Reversal of the Star-Formation Density Relation at the Densest Environment in Clusters at z~1.5

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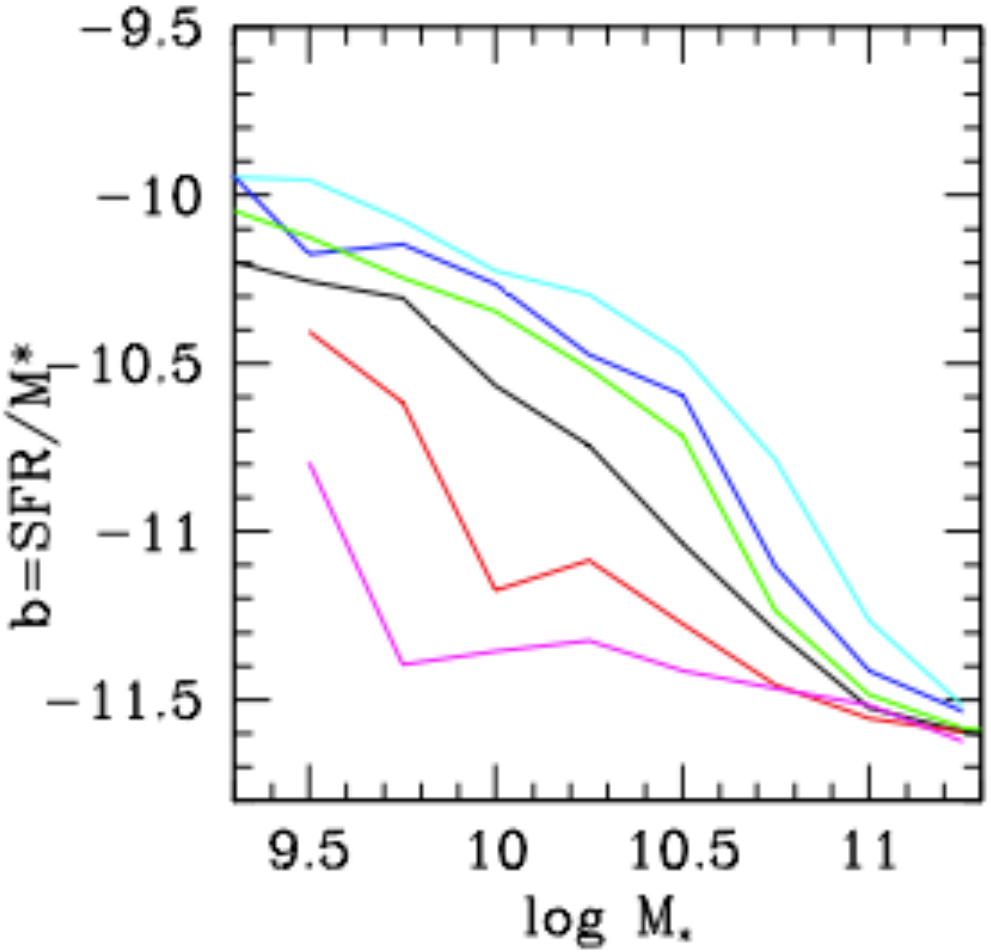
DEX (Durham) 10 Jan 2014

Star-Formation Density Relation

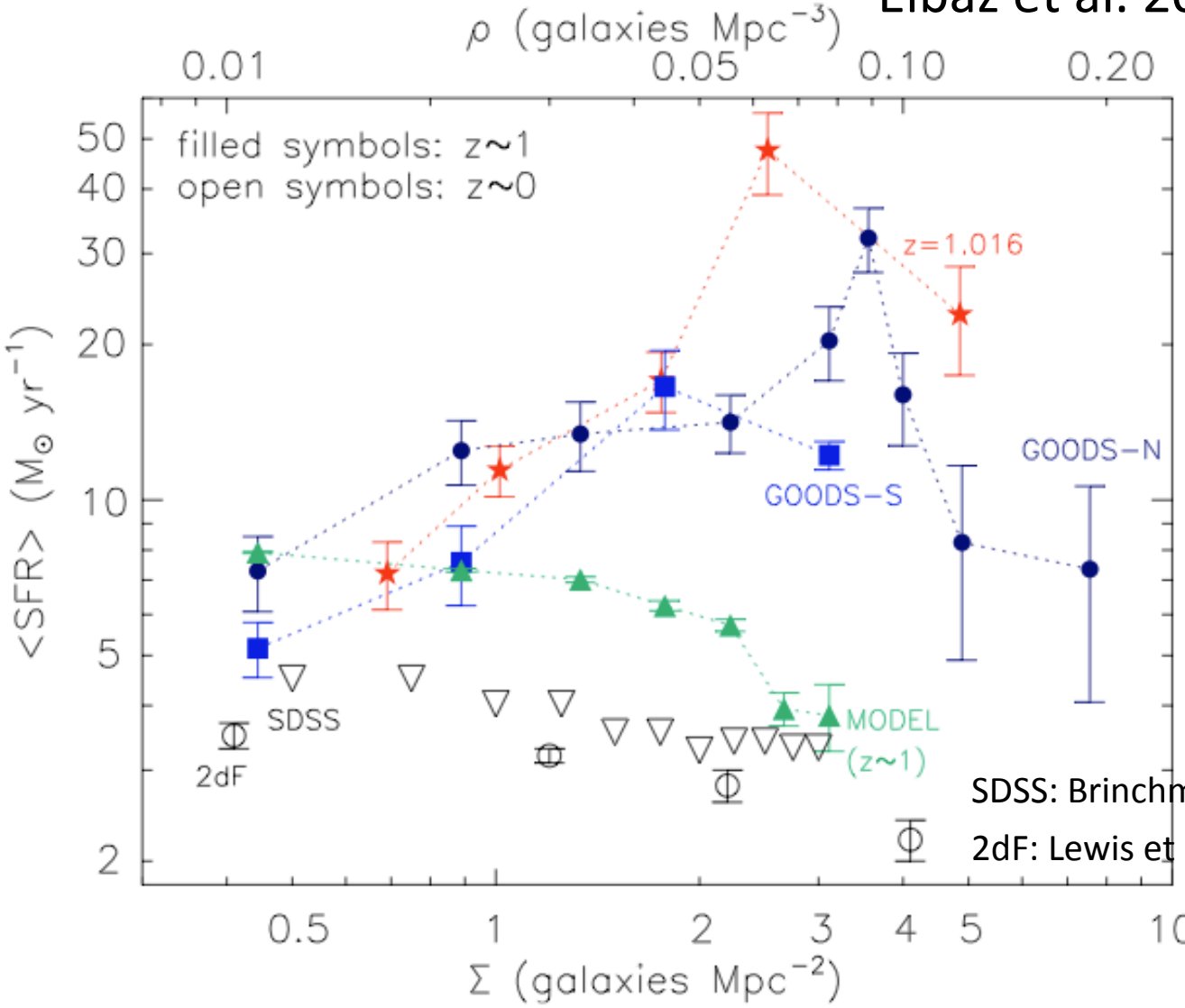


Kauffmann et al. 2004:

- SDSS 46892 galaxies with spectrum at 0.03<z<0.1.
- Magnitude limit: r_mag < 17.77 @ z=0.1
- Local galaxy density: neighbor counts within 8Mpc radius
- SFR: from spectral indexes (D4000, Halpha)
- COLOR: local galaxy density, >17: magenta, 12-16: red, …, 0-1: cyan

Evolution of SFD relation (Field)

Elbaz et al. 2007



SDSS: Brinchmann et al. 2004

2dF: Lewis et al. 2002

Results from individual clusters (z~1.5)

★Enhanced SFR:

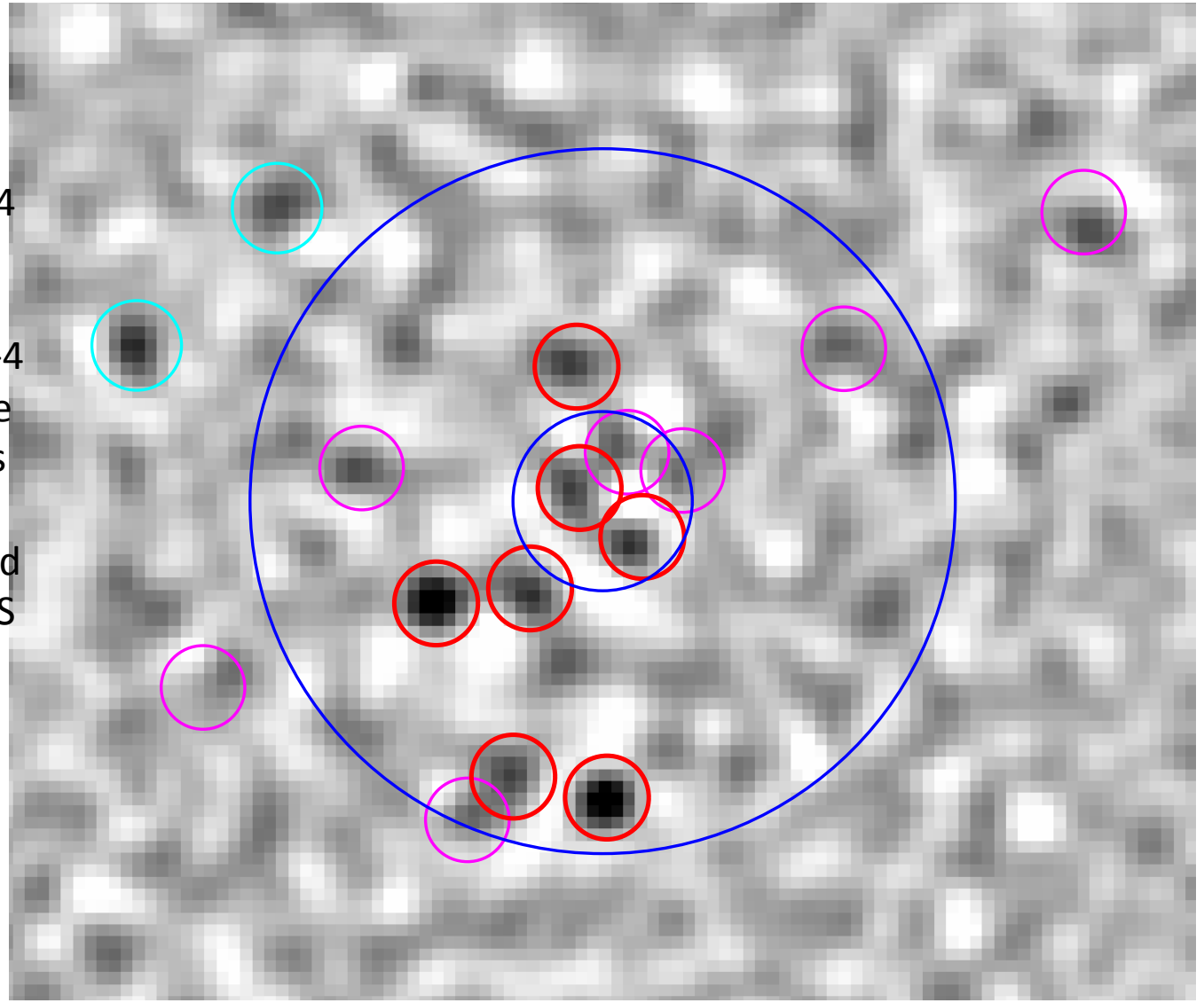
- **XCSJ2215.9-1738** @ z=1.46: Hilton et al. 2007, 2009, 2010; Hayashi et al. 2010, 2011.
- ClJ0218.3 @ z=1.62: Papovich et al. 2010; Tran et al. 2010; Tadaki et al. 2012; Smail et al. 2014; Santos et al. 2014.

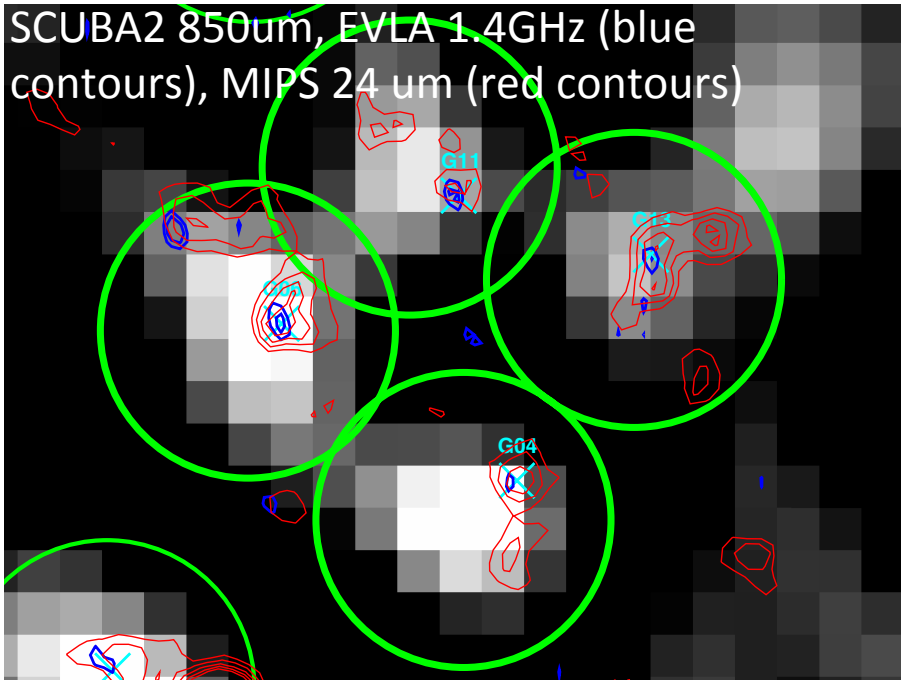
★No evidence of SF activity at center:

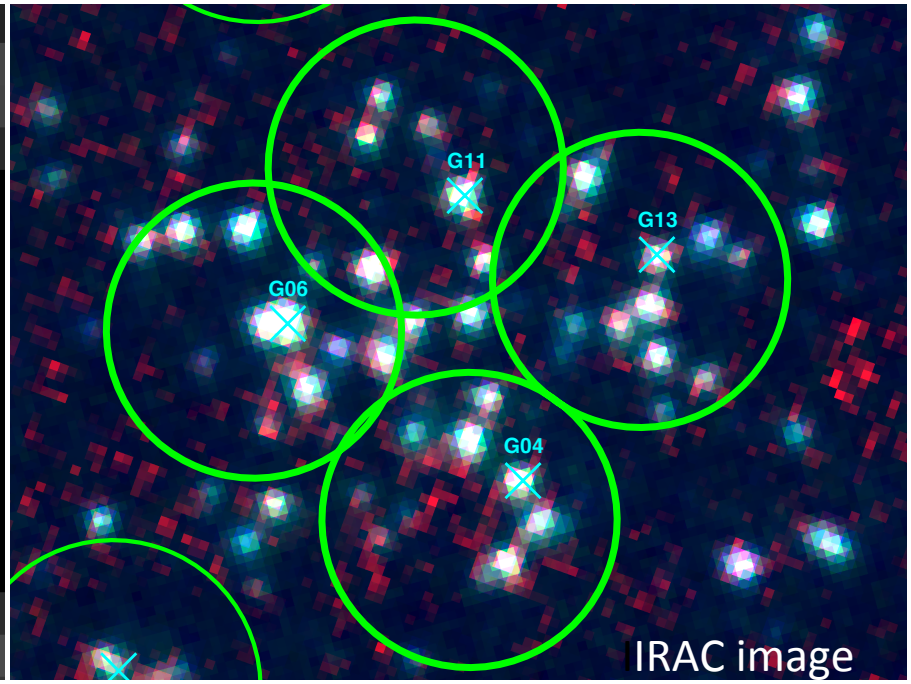
- XMMUJ2235 @z=1.4: Grutzbach et al. 2012, Santos et al. 2013

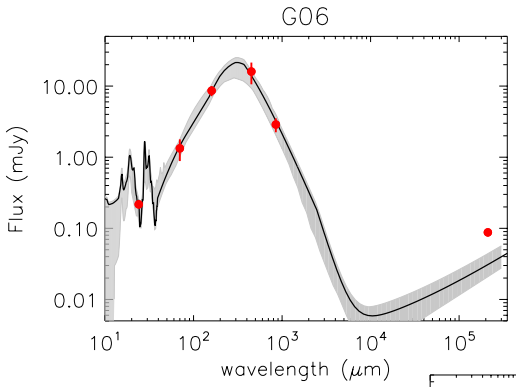
SCUBA2 850um image of XCSJ2215

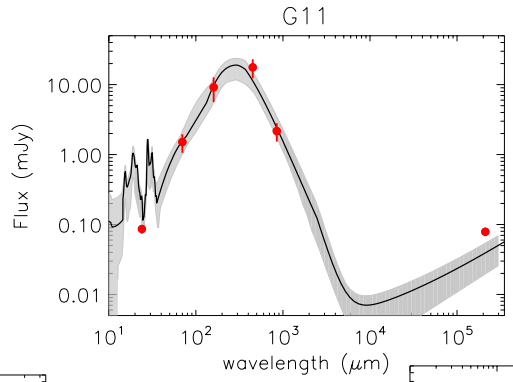
- ★ Matched filtered image
- ★ Noise: 0.6mJy/beam
- ★ Within 1Mpc radius, 7 sources are detected > 4 sigma (Red) with MIPS 24um counterpart; 5 sources (Magenta) at 3-4 sigma at 850um, but are detected in other bands (Hershel PACS, MIPS 24um); sources detected >4sigma but out of MIPS 24um field of view are plotted in Cyan.
- ★ Expected to have ~0.5 sources within 1Mpc radius field in general.

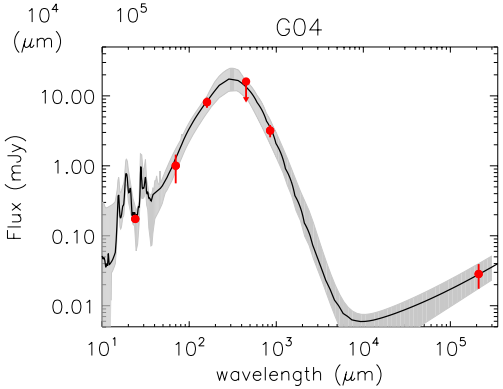


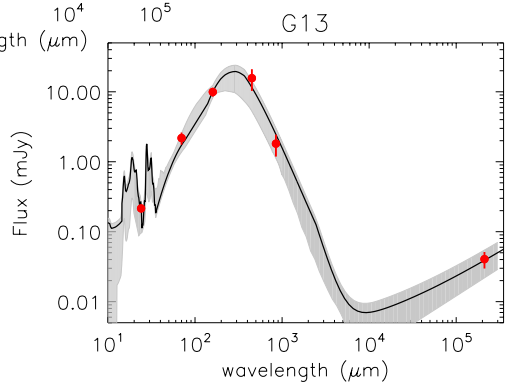

SCUBA2 850um, EVLA 1.4GHz (blue contours), MIPS 24 um (red contours)
G11
G04


G11
G13
G06
G04
IRAC image


G06
Flux (mJy)
wavelength (μm)

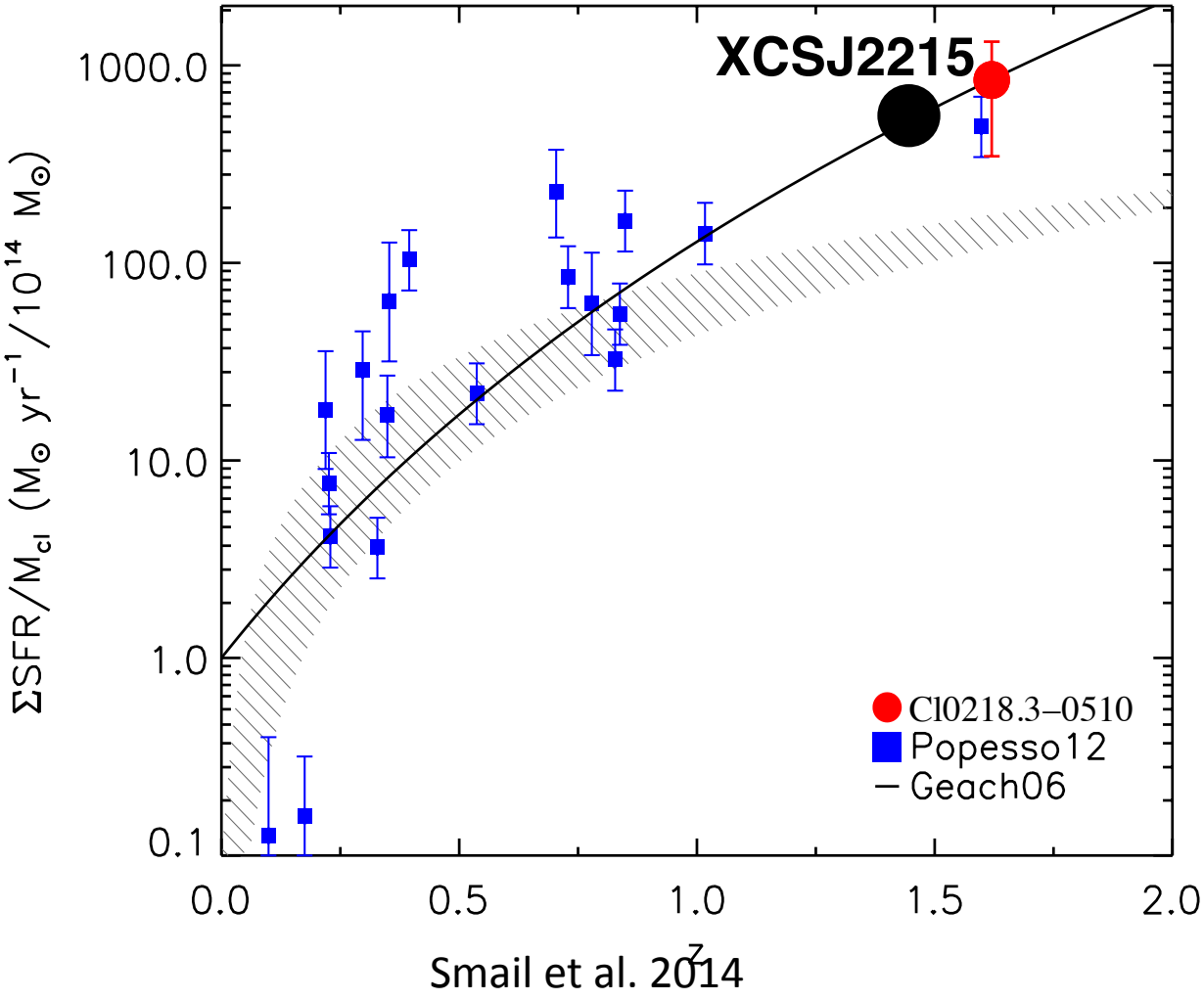

G11
Flux (mJy)
wavelength (μm)


G04
Flux (mJy)
wavelength (μm)


G13
Flux (mJy)
wavelength (μm)

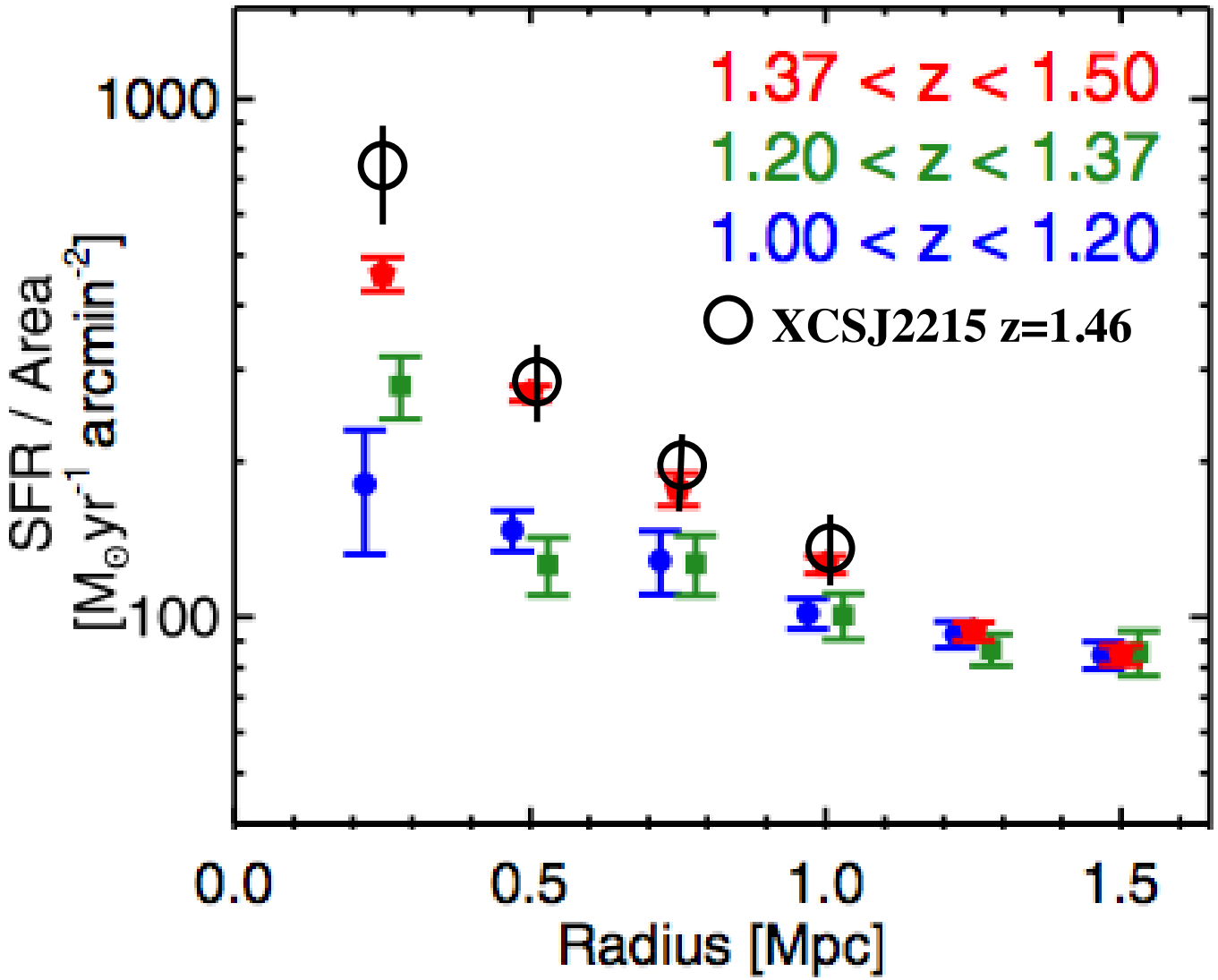
Evolution of mass-normalized SFR

- Total SFR within 250kpc radius is 560±90 $M_{\odot}$/yr, and reaches 1700±200$M_{\odot}$/yr within 1Mpc radius.
- Consistent with SFR calculated from MIPS 24um data in Hilton et al. 2010.
- The mass-normalized SFR of XCSJ2215 seems to follow the (1+z)^7 trend in Geach et al. 2006.



Smail et al. 2014

SFR surface density in the center of XCSJ2215



Brodwin et al. 2013

16 clusters at 1.0<z<1.6 from IRAC Shallow Cluster Survey

Summary

- ★ Identified 4 starburst galaxies within 250kpc radius of XCSJ2215
- ★ The 850um sources within 1Mpc have 24um and, mostly, 1.4GHz counterparts. Almost all (10/14) of the major counterparts are at cluster redshifts.
- ★ The cluster-mass-normalized SFR of the cluster is high, and seems to follow the evolution trend of (1+z)^7 of Geach et al. 2006 derived from field LIRGs.
- ★ The SFR surface density in the cluster core is ~2850±400 $M_{\odot}$/yr/Mpc^2. High SFR at the center of XCSJ2215 suggests the reversal of SFD relation, similar to the infrared selected clusters at z~1.5 in Brodwin et al. 2013.