et al. (MNRAS, submitted).

Implications



Counts of starbursting clusters at different λ predicted by Granato et al. (2015) model. Observed counts much greater.



SFRD evolution for these clumps & other clusters observed in far-IR/submm compared to evolution of field & cluster galaxies.