



LASCAR

LABOCA Survey of Clusters at All Redshifts

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“Multiwavelength Views of the ISM in High-redshift Galaxies”

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Overview

* Where it all started:

- Atacama Cosmology Telescope (ACT) and SZE selected clusters.

* LASCAR:

- Survey description
- Motivation
- Complementary datasets
- Observations

* Preliminary results

ACT: Atacama Cosmology Telescope

Cerro Toco



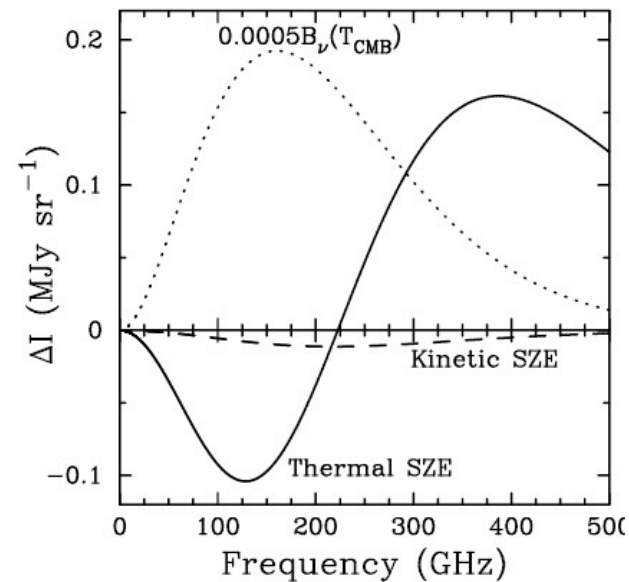
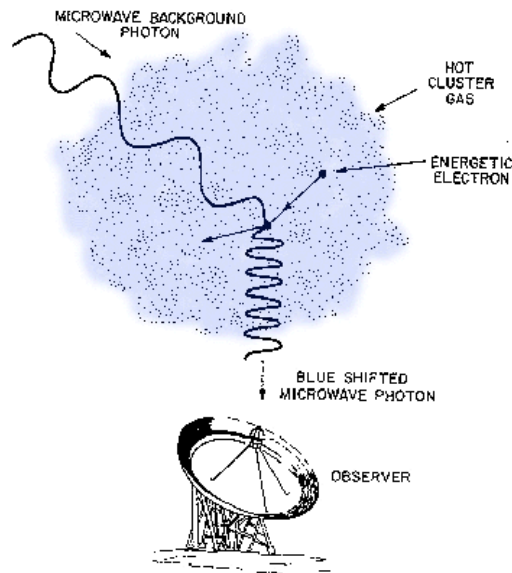
ACT: Atacama Cosmology Telescope

* The telescope:

- 6m millimeter-wave telescope @ Cerro Toco
- 3 detector arrays: 145 GHz, 215 GHz & 280 GHz
- Scans swaths of sky at constant elevation.
- Survey Area: 455 deg² in the Southern Strip, Equatorial Strip
- 4 seasons: 2007 (145 GHz only), 2008, 2009, 2010

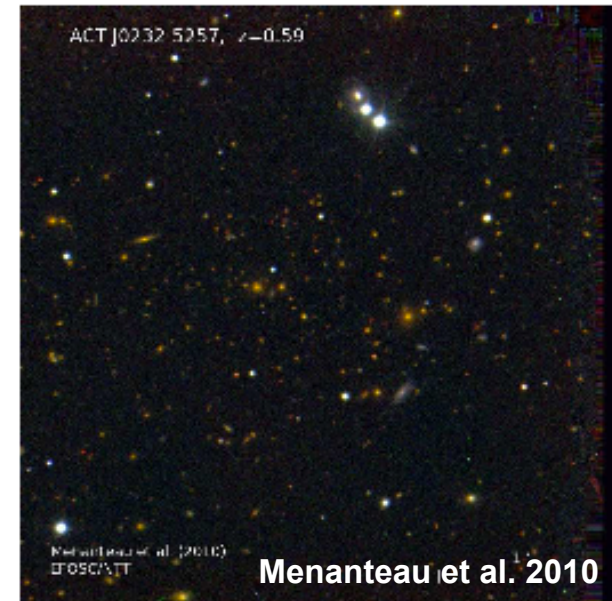
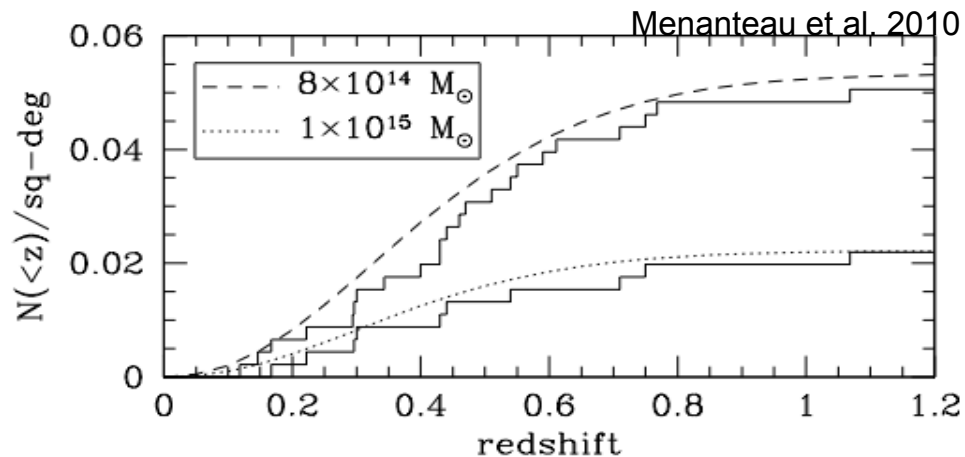
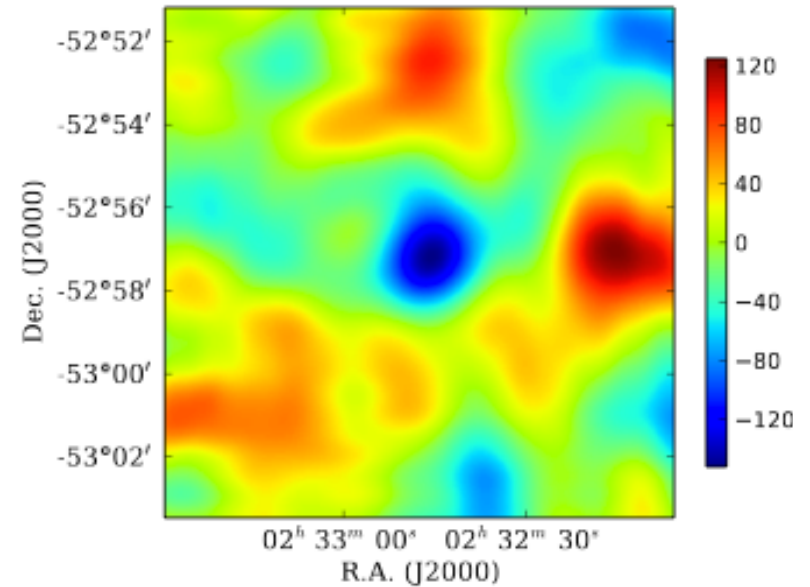
* Motivations:

- Measure CMB anisotropies at scales ~ 1 arcmin.
- Detect galaxy clusters through Sunyaev-Z'eldovich signal.



ACT: Mass-selected Cluster Sample

- * 23 clusters detected as decrements @ 148 GHz from 2008 data in the Southern Strip.
- * All optically confirmed (Menanteau et al. 2010)
 - Brightest Cluster Galaxy (BCG)
 - Lensed arcs
 - Red sequence
- * Redshift Distribution: $0.36 \leq z \leq 1.06$
- * Mass-selected sample:



2006

LABOCA Survey of Clusters at All Redshifts



Team:

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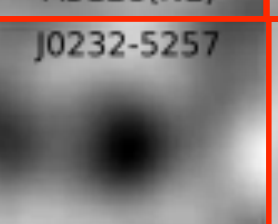
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LASCAR: LABOCA Survey of Clusters at All Redshifts

* Motivations:

- **Detect background SMGs and study the properties of distant, active obscured star-forming systems.**
 - Number counts, spatial distribution, redshift estimation
 - Build up source catalogues for ALMA follow-up
- **Estimate contamination of SZE signal from Submillimeter Galaxies (SMGs)**
 - Can SMGs bias the SZE decrement - mass relation?
 - Does it affect estimation cosmological parameters (e.g. Seghal et al. 2010)
- **Detect SZE increments**
 - Place constraints on the shape of the thermal SZE spectrum.
- **Enable analysis of obscured star formation in cluster galaxies**
 - Stack over optically selected cluster members and estimate contribution of active, obscured star formation (e.g. Braglia et al. 2010)

LASCAR: Sample

J0658-5557  1E0657-56	J0638-5358  AS0592	J0245-5302  AS0295	J0102-4915  New	J0438-5419  New	J0645-5413  A3404
J0546-5345  SPT-0547-5345	J0235-5121  New	J0330-5227  A3128(NE)	J0616-5227  New	J0559-5249  SPT-J0559-5249	J0215-5212  New
J0509-5341  SPT-0509-5342	J0641-4949  A3402	J0232-5257  New	J0516-5430  AS0520	J0346-5438  New	J0217-5245  RXC J0217-5244
J0145-5301  A2941	J0237-4939  New	J0304-4921  New	J0707-5522  New	J0528-5259  SPT-0528-5300	

LASCAR: Observations

* Observational Goal:

Obtain 870 μm imaging to uniform sensitivity (~ 1.6 mJy/beam) over an 8' diameter field for SZE-selected clusters with $>4\sigma$ 148 GHz decrements and no previous mm/submm observations.

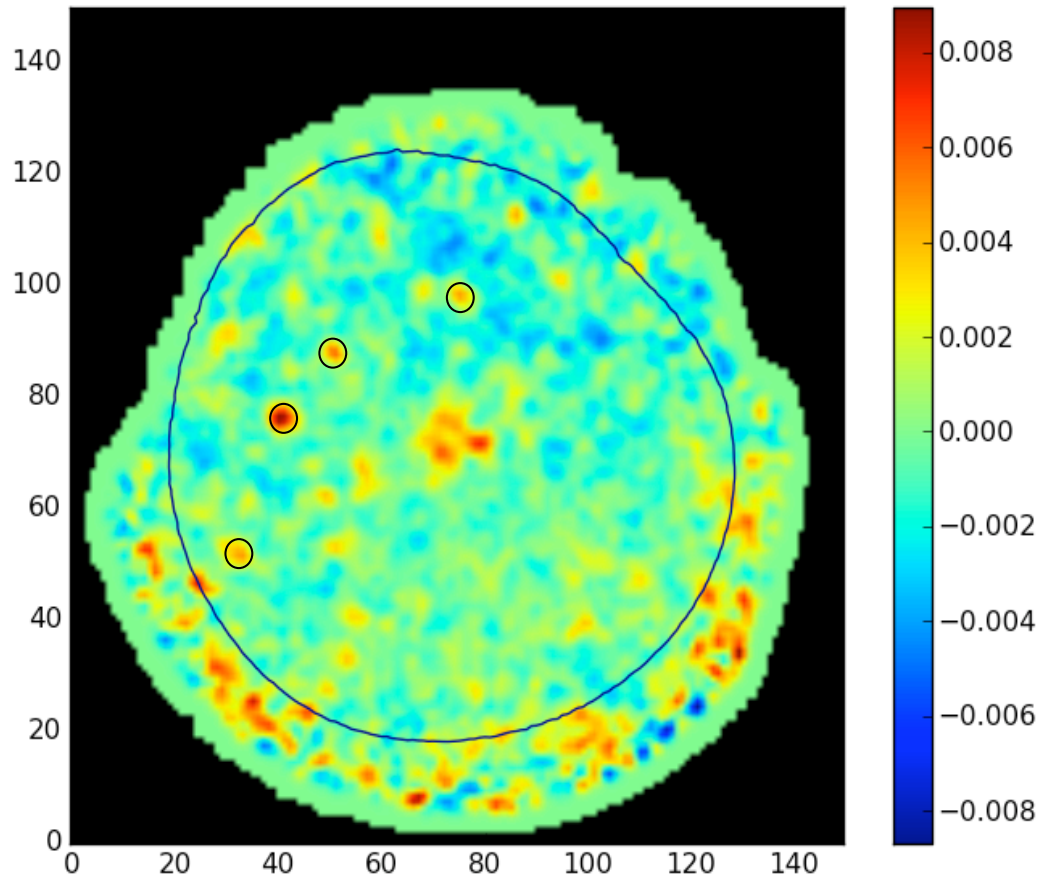
→ 25 hours of observation time per cluster

Target	z	Observed / Reduced
ACT-J0546-5345	1.06	✓✓
ACT-J0438-5419	0.54	✓✓
ACT-J0330-5227	0.44	✓✓
ACT-J0232-5257	0.59	✓✓
ACT-J0559-5249	0.611	✓✗
ACT-J0235-5121	0.43	✓✗

Additional Data

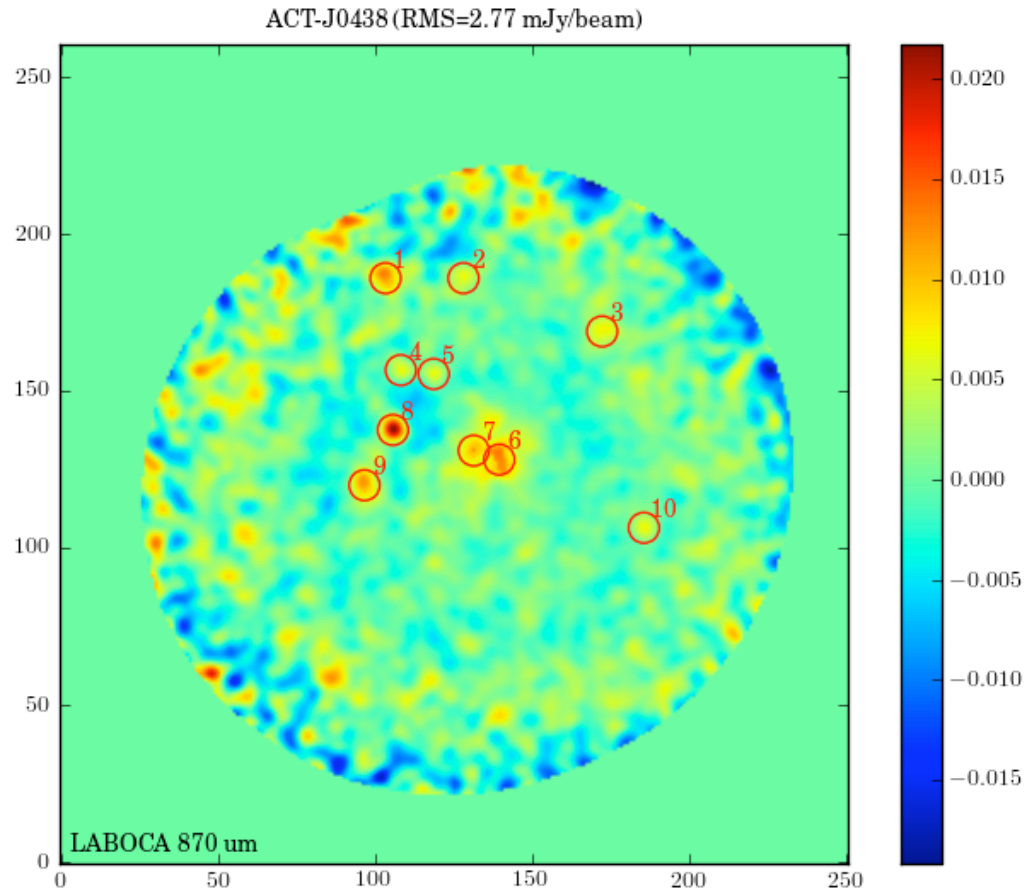
- * **ATCA: 2.275 GHz (Baker et al.)**
 - ACTJ0232 & ACTJ0330 already mapped, 6 more clusters submitted
 - Identify submm source counterparts & estimate photo-z
- * **Spitzer / IRAC (Hilton et al.)**
 - 3.6 & 4.5 um data for all clusters
 - Constrain stellar masses
- * **Chandra XR observations for all clusters (Hughes et al.)**
 - Constrain intracluster gas temperatures and masses
- * **Optical**
 - VLT / Gemini spectroscopic data for 15 clusters (Sifón et al.)
 - Identify cluster members, measure velocity dispersion & redshifts
 - Estimate dynamical masses & scaling relations

First Results: ACT-J0546



- * Highest-z cluster: $z=1.06$
- * RMS~1.4 mJy/beam
- * Detection of point sources and SZE increment signal

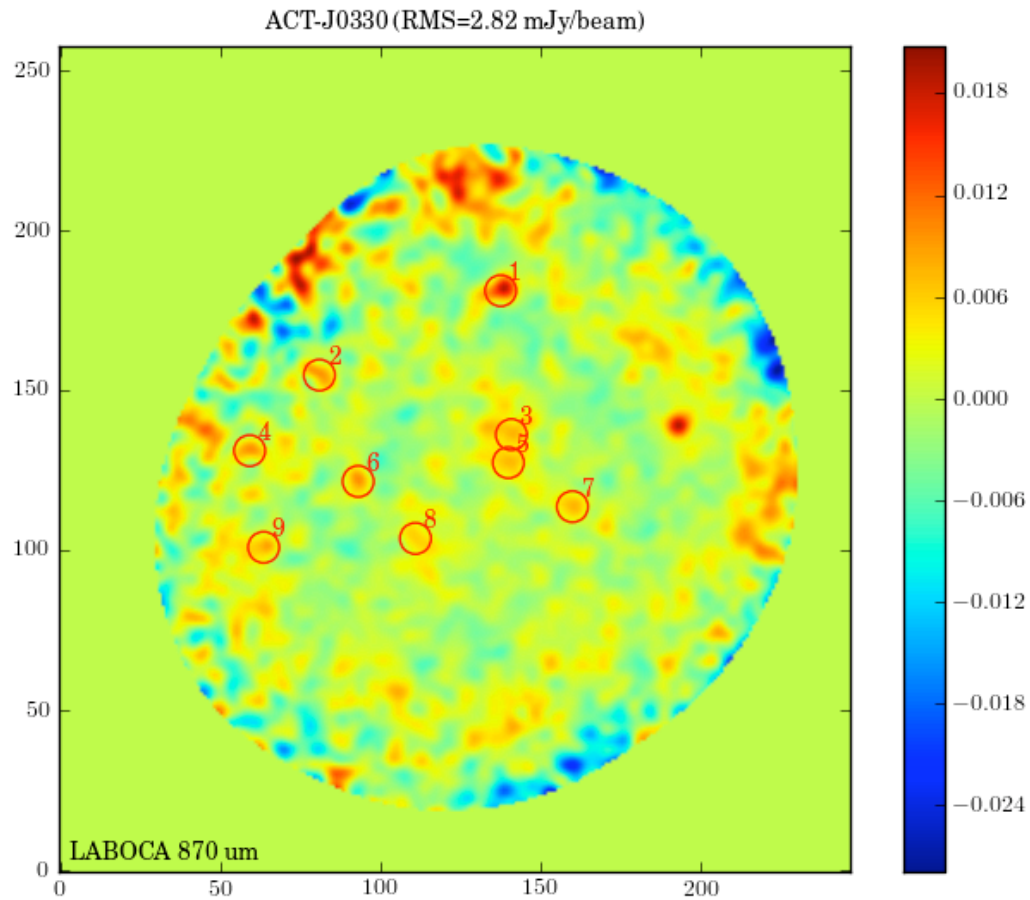
First Results: ACT-J0438



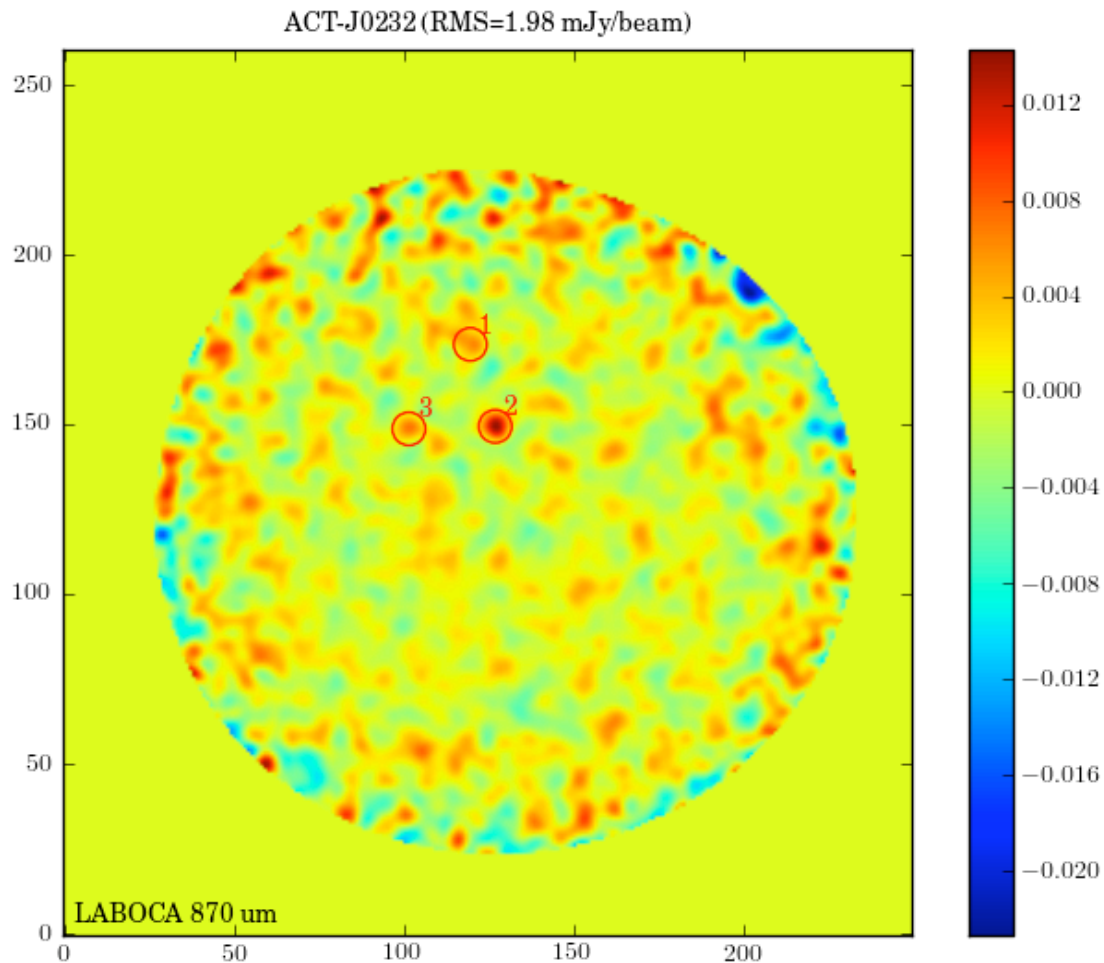
- * Most massive cluster in the ACT sample.
- * Falls within the ACT “deep survey” area (30 deg²)



First Results: ACT-J0330

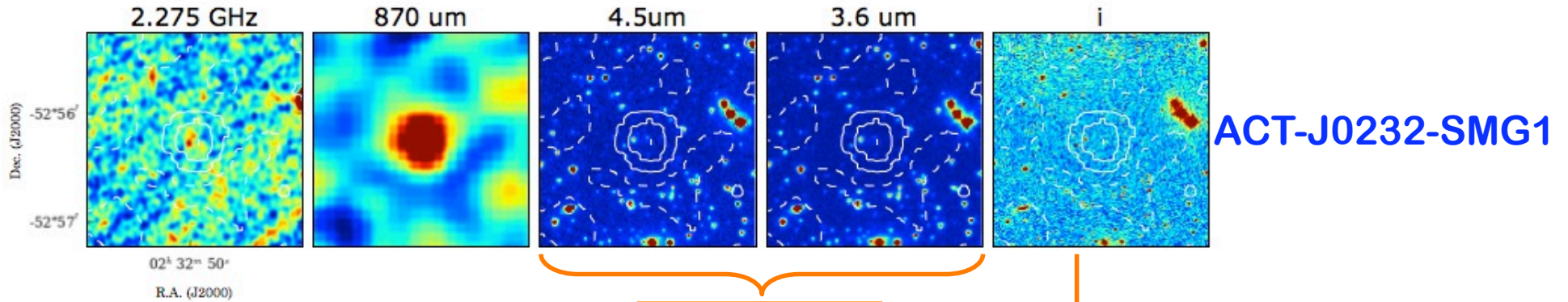


First Results: ACT-J0232



- * Few sources and no apparent SZE signal
- * ACTJ0232-SMG1: example of interesting SMG detections possible with LASCAR

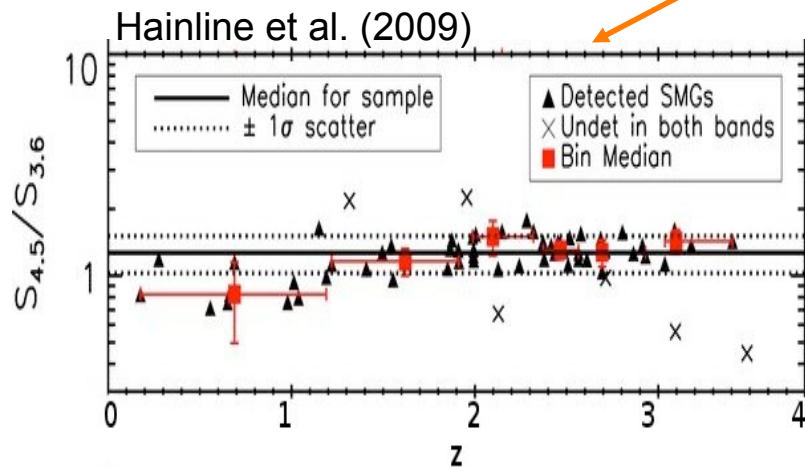
An SMG in the LASCAR Sample



By Robert Lindner
(Rutgers University)

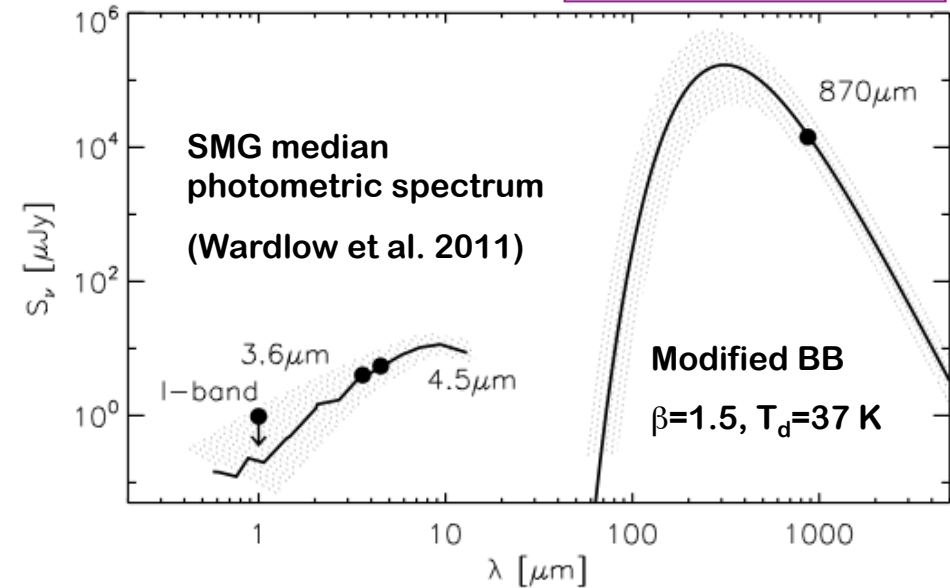
$$\frac{S_{4.5\mu\text{m}}}{S_{3.6\mu\text{m}}} = 1.36 \pm 0.06$$

$$z_{\text{phot}} = 4.2 \pm 0.5$$

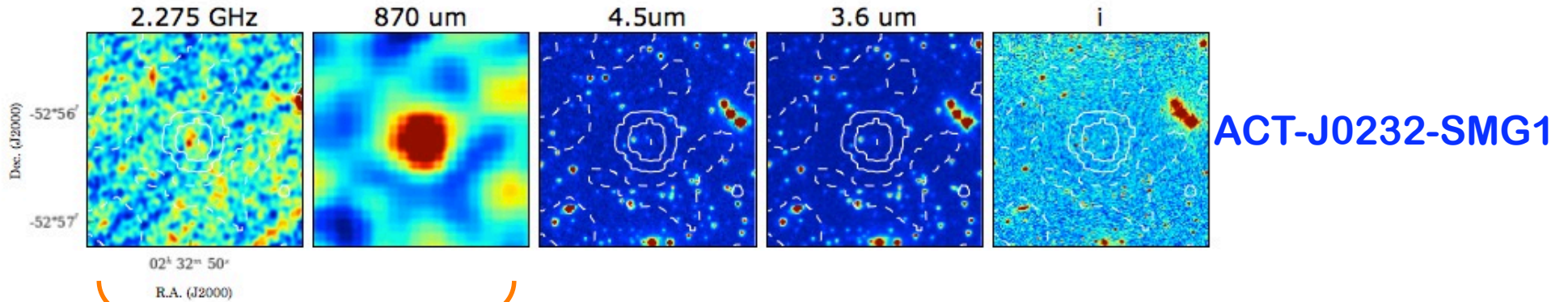


$$\langle S_{4.5\mu\text{m}} / S_{3.6\mu\text{m}} \rangle = 1.27 \pm 0.24$$

73 SMGs from Chapman et al. SCUBA Galaxies



An SMG in the LASCAR Sample

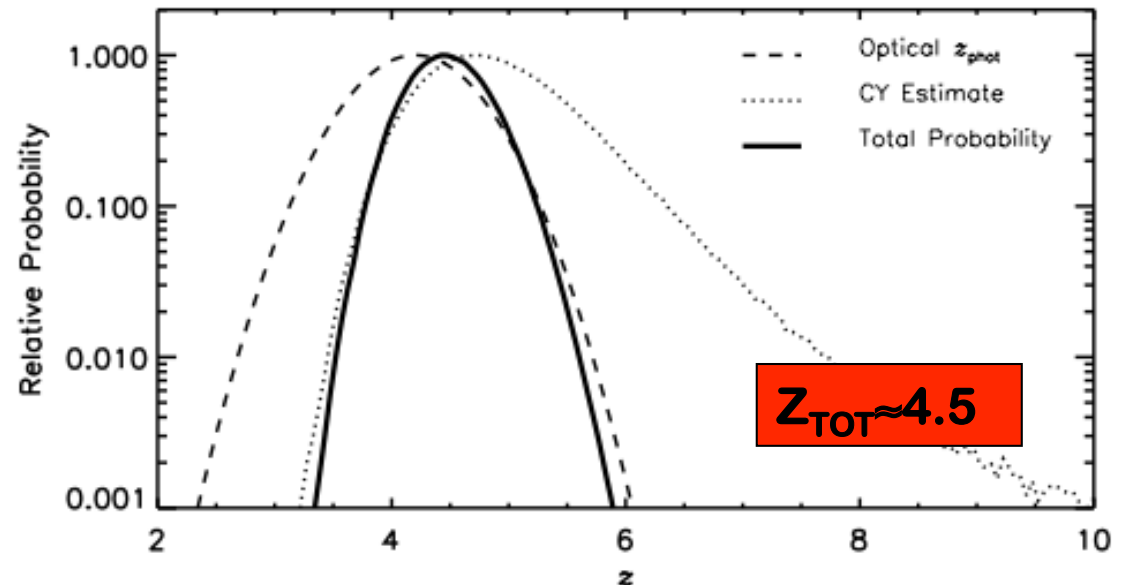


$S(870\mu\text{m})=14.3\pm 1.7 \text{ mJy}$
 $S(2.275 \text{ GHz})=30\pm 8 \mu\text{Jy}$

Carilli & Yun (1999)
 Radio/submm redshift estimator

$Z_{\text{CY}}=4.8\pm 0.3$

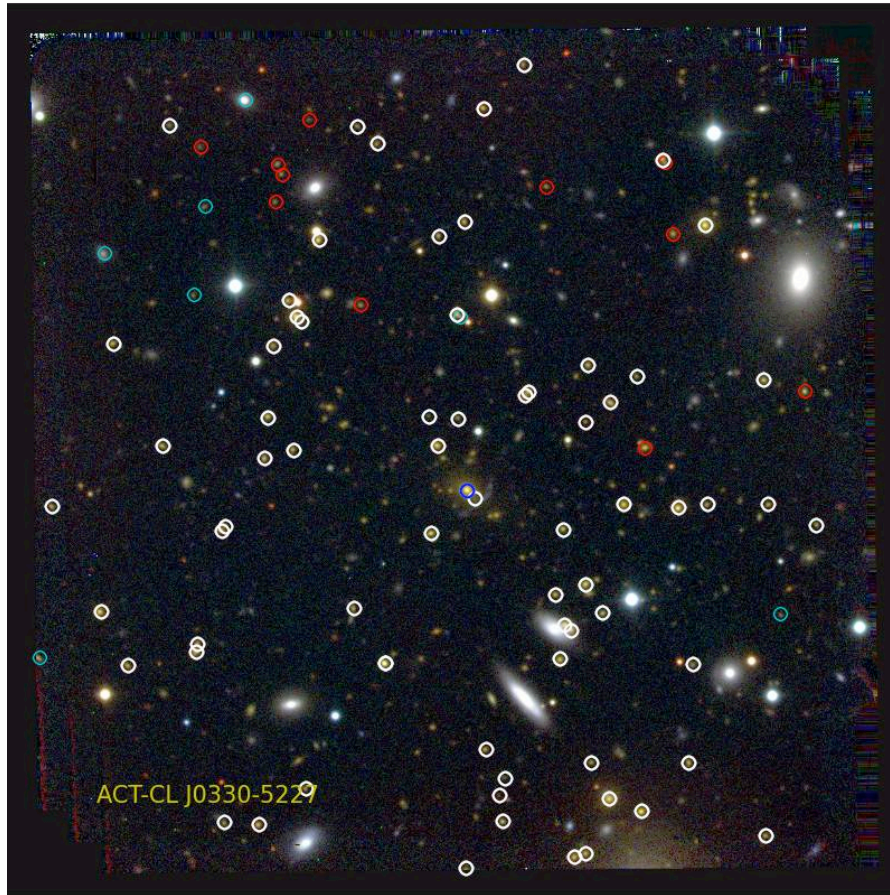
By Robert Lindner
 (Rutgers University)



Results from Optical Spectroscopy (Sifón et al. 2011)

- * **VLT/Gemini spectroscopy has enabled:**
 - **Confirmation of ~65 members per cluster**
 - **Calculation of velocity dispersion & dynamic mass estimates**
 - **Determination of cluster's dynamic state and substructure analysis.**

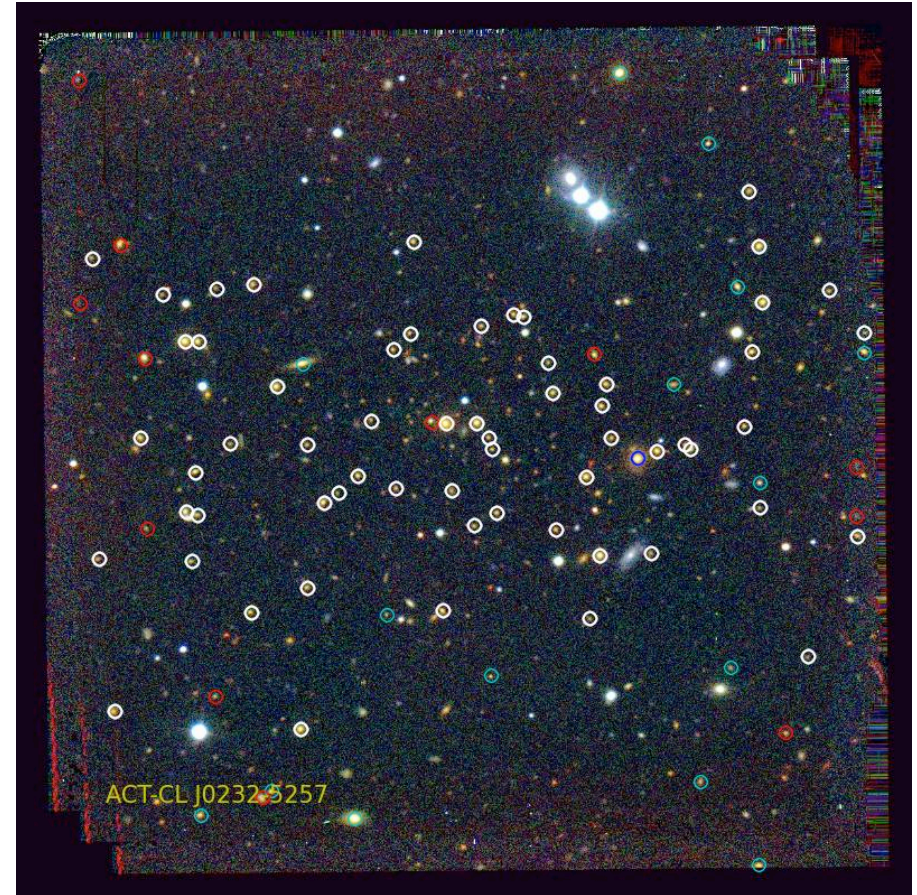
ACT-J0330 / ACT-J0232



* $N_{\text{gal}}=71$

* $z=0.44253\pm 0.00009$

* $M_{200}=12.1\pm 2.8 \cdot 10^{14}h^{-1}M_{\text{sun}}$

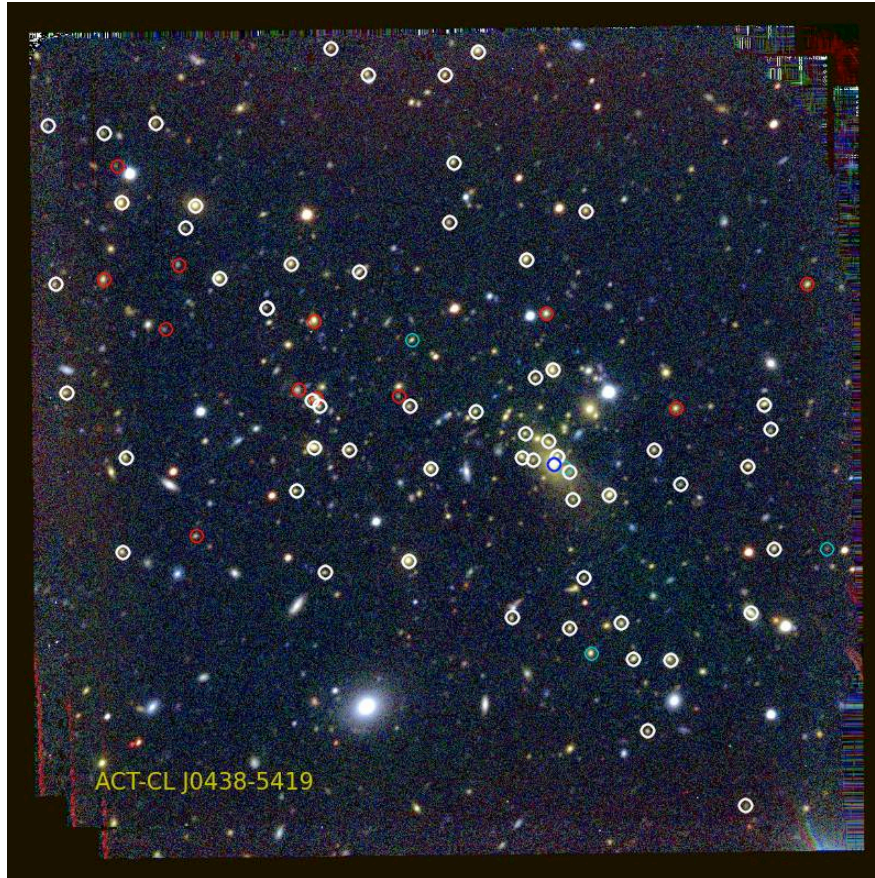


* $N_{\text{gal}}=64$

* $z=0.55700\pm 0.00009$

* $M_{200}=4.7\pm 1.7 \cdot 10^{14}h^{-1}M_{\text{sun}}$

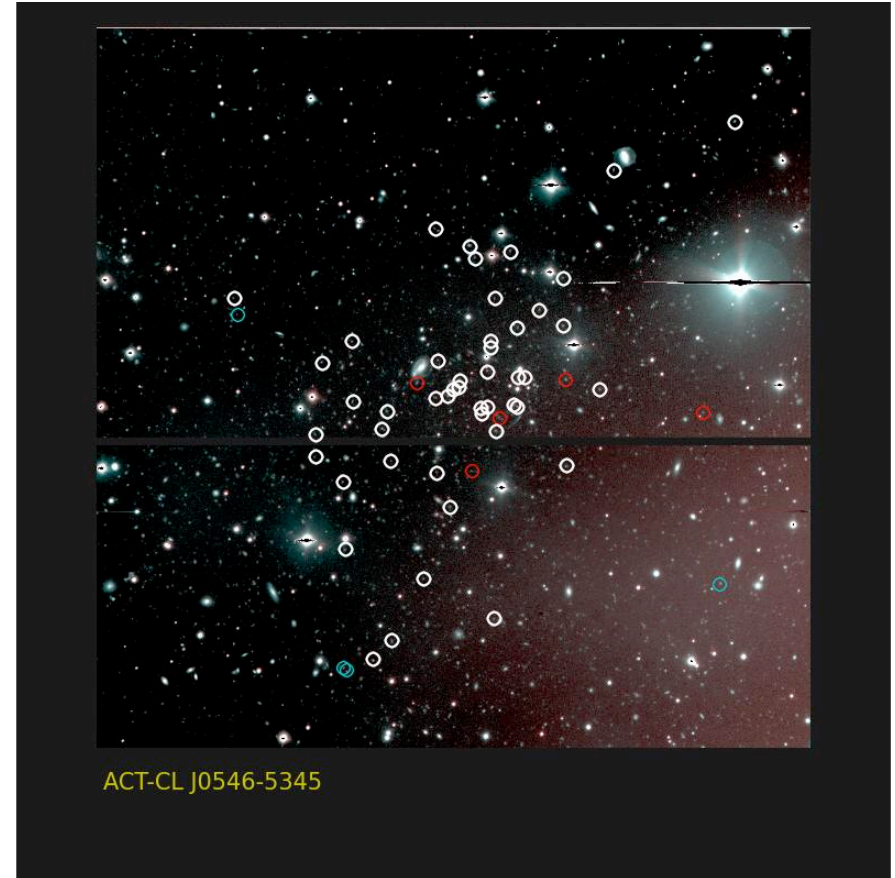
ACT-J0438 / ACT-J0546



* $N_{\text{gal}}=65$

* $z=0.42218\pm 0.00011$

* $M_{200}=14.9\pm 1.5 \ 10^{14}h^{-1}M_{\text{sun}}$



* $N_{\text{gal}}=48$

* $z=1.066628\pm 0.00020$

* $M_{200}=5.7\pm 2.9 \ 10^{14}h^{-1}M_{\text{sun}}$

Summary.

- * **LASCAR will allow us to study both galaxy clusters and obscured, star-forming galaxies from the same dataset.**
- * **Observations are in progress and first results are coming in.**
- * **Preliminary maps and first SMG detections give a promising perspective of our ability to reach our science goals.**
- * **More observations to complete, and lots of work to be done!!**
 - **SMG population analysis, SZE signal modelling, stacking analysis, etc...**