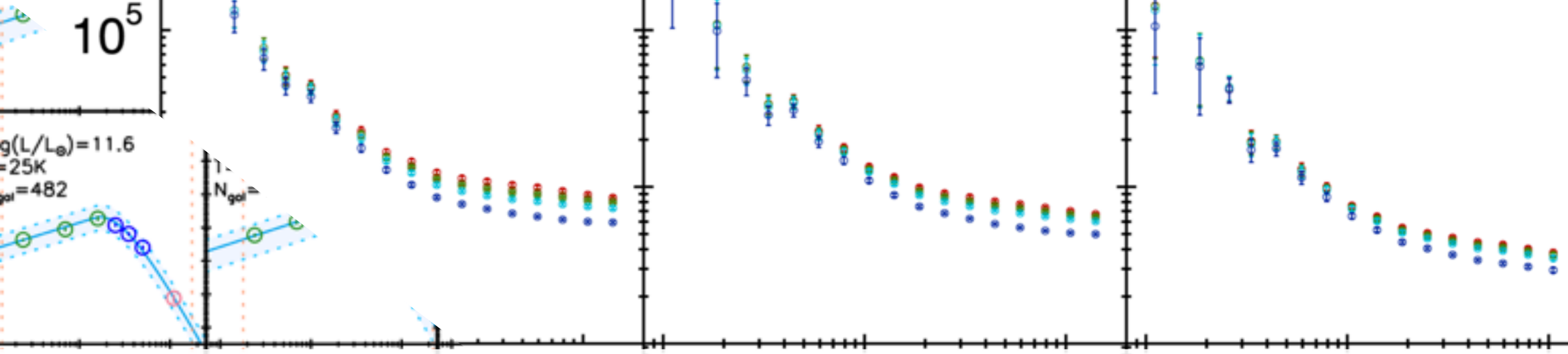
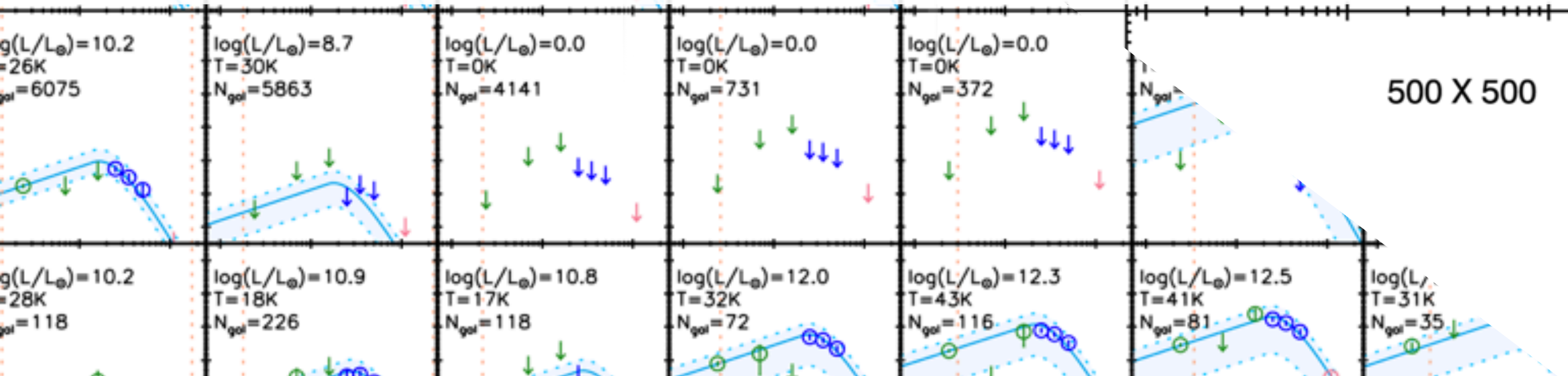
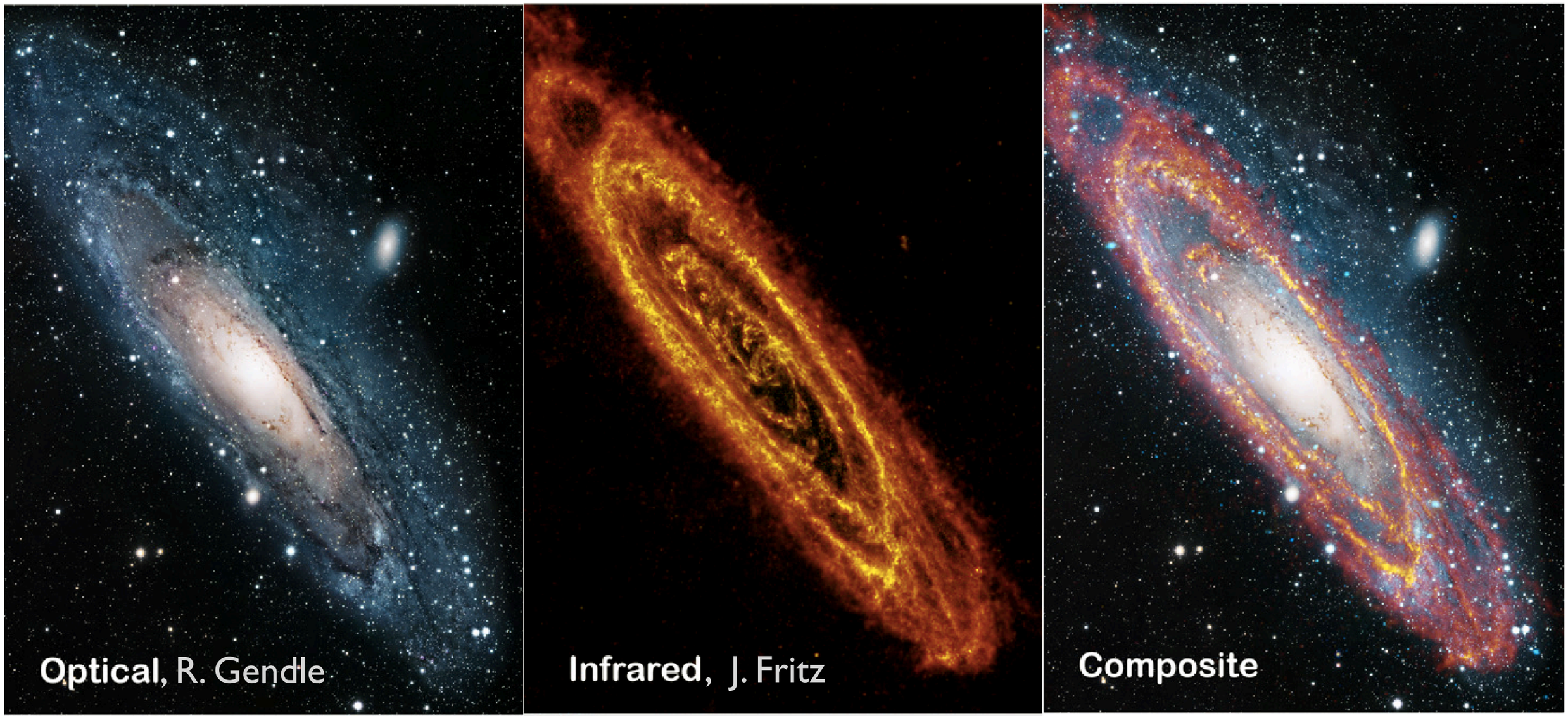


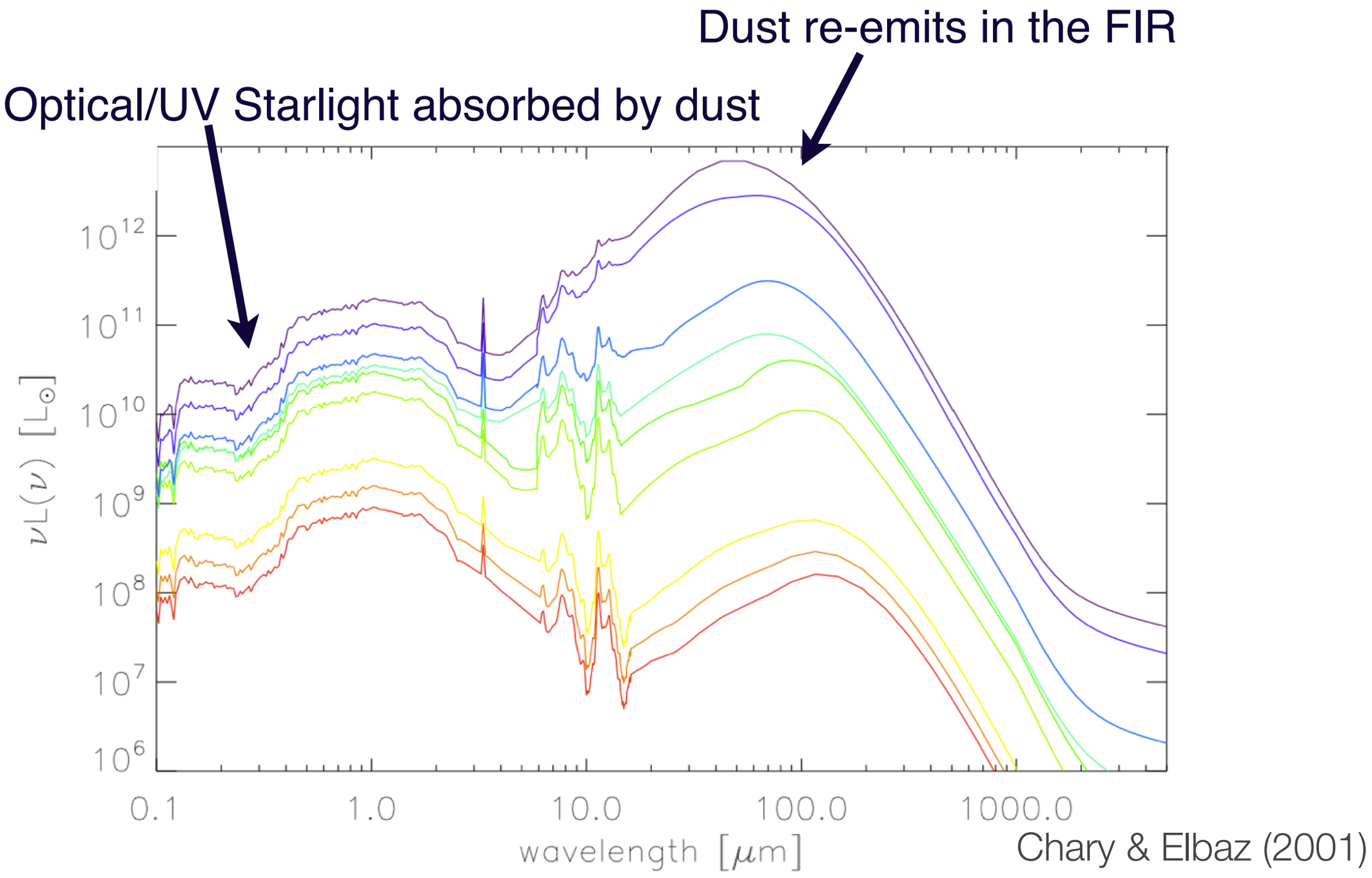
Understanding the Cosmic Infrared Background (CIB) with *Herschel*/SPIRE

Marco Viero - Caltech





M31 in the optical and IR

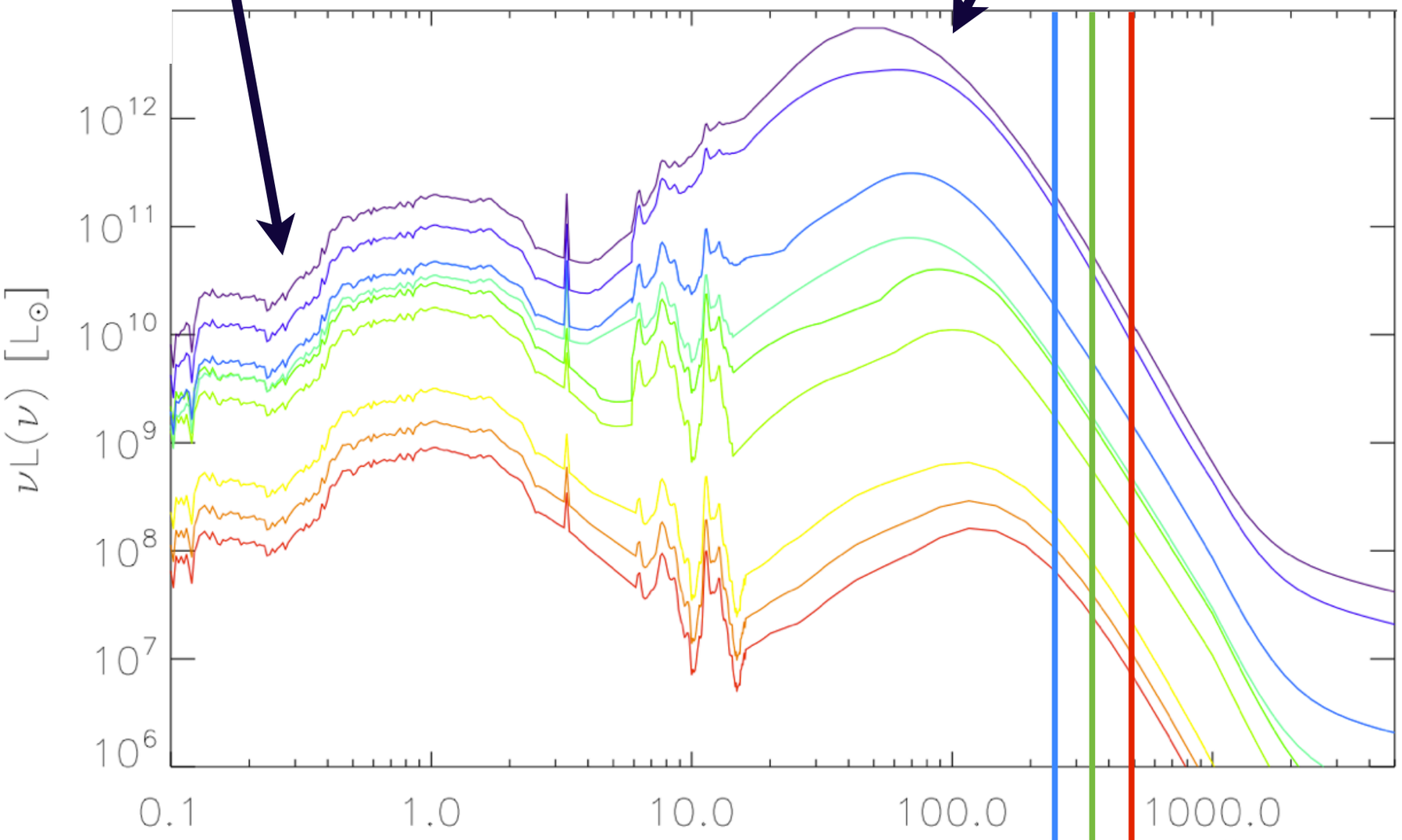


Chary & Elbaz (2001)

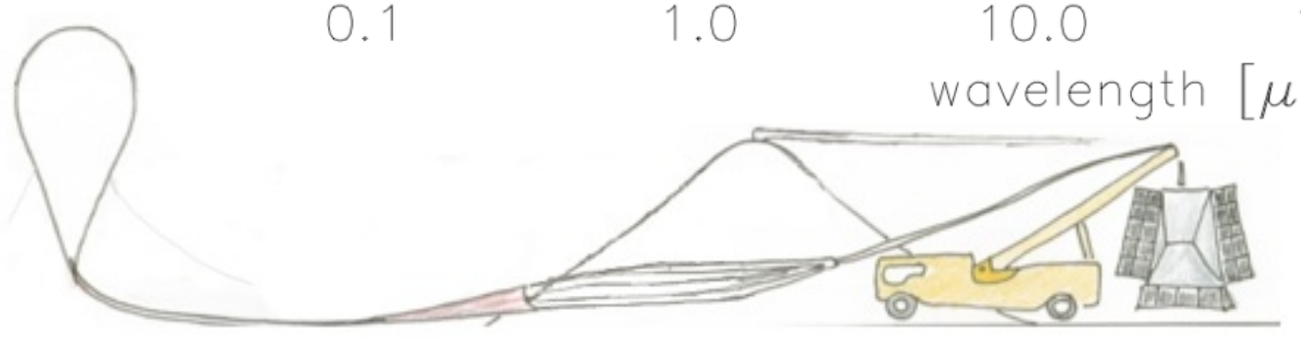
UV/optical to IR relationship

Dust re-emits in the FIR

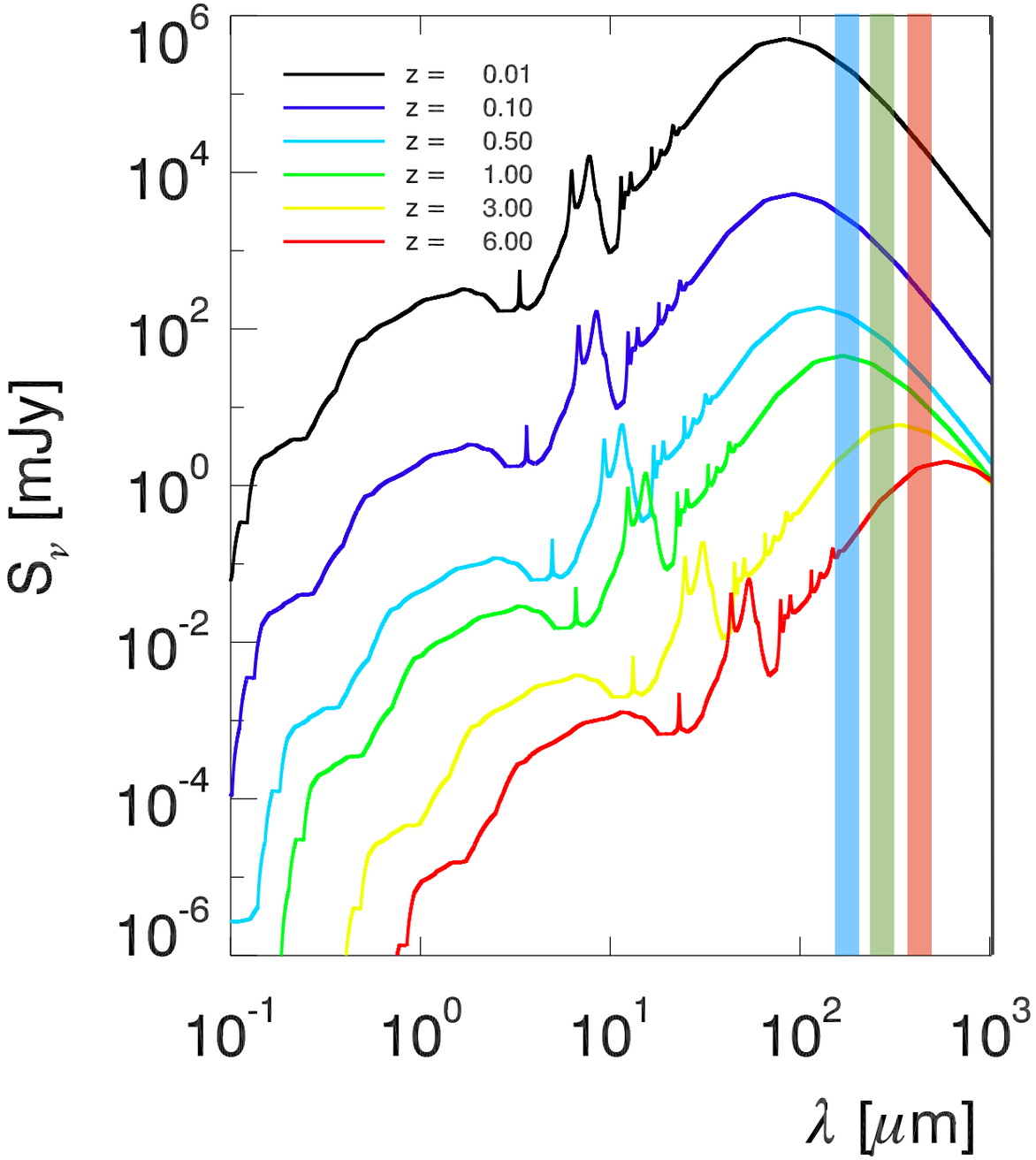
Optical/UV Starlight absorbed by dust



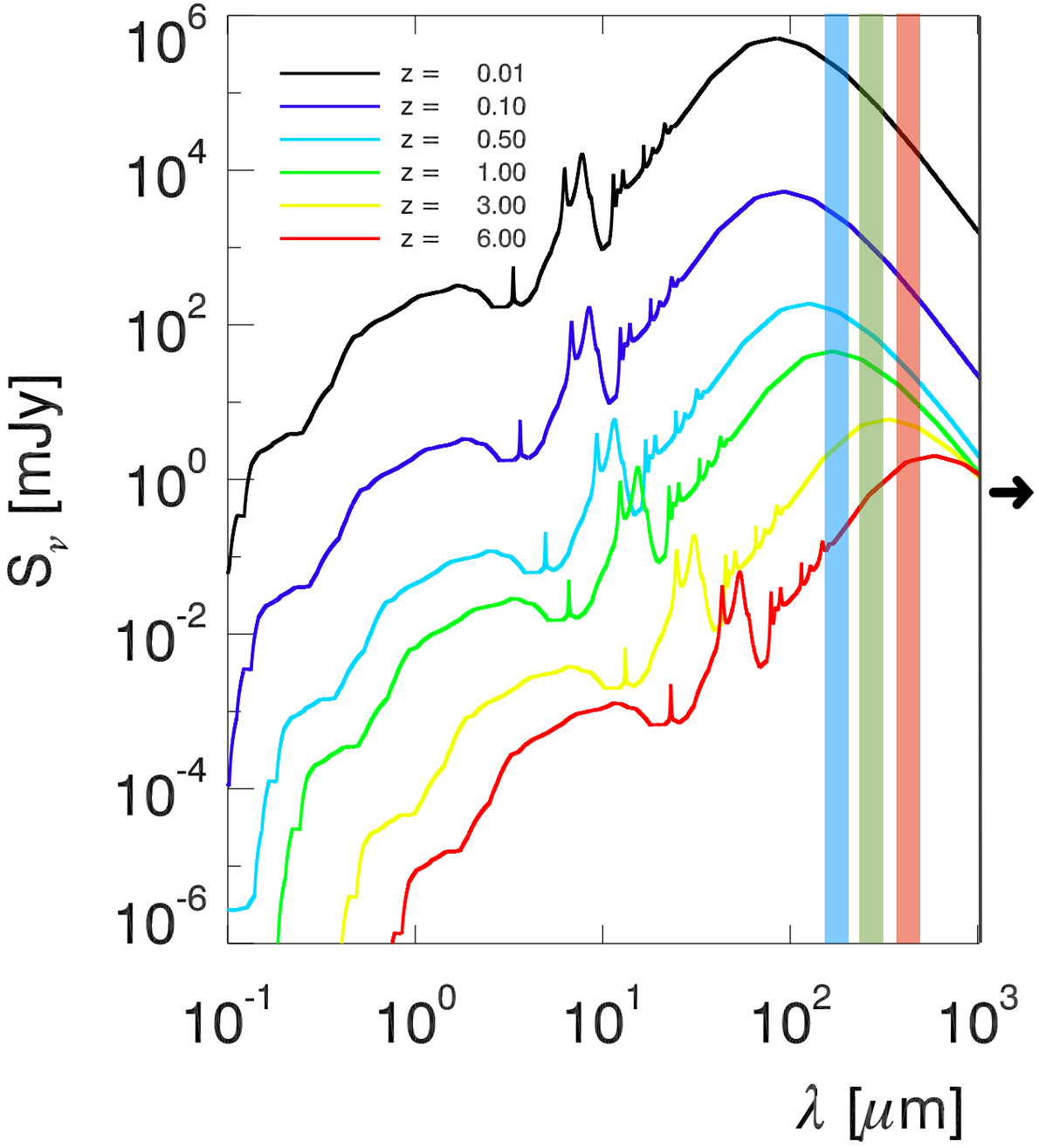
Chary & Elbaz (2001)

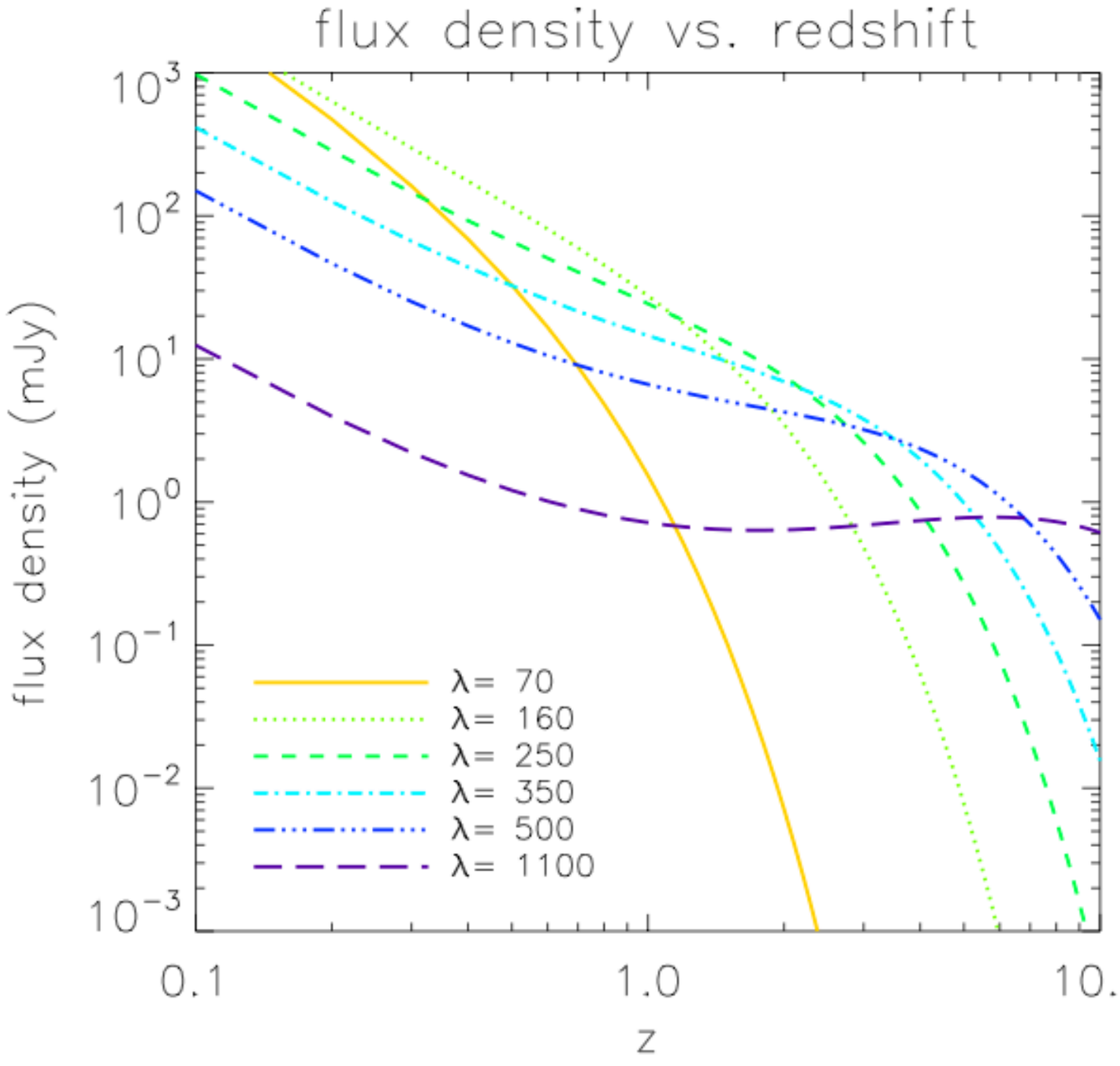


UV/optical to IR relationship

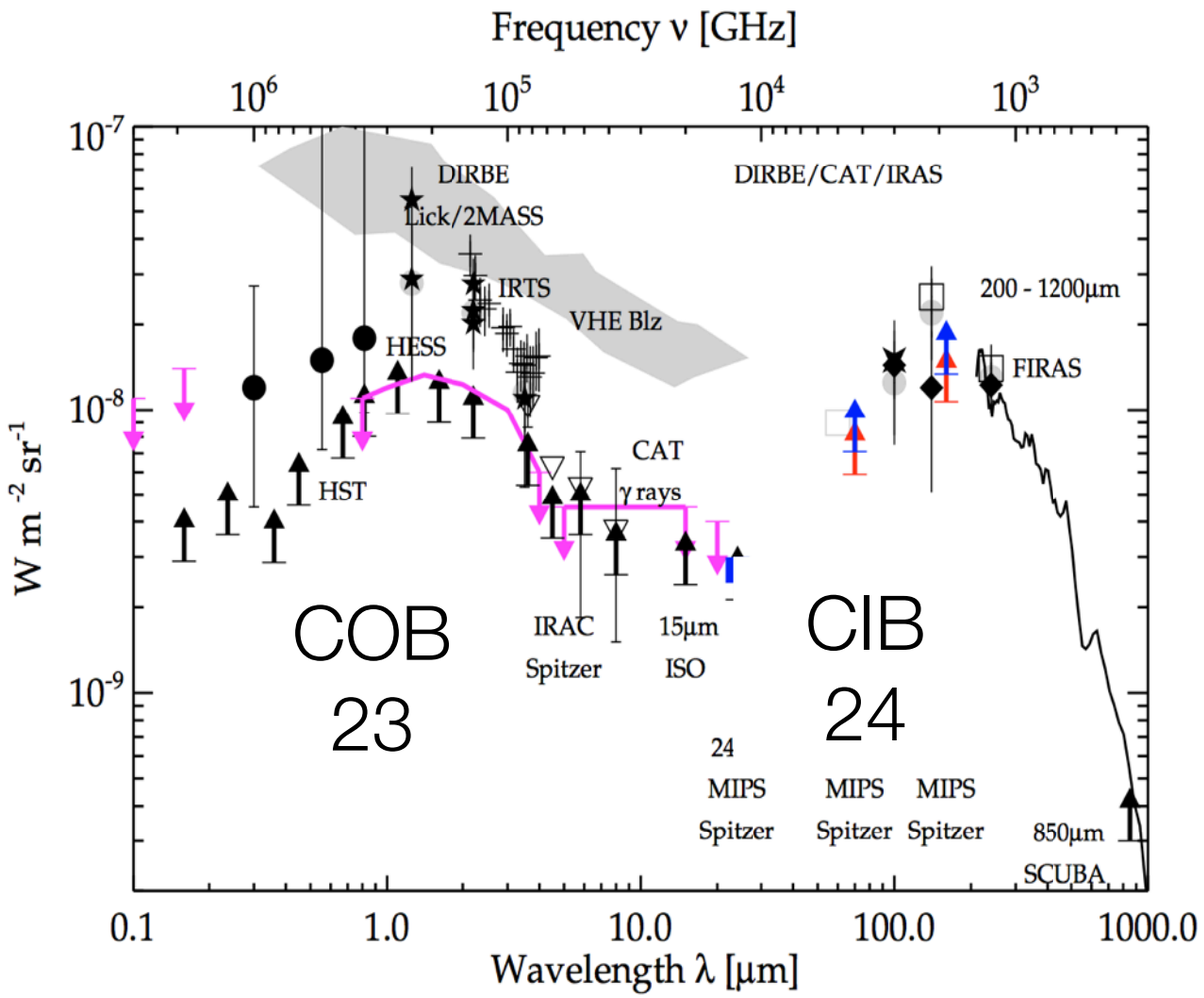


negative *K*-correction



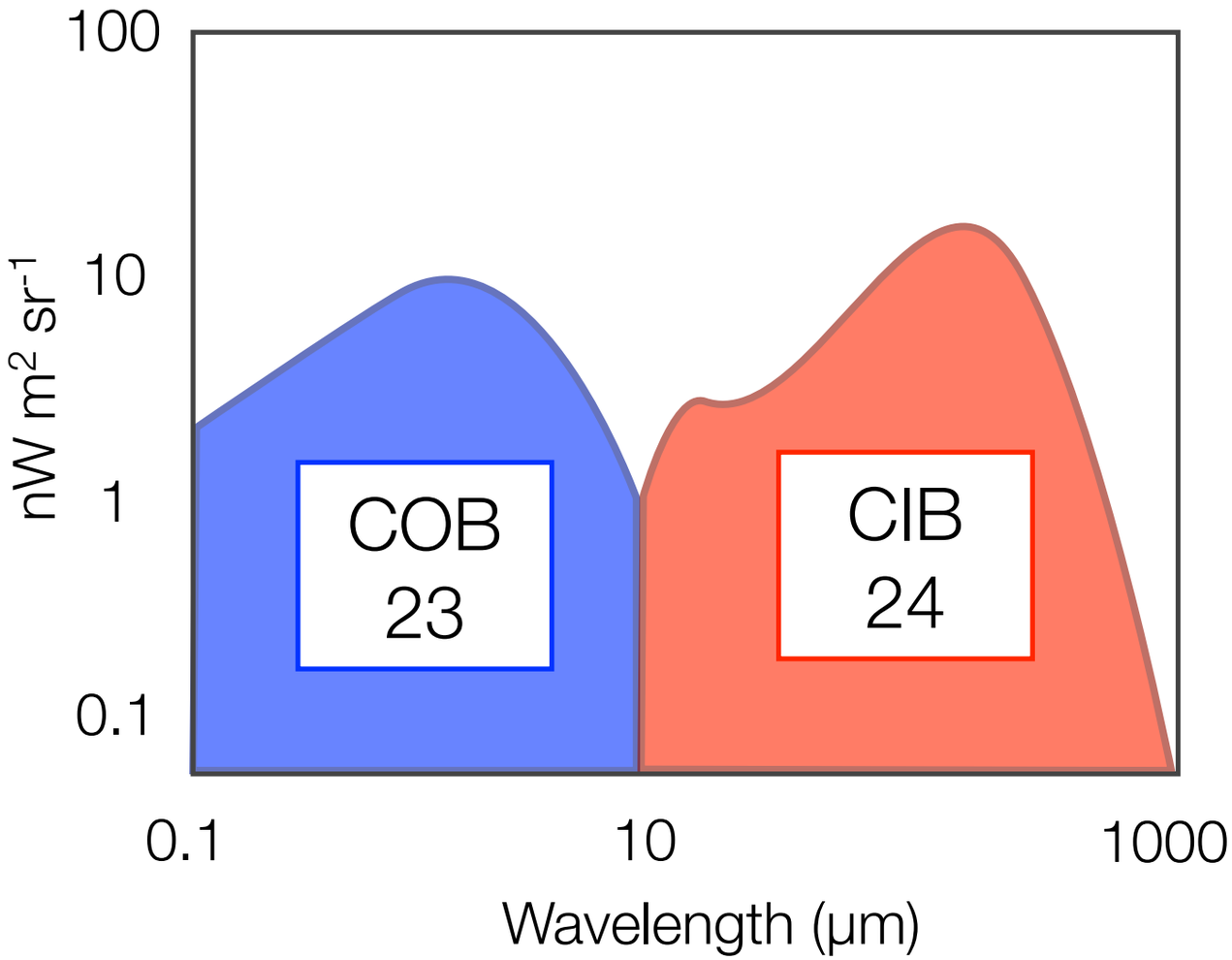


negative *K*-correction

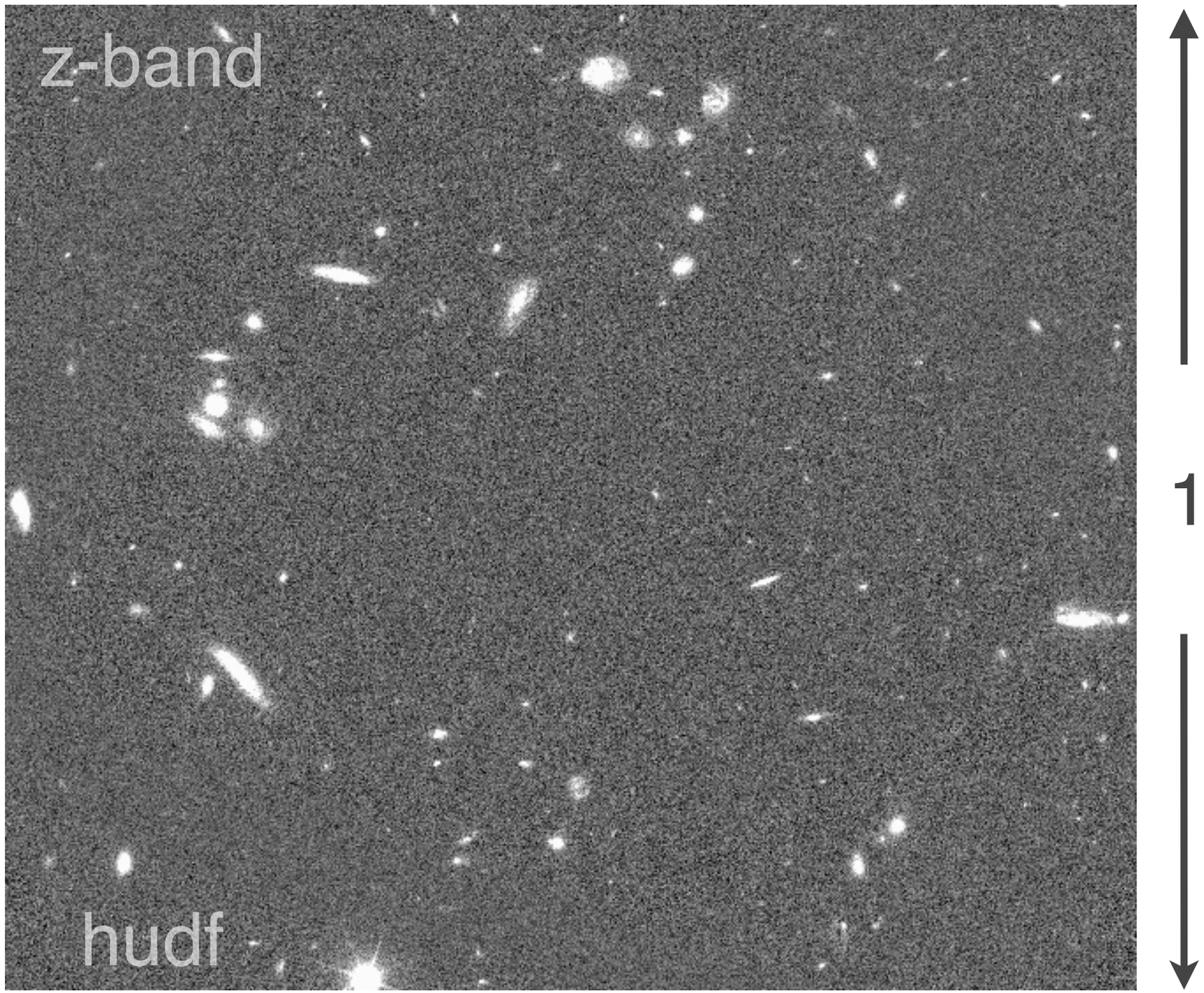


Dole et al (2006)

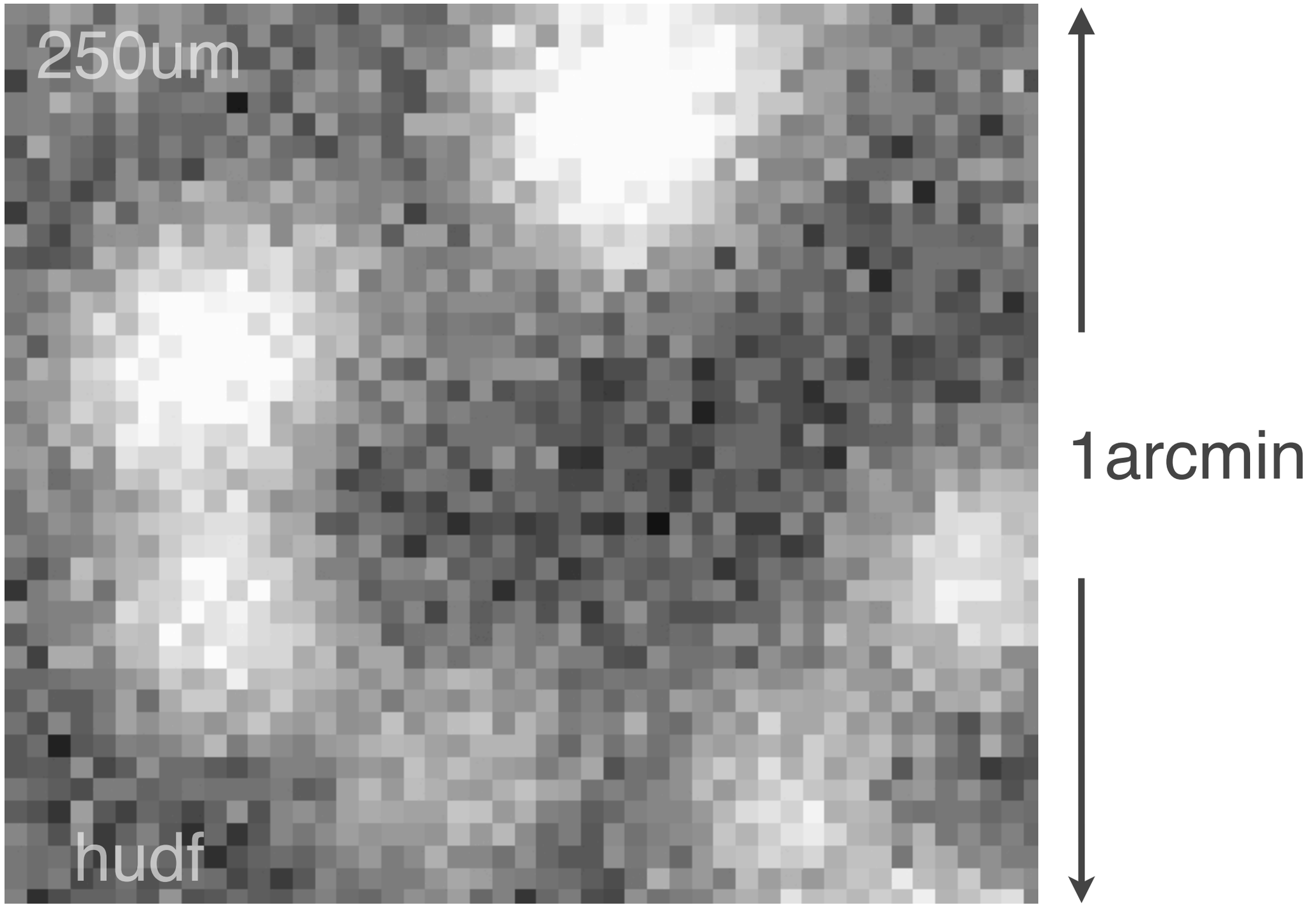
optical and infrared backgrounds



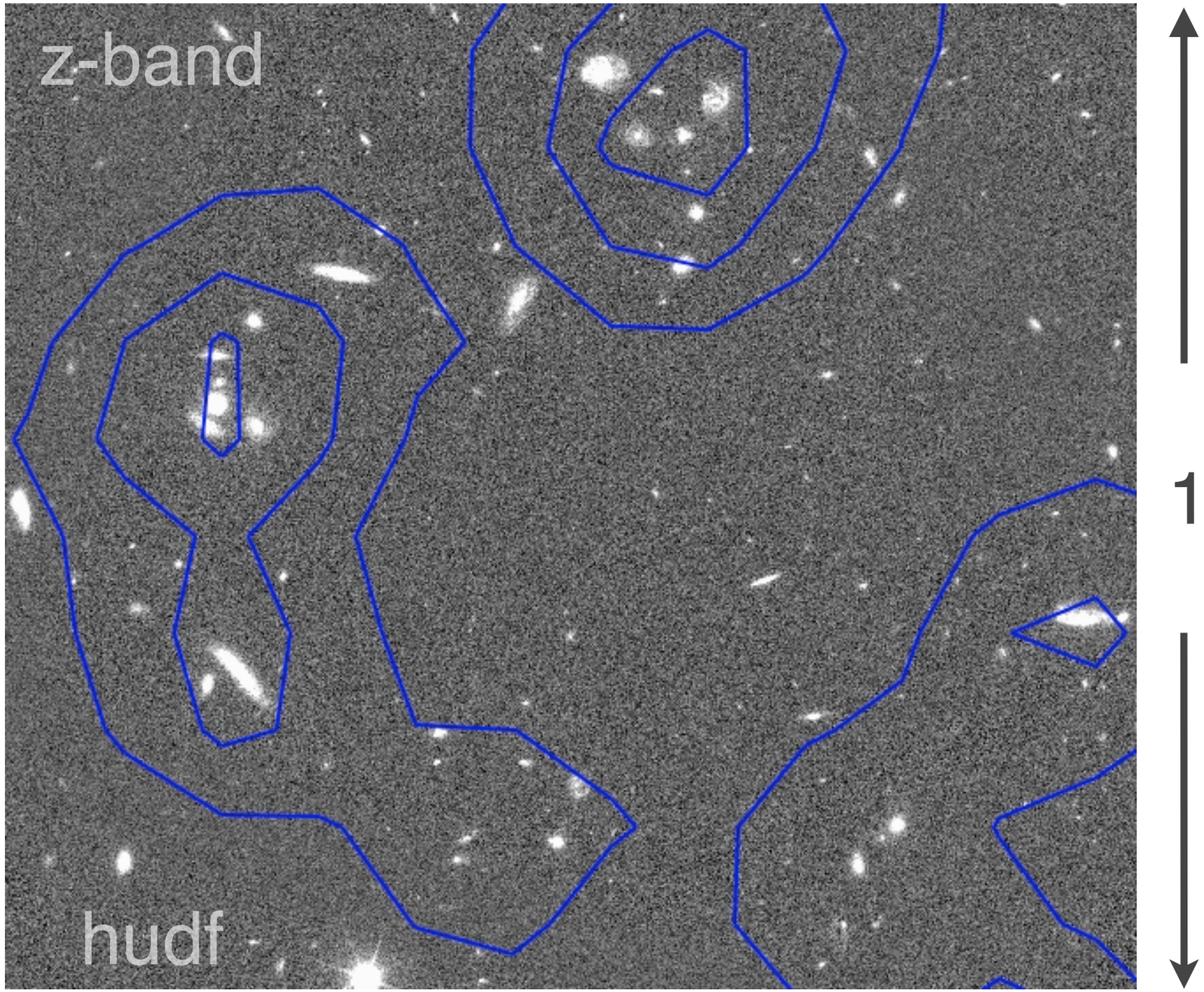
optical and infrared backgrounds



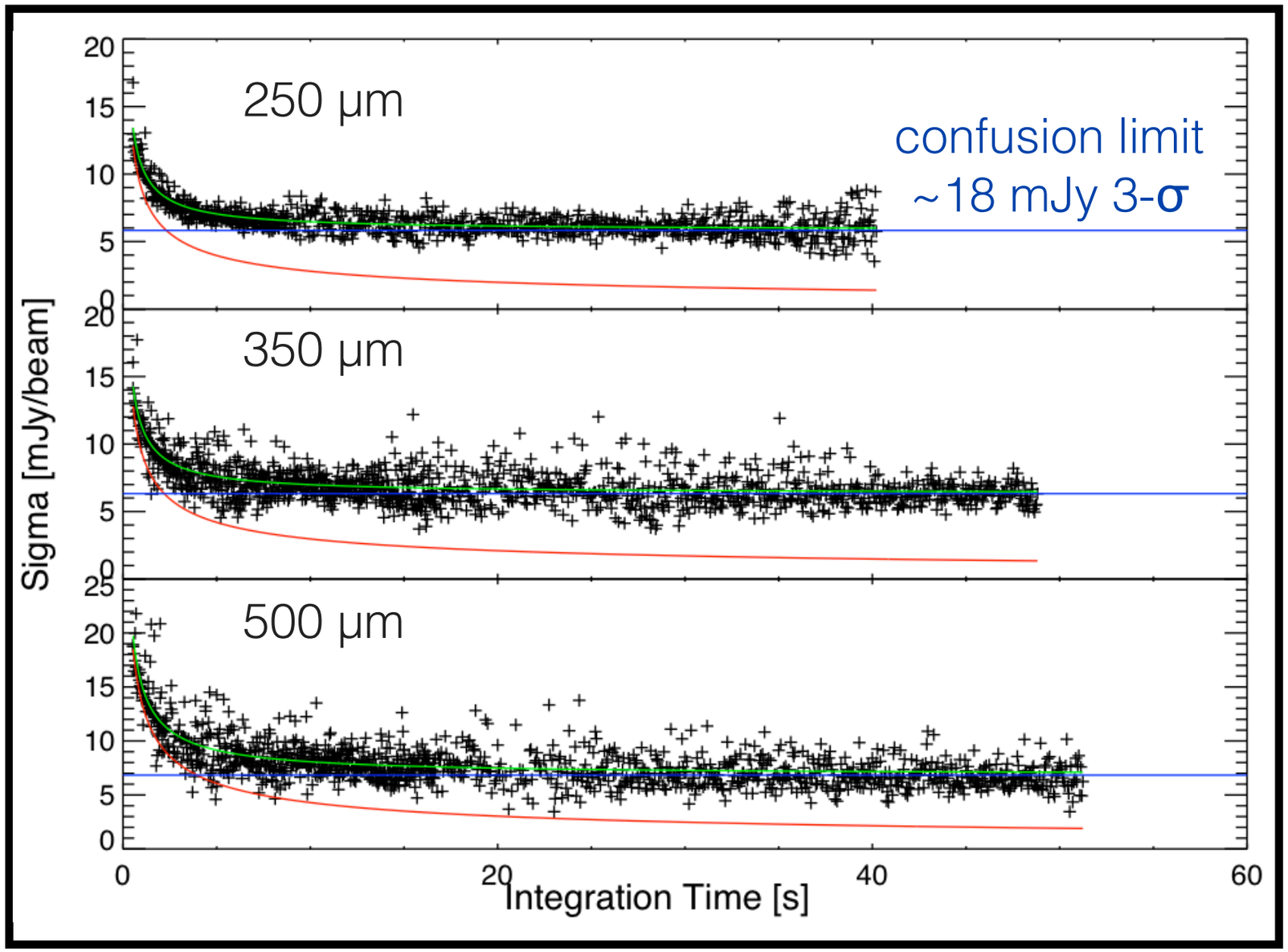
source confusion



source confusion



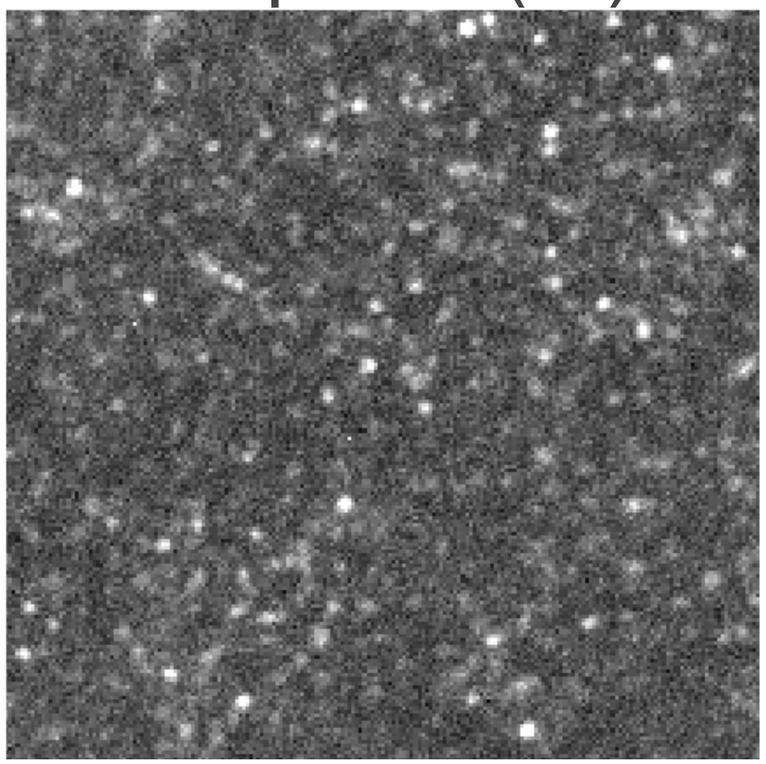
source confusion



Nguyen et al. (2009)

source confusion

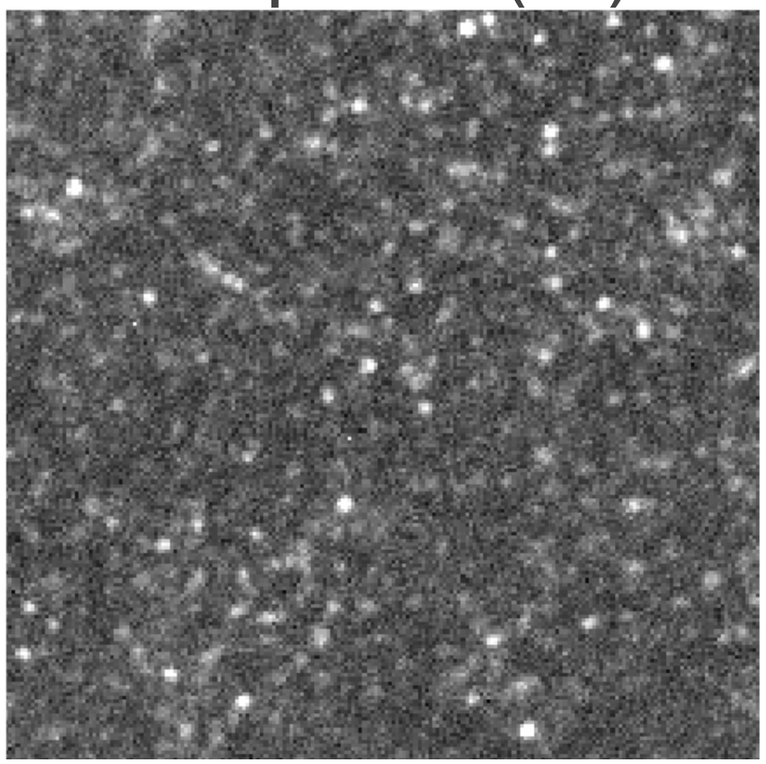
2 repeats (fls)



33.5 mJy (3σ)

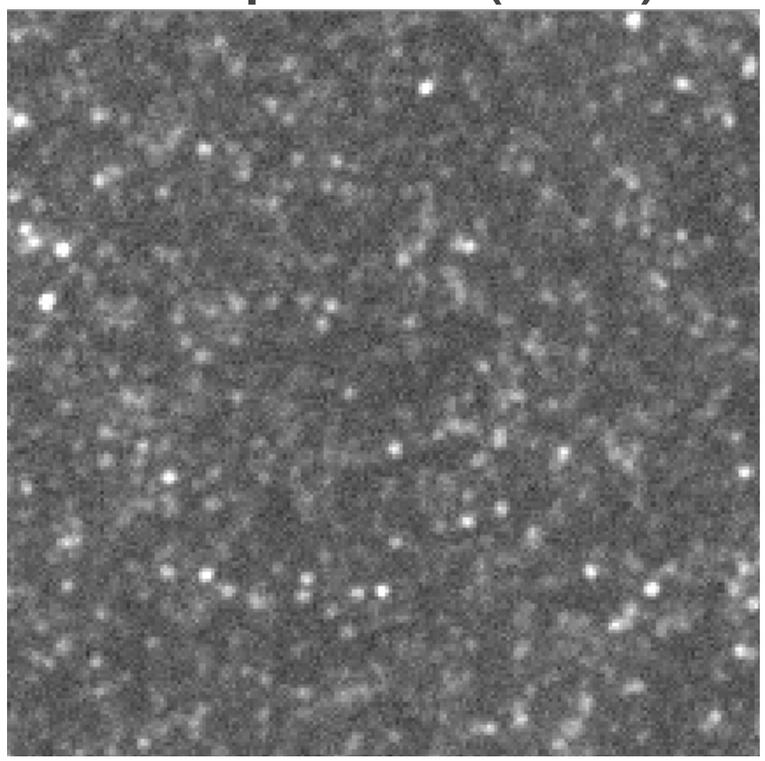
source confusion

2 repeats (fls)



33.5 mJy (3σ)

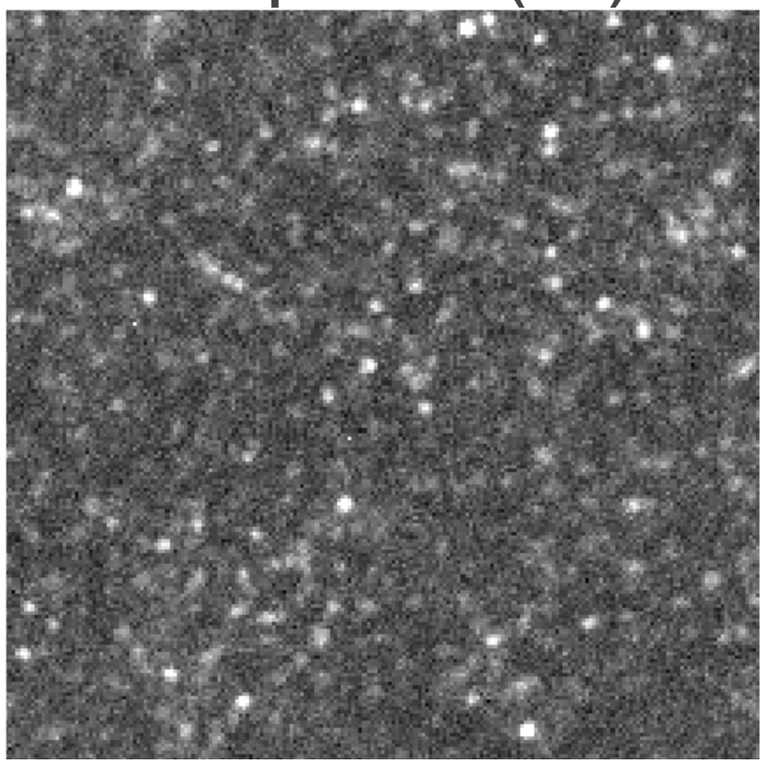
7 repeats (uds)



24.7 mJy (3σ)

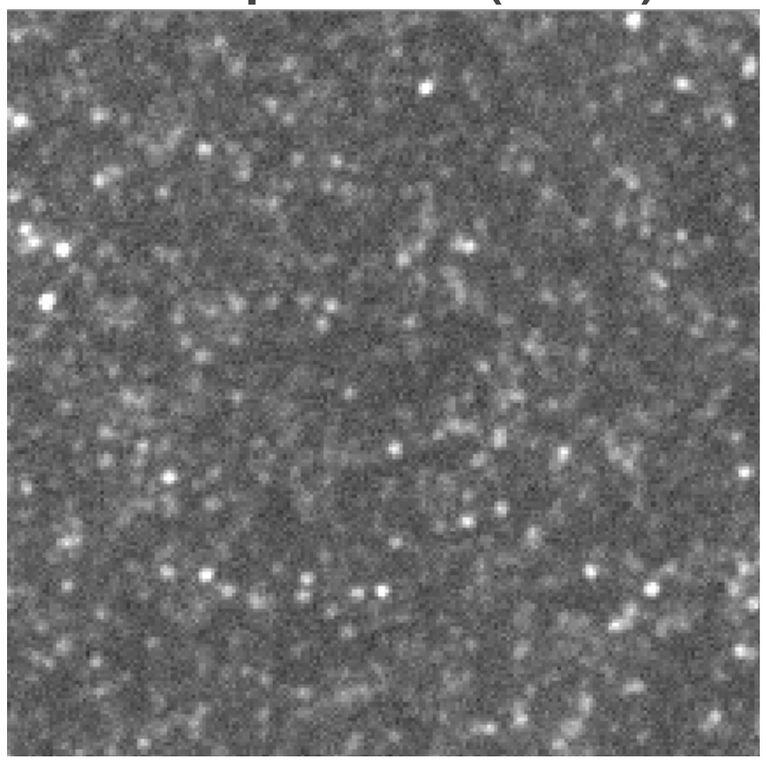
source confusion

2 repeats (fls)



33.5 mJy (3σ)

7 repeats (uds)

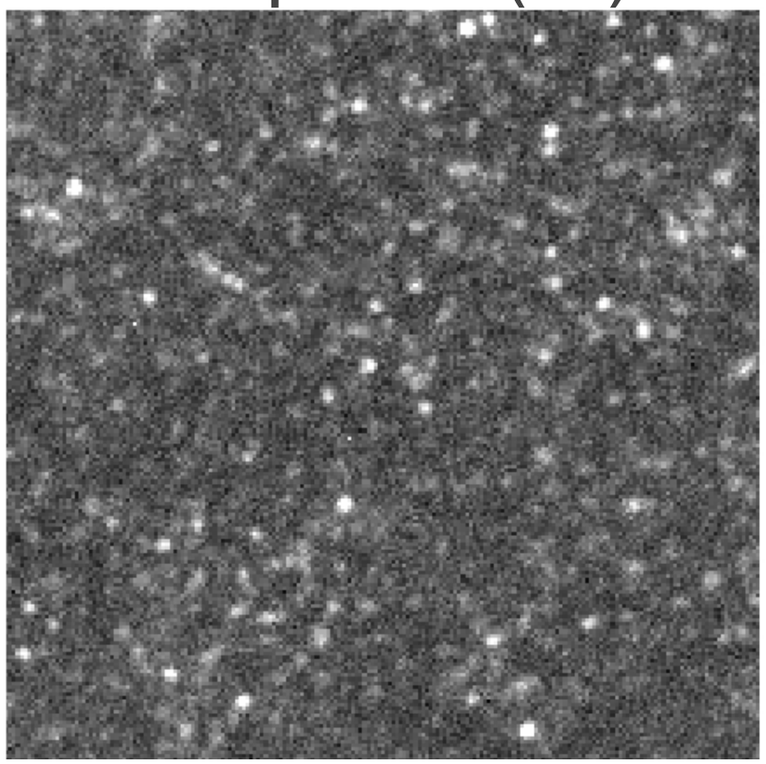


24.7 mJy (3σ)

76 repeats (goods-s)

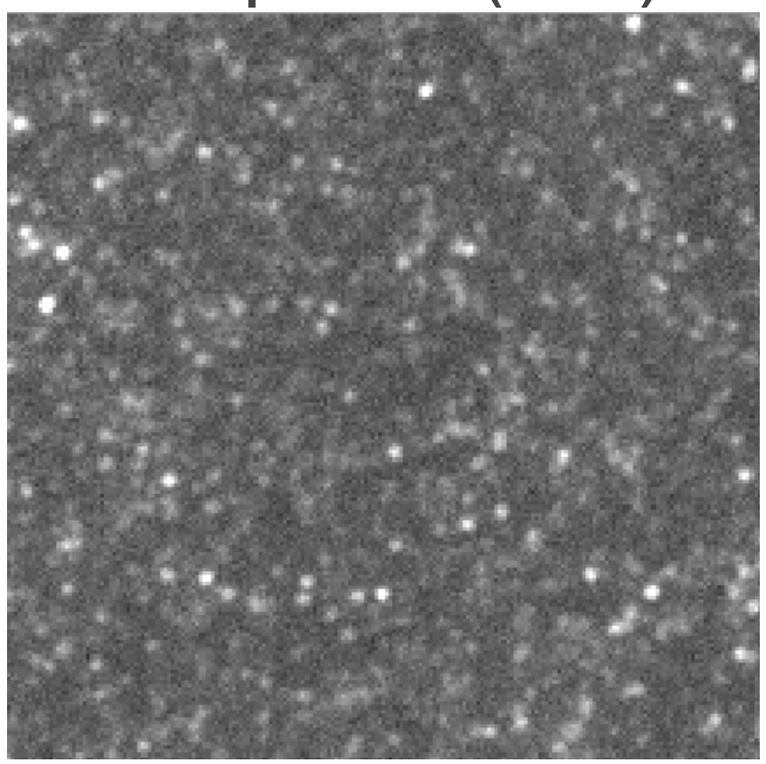
source confusion

2 repeats (fls)



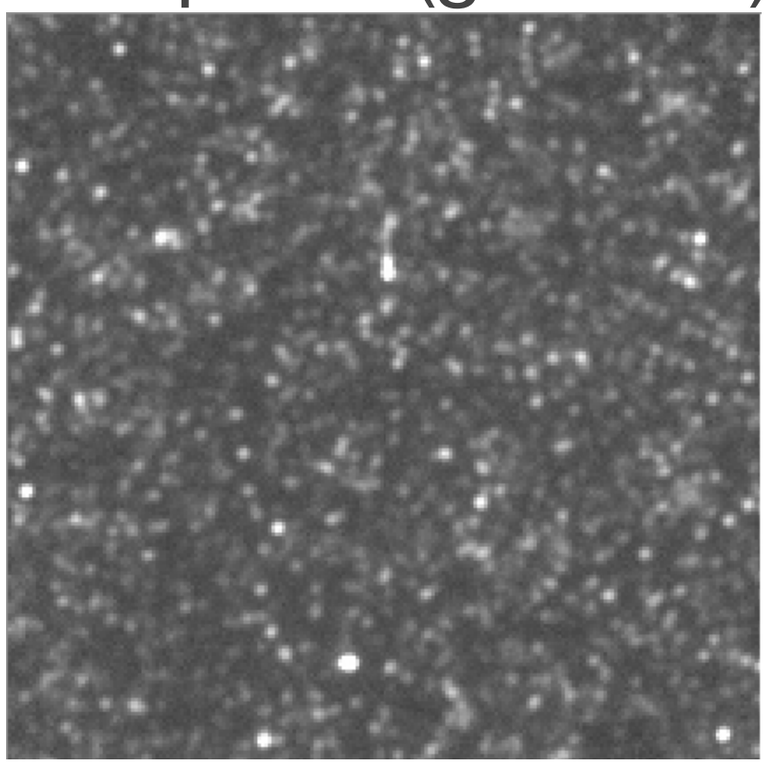
33.5 mJy (3σ)

7 repeats (uds)



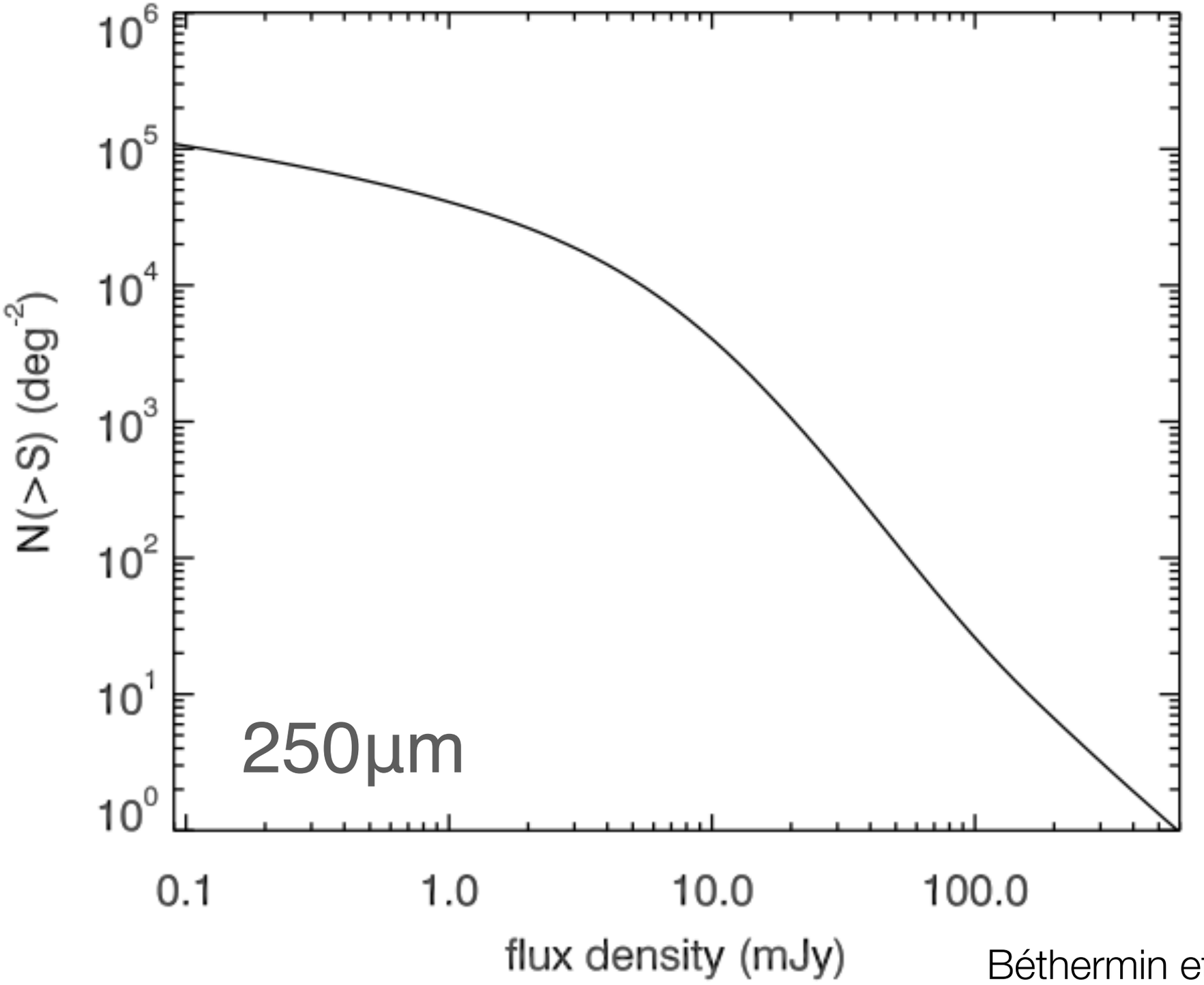
24.7 mJy (3σ)

76 repeats (goods-s)



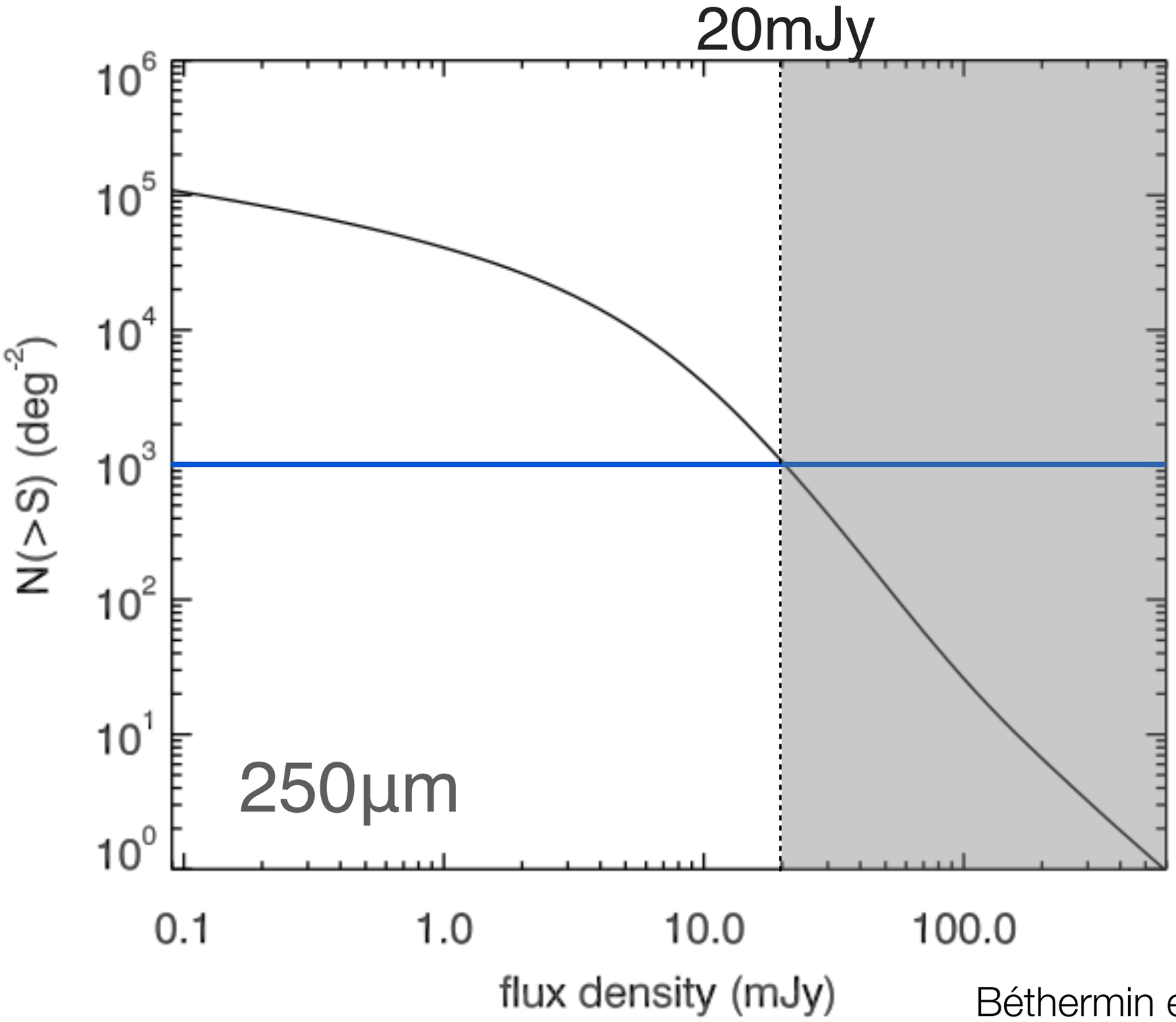
20.2 mJy (3σ)

source confusion



Béthermin et al. (2011)
arXiv:1010.1150

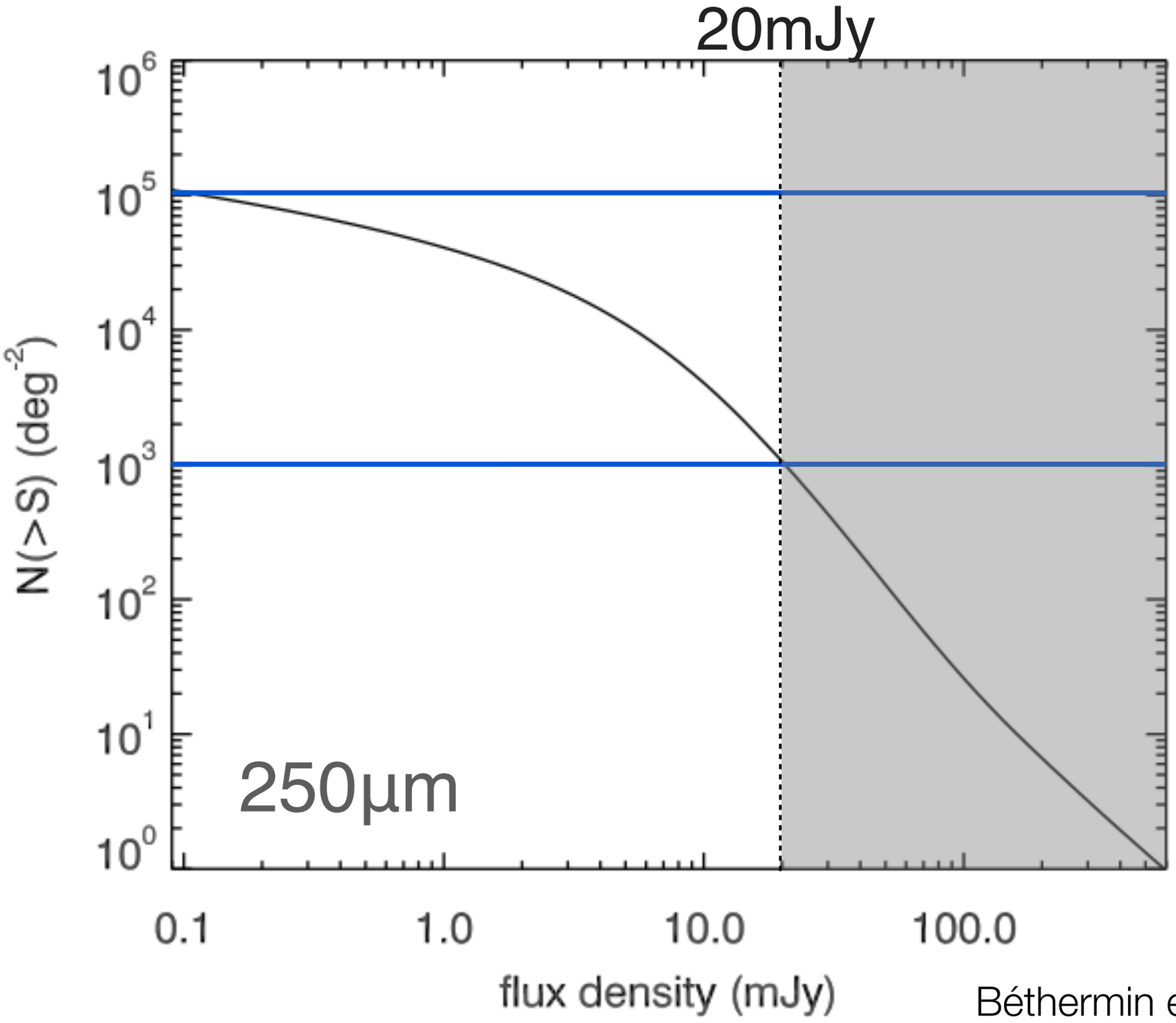
cumulative number counts



~ 0.3 sources/ arcmin^2

Béthermin et al. (2011)
arXiv:1010.1150

cumulative number counts



~ 30 sources/ arcmin^2

~ 0.3 sources/ arcmin^2

effectively ~ 1% of sources are resolved at 250 μm

Béthermin et al. (2011) arXiv:1010.1150

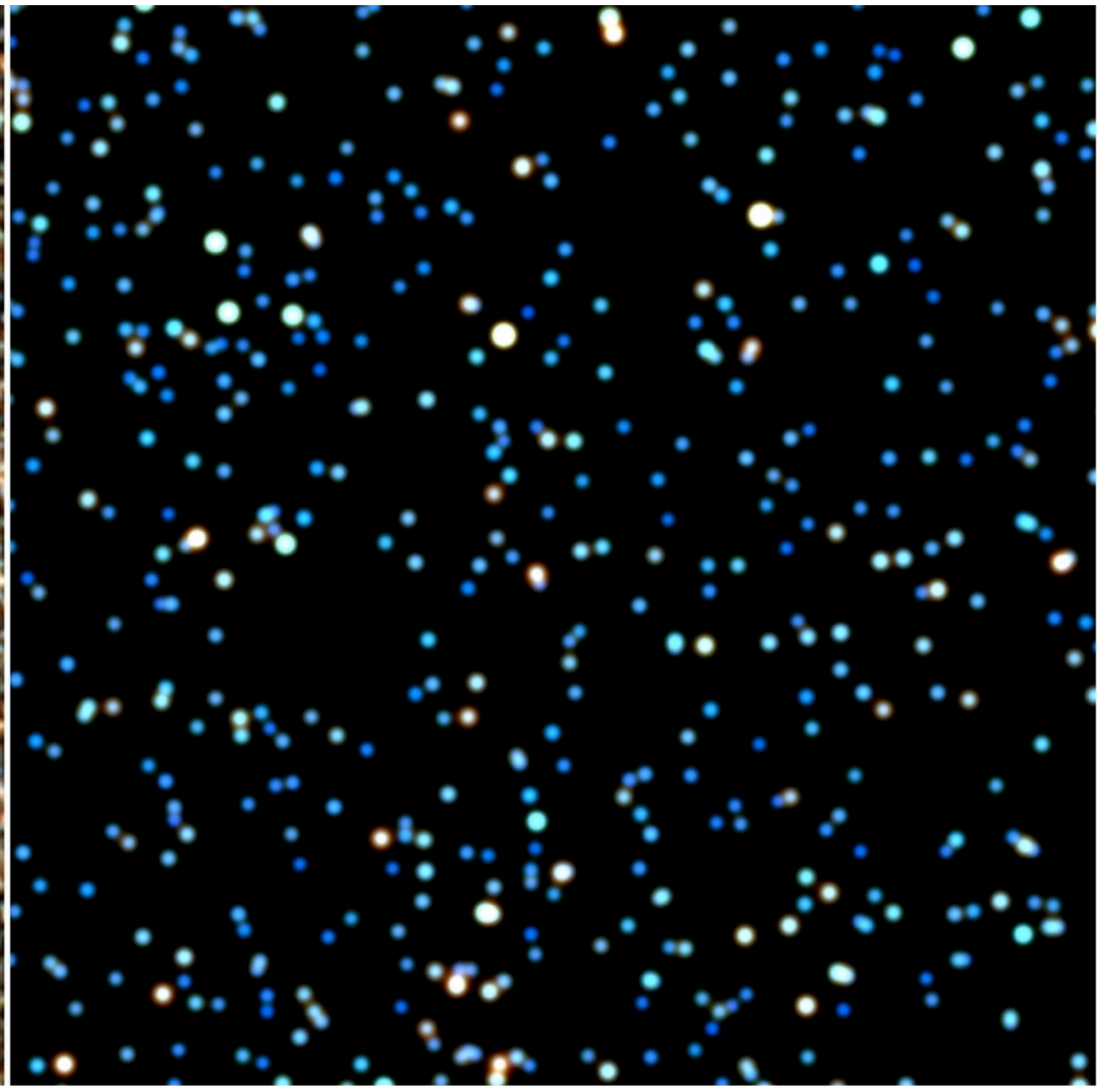
cumulative number counts

The Cosmic Infrared Background

The Cosmic Infrared Background

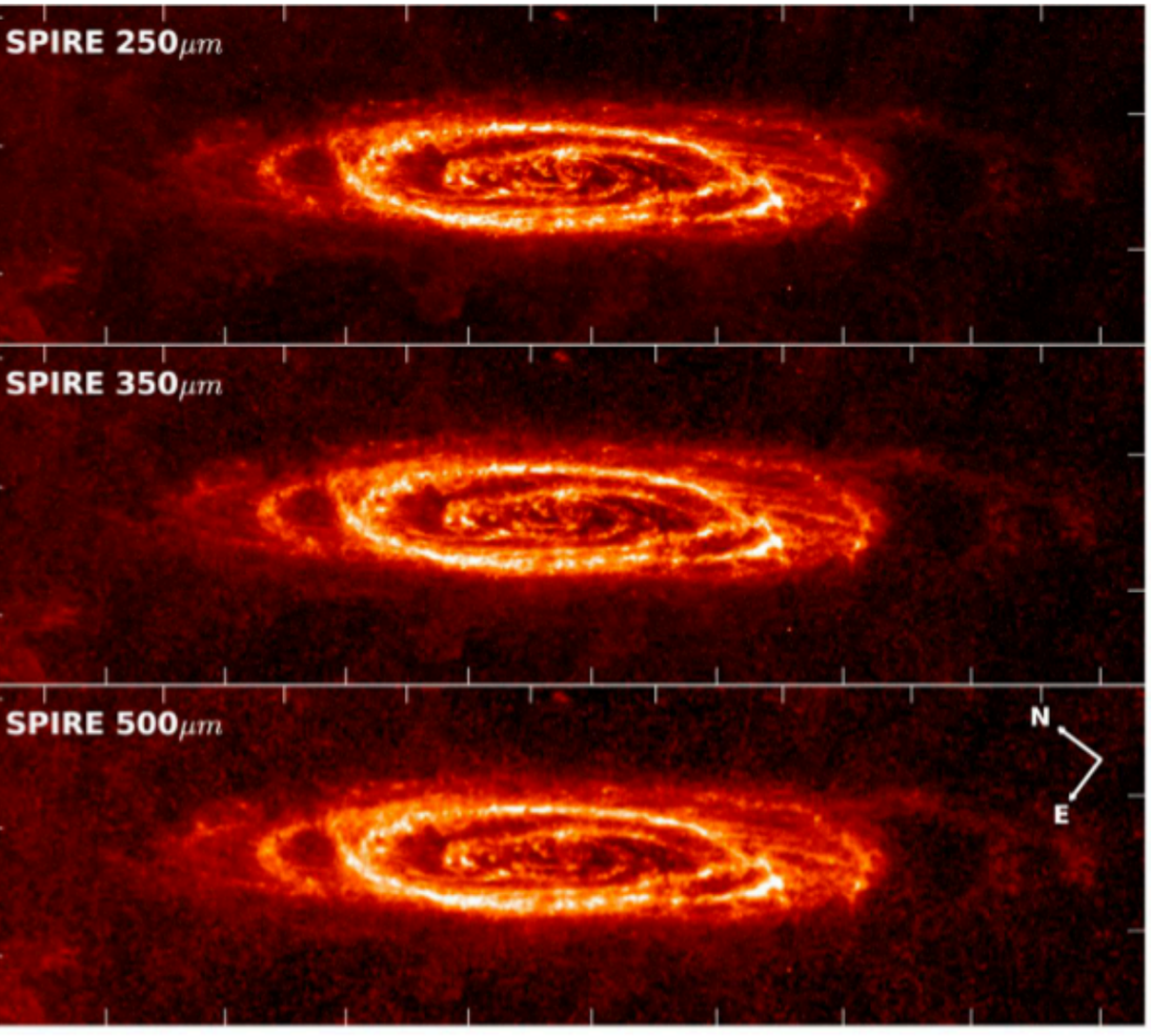
CIB Results in 2 parts: Unresolved/Resolved

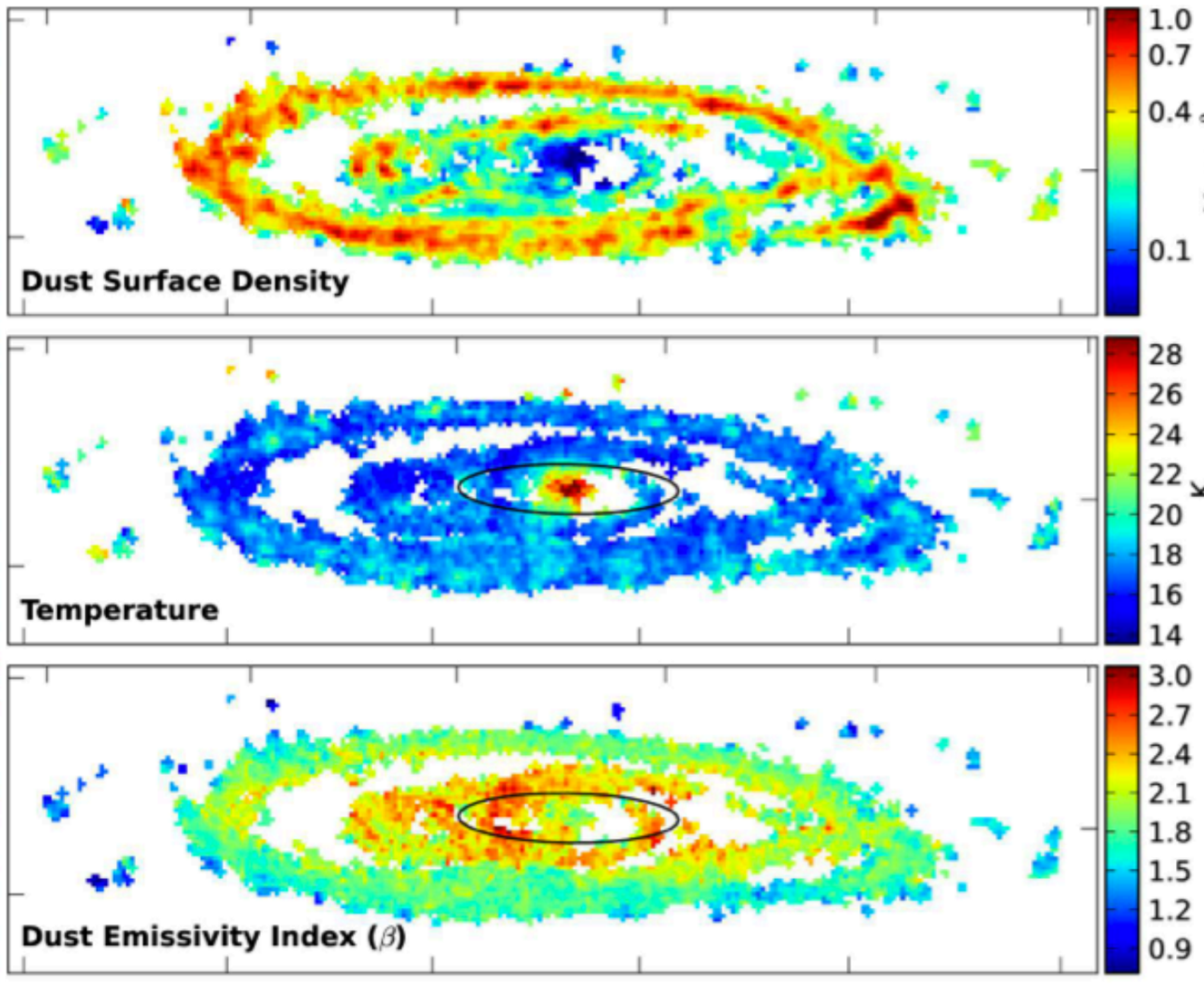
S < 20 mJy : 36,000/deg²



S > 20 mJy : 1,200/deg²

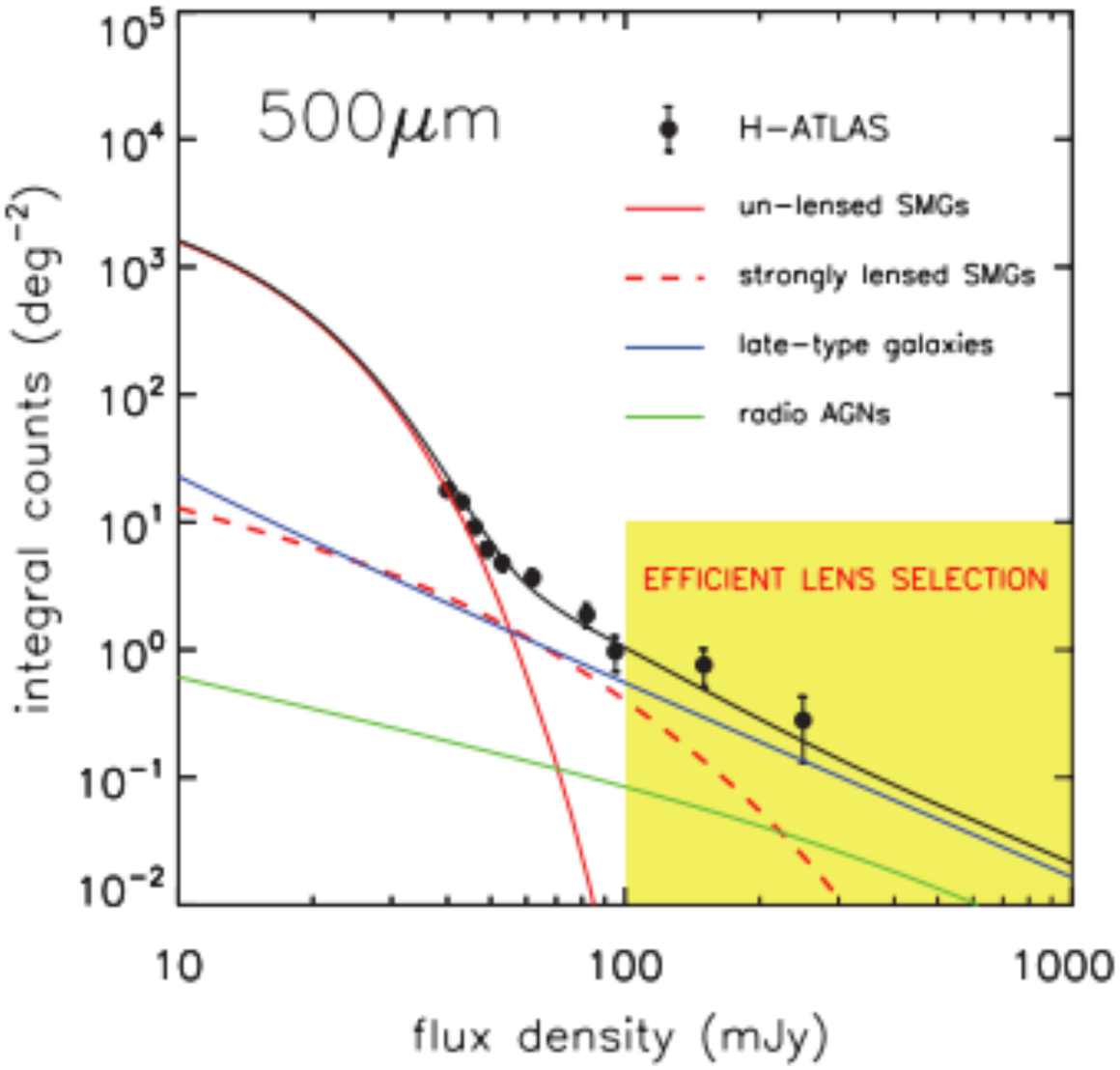
Local Resolved Galaxies





Smith++ 2012, *ApJ*, 756, 40
The Herschel Exploitation of Local Galaxy Andromeda (HELGA) II
See also: Mentuch Cooper++2013, Foyle++2013, SINGS: Wilson++2012

Lensed Sources



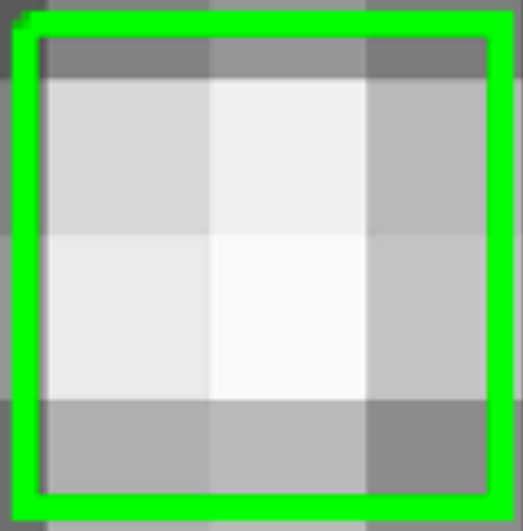
- Sources with flux density S > 100mJy at 500μm have high probability of being lensed

Negrello++ 2010
The Detection of a Population of Submillimeter-Bright, Strongly Lensed Galaxies. Science 330, 800.

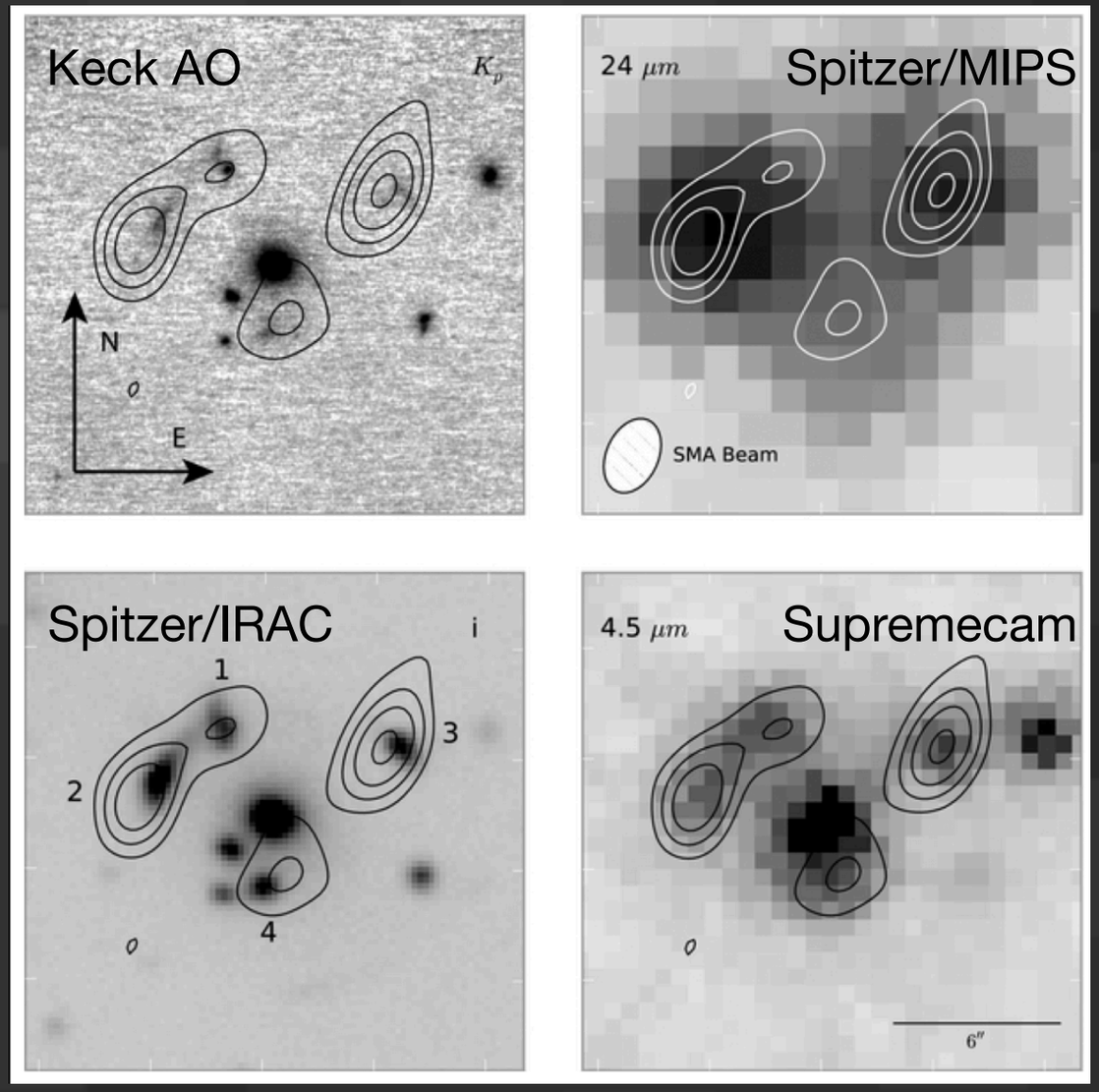
)

Lensed Sources

SPIRE 250μm (6” pixels)



z=2.97 from spectroscopic follow-up



Contours From Submillimeter Array (SMA)

Conley++ 2011, DISCOVERY OF A MULTIPLY LENSED SUBMILLIMETER GALAXY IN EARLY HerMES *HERSCHEL/SPIRE* DATA

also see: Negrello++ 2010, Gonzalez-Nuevo++ 2012, Wardlow++ 2012, Fu++ 2013

“Red” Sources

Near-Infrared (Keck)
Millimetre (PdBI)

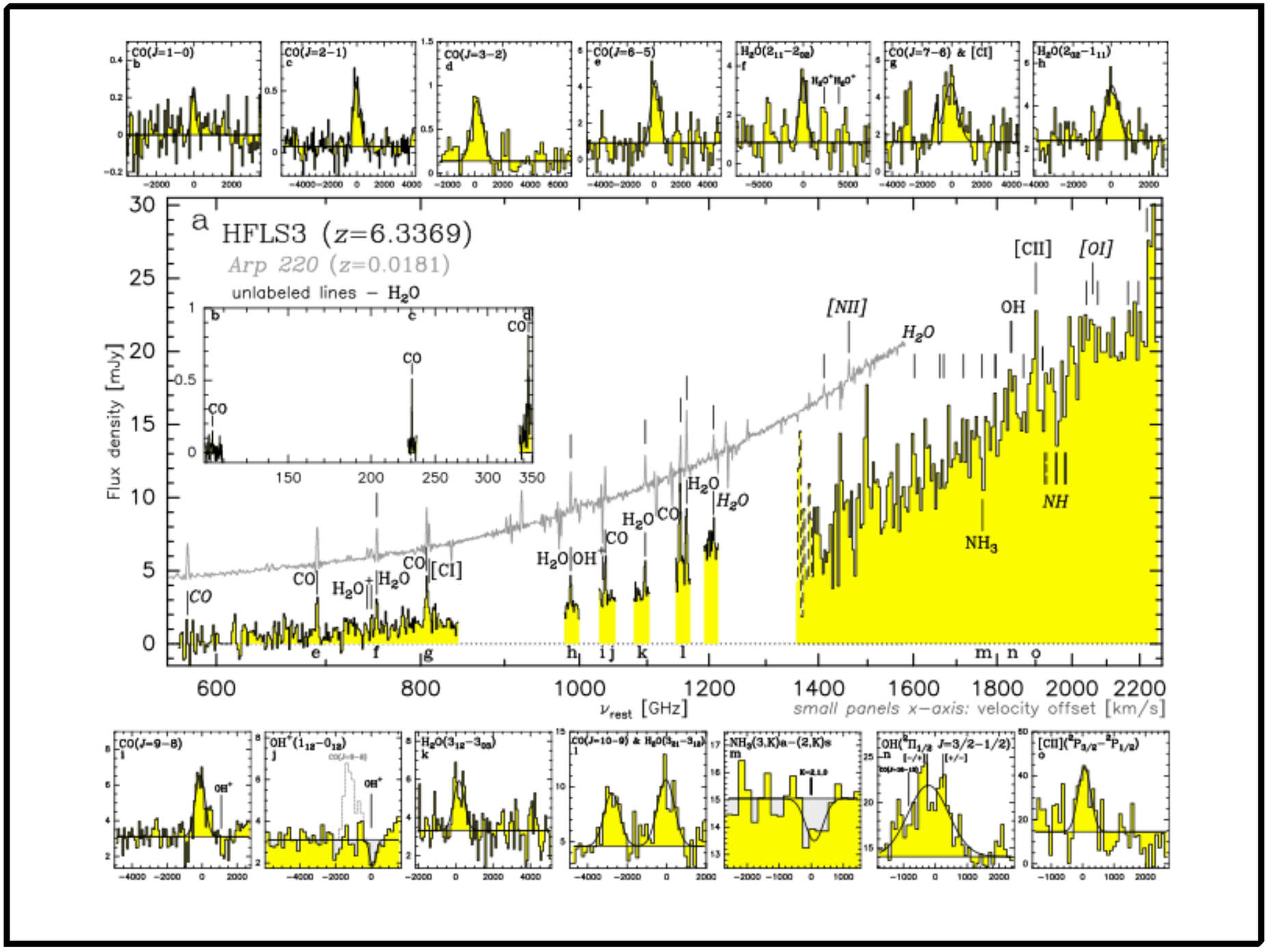
Optical (GTC)

250 μm

350 μm

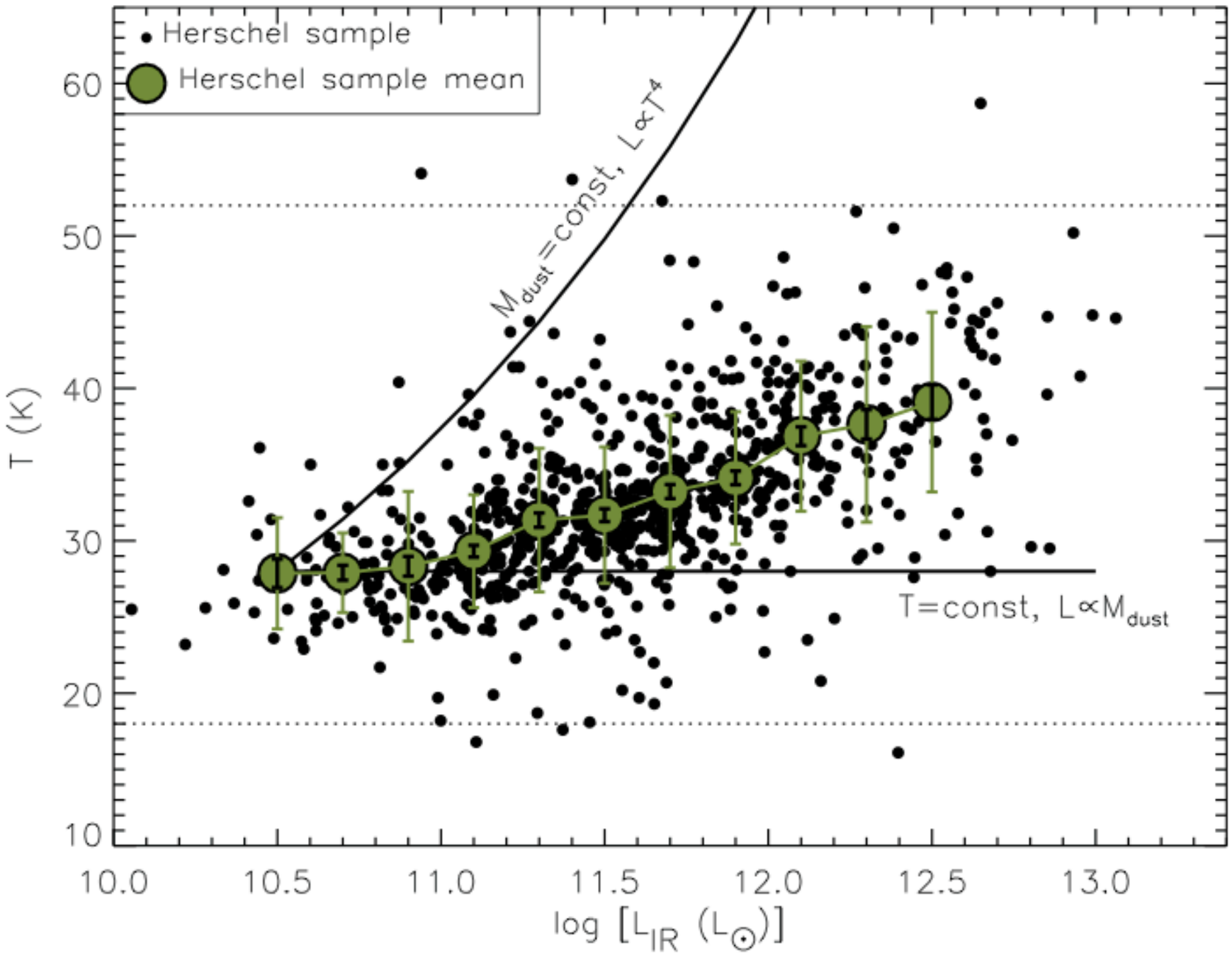
500 μm

z=6.337 “red” source



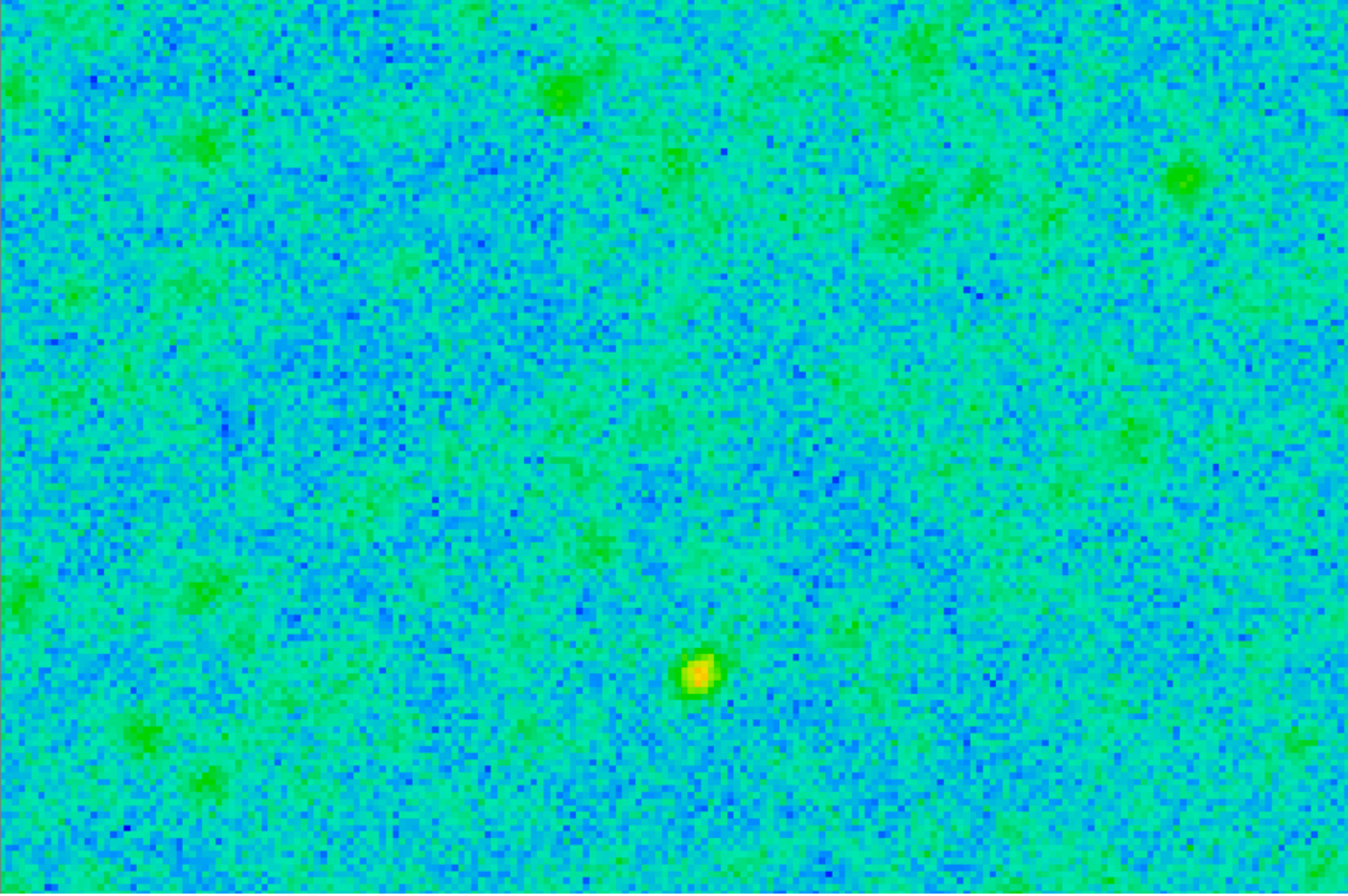
Riechers++ 2013, *Nature*, 496(7), pp.329–333
A dust-obscured massive maximum-starburst galaxy at a redshift of 6.34
See also: Dowell++ in prep., Gill++ in prep.

SEDs

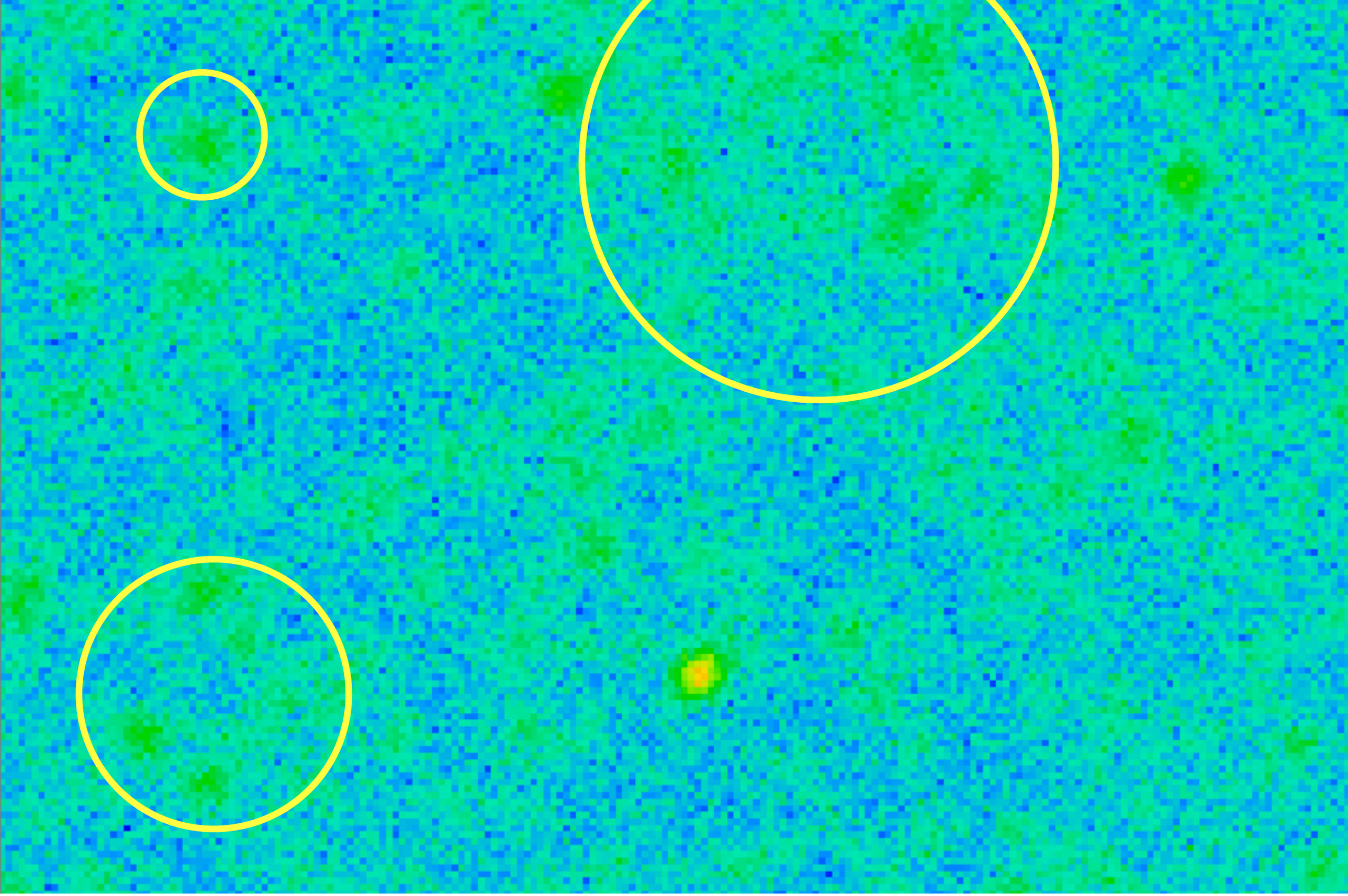


Symeonidis++ 2013, The *Herschel* Census of Infrared SEDs through cosmic time, *MNRAS*, 431(3), pp. 2317–2340.

See also: Casey++ 2012a,b, Magdis++ 2010, 2012, Canalog++ 2013

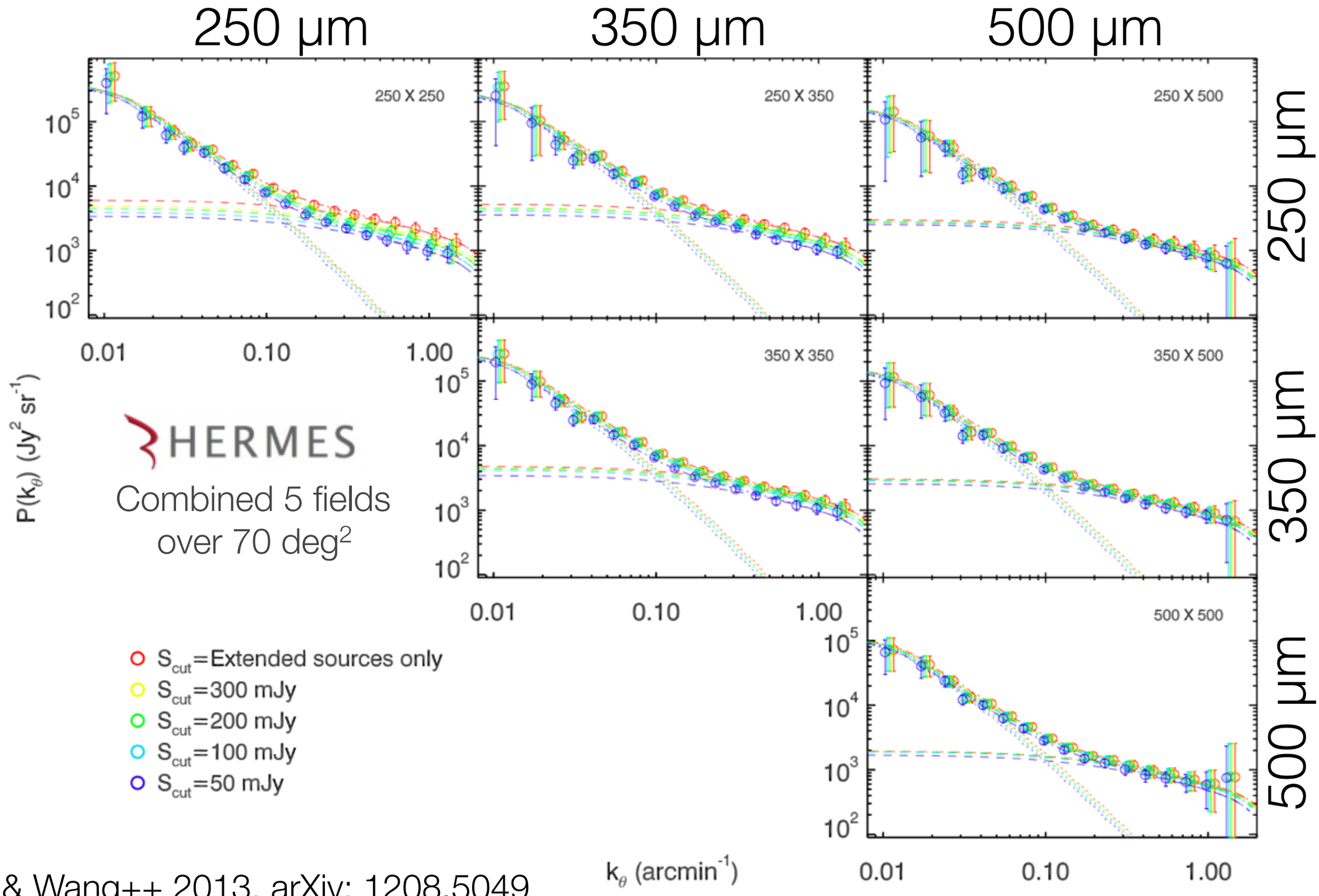


ii) The Unresolved Background



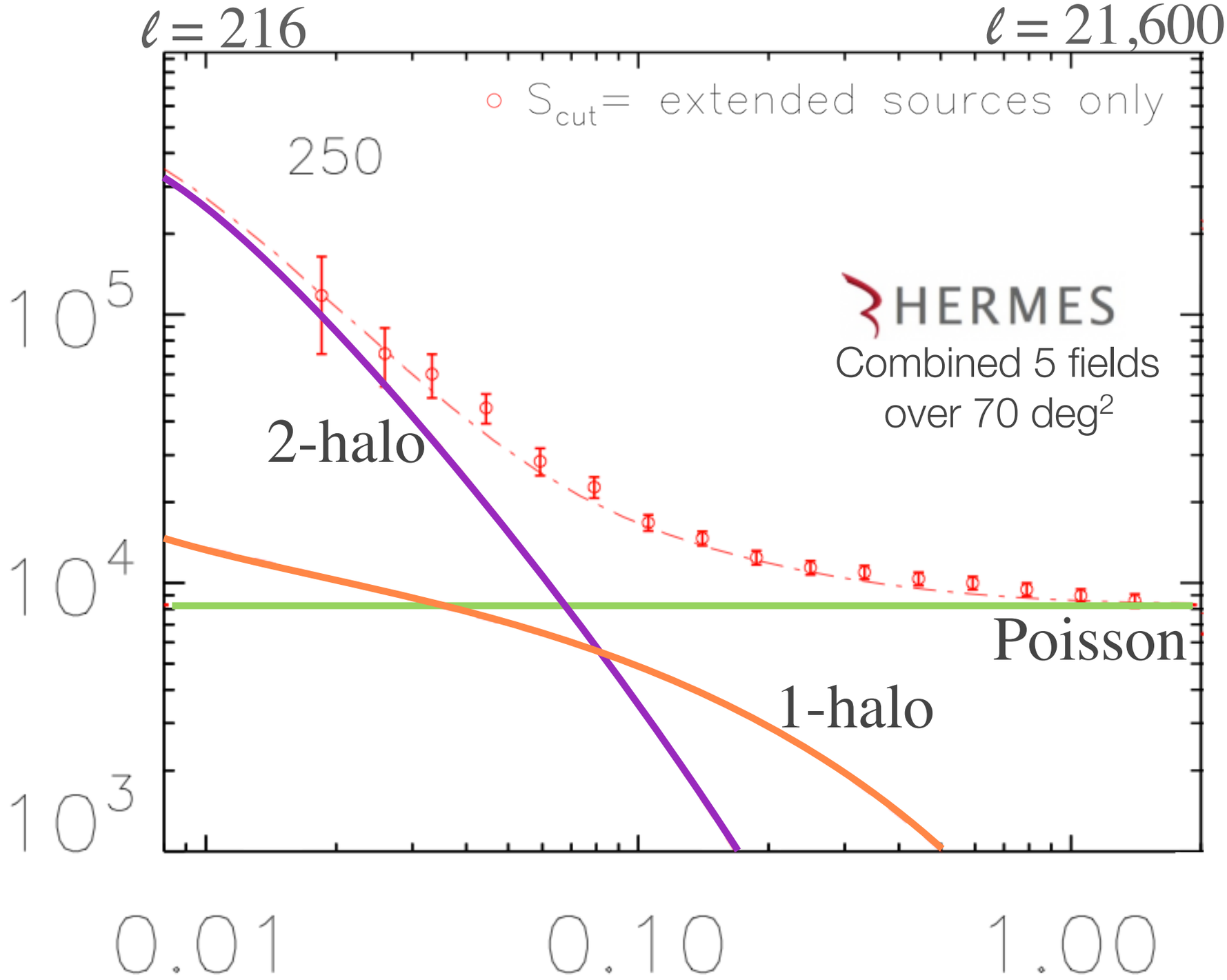
CIB Anisotropies (CIBA)

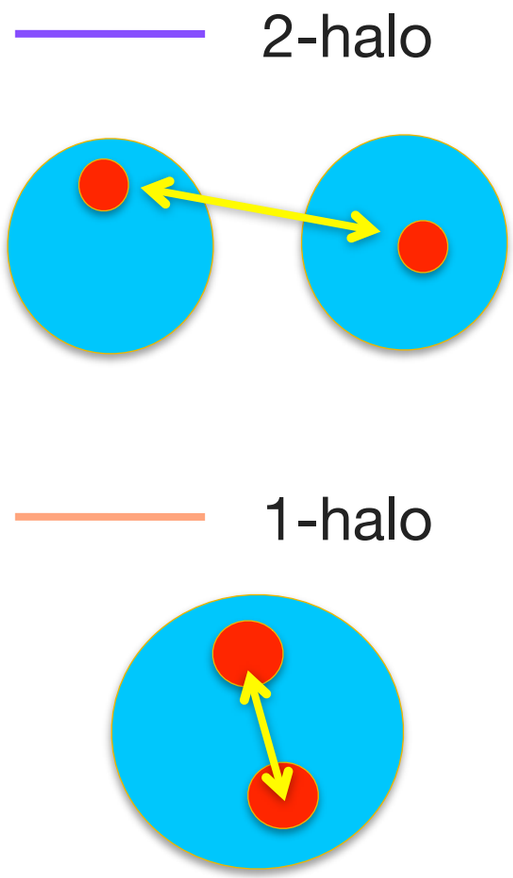
CIBA power spectra



Viero & Wang++ 2013, arXiv: 1208.5049
See also: Amblard++ 2011, Thacker++ 2013

Clustering of DSFGs

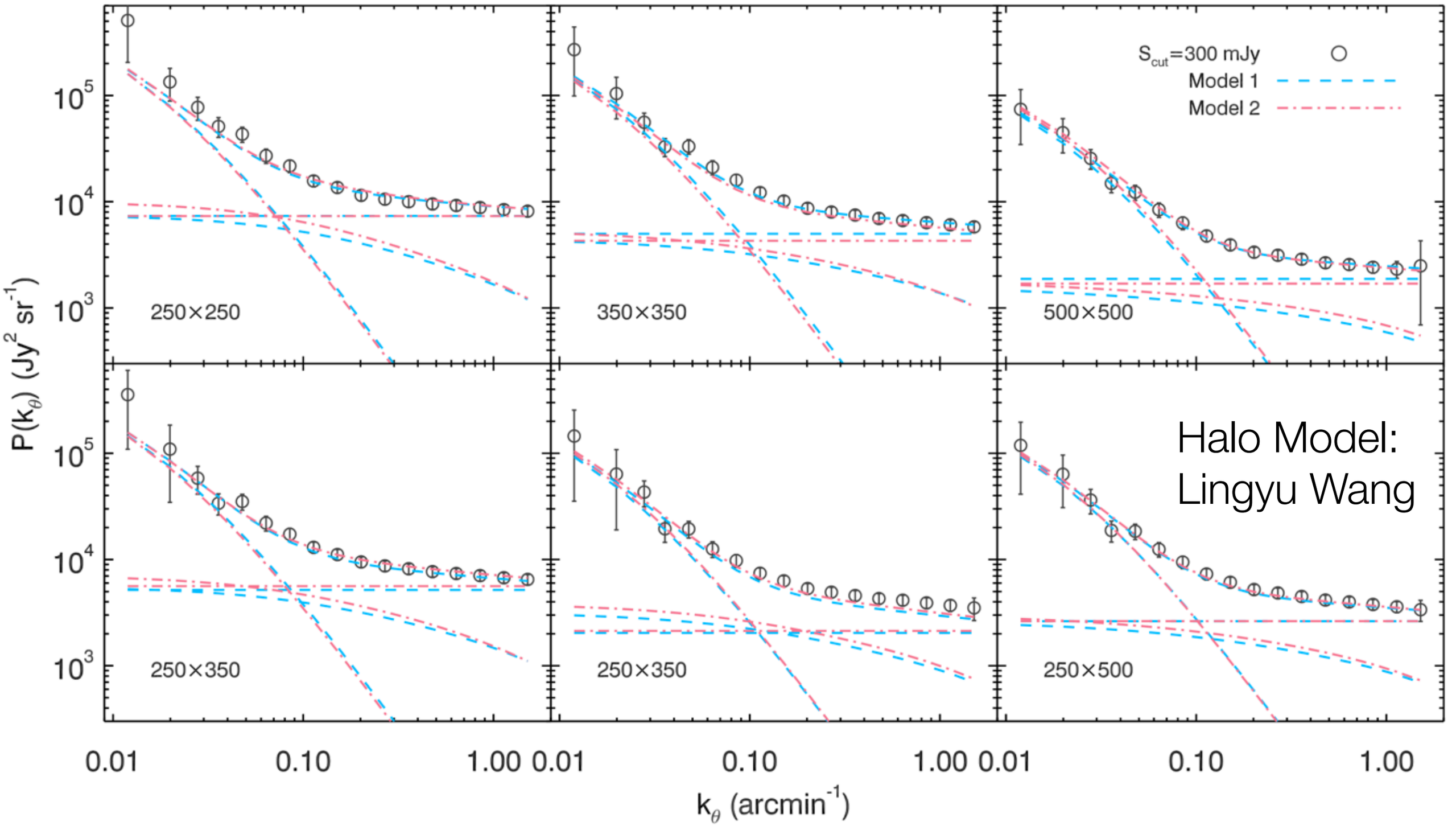




Viero & Wang++ 2012, arXiv: 1208.5049

See also: Bethermin++ 2013, Wang++ 2013

Best-Fit Halo Model



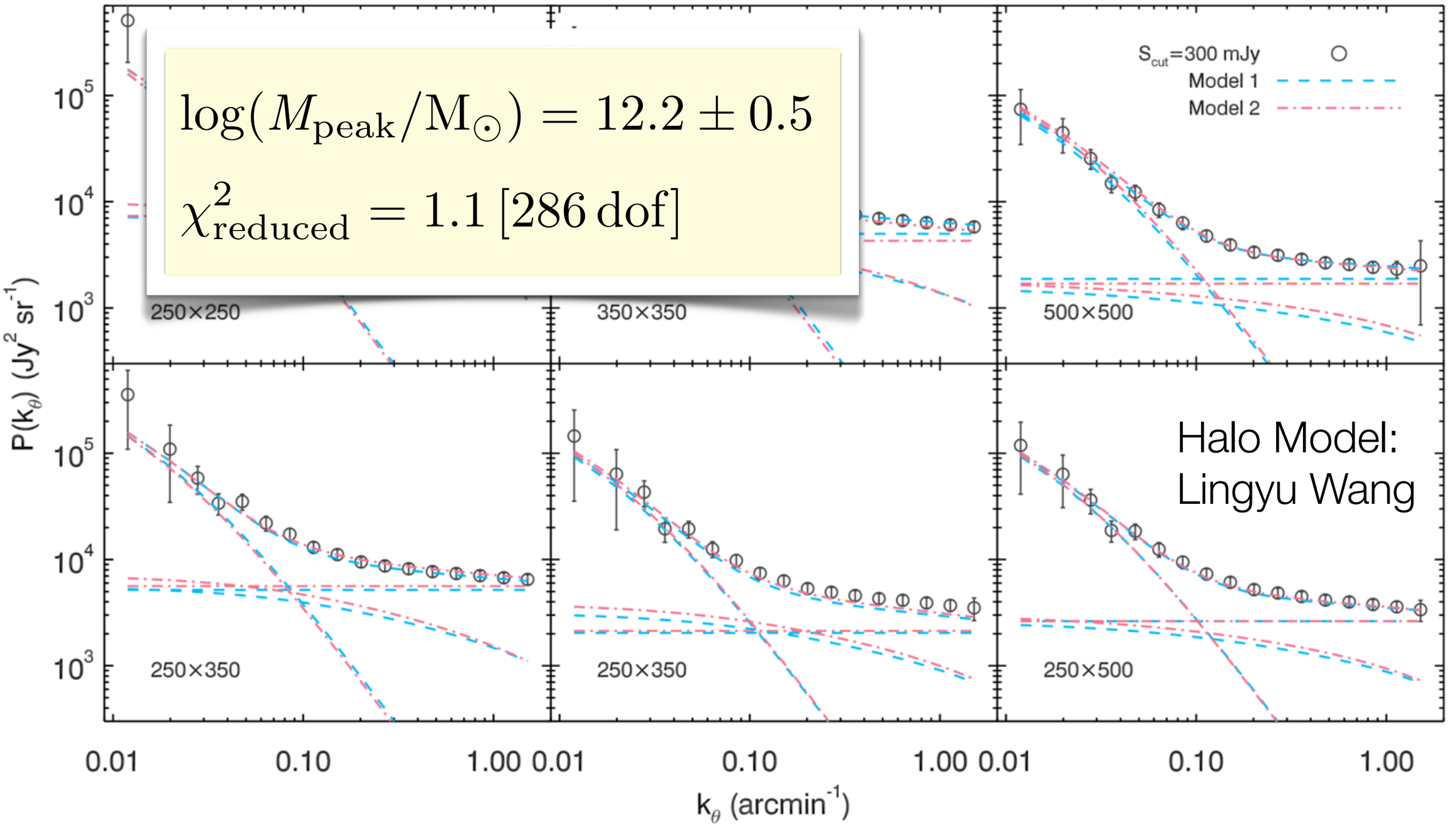
Viero & Wang++ 2012, arXiv: 1208.5049

See also: Bethermin++ 2013, Wang++ 2013

Best-Fit Halo Model

$$\log(M_{\rm peak}/{\rm M}_\odot) = 12.2 \pm 0.5$$

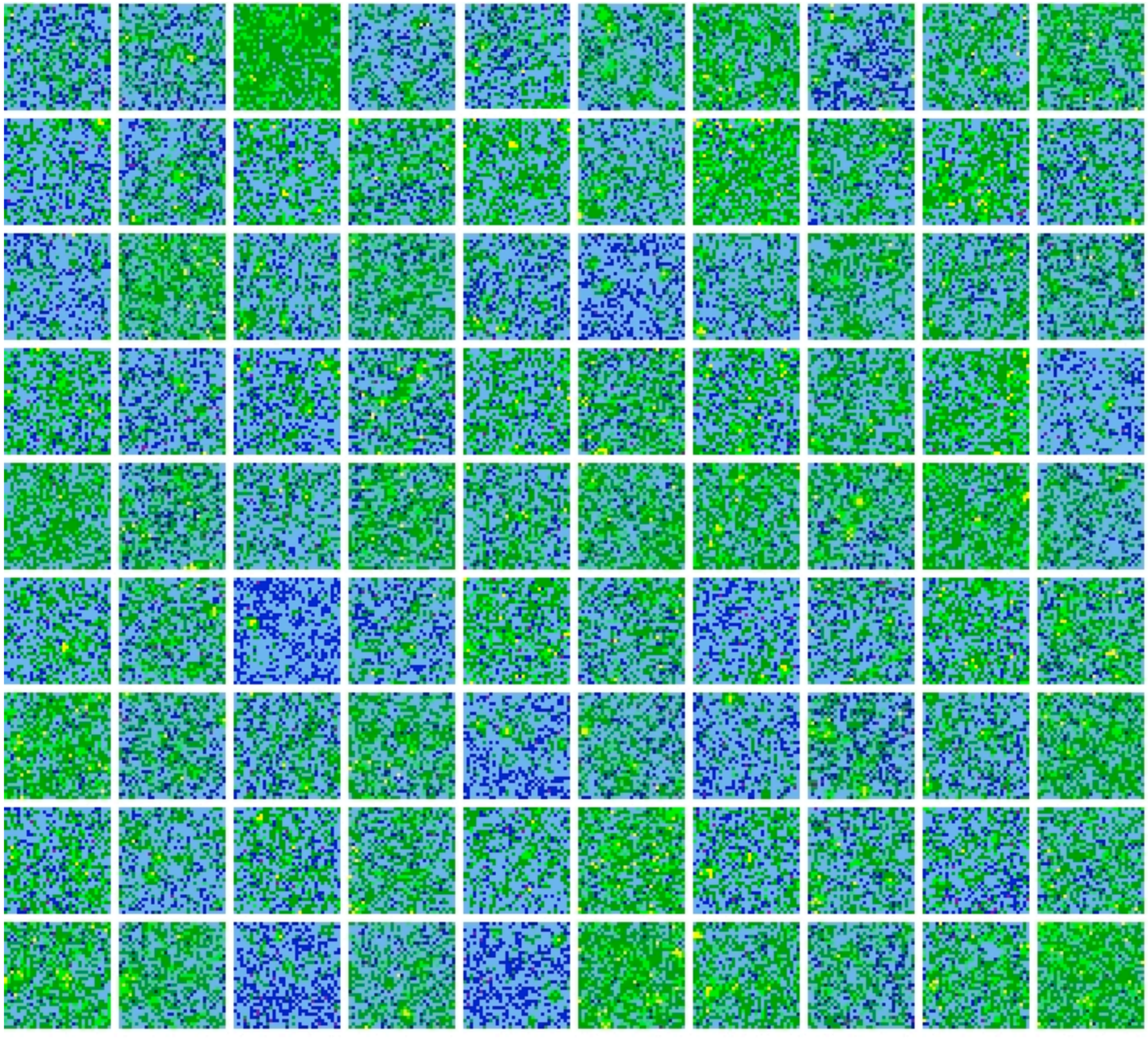
$$\chi^2_{\rm reduced} = 1.1\,[286\,{\rm dof}]$$



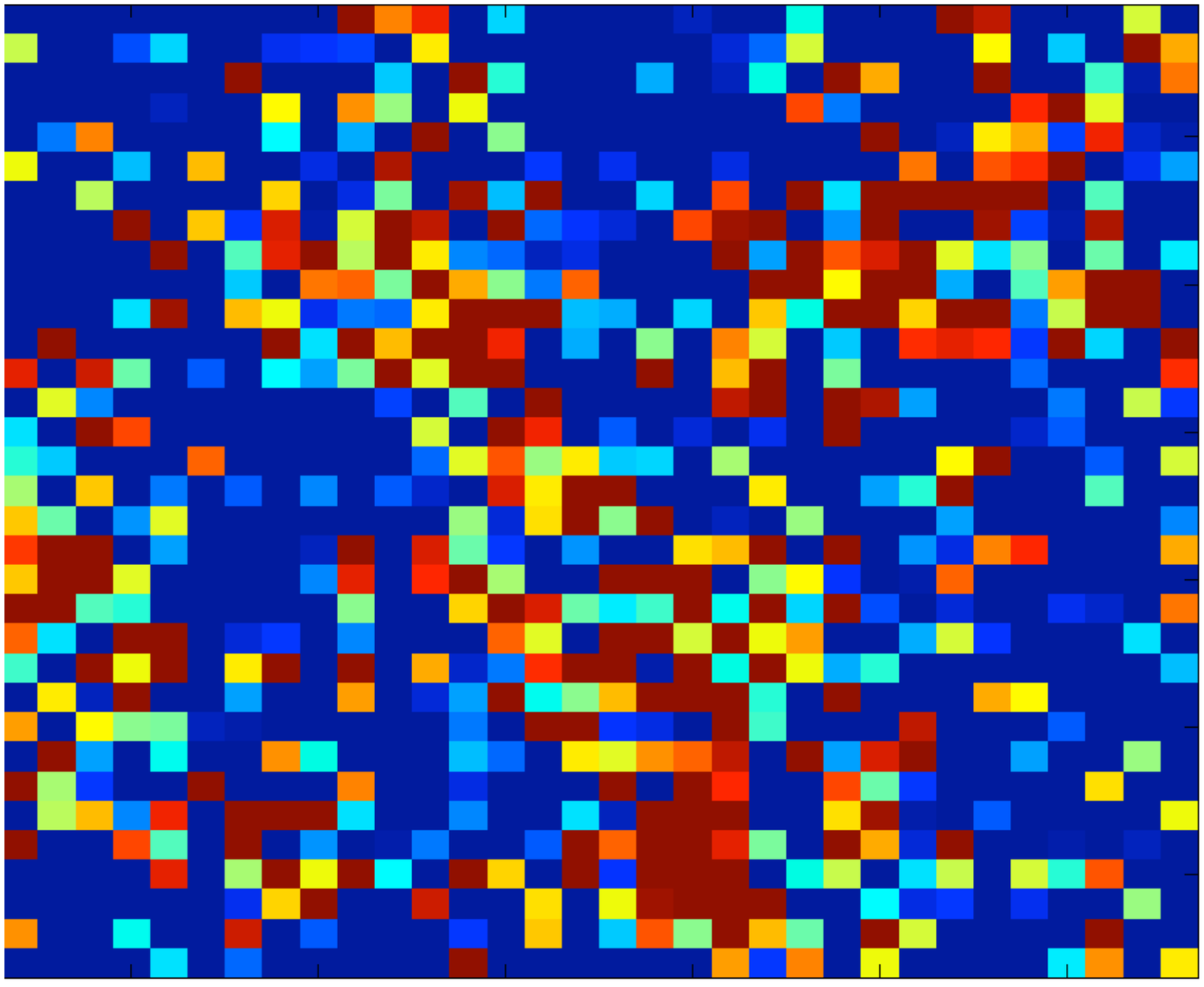
Viero & Wang++ 2012, arXiv: 1208.5049

See also: Bethermin++ 2013, Wang++ 2013

k-band selected sources at z=1.2 on SPIRE 250μm map



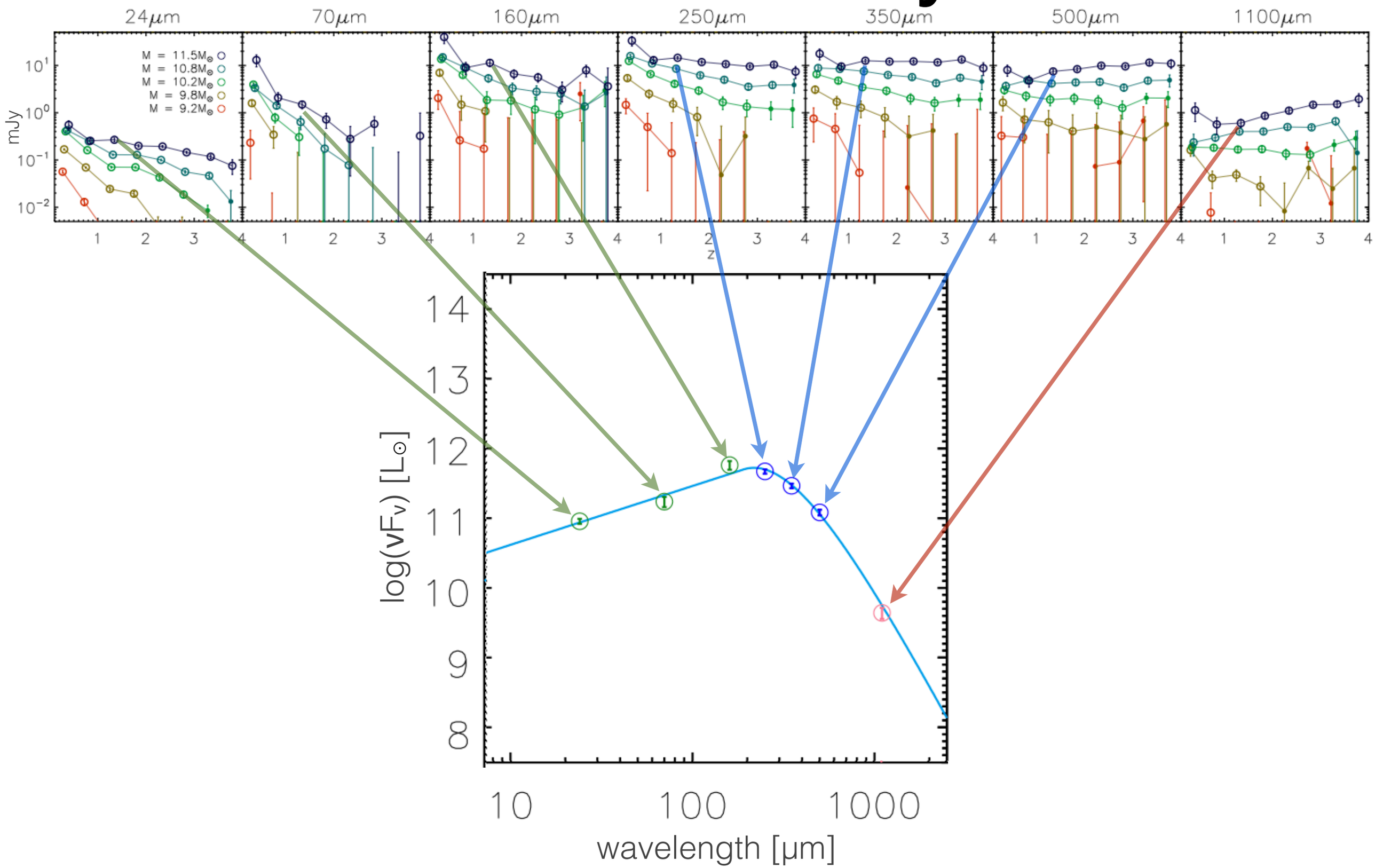
stacking



Phil Korngut (Caltech)

stacking

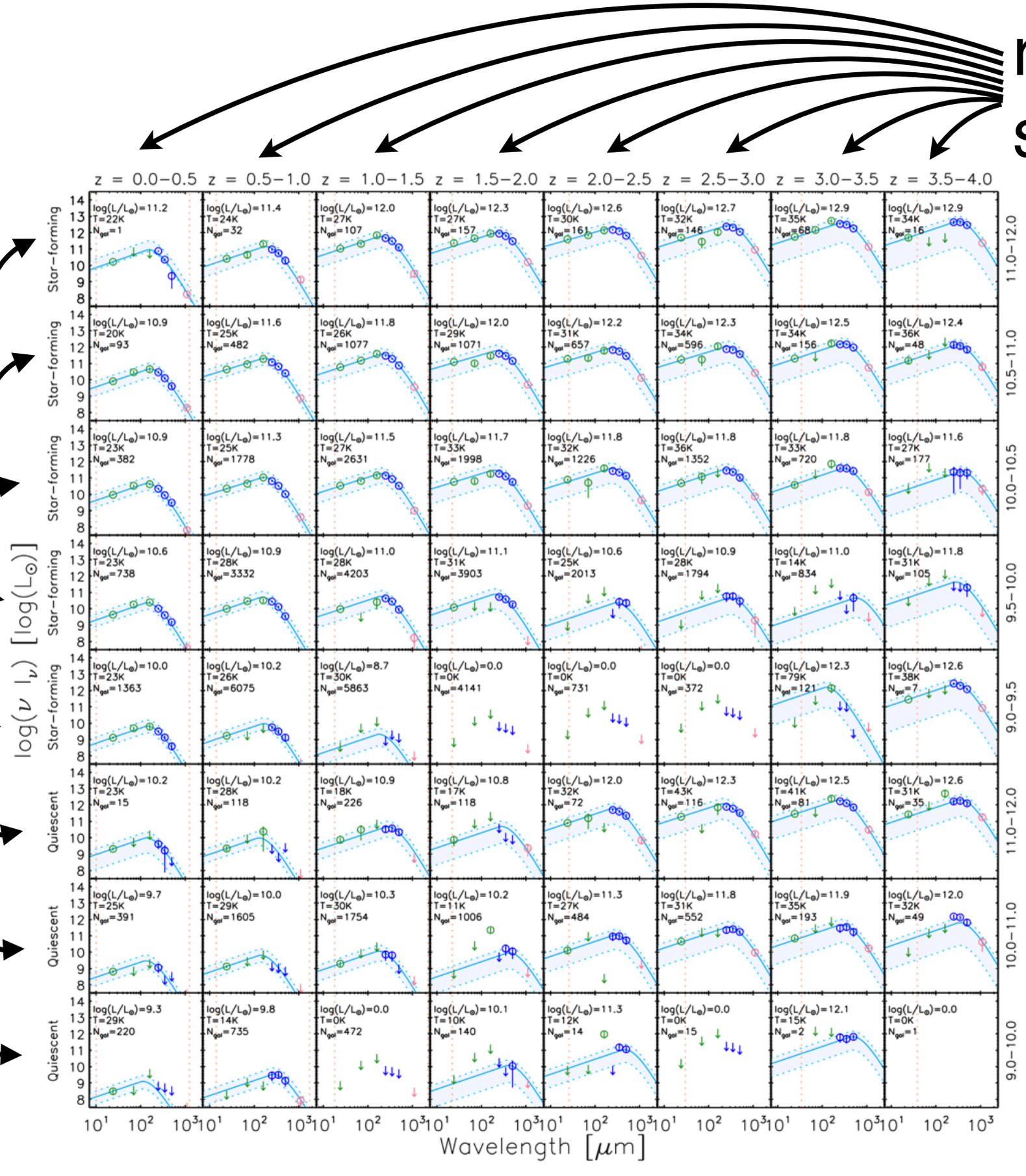
stacked flux density



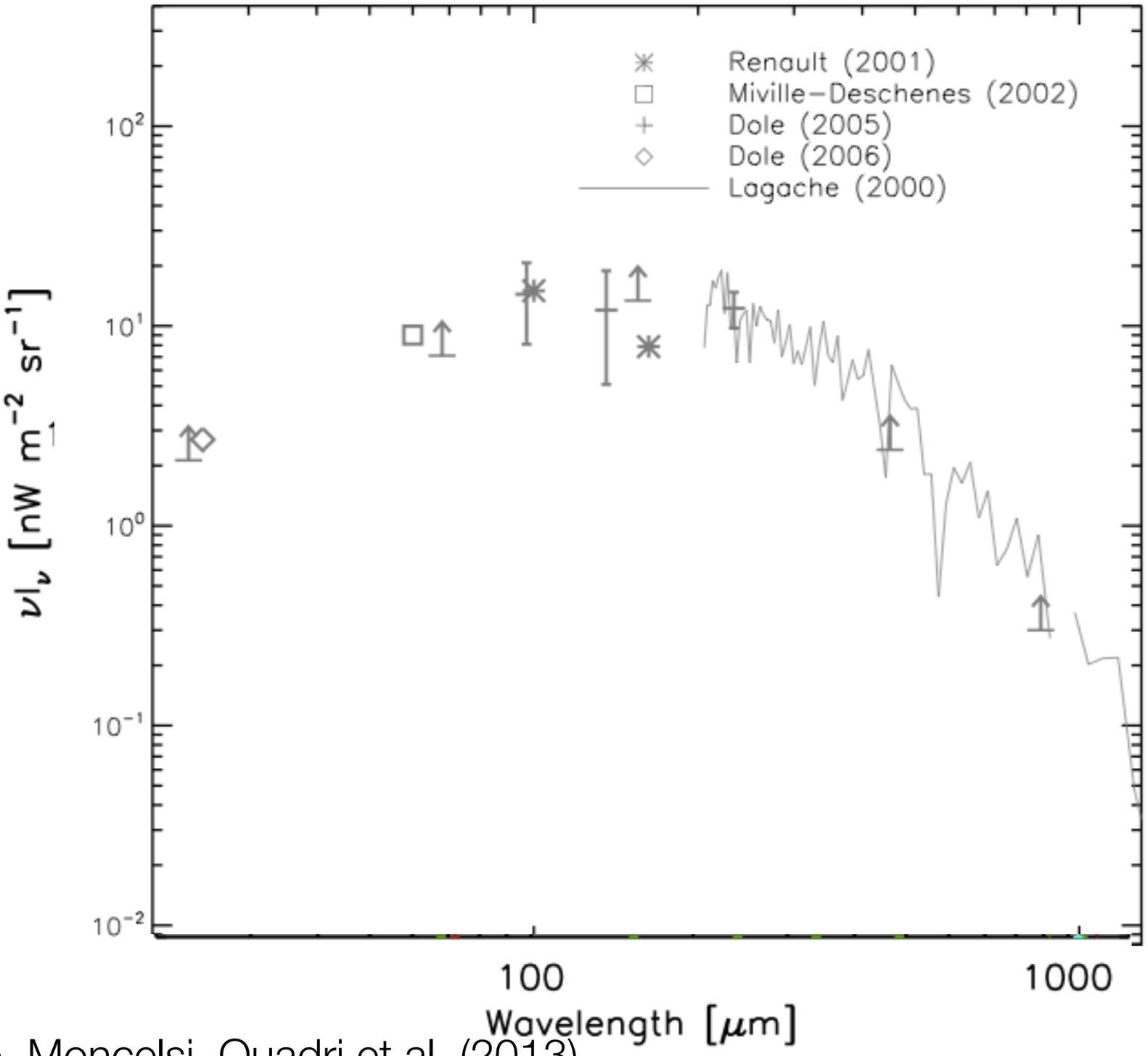
SEDs

redshift slices

mass slices



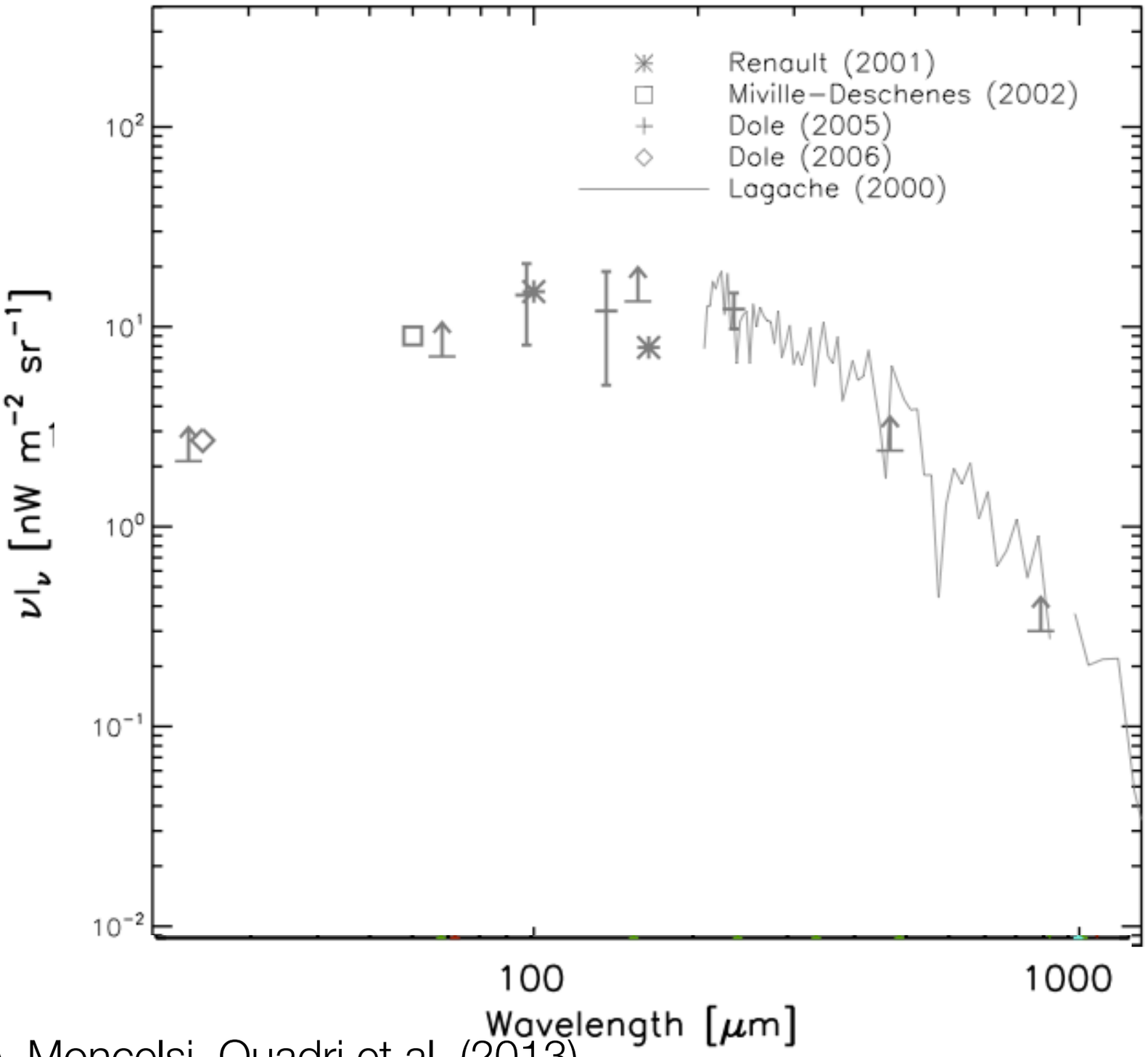
stacked CIB



Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

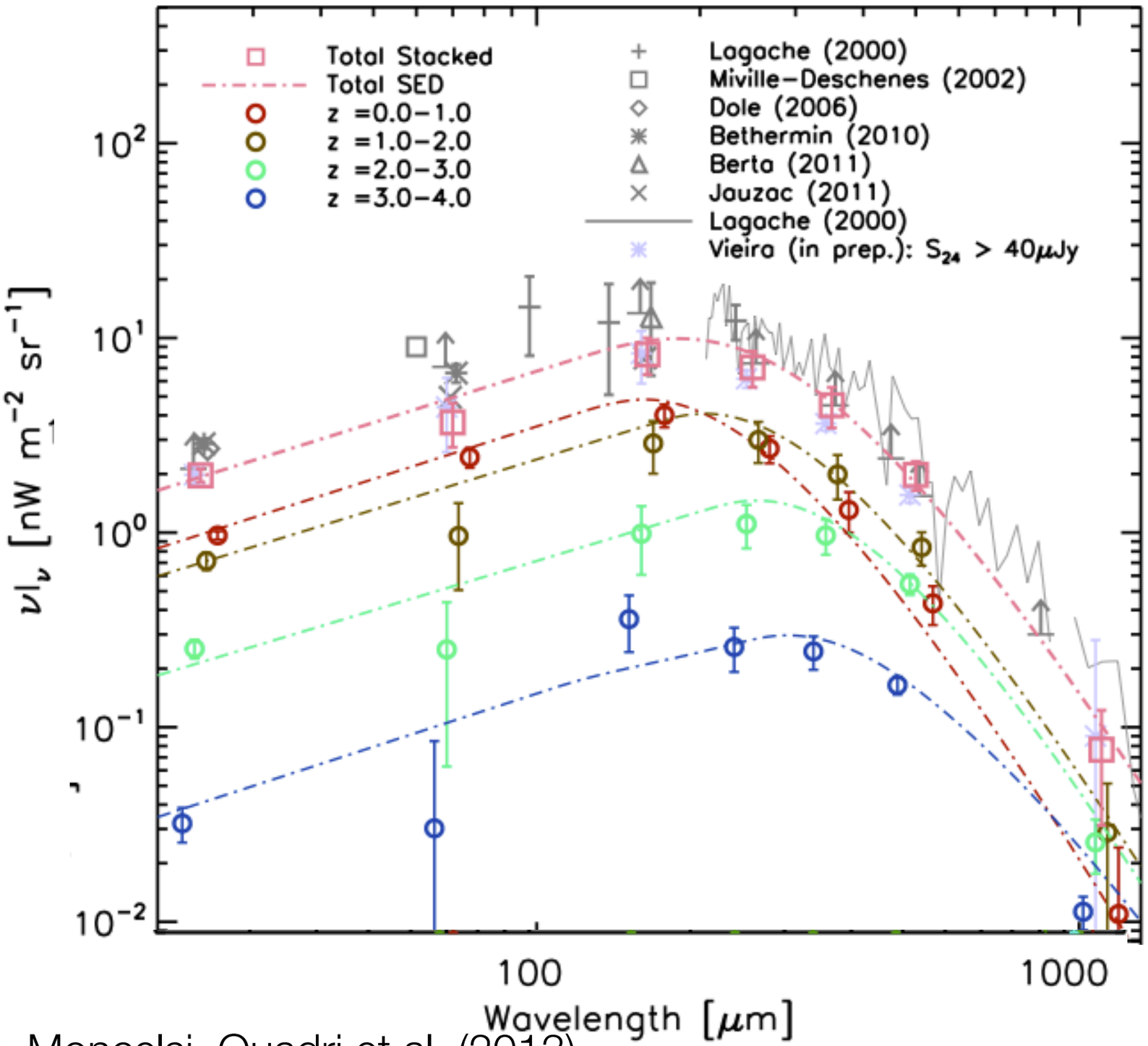
stacked CIB



Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

stacked CIB

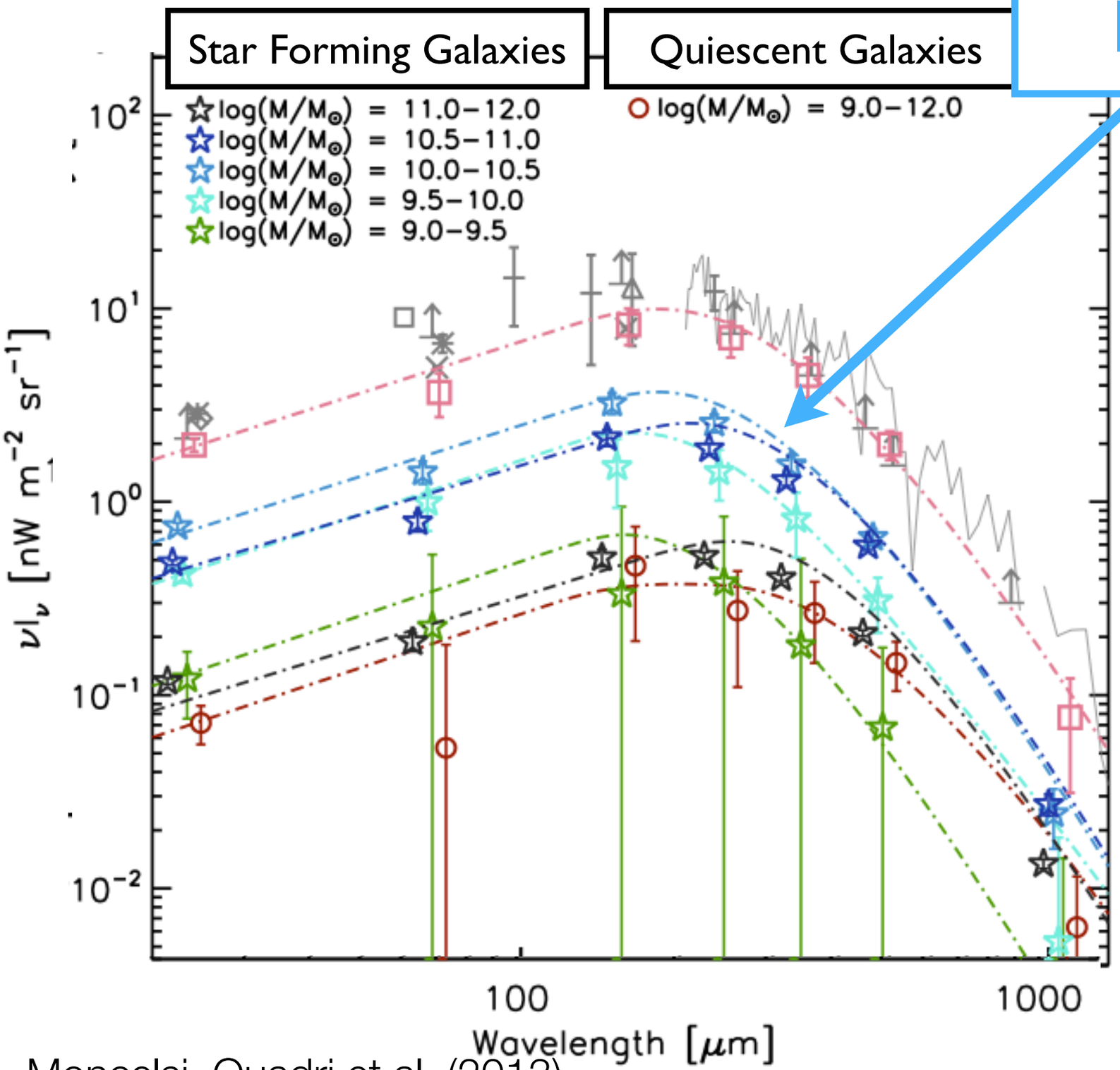


~80% at SPIRE wavelengths

Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

stacked CIB

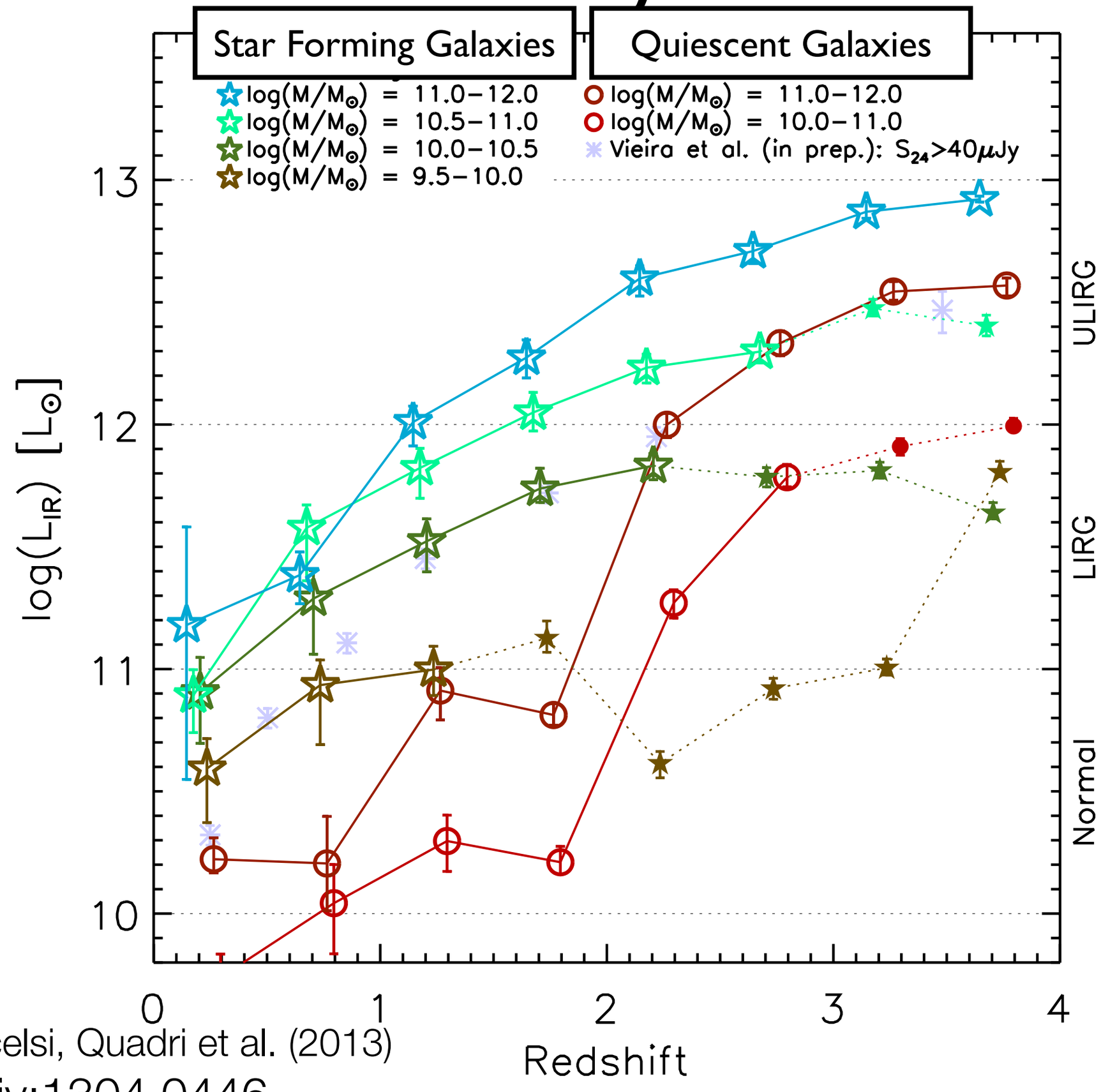


z~1.5-2.5
log(M/M⊙~10-11)

Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

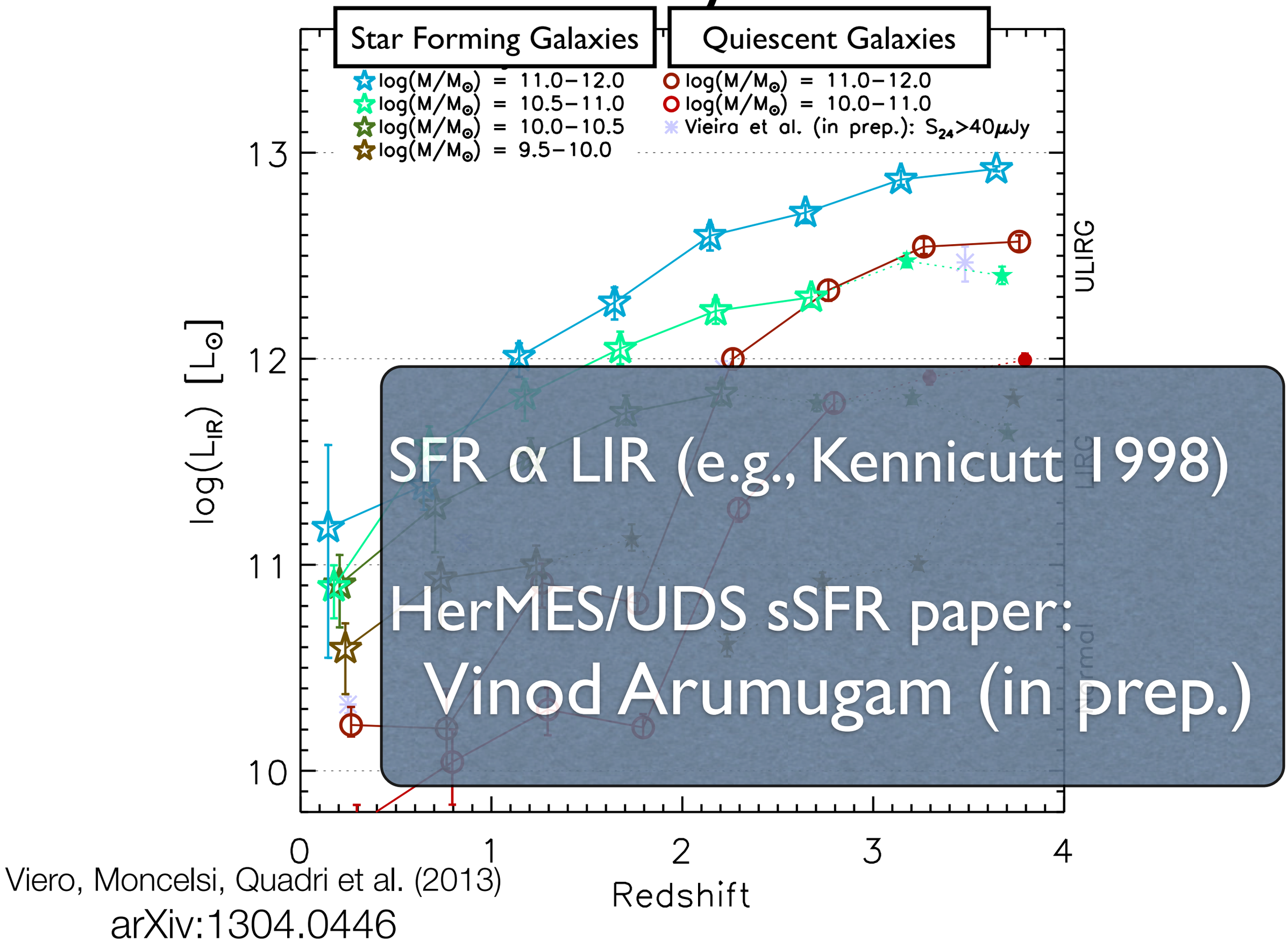
Infrared Luminosity



Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

Infrared Luminosity

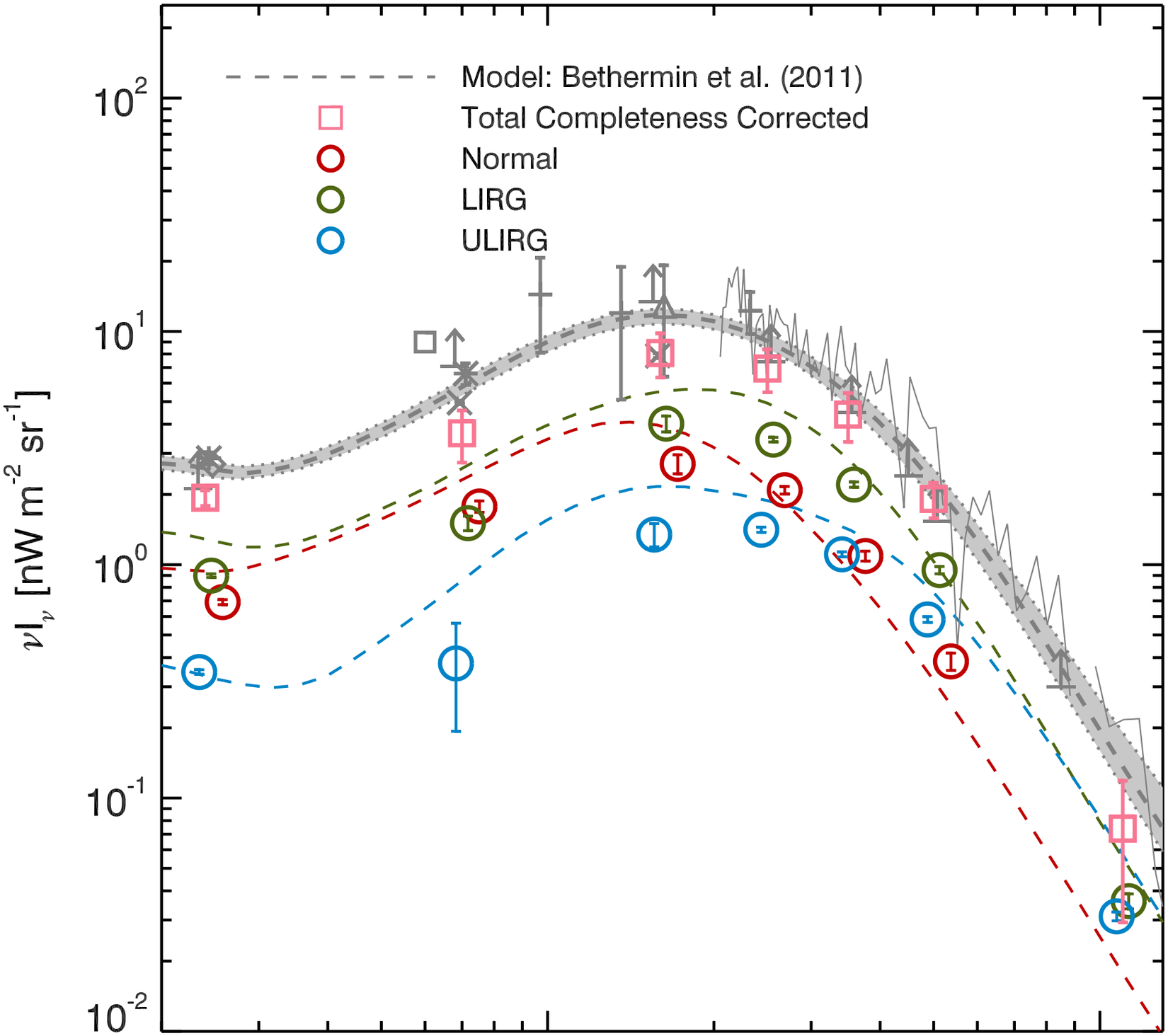


SFR α LIR (e.g., Kennicutt 1998)

HerMES/UDS sSFR paper:
Vinod Arumugam (in prep.)

Viero, Moncelsi, Quadri et al. (2013)
arXiv:1304.0446

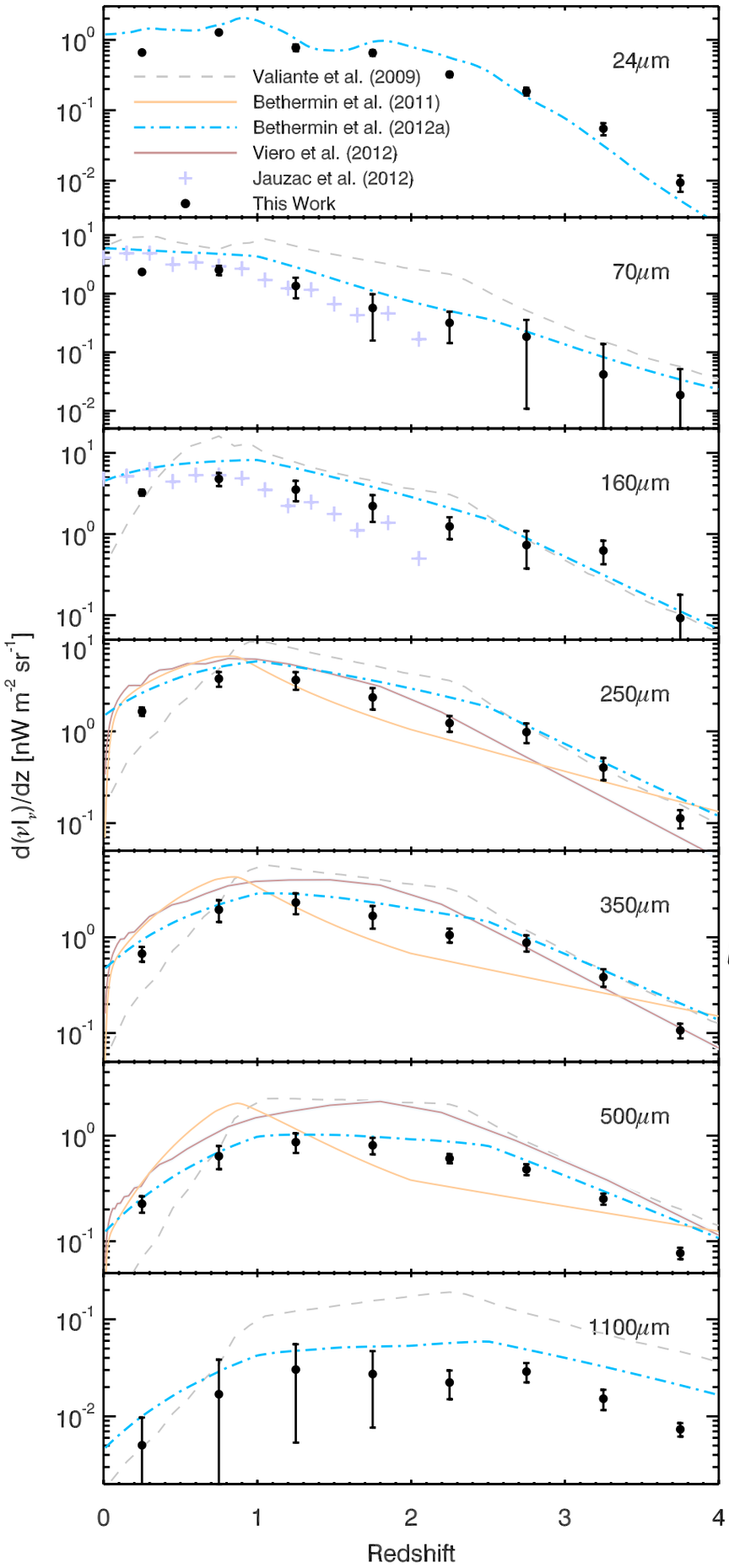
CIB by Luminosity Class

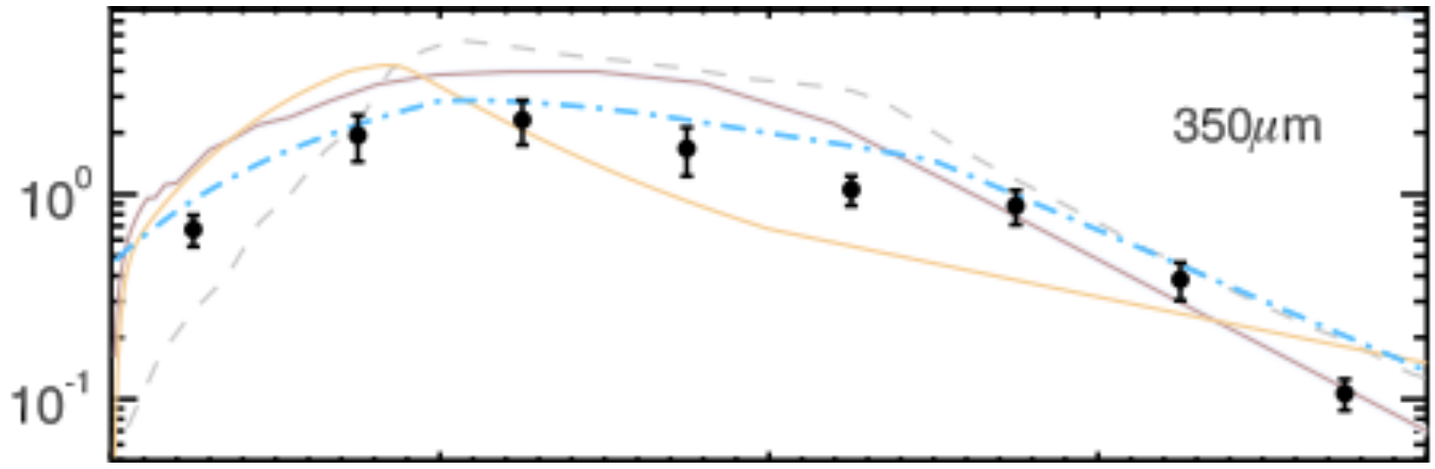


Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

Redshift Distribution of CIB

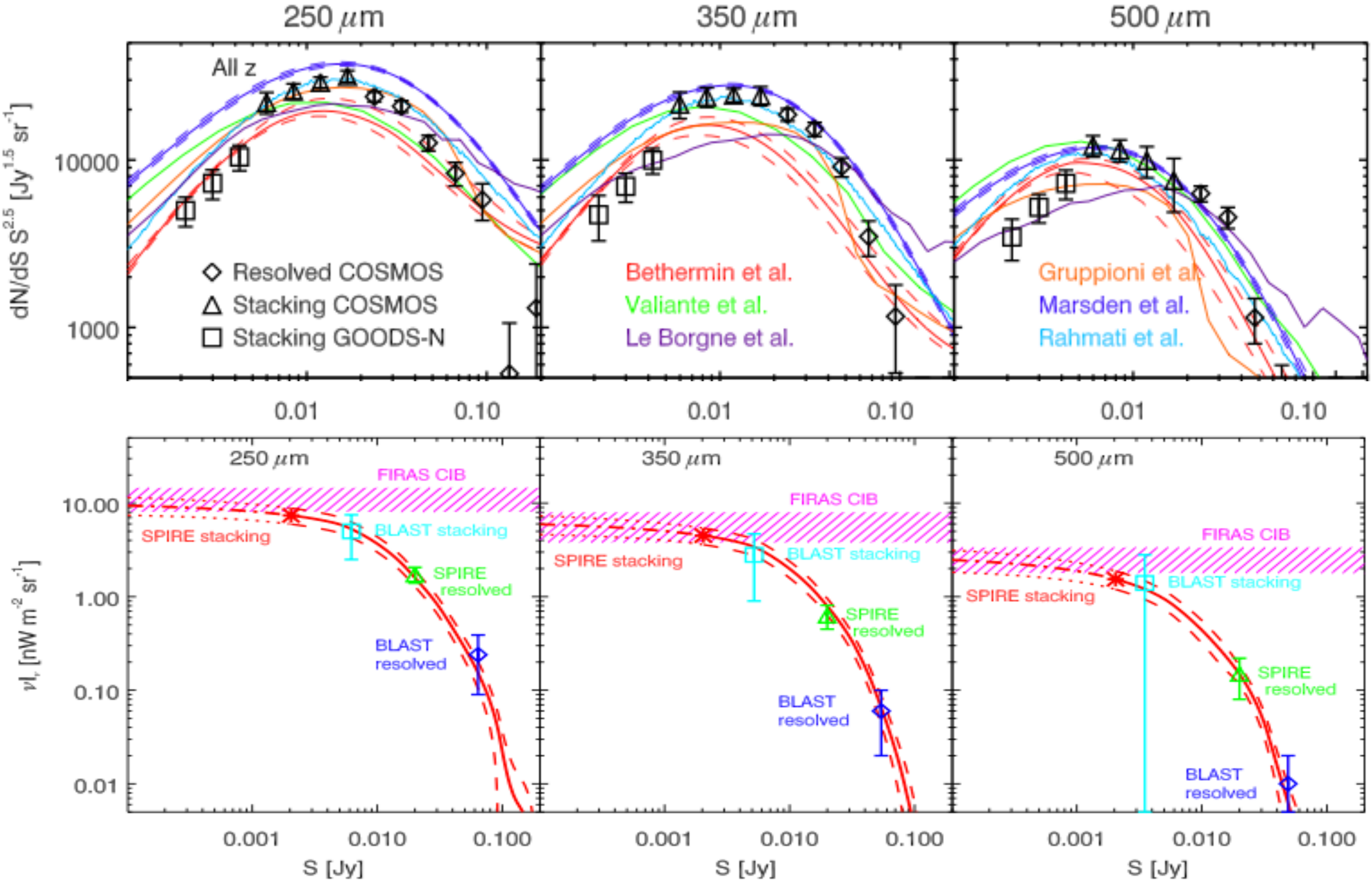




Viero, Moncelsi, Quadri et al. (2013)

arXiv:1304.0446

Deep Counts and the CIB



Bethermin et al. (2012) arXiv: 1203.1925

See also: Heinis++ 2013, Hilton++ 2012

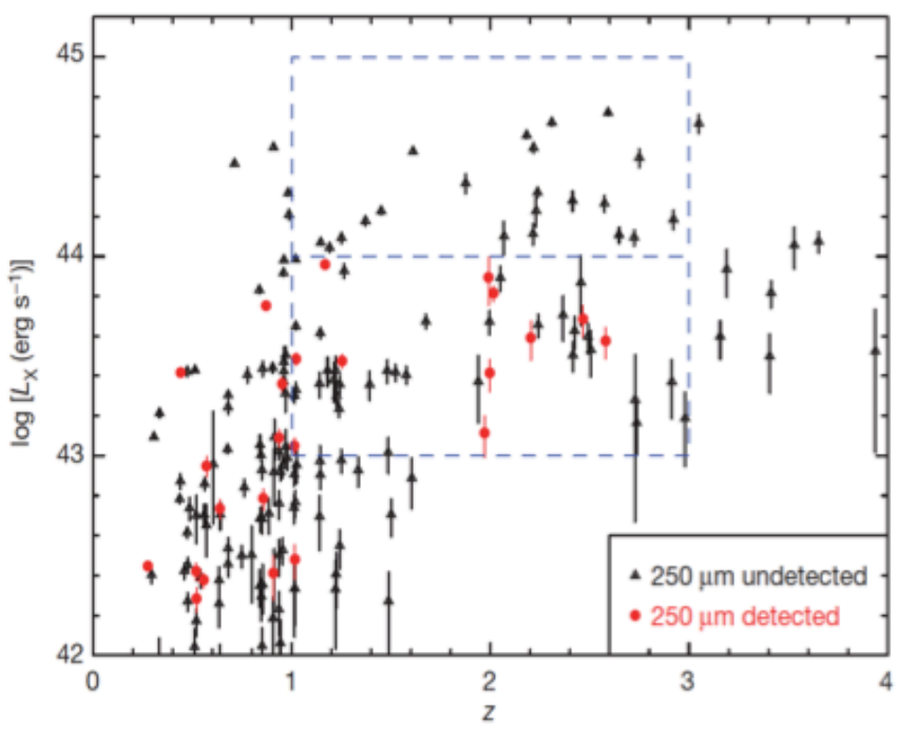
AGN Stacking

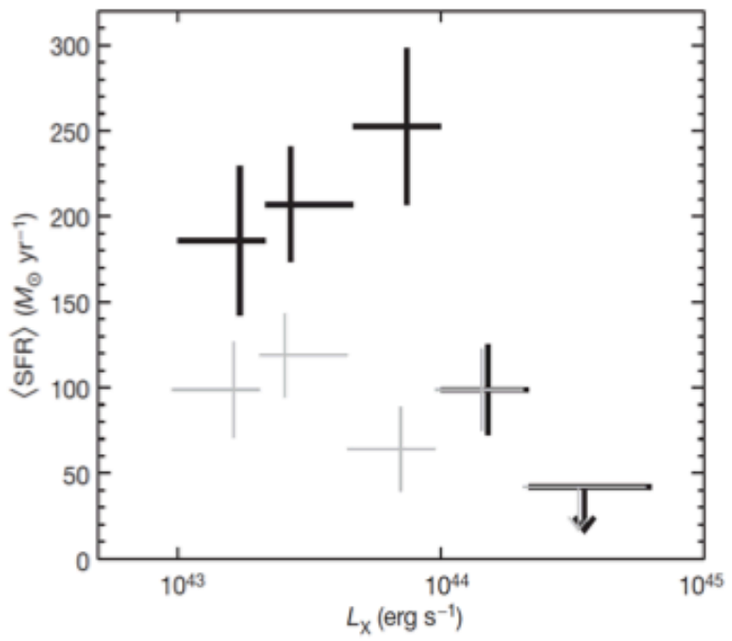
LETTER

doi:10.1038/nature11096

The suppression of star formation by powerful active galactic nuclei

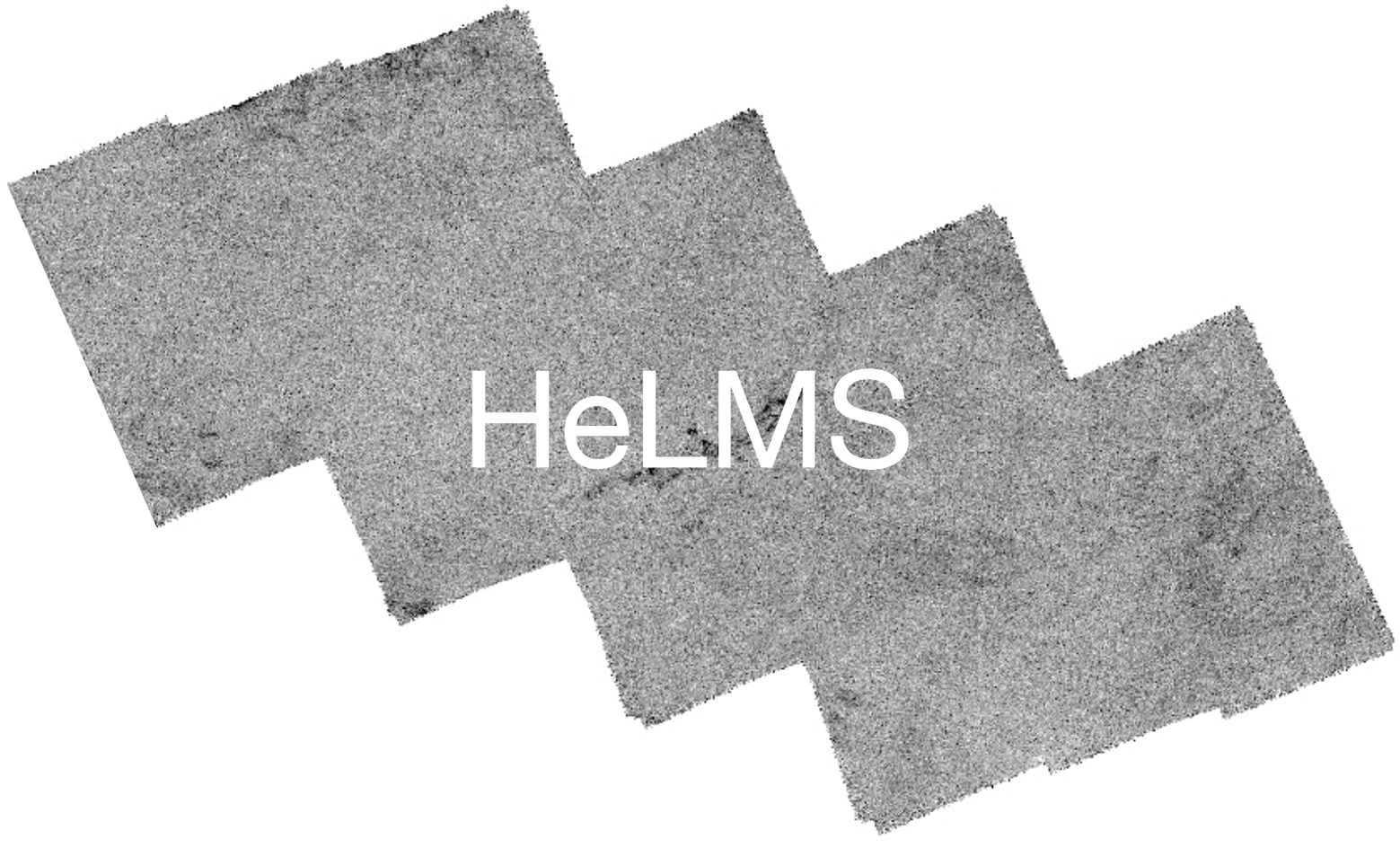
M. J. Page[1], M. Symeonidis[1], J. D. Vieira[2], B. Altieri[3], A. Amblard[4], V. Arumugam[5], H. Aussel[6], T. Babbedge[7], A. Blain[8], J. Bock[2,9], A. Boselli[10], V. Buat[10], N. Castro-Rodríguez[11,12], A. Cava[13], P. Chanial[6], D. L. Clements[7], A. Conley[14], L. Conversi[3], A. Cooray[2,15], C. D. Dowell[2,9], E. N. Dubois[16], J. S. Dunlop[5], E. Dwek[17], S. Dye[18], S. Eales[19], D. Elbaz[6], D. Farrah[16], M. Fox[7], A. Franceschini[20], W. Gear[19], J. Glenn[14,21], M. Griffin[19], M. Halpern[22], E. Hatziminaoglou[23], E. Ibar[24], K. Isaak[25], R. J. Ivison[5,24], G. Lagache[26], L. Levenson[2,9], N. Lu[2,27], S. Madden[6], B. Maffei[28], G. Mainetti[20], L. Marchetti[20], H. T. Nguyen[2,9], B. O'Halloran[7], S. J. Oliver[16], A. Omont[29], P. Panuzzo[6], A. Papageorgiou[19], C. P. Pearson[30,31], I. Pérez-Fournon[11,12], M. Pohlen[19], J. I. Rawlings[1], D. Rigopoulou[30,32], L. Riguccini[6], D. Rizzo[7], G. Rodighiero[20], I. G. Roseboom[5,16], M. Rowan-Robinson[7], M. Sánchez Portal[3], B. Schulz[2,27], D. Scott[22], N. Seymour[1,33], D. L. Shupe[2,27], A. J. Smith[16], J. A. Stevens[34], M. Trichas[35], K. E. Tugwell[1], M. Vaccari[20], I. Valtchanov[3], M. Viero[2], L. Vigroux[29], L. Wang[16], R. Ward[16], G. Wright[24], C. K. Xu[2,27] & M. Zemcov[2,9]





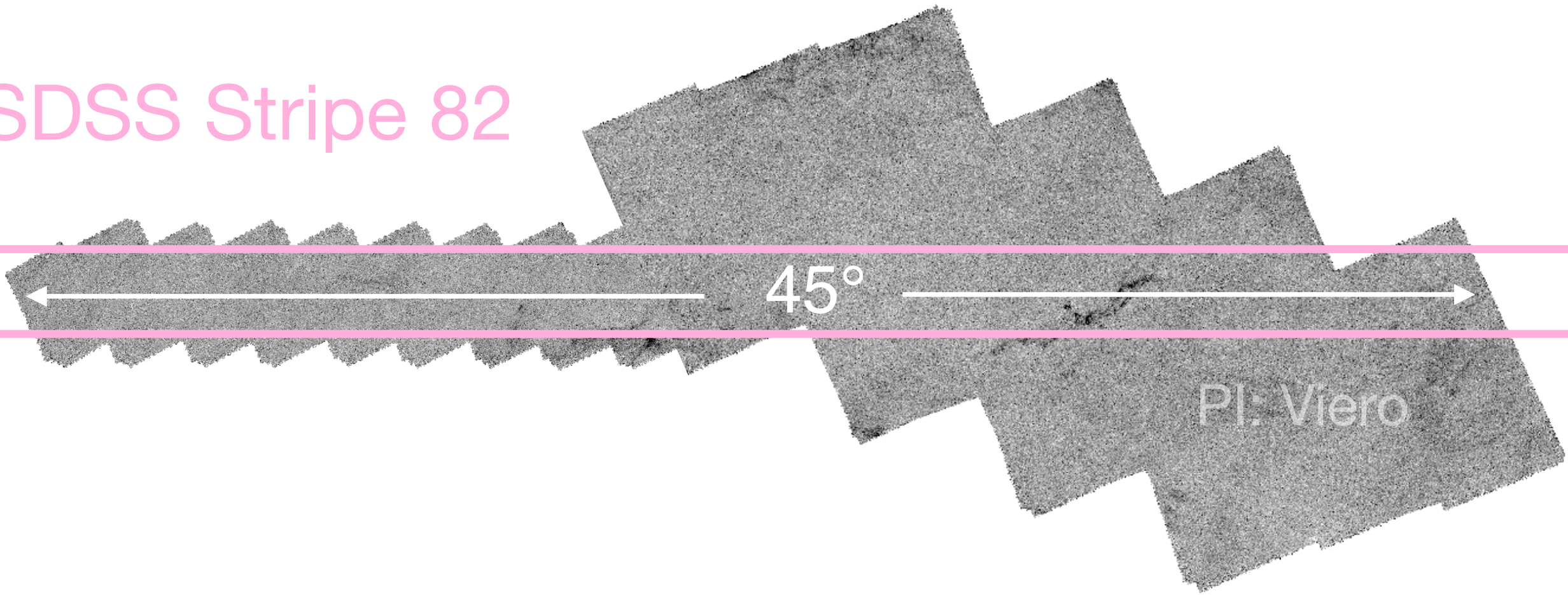
Page++ 2012, *Nature*, 485(7), pp.213–216

See also: Seymour++ 2011, Hatziminaoglou++ 2010, Dai++ 2012

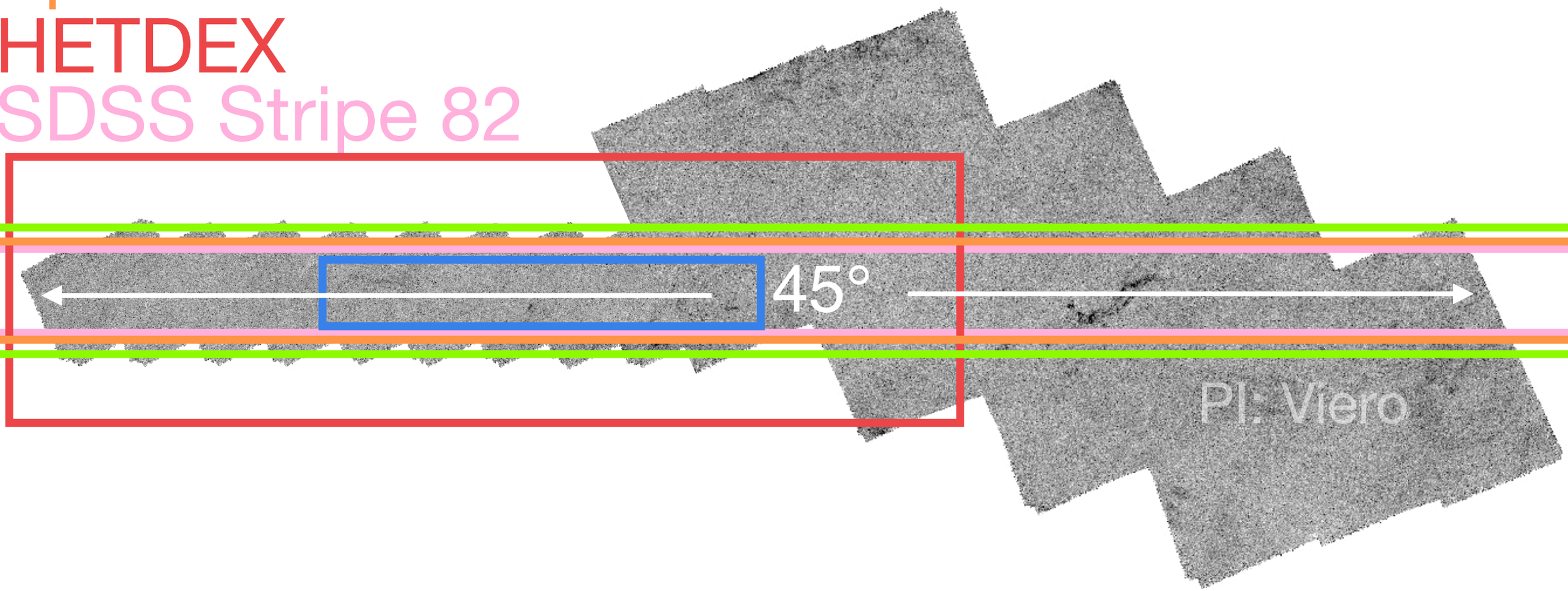


SDSS Stripe 82

SDSS Stripe 82



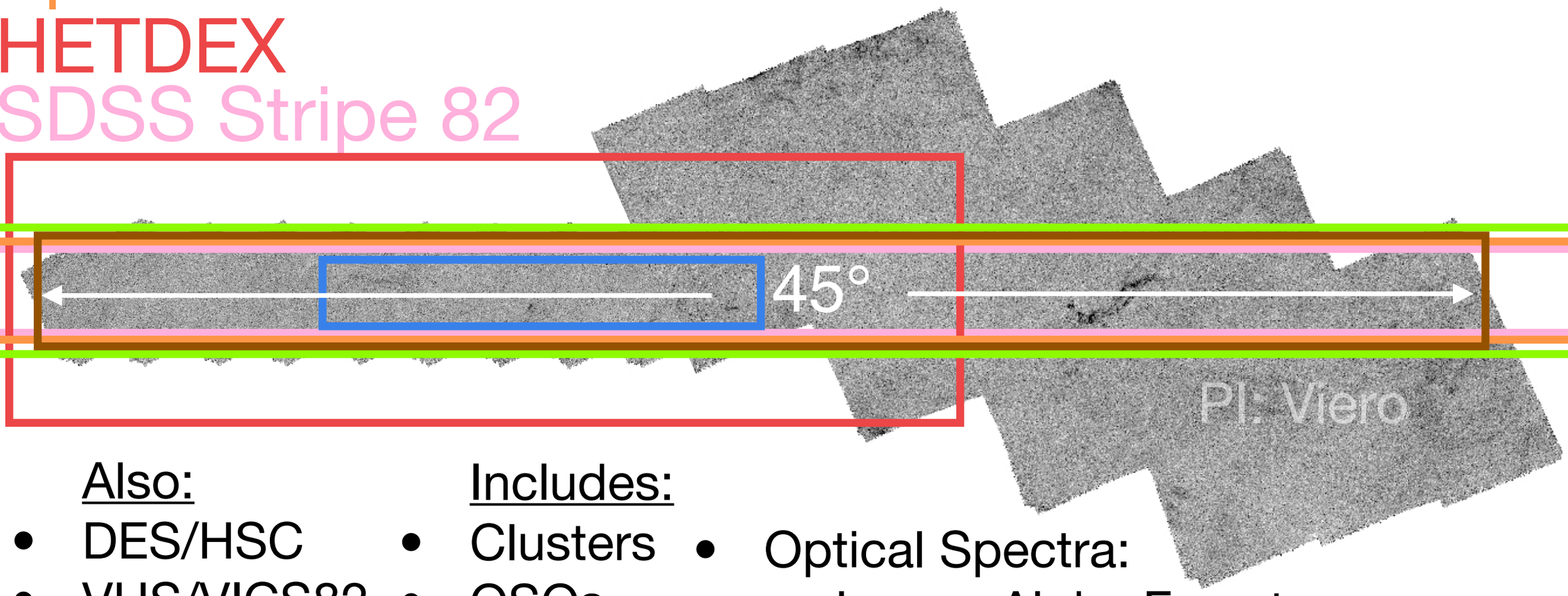
ACT
SHELA
SpIES
HETDEX
SDSS Stripe 82



Viero++2013, Herschel Stripe 82 Survey; arXiv:1308.4399

Find Maps/Catalogs at: http://www.astro.caltech.edu/hers

ACT
SHELA
SpIES
HETDEX
SDSS Stripe 82



Also:

- DES/HSC
- VHS/VICS82
- VLA
- Wiggle-z
- LSST

Includes:

- Clusters
- QSOs
- LRGs
- maxBCGs
- HI

- Optical Spectra:
  - Lyman Alpha Forest
  - DLAs/Mg2/CIV

END!