A submillimetre-bright \( z \sim 3 \) overdensity behind a \( z \sim 1 \) supercluster revealed by SCUBA–2 and Herschel

A. G. Noble\(^1\)\(^\dagger\), J. E. Geach\(^1\)\(^,\)\(^2\), A. J. van Engelen\(^3\), T. M. A. Webb\(^1\), K. E. K. Coppin\(^1\)\(^,\)\(^2\), A. Delahaye\(^1\), D. G. Gilbank\(^4\), M. D. Gladders\(^5\), R. J. Ivison\(^6\)\(^,\)\(^7\), Y. Omori\(^1\), H. K. C. Yee\(^8\)

\(^1\)Department of Physics, McGill University, 3600 Rue University, Montréal, Québec, H3A 2T8, Canada
\(^2\)Centre for Astrophysics Research, Science & Technology Research Institute, University of Hertfordshire, Hatfield, AL10 9AB
\(^3\)Department of Physics and Astronomy, Stony Brook University, Stony Brook, NY, 11794-3800, USA
\(^4\)South African Astronomical Observatory, PO Box 9, Observatory, 7935, South Africa
\(^5\)UK Astronomy Technology Centre, Science and Technology Facilities Council, Royal Observatory, Blackford Hill Edinburgh, EH9 3HJ, UK
\(^6\)Institute for Astronomy, University of Edinburgh, Blackford Hill Edinburgh, EH9 3HJ, UK
\(^7\)Department of Astronomy and Astrophysics, University of Toronto, 50 St George Street, Toronto, Ontario M5S 3H4, Canada
\(^8\)Department of Astronomy and Astrophysics, University of Chicago, 5640 S. Ellis Ave., Chicago, IL, 60637, USA

\* Herschel is an ESA space observatory with science instruments provided by European-led Principal Investigator consortia with important participation from NASA.
\\dagger\ E-mail: nobleal@physics.mcgill.ca

ABSTRACT

We present a wide-field (30' diameter) 850\( \mu \)m SCUBA-2 map of the spectacular three-component merging supercluster, RCS 231953+00, at \( z = 0.9 \). The brightest submillimetre galaxy (SMG) in the field (\( S_{850} \approx 12\,\text{mJy} \)) is within 30' of one of the cluster cores (RCS 2319-C), and is likely to be a more distant, lensed galaxy. Interestingly, the wider field around RCS 2319-C reveals a local overdensity of SMGs, exceeding the average source density by a factor of 4.5, with a < 1% chance of being found in a random field. Utilizing Herschel-SPIRE observations, we find three of these SMGs have similar submillimetre colours. We fit their observed 250–850\( \mu \m\) spectral energy distributions to estimate their redshift, yielding \( 2.5 < z < 3.5 \), and calculate prodigious star formation rates (SFRs) ranging from 500 – 2500 \( M_\odot \) yr\(^{-1} \). We speculate that these galaxies are either lensed SMGs, or signpost a physical structure at \( z \approx 3 \): a ‘protocluster’ inhabited by young galaxies in a rapid phase of growth, destined to form the core of a massive galaxy cluster by \( z = 0 \).

Key words: galaxies: clusters: individual (RCS 231946+0030.6) – galaxies: formation – galaxies: evolution – galaxies: high-redshift – submillimetre: galaxies

1 INTRODUCTION

Submillimetre (submm) surveys have a history of exciting revelations, beginning with the discovery of a population of submm-bright galaxies (SMGs) over a decade ago \( [\text{Smail et al. 1997}] \), \( [\text{Barger et al. 1998}] \), \( [\text{Hughes et al. 1998}] \). These SMGs are now known to be high-\( z \) \( [\text{Chapman et al. 2005}] \), \( [\text{Wardlow et al. 2011}] \), gas-rich \( [\text{Frayer et al. 1998}] \), \( [\text{Frayer et al. 1999}] \) systems undergoing intense episodes of star formation, and are the likely progenitors of massive elliptical galaxies seen locally \( [\text{Eales et al. 1999}] \), \( [\text{Lilly et al. 1999}] \). The latest generation of submm telescopes, namely the Herschel Space Observatory \( [\text{Pilbratt et al. 2010}] \) and SCUBA-2 \( [\text{Holland et al. 2013}] \) on the James Clerk Maxwell Telescope (JCMT), are ushering in a new era of submm astronomy, yielding samples of thousands of SMGs \( [\text{Eales et al. 2010}] \) and promising many discoveries \( [\text{Chen et al. 2013}] \), \( [\text{Geach et al. 2013}] \), \( [\text{Casey et al. 2013}] \).

The wide-field mapping power of SCUBA-2 opens up a new parameter space in submm studies: the capability to survey volumes that sample the full range of galaxy environment at high redshifts. The densest regions—the nodes in the cosmic web—are the likely progenitors of massive elliptical galaxies \( [\text{Eales et al. 1999}] \), \( [\text{Lilly et al. 1999}] \). The latest generation of submm telescopes, namely the Herschel Space Observatory \( [\text{Pilbratt et al. 2010}] \) and SCUBA-2 \( [\text{Holland et al. 2013}] \) on the James Clerk Maxwell Telescope (JCMT), are ushering in a new era of submm astronomy, yielding samples of thousands of SMGs \( [\text{Eales et al. 2010}] \) and promising many discoveries \( [\text{Chen et al. 2013}] \), \( [\text{Geach et al. 2013}] \), \( [\text{Casey et al. 2013}] \).

The wide-field mapping power of SCUBA-2 opens up a new parameter space in submm studies: the capability to survey volumes that sample the full range of galaxy environment at high redshifts. The densest regions—the nodes in the cosmic web—are the likely progenitors of massive elliptical galaxies. These SMGs are now known to be high-\( z \) \( [\text{Chapman et al. 2005}] \), \( [\text{Wardlow et al. 2011}] \), gas-rich \( [\text{Frayer et al. 1998}] \), \( [\text{Frayer et al. 1999}] \) systems undergoing intense episodes of star formation, and are the likely progenitors of massive elliptical galaxies seen locally \( [\text{Eales et al. 1999}] \), \( [\text{Lilly et al. 1999}] \). The latest generation of submm telescopes, namely the Herschel Space Observatory \( [\text{Pilbratt et al. 2010}] \) and SCUBA-2 \( [\text{Holland et al. 2013}] \) on the James Clerk Maxwell Telescope (JCMT), are ushering in a new era of submm astronomy, yielding samples of thousands of SMGs \( [\text{Eales et al. 2010}] \) and promising many discoveries \( [\text{Chen et al. 2013}] \), \( [\text{Geach et al. 2013}] \), \( [\text{Casey et al. 2013}] \).

The wide-field mapping power of SCUBA-2 opens up a new parameter space in submm studies: the capability to survey volumes that sample the full range of galaxy environment at high redshifts. The densest regions—the nodes in the cosmic web—are the likely progenitors of massive elliptical galaxies. These SMGs are now known to be high-\( z \) \( [\text{Chapman et al. 2005}] \), \( [\text{Wardlow et al. 2011}] \), gas-rich \( [\text{Frayer et al. 1998}] \), \( [\text{Frayer et al. 1999}] \) systems undergoing intense episodes of star formation, and are the likely progenitors of massive elliptical galaxies seen locally \( [\text{Eales et al. 1999}] \), \( [\text{Lilly et al. 1999}] \). The latest generation of submm telescopes, namely the Herschel Space Observatory \( [\text{Pilbratt et al. 2010}] \) and SCUBA-2 \( [\text{Holland et al. 2013}] \) on the James Clerk Maxwell Telescope (JCMT), are ushering in a new era of submm astronomy, yielding samples of thousands of SMGs \( [\text{Eales et al. 2010}] \) and promising many discoveries \( [\text{Chen et al. 2013}] \), \( [\text{Geach et al. 2013}] \), \( [\text{Casey et al. 2013}] \).

The wide-field mapping power of SCUBA-2 opens up a new parameter space in submm studies: the capability to survey volumes that sample the full range of galaxy environment at high redshifts. The densest regions—the nodes in the cosmic web—are the likely progenitors of massive elliptical galaxies. These SMGs are now known to be high-\( z \) \( [\text{Chapman et al. 2005}] \), \( [\text{Wardlow et al. 2011}] \), gas-rich \( [\text{Frayer et al. 1998}] \), \( [\text{Frayer et al. 1999}] \) systems undergoing intense episodes of star formation, and are the likely progenitors of massive elliptical galaxies seen locally \( [\text{Eales et al. 1999}] \), \( [\text{Lilly et al. 1999}] \). The latest generation of submm telescopes, namely the Herschel Space Observatory \( [\text{Pilbratt et al. 2010}] \) and SCUBA-2 \( [\text{Holland et al. 2013}] \) on the James Clerk Maxwell Telescope (JCMT), are ushering in a new era of submm astronomy, yielding samples of thousands of SMGs \( [\text{Eales et al. 2010}] \) and promising many discoveries \( [\text{Chen et al. 2013}] \), \( [\text{Geach et al. 2013}] \), \( [\text{Casey et al. 2013}] \).

Here, we report early findings from a wide-field SCUBA-2 and Herschel-SPIRE survey of a spectacular merging \( z = 0.9 \) supercluster, RCS 231953+00 (hereafter RCS 2319+00;
The RCS 2319+00 Supercluster

Originally discovered in the Red-sequence Cluster Survey (RCS-1: Gladders & Yee 2005) and presented in Gilbank et al. (2008), the RCS 2319+00 structure now has extensive follow-up observations. Much of the work has focused on the northern-most cluster (RCS 2319–A); it was revealed to be a remarkable strong-lensing cluster with three gravitationally lensed radial arcs (Gladders et al. 2003), and has a significant weak lensing signal (Jee et al. 2011). SCUBA imaging of the core of RCS 2319–A unveiled a candidate lensed SMG (Noble et al. 2012) and Herschel-SPIRE imaging revealed a 2.5 Mpc filament of SMGs connecting RCS 2319–A to its eastern companion, RCS 2319–B (Coppin et al. 2012).

2.2 850μm SCUBA–2 observations

SCUBA-2 observations were conducted at the JCMT in Band 2 weather (0.05 < τ_225 GHz < 0.08) between 17–21 September 2012 using the 30’ PONG mapping pattern. The total mapping time was 7.75 hr, split into 11× 40 min scans. Individual scans are reduced using the dynamic iterative map-maker (makemap) of the SMURF package (Chapin et al. 2013) following the procedure outlined in Geach et al. (2013). These scans are co-added in an optimal, noise-weighted manner, using the MOSAIC package (Chapin et al. 2013) recipe in the PICARD environment. Finally, to improve the detectability of faint point sources, we use SCUBA2 MATCHED FILTER, which removes large angular scale varying pattern noise in the map by smoothing with a 30’ Gaussian kernel, subtracting this, and then convolving the map with the 850μm beam. The average exposure time over the ‘nominal’ 30’ mapping region in the co-added map is ≈10 ksec, reaching a central depth of 1.5 mJy.

2.3 Herschel-SPIRE observations

The Herschel-SPIRE (Griffin et al. 2010) data were taken on January 2, 2013, with a total of 8.1 hours of integration time over five dithered maps at 250, 350, and 500μm (OBSIDs 1342258348,
1342258349, 1342258350, 1342258351, 1342258352). The observations cover 30′×30′, including all three cluster cores, and were carried out in array mode using the nominal scan speed. Each map is reprocessed individually using HYPE v10.0 (Ott 2010) and the latest calibration tree. One map has significant artifacts and requires smoothing with a convolution kernel and using a sub-pixel correction factor. This has been found to be a more reliable flux estimate with quadrature with a nominal confusion noise of 5.8, 6.3, and 6.8 mJy at 250, 350, and 500 µm, respectively.

Point sources are extracted using SUSSEXtractor (Savage & Oliver 2007) at a relatively low detection threshold of 3.5σ to maximize counterpart completeness. The source list is passed to a timeline fitter that utilizes the merged Level 1 timeline data to fit a Gaussian at the source position. For sources below 30 mJy, the flux is measured as the peak on the image after smoothing with a convolution kernel and using a sub-pixel correction factor. This has been found to be a more reliable flux estimate for faint sources (SPIRE Webinar, private communication). The uncertainties on the fluxes are estimated from pixel noise added in quadrature with a nominal confusion noise of 5.8, 6.3, and 6.8 mJy at 250, 350, and 500 µm, respectively (Nguyen et al. 2010).

3 ANALYSIS AND RESULTS

Point sources are extracted from the central ∼25′ of the beam-convolved map, where the sensitivity is fairly uniform and the noise is < 3× the central 1σ r.m.s., corresponding to a total uniform area of ∼473 arcmin². We detect 29 point sources at 850 µm at a significance of >3.5σ, 16 of which are at > 4σ. The detections are indicated by orange circles in Figure 1 and named in order of descending signal-to-noise ratio. We quantify the false-detection rate by running the detection algorithm on jack-knife versions of the map (details given in Geach et al. 2013). Within the source detection area, we find a false-detection rate of 4.5% (20%) at 4.0σ (3.5σ). We note that both these rates are 25% lower where the noise is < 2× the central r.m.s., encompassing all but one of the SMGs.

3.1 SCUBA-2/SPIRE source identification

Very Large Array radio imaging at 1.4 GHz covers the entirety of the SCUBA-2 and SPIRE maps, although with roughly 2× the noise at the edges due to primary beam attenuation (Noble et al. 2012). We also exploit deep IR imaging from the Multiband Imaging Photometer (MIPS) aboard Spitzer (Webb et al. 2013). The extensive, multi-wavelength counterpart identification process, including the completeness and false-detection rate, will be presented in Noble et al. (in preparation); we provide only a brief description in this communication.

Given the ≈15′′ beam at 850 µm, we search for radio and 24 µm emission within 10′ of the SCUBA-2 positions, ensuring we detect all possible counterparts (Ivison et al. 2007; Biggs et al. 2011). While a 10′ search radius is generous, in practice we find that all the counterparts to >4σ SMGs are within 6′, with an average offset of 3′. We robustly detect a 24 µm and/or radio counterpart for 20 of the 29 (70%) sources within our catalog. Of the remaining SCUBA-2 detections, eight lack MIPS coverage (and have no radio detection), and one source eludes any counterpart emission. For cases where multiple 24 µm sources are detected within the search area (and no radio emission), we assign the nearest source as the most likely counterpart, which in all occurrences is also the brightest 24 µm detection within the search area.

Counterpart SPIRE emission can further verify the validity of each SCUBA-2 source, although it is not a requirement as 20–60% of z > 2 SMGs are undetectable with SPIRE (Casey et al. 2012). Given the large SPIRE beam, we search within the entire SCUBA-2 beam for 250–500 µm emission, resulting in detections in one or more SPIRE bands for 18 of the 29 850 µm sources. Four of the SMGs lacking MIPS coverage or a radio counterpart are detected with SPIRE, yielding a final catalog of 24 (80%) SCUBA-2 sources with counterparts in another band. Any emission that is blended or confused in SPIRE (four cases in total) is omitted from the counterpart catalog for the purposes of far-IR SED fitting (see § 3.2).

3.2 Evidence of a line-of-sight, submillimetre-bright protocluster

The average surface density of 850 µm sources across the 30′ RCS 2319+00 field is consistent with that expected from the number counts measured in blank-field submm surveys (Copin et al. 2006). However, it is clear that there are large variations in the local surface density on scales of several arcminutes. Indeed, there appears to be a local relative overdensity of 850 µm detections in the vicinity of RCS 2319–C. To quantify this, we create a Gaussian smoothed (θ = 4′) surface density map, normalized to the fractional overdensity of SMGs: δpeak = (ρ̅ − ρ̅bar)/(ρ̅bar) (Figure 1).

There is a δpeak = 3.5 close to RCS 2319–C. To assess the significance of this local peak, we generate simulated catalogues of the same size as the real map, and with the same source density as the detected SMGs. In addition to the shot noise properties of the sources, we also include the effects of clustering on linear scales, assuming a redshift distribution and bias factor matching the current best estimate for 850 µm-selected SMGs (Hickox et al. 2012). We check the clustering properties of the fake catalogues by applying the Landy-Szalay estimator (Landy & Szalay 1993) and find the angular correlation function w(θ) to be consistent with
The parameters for the best fit values with $\beta$ fixed at 1.5 (blue), 1.75 (green) and 2.0 (red) are listed in each panel. The lowest reduced $\chi^2$ values are given by $z = [3.5, 2.9, 2.5] \pm 0.6$ and $T_d = [48, 43, 41] \pm 8$ K for SMMs J2319.1, 2319.6, and 2319.16, respectively. We note that SMM J2319.1 has only a weak radio detection, just below the catalogue limit; we therefore assign it the 3σ rms limit of 45 mJy.

Figure 3. Modified blackbody fits to the SPIRE and SCUBA-2 fluxes for the three possible protocluster members, using the technique described in Section 3.2.

We estimate the redshifts of these sources by fitting to the submm photometry, assuming the SED can be modeled by a single temperature modified blackbody, with a smooth transition into a dust temperature from the modified blackbody described above and conservatively assume a 10 K scatter in $T_d$.

This fitting algorithm greatly reduces the degeneracy between $z$ and $T_d$ and produces typical uncertainties of $\Delta z = 0.6$ and $\Delta T_d = 8$ K. The best fit SEDs are shown in Figure 3. The lowest values of $\chi^2/\nu$ yield $z = [3.5, 2.9, 2.5]$ and $T_d = [48, 43, 41]$ K for SMMs J2319.1, J2319.6, and 2319.16, respectively. These redshifts are all within $\sim 1\sigma$ and further support the existence of an SMG protocluster behind RCS2319-C at $z > 2.5$. Although this redshift range is representative of the typical SMG (Chapman et al. 2005), we emphasize the similarity of submm colours for these SMGs, which isolates them from the rest of the sample through a consistent comparison. The SED fit also provides an estimate of the IR luminosity which can be converted to a SFR (Salpeter IMF; Kennicutt 1989), and we find all three candidate protocluster members are highly active, with SFRs of 2500, 1100, and 500 M$\odot$ yr$^{-1}$ (assuming no AGN contamination). We note that these could be overestimated if any of the SMGs are strongly lensed.

3.3 A submillimetre-bright, strongly lensed galaxy

Within this putative protocluster lies the brightest 850$\mu$m source in the catalogue, SMM J2319.1, with $S_{850} = 12.05 \pm 1.56$ mJy. This source is only 28$''$ away from the X-ray peak of RCS 2319–C and could be strongly lensed by the cluster potential, though it is only 1.5$\times$ as bright as the second brightest protocluster member, SMM J2319.1. This source is coincident with an extremely red spur-like feature—possibly the optical/near-IR counterpart to the SMG. It is considerably redder than the red-sequence galaxies in the cluster, implying that it is probably at higher redshift. Indeed, the SED fit places this source at $z = 3.5$, although (sub)mm spectroscopic identification will be required to accurately determine the redshift.

In Figure 4 we present a gK[4.5] composite image of the cluster core. 850$\mu$m S/N contours mark the position of the galaxy. There are hints of a blue arc-like feature around the BCG, indicating that this may be a strong lensing cluster. We lack an accurate mass model for this cluster (high-resolution optical imaging only exists for RCS 2319–A), but assuming an isothermal sphere with $\sigma_v = 759$ km s$^{-1}$ (Faloona et al. 2013) and $z = 3.0$ for the source plane, we calculate an Einstein radius of $\sim 9''$, which is consistent...
with the distance between the BCG and blue arc. We emphasize that the projected overdensity of SMGs around RCS2319–C could also be due to boosted counts from lensing of the random field, rather than a physical protocluster (spectroscopic confirmation will answer this question). However, the peak of the overdensity is offset from the core of RCS2319–C by >1′, while the average lensing magnification beyond the central 30″ is expected to be < 2 for similarly massive clusters (Noble et al. 2012).

4 SUMMARY

This Letter presents the first wide-field SCUBA-2 850 μm map of a high-z galaxy cluster field. We target a rare, three-component supercluster at z = 0.9 – RCS 2319+00 – detecting 29 SMGs, the majority of which have robust counterparts at 24 μm, 1.4 GHz and/or in the Herschel-SPIRE bands. Previous work on RCS 2319+00 has focused on the northern core, RCS 2319–A, which is a well-known strong-lensing system, whereas the new SCUBA-2 map reveals that RCS2319–C, the southern-most component, also has some interesting traits. We make two discoveries:

(i) RCS2319–C has features indicative of a strongly lensing cluster, with a distinct blue arc just below the BCG (at a radius consistent with the Einstein radius expected for this cluster). We report the discovery of a bright (S850 ≈ 12 mJy) SMG 28″ from the core, associated with a very red optical/near-IR counterpart that is likely to be a lensed galaxy at z ≈ 3. Thus, it offers the rare opportunity to study the properties of the SMG in much finer detail than would otherwise be possible.

(ii) There is a significant local overdensity of SMGs in the vicinity of RCS2319–C, with a peak of δ = 3.5 in density contrast when smoothed at 4″. Simulations indicate that there is a <1% chance of finding a similar structure in a (clustered) blank field of the same area. We estimate the redshifts for three of the sources within this overdensity by fitting the observed 250–850 μm photometry with a modified blackbody SED, finding them consistent with 2.5 < z < 3.5. They have high IR luminosities, corresponding to SFRs ranging from 500 – 2500 M⊙ yr⁻¹. We speculate that the SMGs are part of a physical association at z ≈ 3, perhaps signposting a starbursting protocluster along the line of sight to RCS 2319–C. This scenario is supported by recent clustering measurements which predict the formation of SMGs in compact protoclusters (Maddox et al. 2010). Indeed, SMGs have been found to trace the underlying distribution of Lyman-α emitters in a z ≈ 3.1 protocluster (Tamura et al. 2009) and in some cases are physically associated with Lyα Blobs in these environments (Chapman et al. 2001; Geach et al. 2005).

We thank many people for assistance with the SCUBA-2/SPIRE data, including the JAC staff and telescope operators, and the SPIRE ICC, especially David Shupe. We also thank Gaëlien Marsden for useful discussions. JG acknowledges support from a Banting Fellowship administered by NSERC. TW is supported by the NSERC Discovery Grant and the FQRNT Nouveaux Chercheurs program. KC receives support from the endowment of the Lorne Trottier Chair in Astrophysics and Cosmology at McGill and NSERC.

REFERENCES

Aretxaga, I., et al. 2007, MNRAS, 379, 1571
Barger, A. J., Cowie, L. L., Sanders, D. B., Fulton, E., Taniguchi, Y., Sato, Y., Kawara, K., & Okuda, H. 1998, Nature, 394, 248
Biggs, A. D., et al. 2011, MNRAS, 413, 2314
Carilli, C. L., & Yun, M. S. 1999, ApJ, 513, L13
Casey, C. M., et al. 2012, ApJ, 761, 140
—. 2013, ArXiv e-prints
Chapin, E. L., Berry, D. S., Gibb, A. G., Jenness, T., Scott, D., Tilanus, R. P. J., Economou, F., & Holland, W. S. 2013, MNRAS, 430, 2545
Chapman, S. C., Blain, A. W., Smail, I., & Ivison, R. J. 2005, ApJ, 622, 772
Chapman, S. C., Lewis, G. F., Scott, D., Richards, E., Borys, C., Steidel, C. C., Adelberger, K. L., & Shapley, A. E. 2001, ApJ, 548, L17
Chary, R., & Elbaz, D. 2001, ApJ, 556, 562
Chen, C.-C., Cowie, L. L., Barger, A. J., Casey, C. M., Lee, N., Sanders, D. B., Wang, W.-H., & Williams, J. 2013, ApJ, 762, 81
Coppin, K., et al. 2006, MNRAS, 372, 1621
Coppin, K. E. K., et al. 2012, ApJ, 749, L43
Daddi, E., et al. 2009, ApJ, 694, 1517
Dunne, L., Eales, S., Edmunds, M., Ivison, R., Alexander, P., & Clements, D. L. 2000, MNRAS, 315, 115
Eales, S., Lilly, S., Gear, W., Dunne, L., Bond, J. R., Hammer, F., Le Fèvre, O., & Crampton, D. 1999, ApJ, 515, 518
Eales, S., et al. 2010, PASP, 122, 499
Fazio, A. J., et al. 2013, ApJ, 768, 104
Frayer, D. T., Ivison, R. J., Scoville, N. Z., Yun, M., Evans, A. S., Smail, I., Blain, A. W., & Kneib, J.-P. 1998, ApJ, 506, L7
Frayer, D. T., et al. 1999, ApJ, 514, L13
Geach, J. E., et al. 2005, MNRAS, 363, 1398
—. 2013, MNRAS, 432, 53
Gilbank, D. G., Yee, H. K. C., Ellingson, E., Hicks, A. K., Gladders, M. D., Barrientos, L. F. & Keeney, B. 2008, ApJ, 677, L89
Gladders, M. D., Hoekstra, H., Yee, H. K. C., Hall, P. B., & Barrientos, L. F. 2003, ApJ, 593, 48
Gladders, M. D., & Yee, H. K. C. 2005, ApJS, 157, 1
Griffin, M. J., et al. 2010, A&A, 518, L3
Hickox, R. C., et al. 2012, MNRAS, 421, 284
Hicks, A. K., et al. 2008, ApJ, 680, 1022
Holland, W. S., et al. 2013, MNRAS, 430, 2513
Hughes, D. H., et al. 1998, Nature, 394, 241
Ivison, R. J., et al. 2007, MNRAS, 380, 199
Jee, M. J., et al. 2011, ApJ, 737, 59
Kennicutt, Jr., R. C. 1998, ARA&A, 36, 189
Landy, S. D., & Szalay, A. S. 1993, ApJ, 412, 64
Lilly, S. J., Eales, S. A., Gear, W. K. P., Hammer, F., Le Fèvre, O.,
Crampton, D., Bond, J. R., & Dunne, L. 1999, ApJ, 518, 641
Maddox, S. J., et al. 2010, A&A, 518, L11
Nguyen, H. T., et al. 2010, A&A, 518, L5
Noble, A. G., et al. 2012, MNRAS, 419, 1983
Oliver, S. J., et al. 2012, MNRAS, 424, 1614
Ott, S. 2010, in ASPCS, Vol. 434, Astronomical Data Analysis
Software and Systems XIX, 139
Papovich, C., et al. 2010, ApJ, 716, 1503
Pilbratt, G. L., et al. 2010, A&A, 518, L1
Roseboom, I. G., et al. 2012, MNRAS, 419, 2758
Savage, R. S., & Oliver, S. 2007, ApJ, 661, 1339
Smail, I., Ivison, R. J., & Blain, A. W. 1997, ApJ, 490, L5+
Tamura, Y., et al. 2009, Nature, 459, 61
Wardlow, J. L., et al. 2011, MNRAS, 415, 1479
Webb, T., et al. 2013, ArXiv e-prints