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J/ApJ/788/125 An ALMA survey of ECDFS submillimeter galaxies (Simpson+, 2014)

An ALMA survey of submillimeter galaxies in the extended Chandra Deep Field-South: the redshift distribution and evolution of submillimeter galaxies.

Simpson J.M., Swinbank A.M., Smail I., Alexander D.M., Brandt W.N., Bertoldi F., de Breuck C., Chapman S.C., Coppin K.E.K., da Cunha E., Danielson A.L.R., Dannerbauer H., Greve T.R., Hodge J.A., Ivison R.J., Karim A., Knudsen K.K., Poggianti B.M., Schinnerer E., Thomson A.P., Walter F., Wardlow J.L., Weiss A., van der Werf P.P.

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ADC_Keywords: Galaxies, photometry ; Photometry, millimetric/submm ;

Photometry, UBVRIJKLMNH ; Redshifts

Keywords: galaxies: evolution - galaxies: high-redshift - galaxies: starburst

Abstract:

We present the first photometric redshift distribution for a large sample of 870 μm submillimeter galaxies (SMGs) with robust identifications based on observations with ALMA. In our analysis we consider 96 SMGs in the Extended Chandra Deep Field South, 77 of which have 4–19 band photometry. We model the SEDs for these 77 SMGs, deriving a median photometric redshift of $z_{\text{phot}}=2.3\pm0.1$. The remaining 19 SMGs have insufficient photometry to derive photometric redshifts, but a stacking analysis of Herschel observations confirms they are not spurious. Assuming that these SMGs have an absolute

H-band magnitude

distribution comparable to that of a complete sample of $z \sim 1-2$ SMGs,

we demonstrate that they lie at slightly higher redshifts, raising the

median redshift for SMGs to $z_{\text{phot}} = 2.5 \pm 0.2$. Critically we show that

the proportion of galaxies undergoing an SMG-like phase at $z \geq 3$ is at

most $35\% \pm 5\%$ of the total population. We derive a median stellar mass

of $M_* = (8 \pm 1) \times 10^{10} M_\odot$, although there are systematic uncertainties of up to 5x for individual sources.

Assuming that the

star formation activity in SMGs has a timescale of ~ 100 Myr, we show

that their descendants at $z \sim 0$ would have a space density and M_H

distribution that are in good agreement with those of local ellipticals.

In addition, the inferred mass-weighted ages of the local ellipticals

broadly agree with the look-back times of the SMG events. Taken

together, these results are consistent with a simple model that

identifies SMGs as events that form most of the stars seen in the

majority of luminous elliptical galaxies at the present day.

Description:

In this study we undertake a multi-wavelength analysis of the

ALMA-detected submm galaxies from the catalog presented by Hodge et al.

(2013, [J/ApJ/768/91](#)) (see also Karim et al. [2013MNRAS.432....2K](#)). To

briefly summarize the observations, we obtained 120 s integrations

of 122 of the original 126 LESS submm sources, initially identified

using the LABOCA camera on the APEX telescope (Weiss et al. 2009,

[J/ApJ/707/1201](#)). These Cycle 0 observations used the compact configuration, yielding a median synthesized beam of $\sim 1.6'' \times 1.2''$. The observing frequency was matched to the original LESS survey, 344 GHz (Band 7), and we reach a typical rms across our velocity-integrated maps of 0.4 mJy/beam.

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
table1.dat	98	19	Summary of Photometry
table2.dat	214	96	Photometry
table3.dat	84	77	Derived Properties

See also:

[J/ApJS/155/73](#) : Photometric redshifts of X-ray sources in CDF-S

(Zheng+, 2004)

[J/ApJ/622/772](#) : Redshift survey of submillimeter galaxies (Chapman+, 2005)

[J/ApJ/699/1610](#) : Spitzer survey of submillimeter galaxies (Hainline+, 2009)

[J/ApJ/707/1201](#) : LABOCA ECDFS Submillimeter Survey (LESS) (Weiss+, 2009)

[J/ApJS/191/124](#) : Optical spectroscopy of ECDF-S X-ray sources

(Silverman+, 2010)

[J/ApJS/203/15](#) : Counterparts to 1.4GHz sources in ECDF-S (Bonzini+, 2012)

[J/ApJ/768/91](#) : ALMA observations of LESS submm galaxies (Hodge+, 2013)

[J/MNRAS/442/577](#) : Selected ALESS submm galaxies radio properties

(Thomson+, 2014)

Byte-by-byte Description of file: [table1.dat](#)

Bytes	Format	Units	Label	Explanations
1- 19	A19	---	Filter	Filter used in the observation
21- 24	F4.2	um	lambda	Effective wavelength
26- 29	F4.1	---	Limit	3 σ detection limit in AB mag
31- 48	A18	---	r_Limit	Detection limit reference
50- 68	A19	---	Bibcode	Reference bibcode
70- 83	A14	---	Cat	Catalog reference in VizieR
85- 98	A14	---	Com	Comment on reference

Byte-by-byte Description of file: [table2.dat](#)

Bytes	Format	Units	Label	Explanations
1- 5	A5	---	---	[ALESS]
7- 11	A5	---	ALESS	SMG identifier (NN.NN; NNN.N) (1)
13	A1	---	f_ALESS	[a] Flag on ALESS (2)
15	A1	---	l_UMmag	[>] The 3 σ upper limit on UMmag
17- 21	F5.2	mag	UMmag	? MUSYC U band magnitude
23- 26	F4.2	mag	e_UMmag	? Uncertainty in UMmag
28	A1	---	l_U38mag	[>] The 3 σ upper limit on U38mag
30- 34	F5.2	mag	U38mag	? MUSYC U38 band magnitude
36- 39	F4.2	mag	e_U38mag	? Uncertainty in U38mag
41	A1	---	l_UVmag	[>] The 3 σ upper limit on UVmag
43- 47	F5.2	mag	UVmag	? VIMOS U band magnitude
49- 52	F4.2	mag	e_UVmag	? Uncertainty in UVmag
54	A1	---	l_Bmag	[>] The 3 σ upper limit on Bmag
56- 60	F5.2	mag	Bmag	? MUSYC WFI B band magnitude
62- 65	F4.2	mag	e_Bmag	? Uncertainty in Bmag
67	A1	---	l_Vmag	[>] The 3 σ upper limit

on Vmag					
69- 73	F5.2	mag	Vmag	? MUSYC WFI V band	
magnitude					
75- 78	F4.2	mag	e_Vmag	? Uncertainty in Vmag	
80	A1	---	l_Rmag	[>] The 3 σ upper limit	
on Rmag					
82- 86	F5.2	mag	Rmag	? MUSYC WFI R band	
magnitude					
88- 91	F4.2	mag	e_Rmag	? Uncertainty in Rmag	
93	A1	---	l_Imag	[>] The 3 σ upper limit	
on Imag					
95- 99	F5.2	mag	Imag	? MUSYC WFI I band	
magnitude					
101-104	F4.2	mag	e_Imag	? Uncertainty in Imag	
106	A1	---	l_zmag	[>] The 3 σ upper limit	
on zmag					
108-112	F5.2	mag	zmag	? MUSYC Mosaic-II z band	
magnitude					
114-117	F4.2	mag	e_zmag	? Uncertainty in zmag	
119	A1	---	l_Jmag	[>] The 3 σ upper limit	
on Jmag					
121-125	F5.2	mag	Jmag	? J band magnitude	
(TENIS if nothing in f_Ksmag)					
				(3)	
127-130	F4.2	mag	e_Jmag	? Uncertainty in Jmag	
132-133	A2	---	f_Jmag	Flag on Jmag (4)	
135	A1	---	l_Hmag	[>] The 3 σ upper limit	
on Hmag					
137-141	F5.2	mag	Hmag	? H band magnitude	
143-146	F4.2	mag	e_Hmag	? Uncertainty in Hmag	
148	A1	---	l_Ksmag	[>] The 3 σ upper limit	
on Ksmag					
150-154	F5.2	mag	Ksmag	? K _s band magnitude	
(TENIS if nothing					
				in f_Ksmag) (3)	
156-159	F4.2	mag	e_Ksmag	? Uncertainty in Ksmag	
161-162	A2	---	f_Ksmag	[* **] Flag on Ksmag and	
Jmag (4)					
164	A1	---	l_3.6mag	[>] The 3 σ upper limit	
on 3.6mag					
166-170	F5.2	mag	3.6mag	SIMPLE/IRAC 3.6 micron	
band magnitude					
172-175	F4.2	mag	e_3.6mag	? Uncertainty in 3.6mag	
177	A1	---	l_4.5mag	[>] The 3 σ upper limit	

on 4.5mag
 179-183 F5.2 [mag](#) 4.5mag SIMPLE/IRAC 4.5 micron
 band magnitude
 185-188 F4.2 [mag](#) e_4.5mag ? Uncertainty in 4.5mag
 190 A1 --- l_5.8mag [>] The 3 σ upper limit
 on 5.8mag
 192-196 F5.2 [mag](#) 5.8mag ? SIMPLE/IRAC 5.8 micron
 band magnitude
 198-201 F4.2 [mag](#) e_5.8mag ? Uncertainty in 5.8mag
 203 A1 --- l_8.0mag [>] The 3 σ upper limit
 on 8.0mag
 205-209 F5.2 [mag](#) 8.0mag ? SIMPLE/IRAC 8.0 micron
 band magnitude
 211-214 F4.2 [mag](#) e_8.0mag ? Uncertainty in 8.0mag

Note (1): All photometry is left blank where a source is not covered by available imaging.

Note (2): Flag as follows:

a = Source is within 4" of a 3.6 micron source of comparable, or greater, flux.

Note (3): We measure J and K_s photometry from three imaging surveys, but quote

a single value, in order of 3 σ detection limit (see Table 1).

Note (4): Flag as follows:

* = Photometry measured from HAWK-I imaging;
 ** = Photometry measured from MUSYC imaging,
 otherwise photometry measured from TENIS imaging.

Byte-by-byte Description of file: [table3.dat](#)

Bytes	Format	Units	Label	Explanations
1- 5	A5	---	---	[ALESS]
7- 12	A6	---	ALESS	SMG identifier
(NNN.NN)				
14	A1	---	f_ALESS	[a] Flag on ALESS
(1)				
16- 17	I2	h	RAh	Hour of Right
Ascension		(J2000)		

19- 20	I2	min	RAm	Minute of Right
Ascension (J2000)				
22- 26	F5.2	s	RA s	Second of Right
Ascension (J2000)				
28	A1	---	DE-	Sign of the
Declination (J2000)				
29- 30	I2	deg	DEd	Degree of
Declination (J2000)				
32- 33	I2	arcmin	DEm	Arcminute of
Declination (J2000)				
35- 38	F4.1	arcsec	DEs	Arcsecond of
Declination (J2000)				
40- 43	F4.2	---	zphot	Photometric
redshift				
45- 48	F4.2	---	E_zphot	Upper limit
uncertainty in zphot				
50- 53	F4.2	---	e_zphot	Lower limit
uncertainty in zphot				
55- 58	F4.2	---	zspec	? Spectroscopic
redshift				
60	A1	---	r_zspec	zspec reference (2)
62- 66	F5.2	---	Chi2	Reduced X^2
68- 69	I2	---	Detec	Number of detection
71- 72	I2	---	Obs	Number of
observation				
74- 79	F6.2	mag	HMag	Absolute H band AB
magnitude				
81- 84	F4.2	Msun/Lsun	M/L	H band mass-to-
light ratio				

Note (1): Flag as follows:

a = As discussed in Section 3.2.1 these SMGs are potential gravitational lenses, or have significantly contaminated photometry. We advise that the photometric redshifts for these SMGs are treated with extreme caution.

Note (2): Reference as follows:

- b = Casey et al. ([2011MNRAS.411.2739C](#));
- c = Zheng et al. (2004, [J/ApJS/155/73](#));
- d = Swinbank et al. ([2012MNRAS.427.1066S](#));
- e = Silverman et al. (2010, [J/ApJS/191/124](#));
- f = Kriek et al. ([2008ApJ...677..219K](#));
- g = Coppin et al. ([2009MNRAS.395.1905C](#));
- h = Coppin et al. ([2012MNRAS.427..520C](#)); Danielson et

al. in prep;
i = Bonzini et al. (2012, [J/ApJS/203/15](#)).

History:

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