The SCUBA-2 Cluster Snapshot Survey and Submillimetre-Bright Central Galaxies

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S2CSS

• Background/Motivation
• Selection
• Analysis
• Results
Cosmic Eyelash

• Observation of MACSJ2135-010217 $z = 0.324$

• Serendipitous discovery of $S_{870} \sim 100\text{mJy}$

• CO (1-0) detection, $z = 2.3$

• Lens model - Magnification $\sim 32x$

• Follow up - insight into the properties of the cold and dense interstellar medium (Danielson et al. 2011, 2013)

• Resolved kpc molecular gas clouds - grip on SFR
Lensed Galaxies

• Lensed galaxies can provide an opportunity to gain an insight into the astrophysics at z\(>1\) and observe below limits

• Gravitational lenses are rare - require chance alignment, even rarer are those which are magnified many times over

• Takes advantage of neg-K correction.

• Typically in blind survey: \(N(S>20\text{mJy}) \sim 1 \text{deg}^{-2}\).

• Not a huge number of these are known - aim to increase this.

• This is the largest dedicated survey aimed at detecting bright lensed systems
Target Selection

• Target the most massive clusters to hunt for brightest eyelash like sources

• Clusters selected based off of their X-Ray luminosity - chose brightest $L_X > 10^{44}$ erg s$^{-1}$

• Selected from BCS, eBCS, REFLEX and MACS

• Typical redshift of clusters $\sim 0.2-0.3$

• Targeted 202 clusters covering 0.33 deg$^2$ with a 1σ depth of 12 mJy beam$^{-1}$
Target Selection

- Poor weather programme JCMT weather band 4-5 typical $\langle \tau \rangle = 0.19 \pm 0.08$

- 30min 850um CV Daisy maps exposures August 2012 - July 2013

- $R = 5'$

- FCF = 556 Jy beam$^{-1}$ pW$^{-1}$
Detection

- Simple peak/centre finder algorithm
- Find $>1300 >3.5\sigma$ sources
- $1016 \ 3.5<\sigma<4, \ 312 \ 4<\sigma<5, \ 39>5$
- Unrealistic that there are 1300 SMG detections from 202 clusters - would mean 6 bright per cluster!
Selection

• Need to select based off of map properties not just sigma (but do believe >5sig)

• Use completeness simulation to determine those sources 4-5sig, c_80 proxy for 5sig e.g Saha 1995

• C_80 determined by injecting PSF in random positions, attempt to extract and repeat for various flux levels multiple times
Selection

- Hard radius cut off of 3.5’ - Deep region of SCUBA-2 map
- Threshold follows:
  - Determined S850/C80 > 0.7 + 0.05*R^2 provided adequate sample size
SPIRE Counterparts

- $3.5 \leq \sigma < 4.0$
- $4.0 \leq \sigma < 5.0$
- $\sigma \geq 5.0$

$S_{850}/C_{80}$ vs. Distance (')

JCMT User Meeting - Seoul - Jan/Feb 2018
• Using structure find ~110 candidate sources

• $\langle S_{850} \rangle \sim 40\text{mJy}$

• $N(S>20\text{mJy}) \rightarrow 101$

• Cluster $<z> \sim 0.26$

• $<R> \sim 1.7'$
HERSCHEL Lensing Survey

- HLS targeted subset of the same clusters Egami et al. 2010

- SPIRE - 250, 350, 500um observations

- Joint SCUBA-2/SPIRE detections provide more confidence of the reality of detections and allow us to roughly estimate redshifts through far-infrared colours.
MBB fit with Redshift as free param, T=40k Shown
Spectroscopic comparison

- Previous work CO: MACSJ0455.2+0657, MACSJ1731.6+2252 and MACSJ2043.2-2144

- MACSJ0455, MACSJ1731 and MACSJ2043, $z = 2.927, 2.712$ and a blended source of $z = 2.04, 3.25, 4.68$ respectively. Zavala 2015

- In comparison we find photometric redshifts for MACSJ0455 $z = 1.3 - 2.3$, MACSJ1731 $z = 1.9 - 3.2$ and MACSJ2043 $z = 1.8 - 3.1$. 
Spectroscopic Comparison

- Private comms with ALMA spectroscopic follow ups of some sources as well

- Find most in good agreement, likely the rest also follow. $z = 2.6$ typical spectroscopic SMG redshift
Brightest Cluster Galaxies

- Targeted at the BCG of each cluster
- Find 7 likely associated with the BCG $R < 0.1'$
- Some sources confirm with previous Hogan 2015
- Also find examples which disagree with H15 and lay $>0.1'$ from BCG
Summary

• Initial detections found 1100 >3.5 sig sources reduced to 112, \( <S_{850}> = 40 \text{mJy}, <R_{S2CSS}> = 1.7' \)

• Photometric Redshifts typical \( Z \sim 2.4 \) Spectro redshift typical \( Z \sim 2.6 \) - good agreement!

• Largest number of unknown lensed cluster sources

• 7 bright submm BCG observations

• Thermal SEDs built for \( \sim 25 \) sources