Candidate Dusty Galaxy Clusters from Planck & Herschel

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Background

- Negrello et al. '05 predicted that
 Planck would be able to find groups/ clusters of dusty
 star-forming galaxies
- New way to find clusters during short but formative phase



Planck & Herschel

- Can identify candidate clusters by examining Herschel image at location of a Planck compact source
- Here report results from ERCSC sources in Herschel survey fields from HerMES & H-ATLAS



- Largest Herschel survey programme
- PACS+SPIRE data in all major fields (~110 sq. deg.)
- Extension to Stripe82 covering ~270 sq. deg.



- Largest area Herschel survey ~570 sq. deg.
- NGP, SGP, GAMA fields; SPIRE and PACS

Clump Search in HerMES & H-ATLAS

- Will report on search for clumps in ~90 sq deg of HerMES and in the H-ATLAS GAMA fields
- Uses ERCSC Planck catalogs
- NB Legacy catalog will be deeper and better

HerMES 250 micron images of all 16 ERCSC sources in 90



HerMES IDs

- II ERCSC sources are NED galaxies, one is Mira
- 4 do not have a bright galaxy/star counterpart
- Instead they are local over densities of Herschel sources, significance 3.6 to 7.2 sigma



14h23m30.00s

Colours



Clump colours & colours of individual Herschel sources consistent with redshifts >~1

Red Sequences



 Use archival or new optical/IR/IRAC data to look for underlying clusters

Photo-z



- Also get photo-z using archival data
- This & RS analysis allows redshift estimates

HerMES Clump Results

Field	z	L_{FIR}	SFR (M_{\odot}/yr)
Boötes	$2.27 \pm 0.12^{!}$	$73{\pm}11$	11632 ± 1800
EGS	$0.76 \pm 0.10^{*}$	$3.7{\pm}0.9$	620 ± 138
Lockman	$2.05 \pm 0.09^{*}$	$31{\pm}6$	4924 ± 946
CDF-S	$1.04 \pm 0.11^{!}$	$10{\pm}2$	1631 ± 356

 These are high (z>>0.5) redshift clusters with member galaxies forming stars very rapidly - just what Negrello 2005 predicted

Cluster Formation



- Can reach higher z than eg. ISCS cluster search
- Allows better constraint on cluster galaxy formation epoch

The H-ATLAS Clumps



- Only one 'clump' found in H-ATLAS GAMA regions (Herranz et al., 2013)
- Possible issues with cirrus foreground in GAMA 9

LABOCA Companions



 Herschel & Herschel-LABOCA colours consistent with companions at same z as lensed source: a group of HLIRGs at z=3.26



SFRD in clusters/clumps



• Data from clusters in literature & clumps from here

• Cluster SFRD drops rapidly from z~0.7, flat above z~1.5

Discussion

- New way to find high z galaxy clusters and to study formative phase in cluster evolution
- Early days yet for understanding these systems but more data coming eg. JVLA, SCUBA2, optical, near-IR etc.
 - Esp. important for probing underlying galaxy population associated with z=3.26 clump

More to Come!



ERCSC source in H-ATLAS NGP associated with a strong lensing cluster

- More area from H-ATLAS & Stripe 82 to work with & better Planck legacy catalogs
- Parallel study within Planck team