The SCUBA-2 Cosmology Legacy Survey and beyond

Jim Geach on behalf of the S2CLS consortium

#SMG20 / Durham / 31st July 2017
Take home message

Please exploit the S2CLS data!
What is was the SCUBA-2 Cosmology Legacy Survey?

Largest of the JCMT Legacy Surveys: 65% of all SCUBA-2 time to be spent on JLS, over half this to be spent on CLS. PIs: Smail, Dunlop, van der Werf, Halpern.

<table>
<thead>
<tr>
<th>Survey Description</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLS (high redshift)</td>
<td>1778</td>
<td>50.9%</td>
</tr>
<tr>
<td>GBS (local star formation)</td>
<td>412</td>
<td>11.8%</td>
</tr>
<tr>
<td>SASSy ('all/ambitious' sky survey)</td>
<td>480</td>
<td>13.8%</td>
</tr>
<tr>
<td>NGLS (nearby galaxies)</td>
<td>100</td>
<td>2.9%</td>
</tr>
<tr>
<td>JPS (Galactic plane)</td>
<td>450</td>
<td>12.9%</td>
</tr>
<tr>
<td>SONS (stars)</td>
<td>270</td>
<td>7.7%</td>
</tr>
<tr>
<td><strong>Total Hours</strong></td>
<td>3490</td>
<td><strong>291 nights</strong></td>
</tr>
</tbody>
</table>

3490 hours = 291 nights
Operating in 450 and 850 micron windows simultaneously using two array(s) of superconducting TES bolometers

Large format allows efficient large-area scanning (8 arcmin FoV ~ 10x SCUBA)

See Holland et al. (2013) for comprehensive details
What is was the SCUBA-2 Cosmology Legacy Survey?

Simple two tier strategy covering well-known fields, observations 2011-2015

- Wide survey at 850um in grade 2-3 conditions ($\tau=0.05-0.12$)
- Target area 10 deg$^2$ (eventually completed $\sim$5 deg$^2$)
- Uniform coverage to 1-sigma=1.2mJy
- PONG mapping strategy

- Deep survey at 450um + 850um in grade 1 conditions ($\tau<0.05$)
- Target area 0.25 deg$^2$ over HST/CANDELS fields
- Uniform coverage 1sigma=1.2mJy @ 450um / confusion limited at 850um
- DAISY (point source) mapping strategy
Science drivers (and outputs)

• Comprehensive survey of SMGs detected at 850um over several ~degree scale fields
  ‣ measure environment / clustering / halo properties (Smail et al. 2014, Wilkinson et al. 2017)
  ‣ constrain bright-end counts, bright SMGs (Geach et al. 2017, Michałowski et al. 2017)
  ‣ reliably probe properties of SMGs (Chen et al. 2016)
  ‣ AGN/starburst connection (Banerji et al. 2015, Ramasawmy et al. 2017 in prep)
  ‣ evolution (Koprowski et al. 2016, Bourne et al. 2017)
  ‣ cross-correlation / stacking studies (Coppin et al. 2015, Koprowski et al. 2017 in prep)
  ‣ resolved follow-up (Simpson et al. 2015, 2017)

• ‘Keyhole’ confusion limited survey at 450+850um
  ‣ properties of 450um-selected SMGs below Herschel confusion limit (Roseboom et al. 2013)
  ‣ resolving CIB at 450um (Geach et al. 2013)
  ‣ probing faint end of counts (Zavala et al. 2017)
  ‣ joint stellar+dust+gas morphologies (HST-CANDELS overlap, ALMA follow-up ongoing)
20 years ago: our first glimpse of the submm (distant) Universe, with SCUBA (Smail et al. 1997, Barger et al. 1998, Hughes et al. 1998)

The HDF

Hughes et al. (1998)
~10 years ago: ‘proper’ submm surveys

GOODS-N Supermap

Borys et al. (2003)
Pope et al. (2005)
~5 years ago SCUBA-2 and CLS
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450um
SCUBA HAIf Degree Extragalactic Survey (SHADES)

SXDF / UDS

~300 hours of SCUBA jiggle mapping

Mortier et al. (2005)
Coppin et al. (2006)
Final UDS map close to confusion limited (0.9 mJy/beam) over 1 degree ~500 hours integration
SCUBA-2 450um

Herschel SPIRE 500um

Geach et al. (2013)
S2CLS is a factory for detecting dusty starbursts and AGN at $z>1$

Excellent ancillary data (e.g. CANDELS) probing stellar emission, redshifts, morphologies

ALMA offers $HST$-matched resolution: directly compare dust and gas to stellar emission on sub-galactic scales
Survey paper: Geach et al. (2017)

Maps and catalogue available at: https://doi.org/10.5281/zenodo.57792

COSMOS not completed during CLS... see Simpson talk later

~3000 SMGs
450μm counts and resolving the CIB

Geach et al. (2013)
850um counts with ~3000 sources $S_{850} > 3.5$ mJy

![Graph showing the distribution of source counts and various models fitting the data.](image)

Geach et al. (2017)
Field-to-field variance of number counts

Field-to-field variance within 50% of mean on 15-30 arcminute scales

2-sigma over-density in GOODS-N, consistent with previous reports of high-z protocluster in this field (e.g. Daddi et al. 2009, Walter et al. 2012)

Geach et al. (2017)
ALMA follow-up of S2CLS sources at sub-arcsec resolution

Simpson et al. (2014, 2015)

(and SMA – see Chapman talk)
SCUBA-2 Large eXtragalactic Survey: S2LXS

PIs: Geach (UK) & Tamura (JP)

873 hour large programme to cover 10 square degrees to 2 mJy depth over XMM-LSS and E-COSMOS – HSC deep fields. First data taken last week!

Probing bright end of SMG distribution, z>4 population and cross-correlation studies
873 hour large programme to cover 10 square degrees to 2 mJy depth over XMM-LSS and E-COSMOS – HSC deep fields.

Probing bright end of SMG distribution, focused on z > 4 population and cross-correlation studies.

PIs: Geach (UK) & Tamura (JP)

S2LXS will be SHADES depth, but over 40x the area.
Atacama Large Aperture Submm/mm Telescope

A two-year EU-ALMA study of the scientific merit for – and technical implementation of – an Atacama Large Aperture Submm/mm Telescope (AtLAST) is underway.

We now invite the community to join in establishing working groups on science and technology aspects of AtLAST.

The science and technology working groups of AtLAST will conclude the study in early 2019 with a public report including recommendations for organizational and financial paths to building an international collaboration.

A workshop to discuss the science and technical aspects of AtLAST to be held at ESO-HQ January 17-19 2018
Talk deadline 3 Nov, Registration deadline 8 Dec
AtLAST@eso.org