Spitzer and the Cosmic Infrared Background

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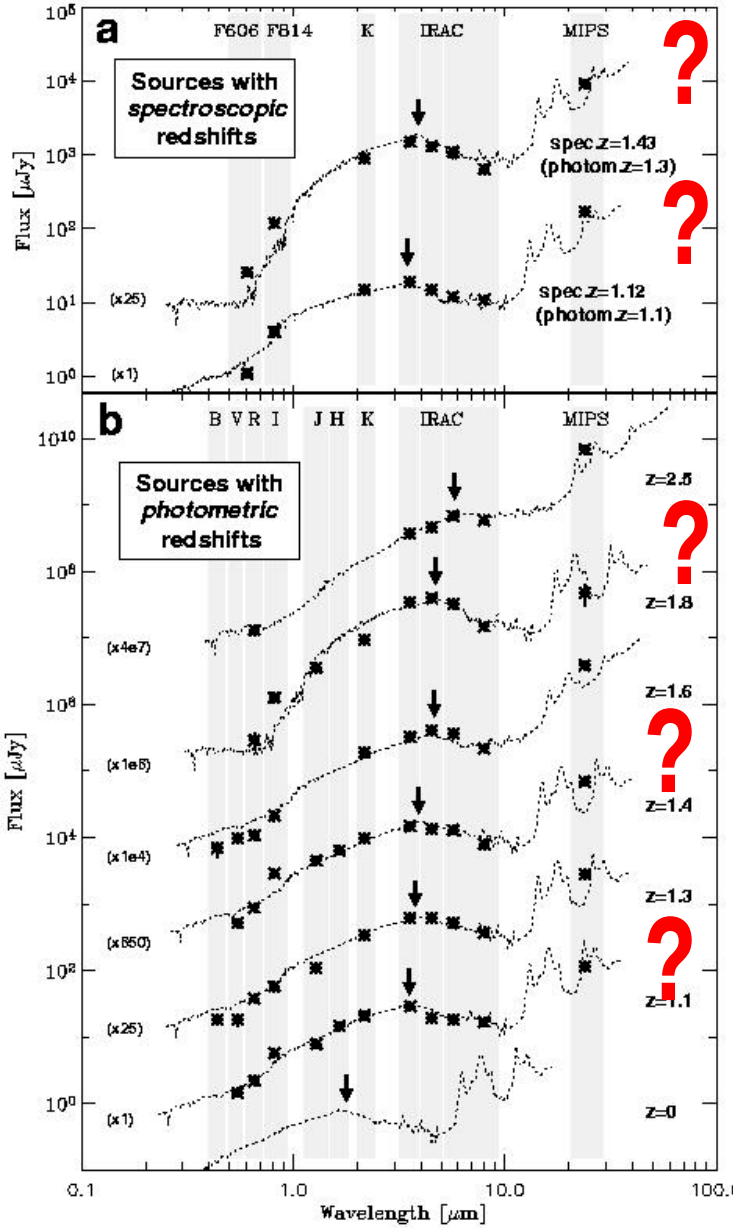
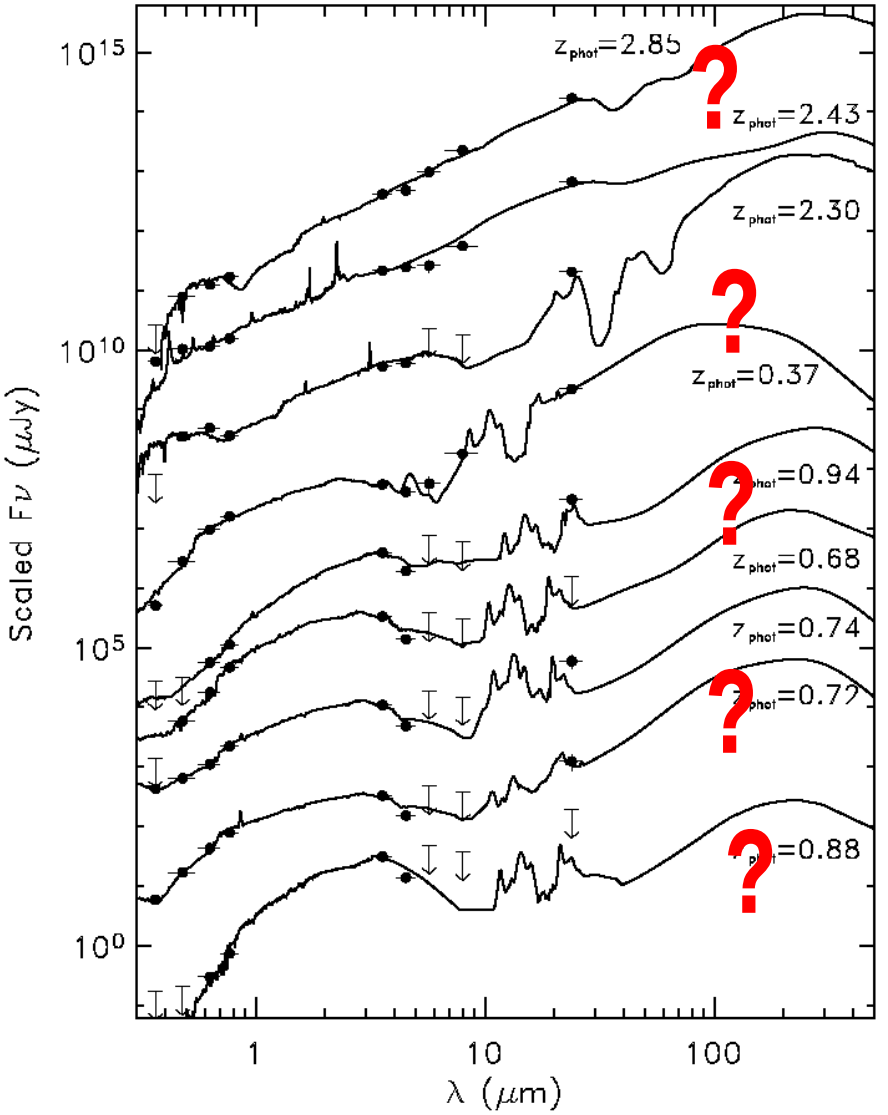
Guadeloupe, FWI, H. Dole, 2005

Getting SEDs





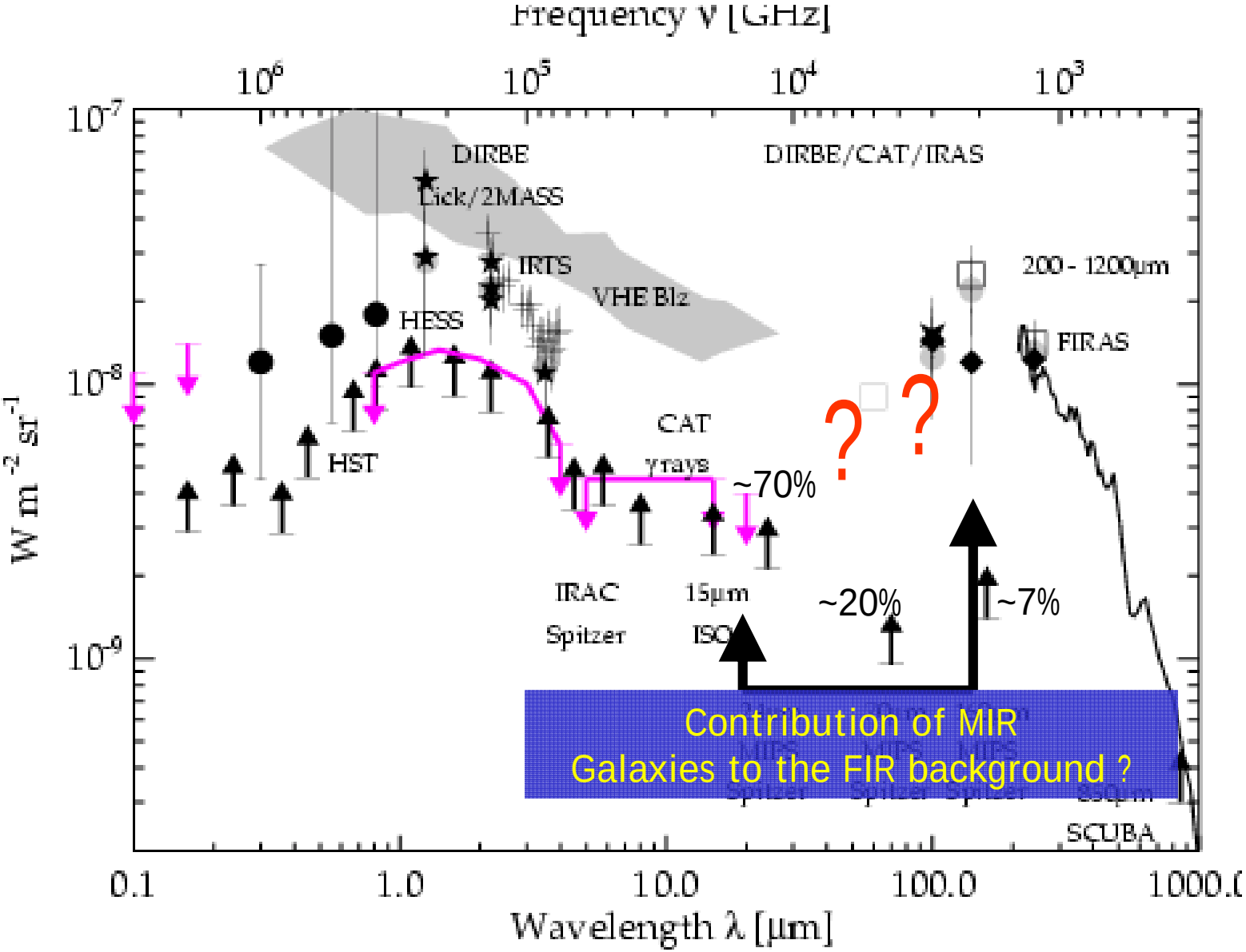
Le Floc'h et al., 2004
Lonsdale et al., 2004

Cosmic Infrared Background

-What is the Nature of the Galaxies Making-up the FIR CIB ?

-What is the Contribution of the MIR Galaxies to the FIR CIB ?

-Use 24um Galaxies to probe the CIB



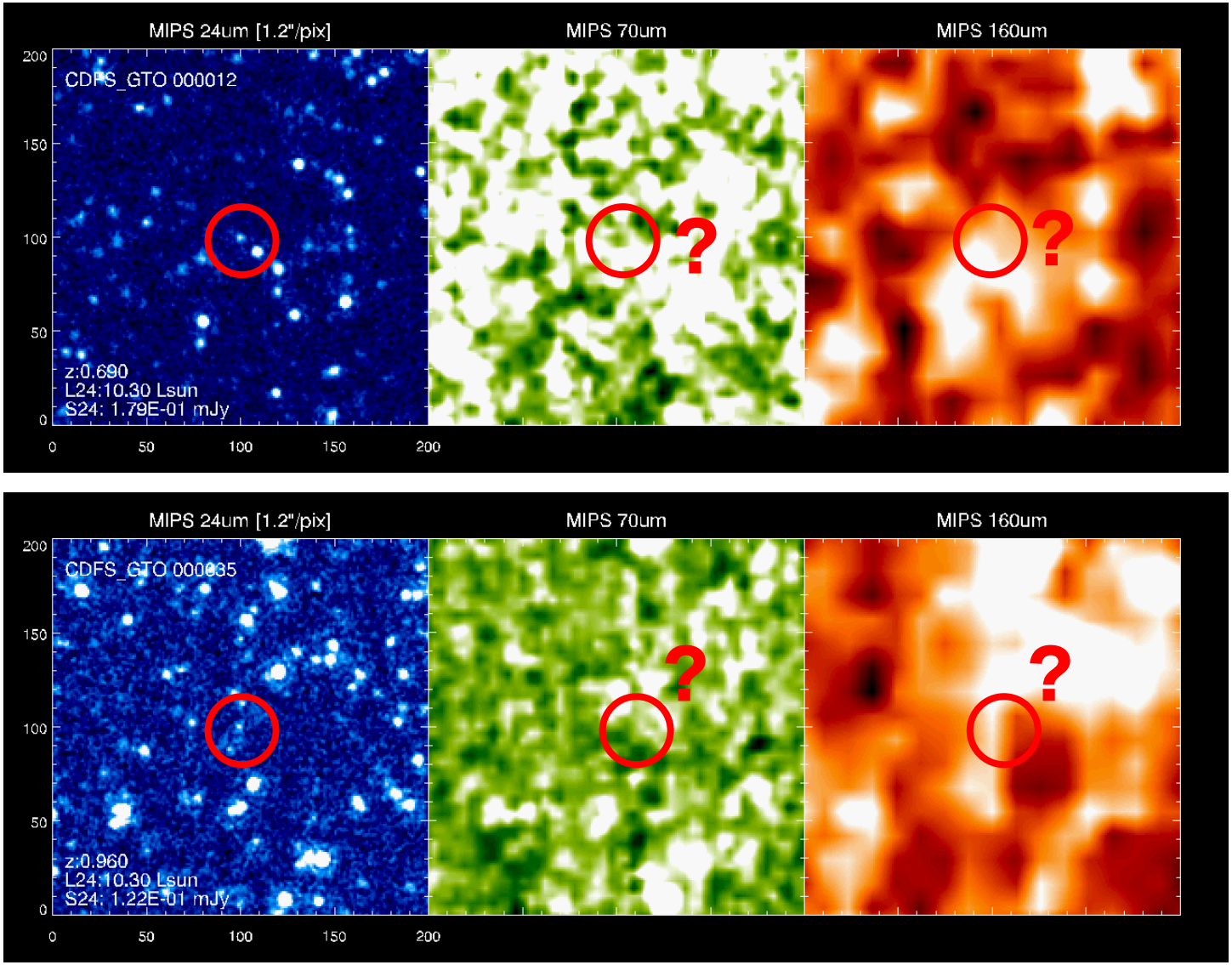
Dole et al., 2006, A&A, 451, 417

The Problem: Confusion & Noise

What to Measure at 70 and 160 when a 24µm source exists ?

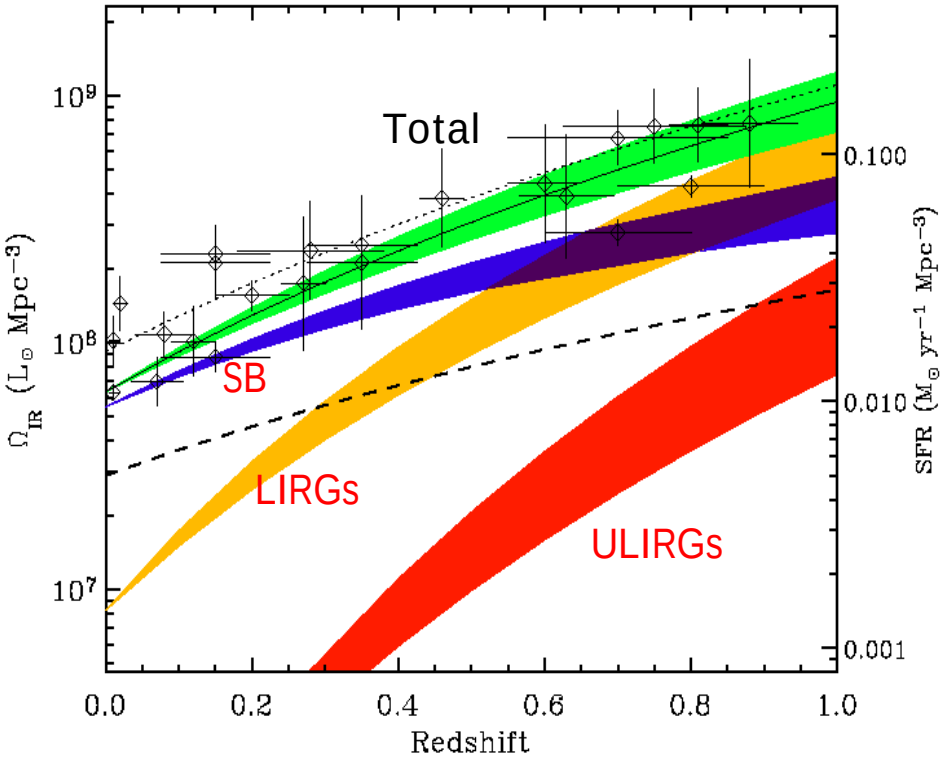
Example of 24µm sources: nothing can simply be detected in the FIR.

z~0.7 180uJy
z~1 120uJy



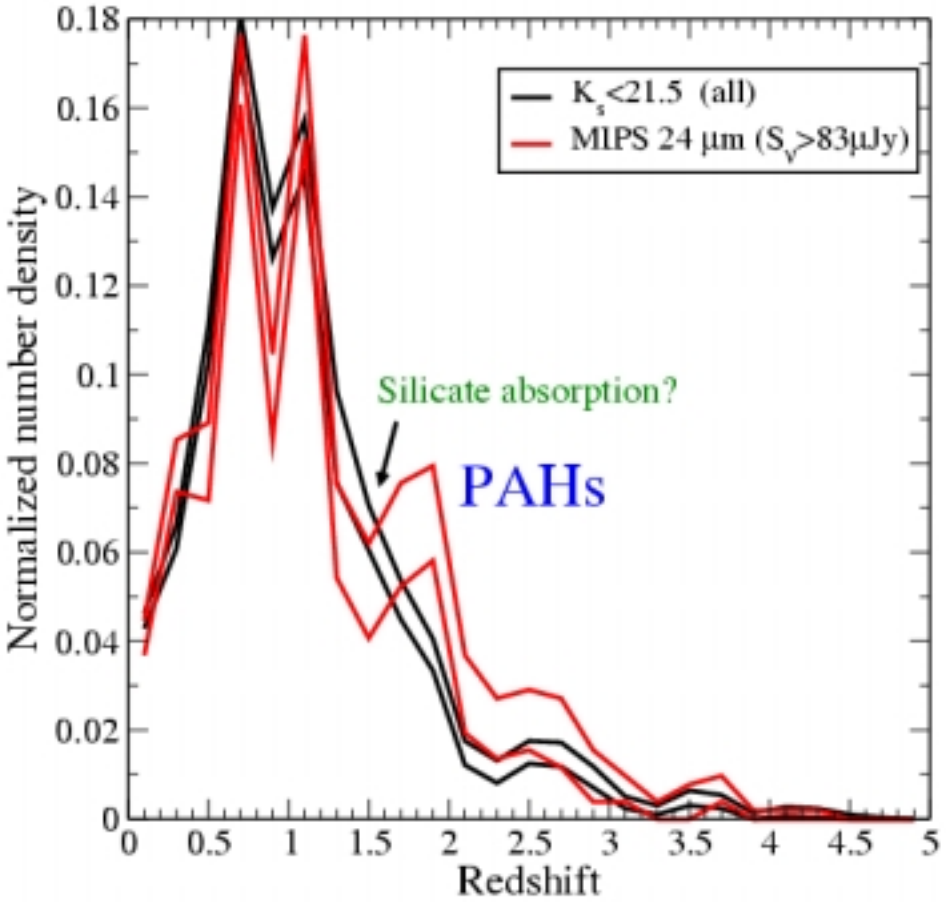
The Solution: 24um Sources

24μm Galaxies: e.g. in CDFS



Le Floc'h et al, 2005, ApJ

At z~1, ~70% of IR energy density comes from LIRGs

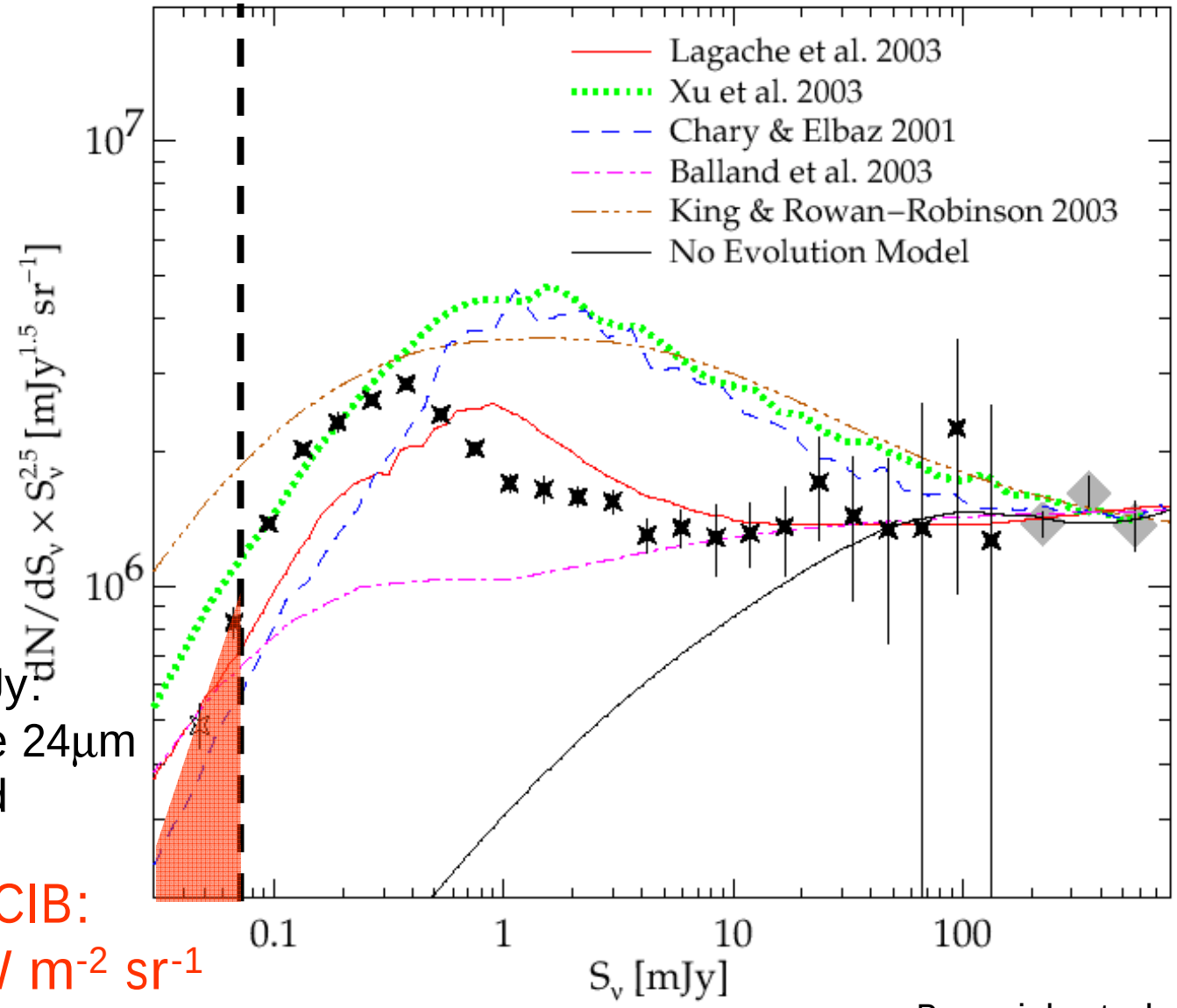


Caputi et al, 2006, ApJ

~30% of galaxies have z>1.5

+ Luminosity Functions up to z~2
(Le Floc'h; Pérez-González; Caputi)

24um Source Counts & CIB

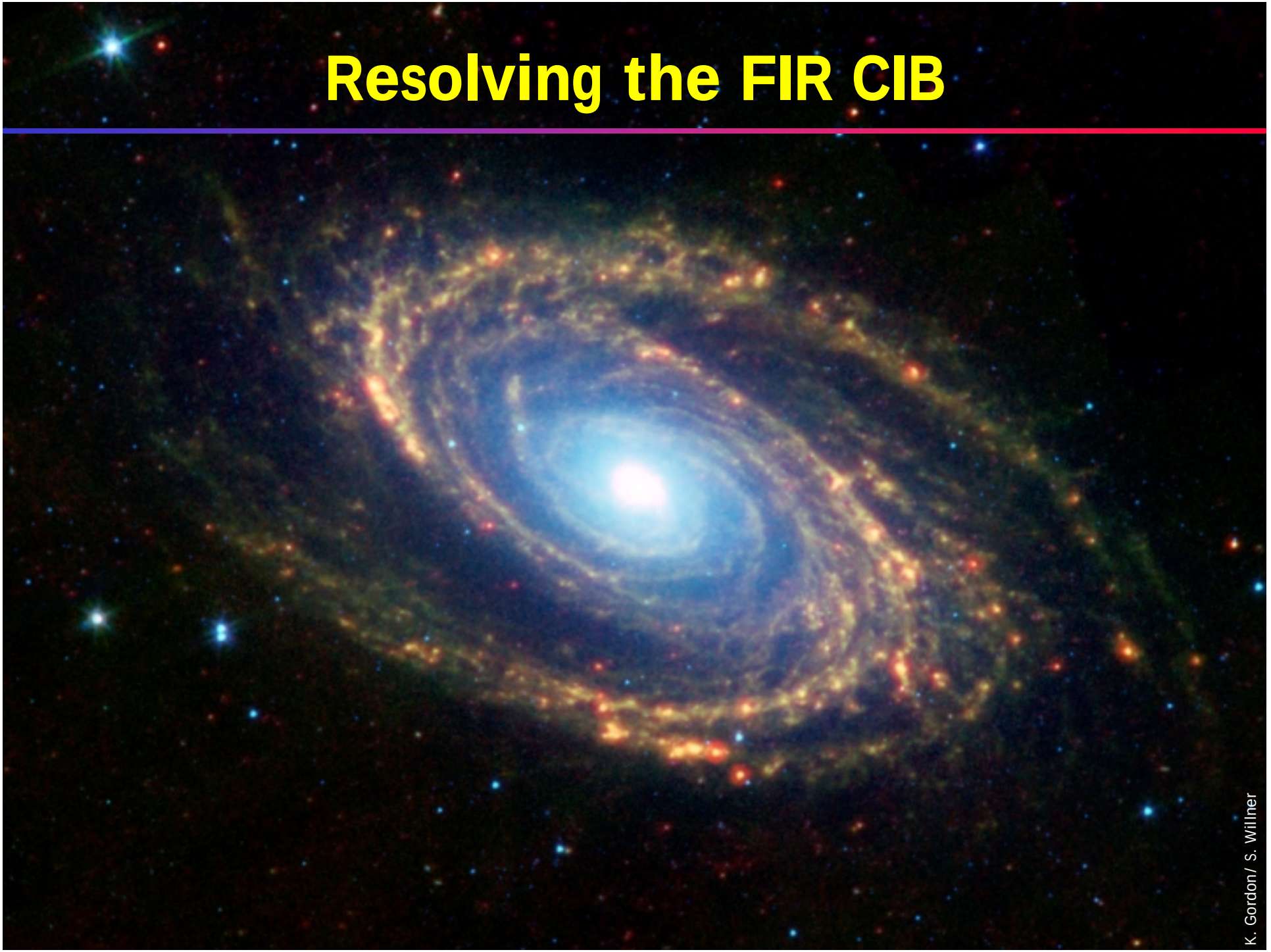


Below 60μJy:
<30% of the 24μm Background

24μm CIB:
2.7 nW m^{-2} sr^{-1}

Papovich et al., 2004

Resolving the FIR CIB

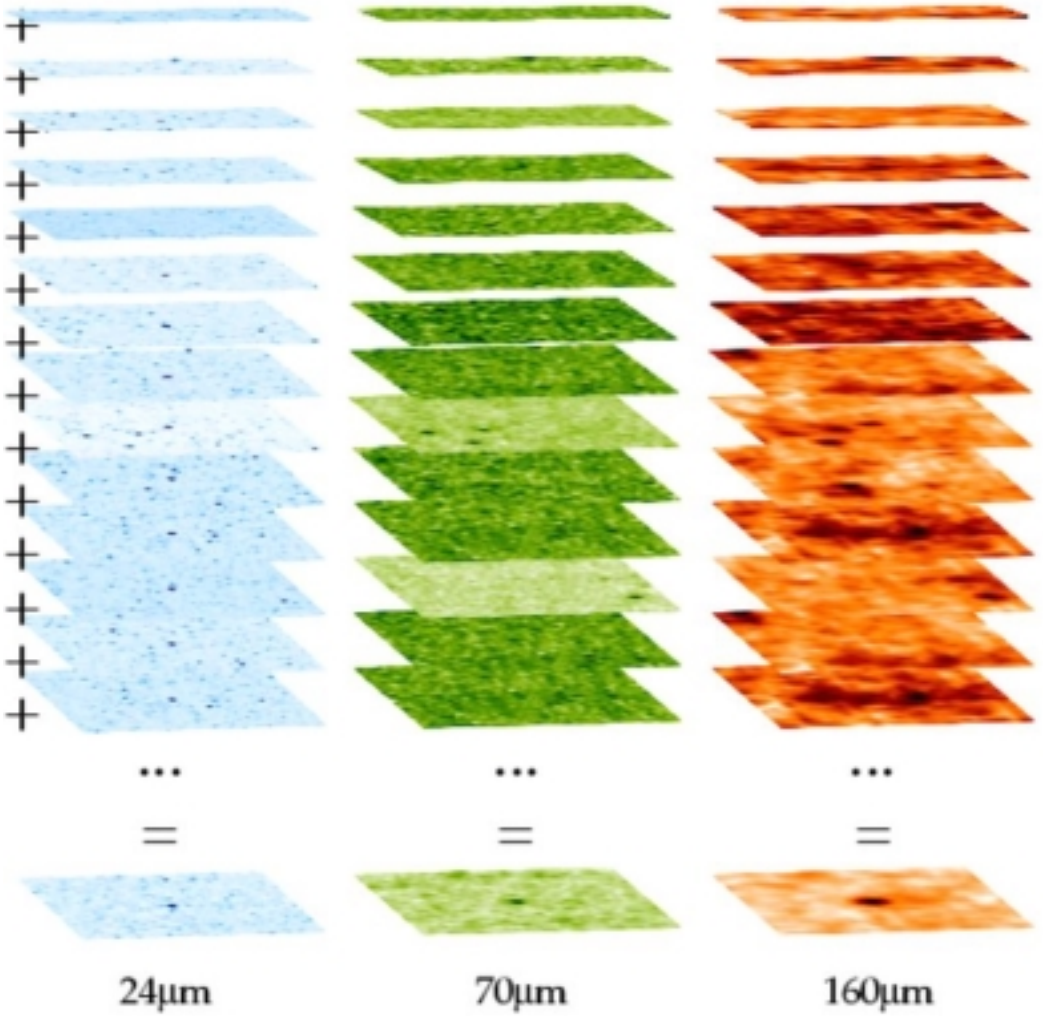


MIPS Stacking Analysis

Dole et al., 2006

Stack ~19000 Galaxies

Watch the Movie at the end of this talk



MIPS 24

Stacking Analysis

-Use 24μm Sources to probe the CIB

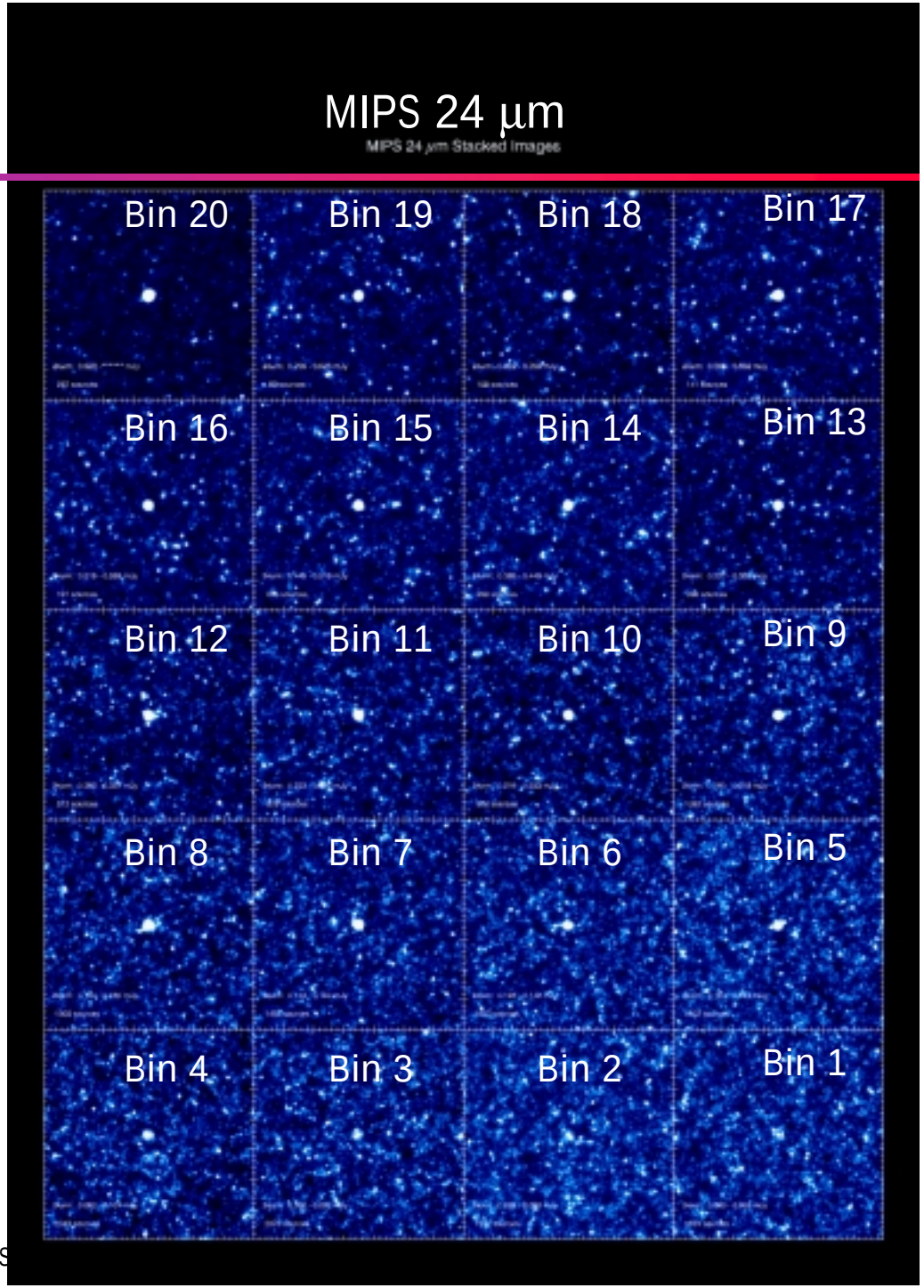
-Take Every 24μm Source in a Flux Bin

-Add Signal at 24

-Add also the Signal at 70 and 160 at the Same Positions

-Stop at S_{24}= 60μJy (50% completeness)

3 GTO Fields
~0.9 Sq. Deg.
~19000 sources

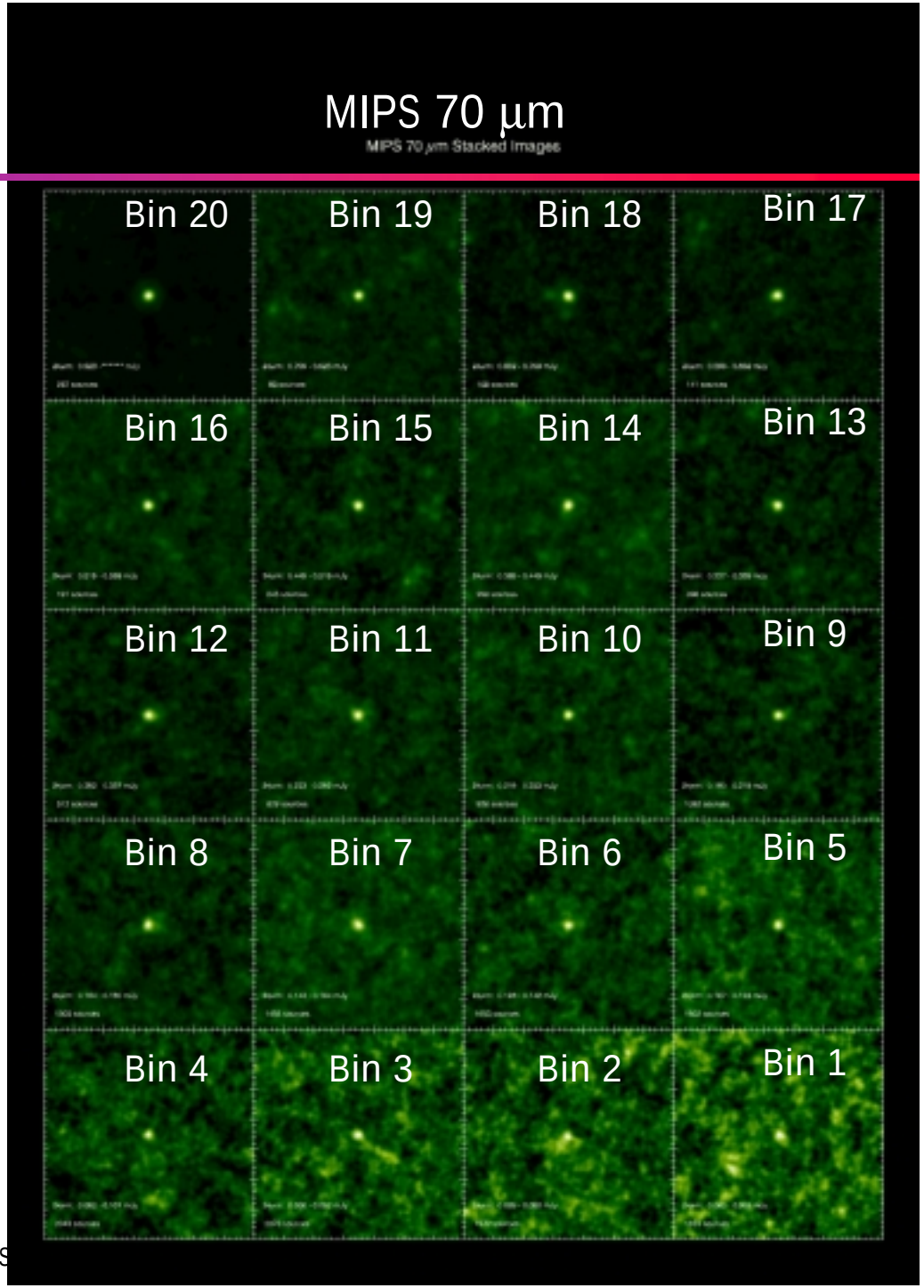


Dole et al., 2006, A&A, 451, 417

MIPS 70

S_{24} bins:

#	flux range	# added sources
20-	> 0.92 mJy	267 gal
19-	800-920 mJy	83 gal
18-	690-800 mJy	108 gal
17-	590-690 mJy	141 gal
16-	520-590 mJy	191 gal
15-	450-520 mJy	245 gal
14-	390-450 mJy	298 gal
13-	337-390 mJy	396 gal
12-	292-337 mJy	512 gal
11-	250-292 mJy	679 gal
10-	219-250 mJy	820 gal
9-	190-219 mJy	1092 gal
8-	164-190 mJy	1300 gal
7-	142-164 mJy	1458 gal
6-	123-142 mJy	1653 gal
5-	107-123 mJy	1902 gal
4-	92-107 mJy	2040 gal
3-	80-92 mJy	2073 gal
2-	69-80 mJy	1972 gal
1-	**60-69 mJy**	1851 gal



Dole et al., 2006, A&A, 451, 417

MIPS 160

S_{24} bins:

#	flux range	# added sources
20-	> 0.92 mJy	267 gal
19-	800-920 mJy	83 gal
18-	690-800 mJy	108 gal
17-	590-690 mJy	141 gal
16-	520-590 mJy	191 gal
15-	450-520 mJy	245 gal
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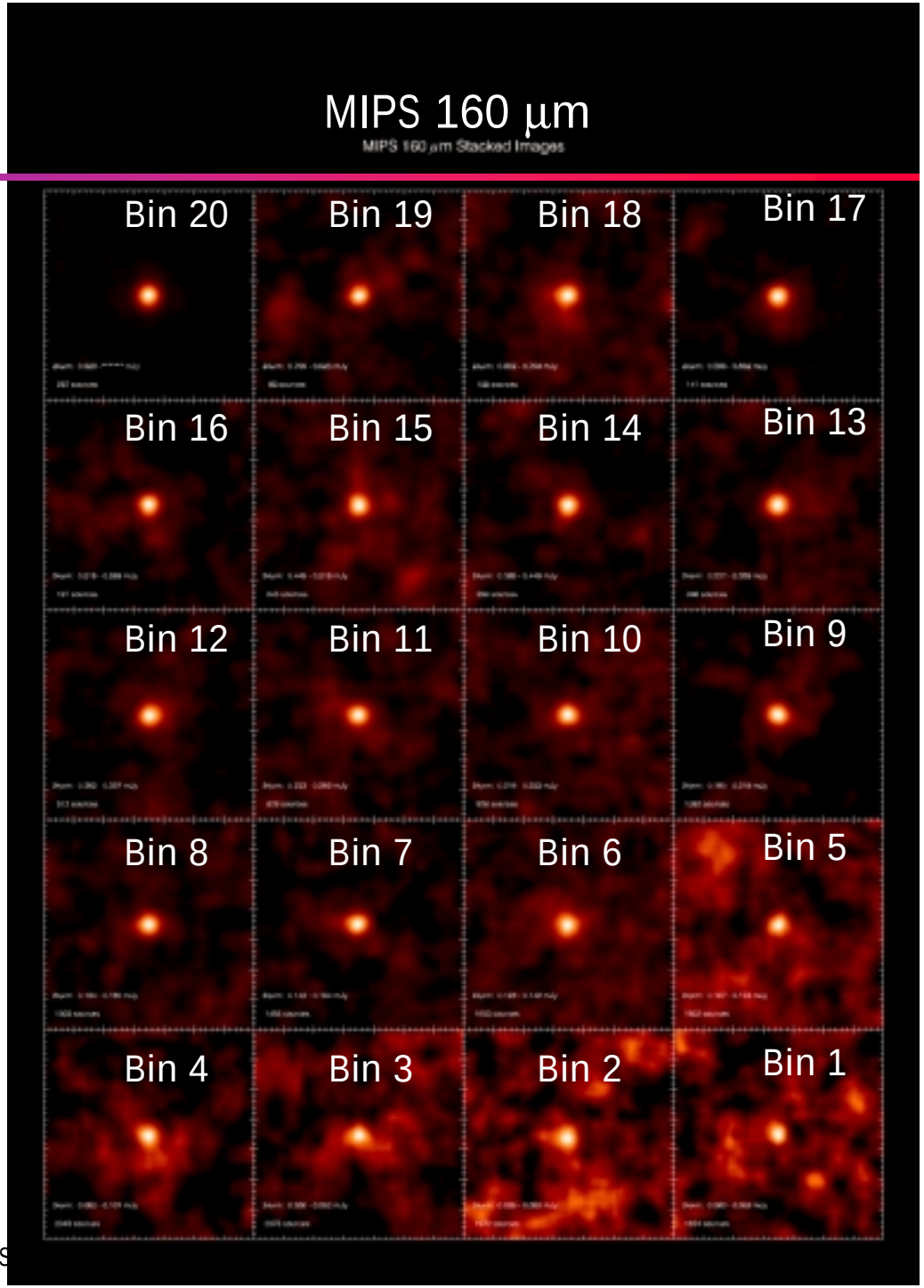
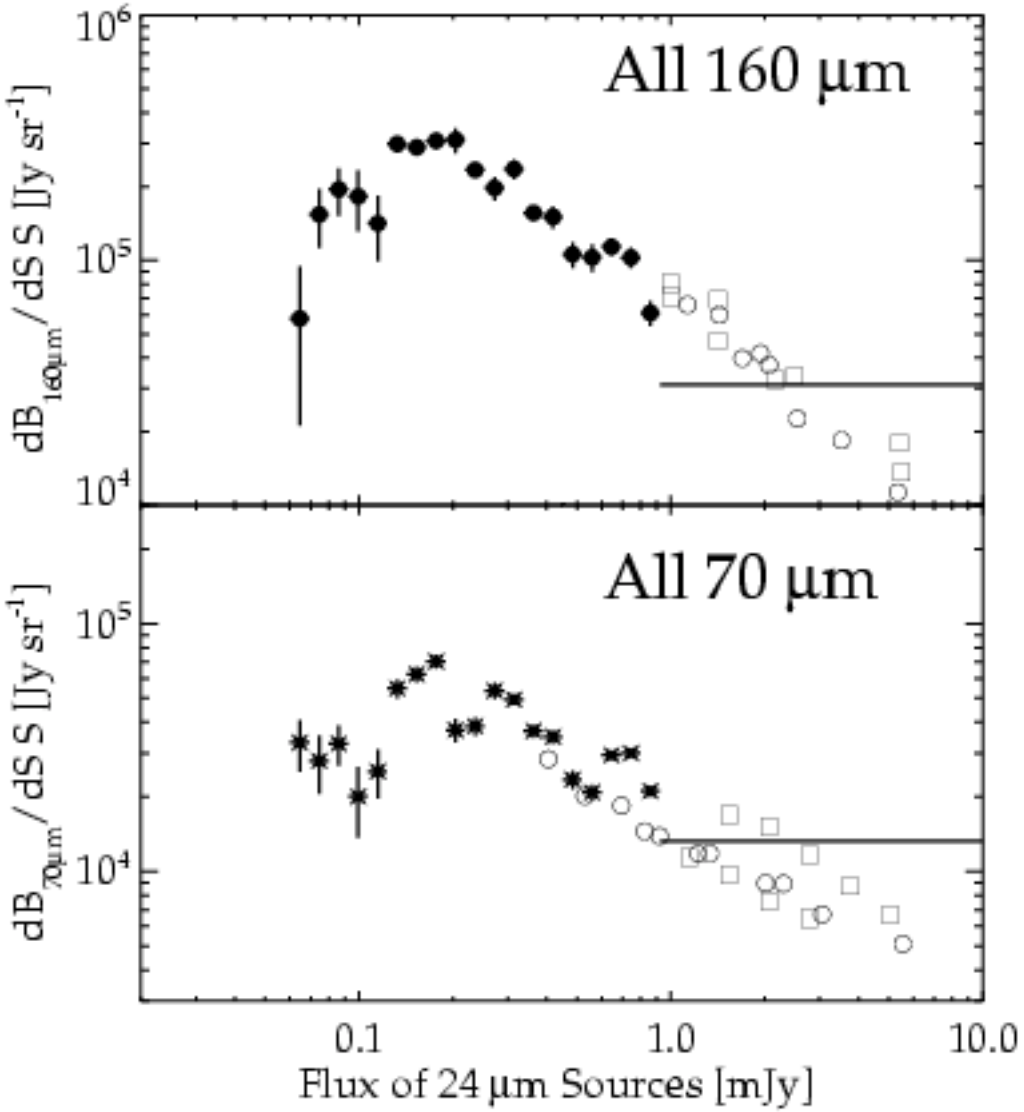


Dole et al., 2006, A&A, 451, 417

CIB Resolved !!!

Contributions to the CIB

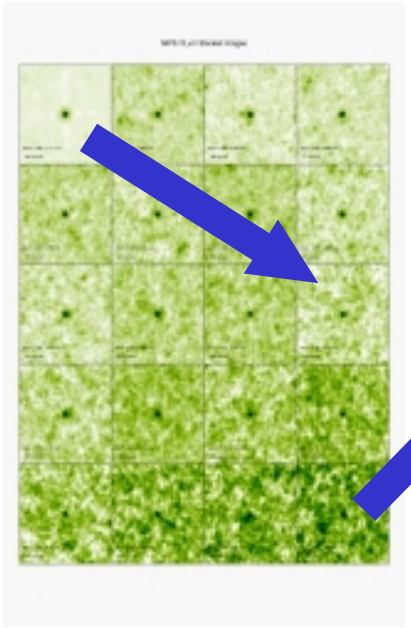


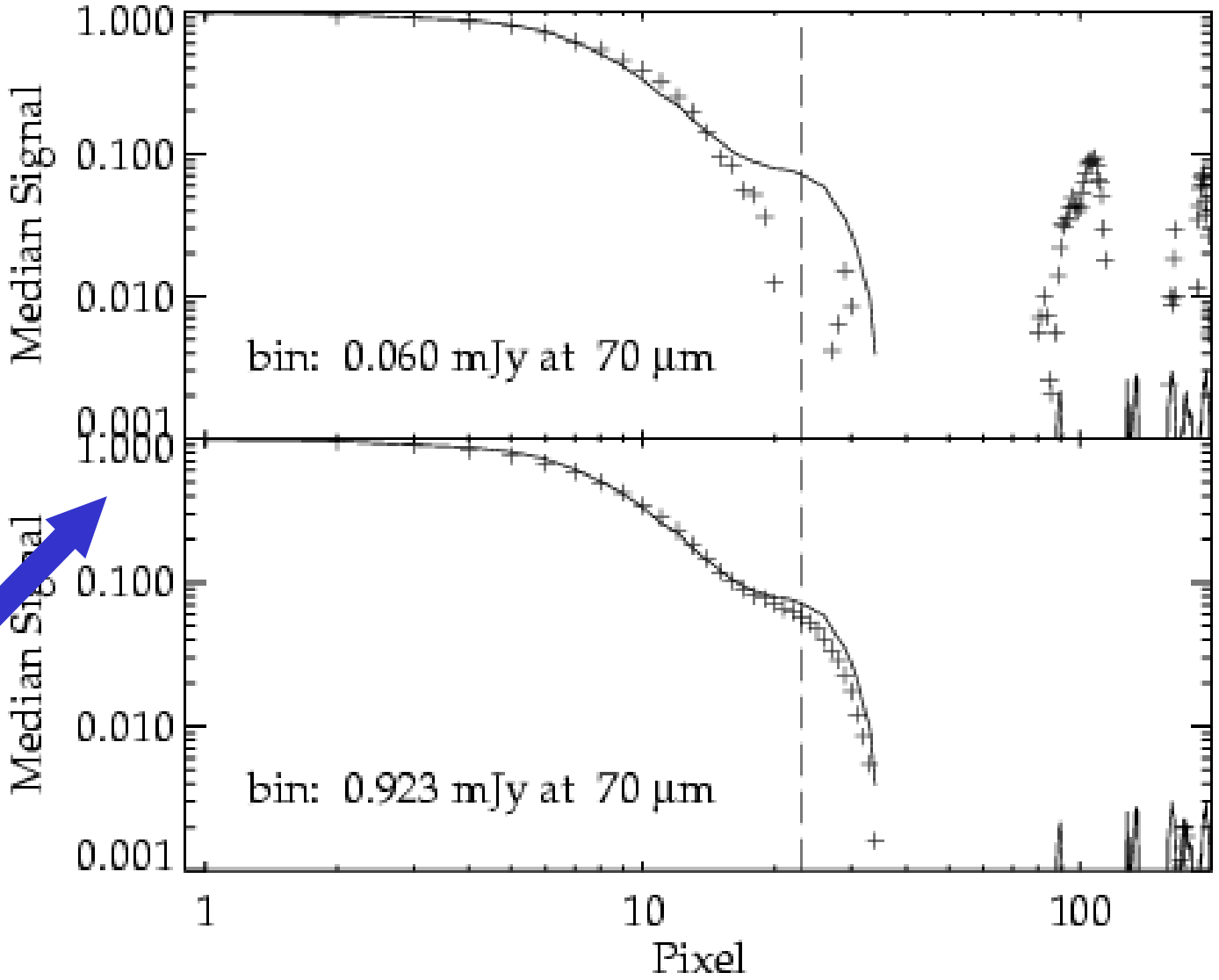
Source Counts from:
-Dole et al, 2004
-Frayer et al, 2005

CIB resolved at:
- 1.6mJy @70
- 6mJy @160

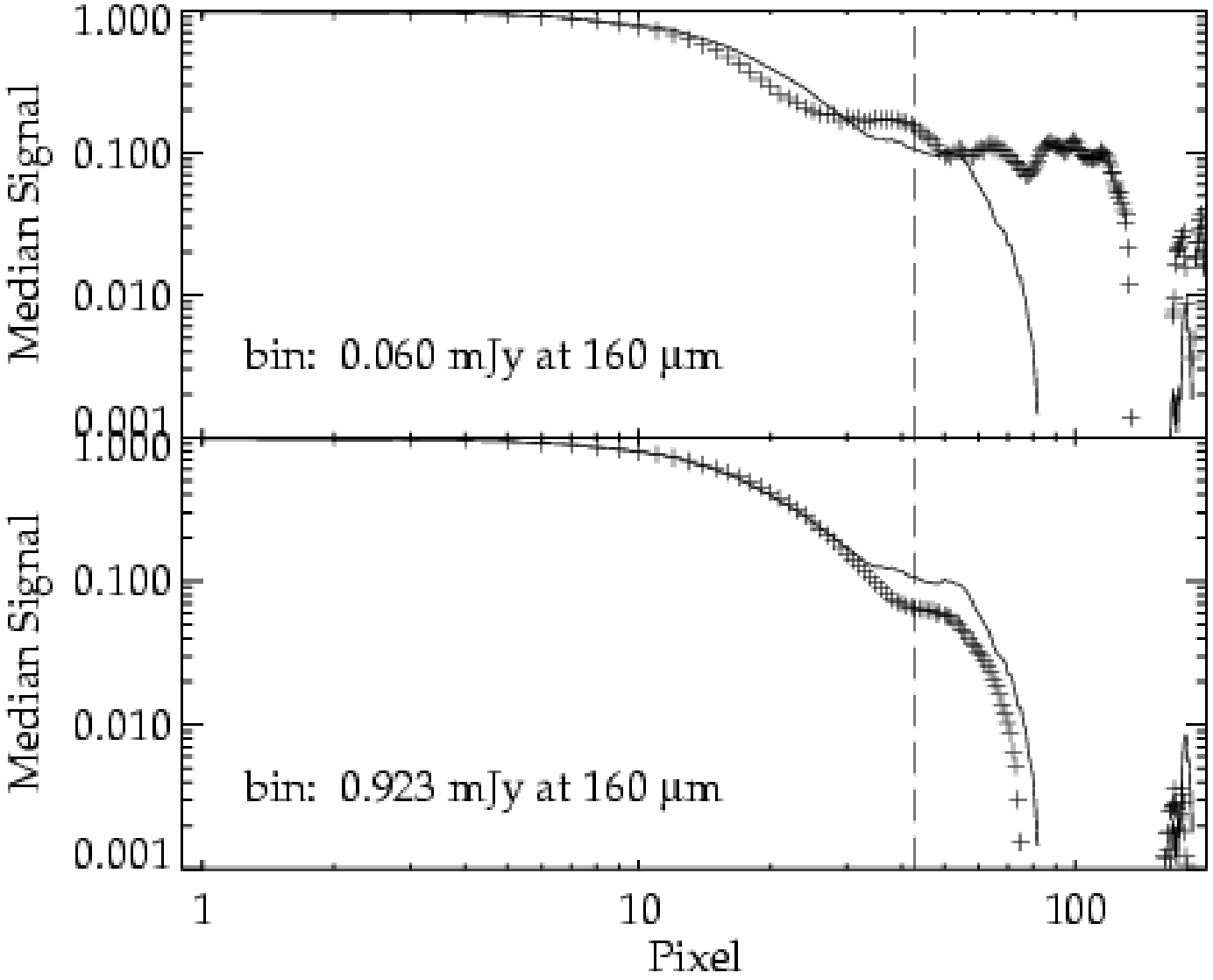
Dole et al., 2006, A&A, 451, 417

Radial Profiles at 70um





Radial Profiles at 160um



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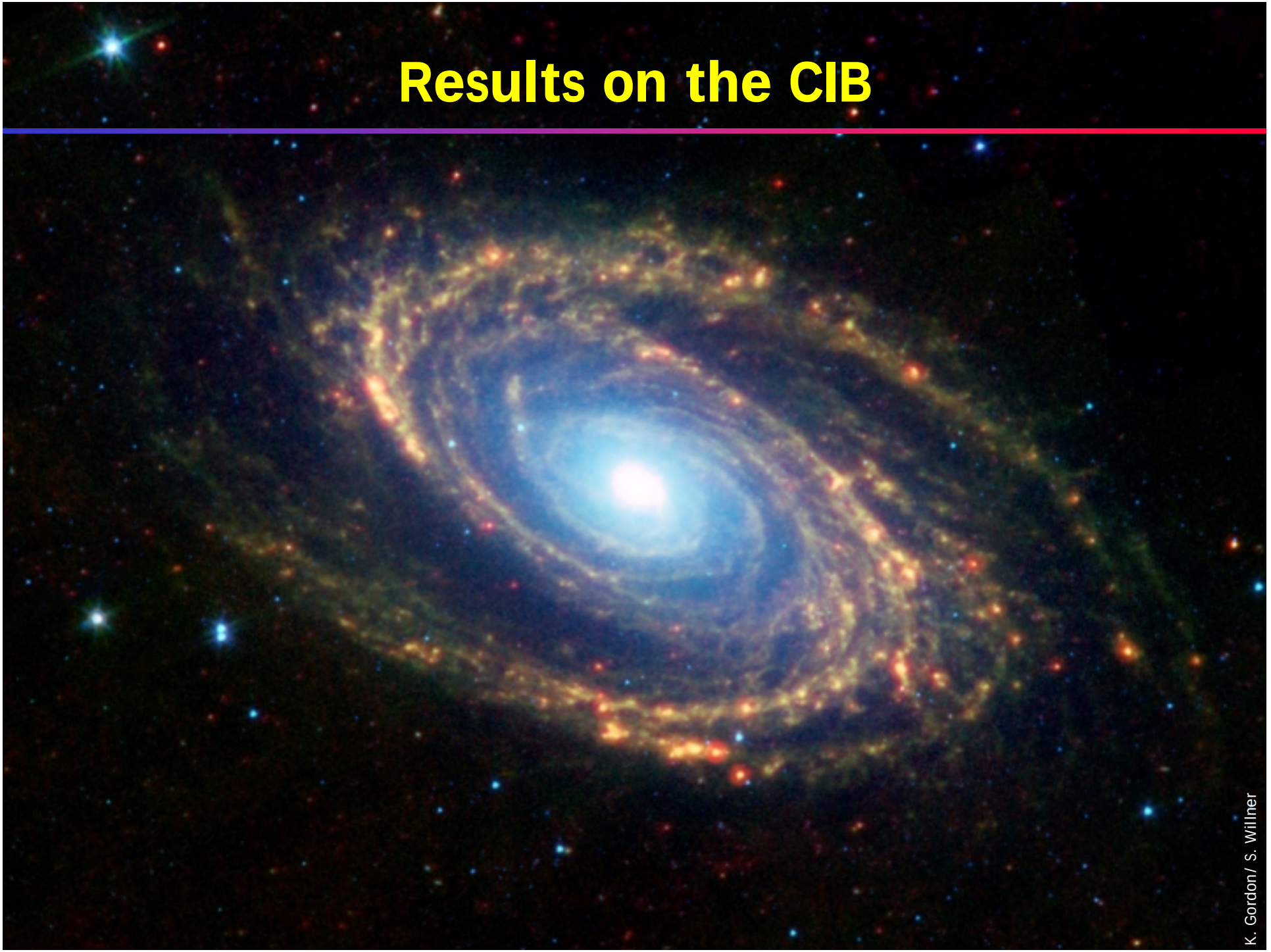
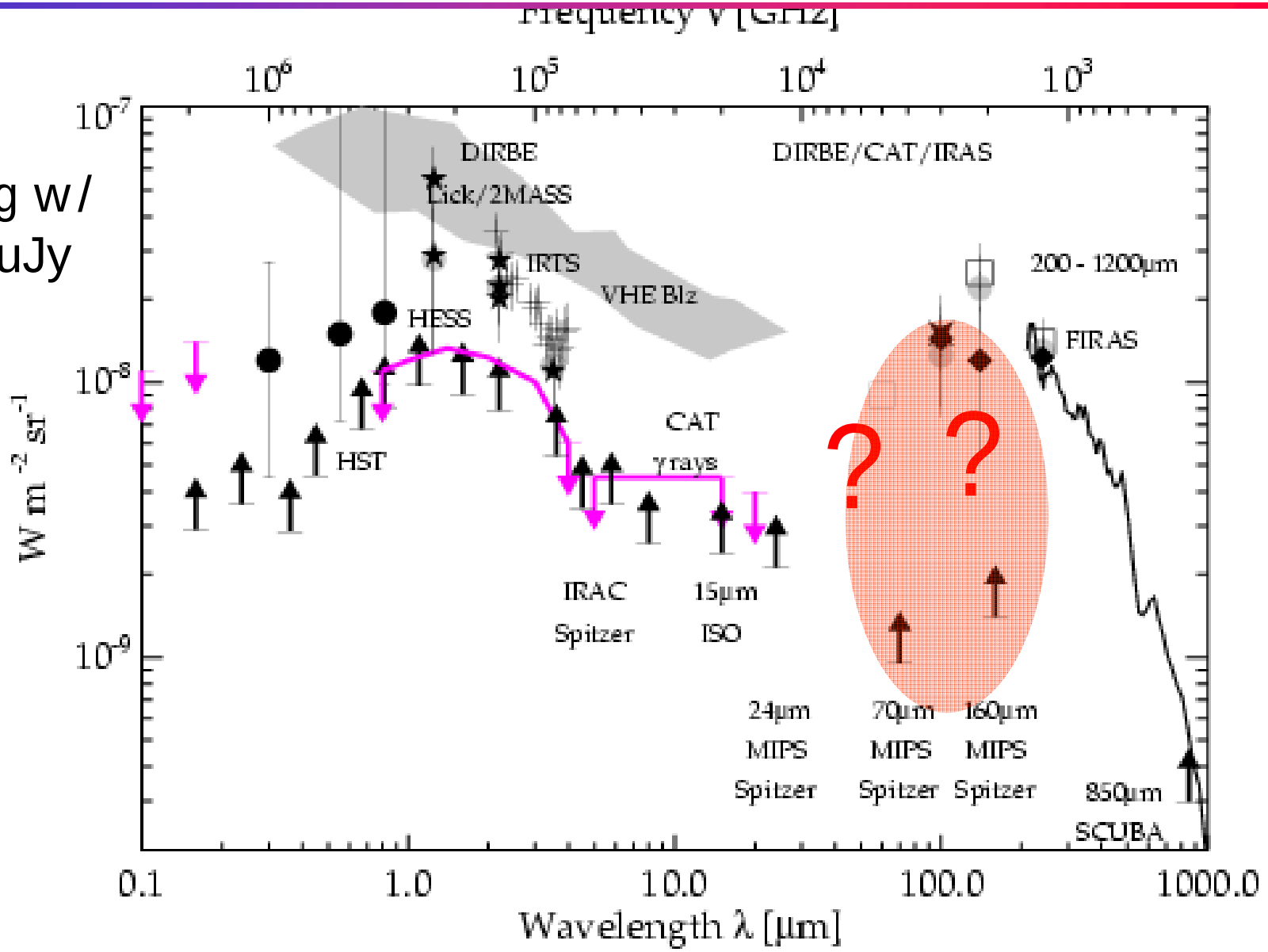
Results on the CIB



EBL and CIB

Stacking w/
S_{24}>60uJy



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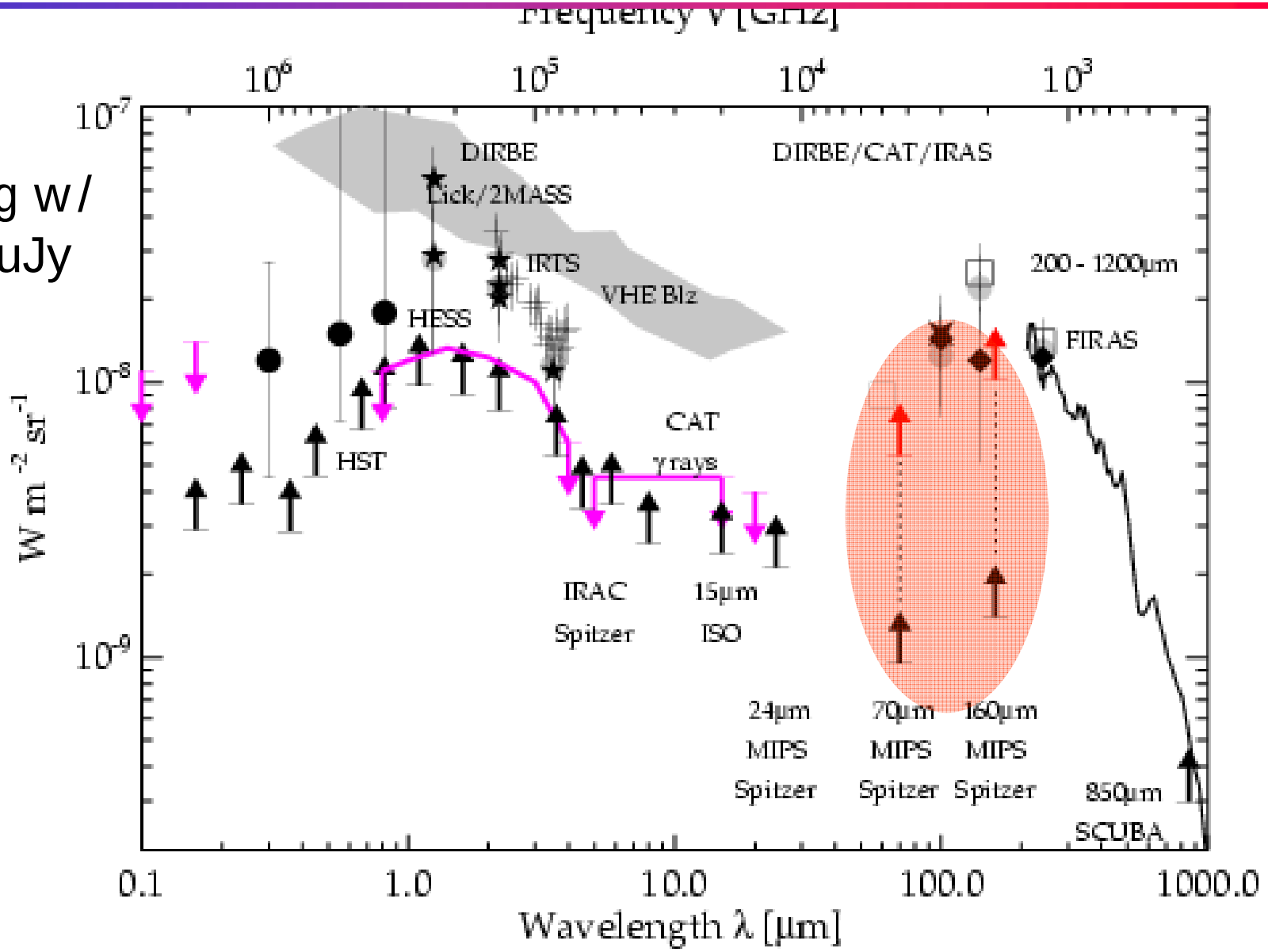
EBL and CIB

Stacking w/
S_{24}>60uJy



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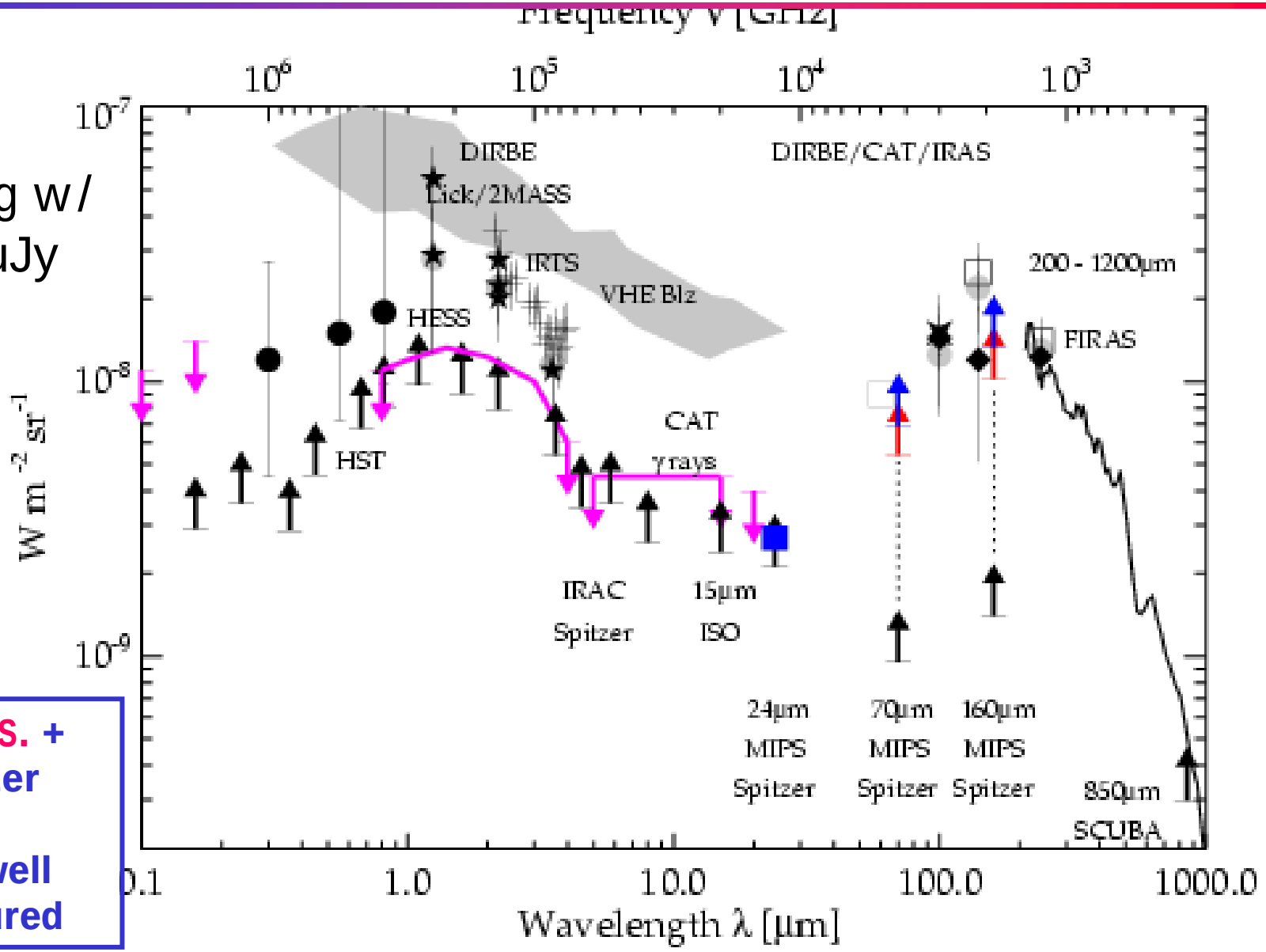
EBL and CIB

Stacking w/
S_{24}>0uJy



H.E.S.S. + Spitzer = EBL well measured

Dole et al., 2006, A&A, 451, 417

Cosmic Infrared Background

- Galaxies Making-up the CIB
  - 24um galaxies [S_{24}>60μJy] contribute to ~80% of the FIR CIB
    - Measured, completely model-independent
    - Confims Elbaz et al (2002) model-dependent result
  - MIR galaxies are thus good tracers of galaxies making-up the bulk of the CIB
  - We can also probe the CIB deeper for the S_{24}<60μJy galaxies …

- New Estimate of the FIR CIB
  - Using Stacking Analysis [S_{24}>60μJy]
  - Using unresolved bkg at 24μm [S_{24}< 60μJy]
  - Using 70/24 and 160/24 observed colors

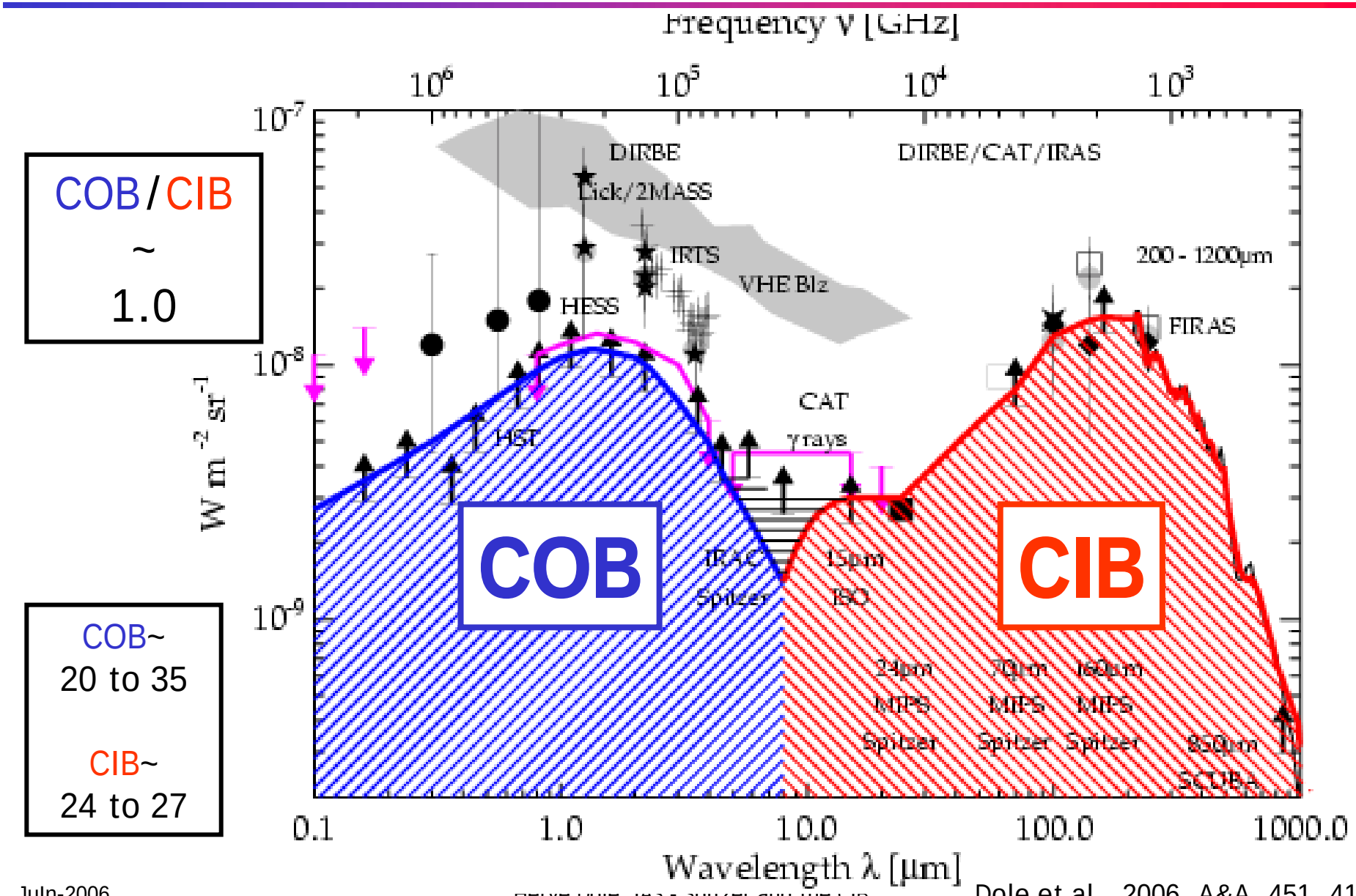
CIB	24 um	70 um	160 um
CIB nW m^{-2} sr^{-1}	2.7	**7.1 +/- 1.0**	**13.4 +/- 1.7**
CIB MJy/sr	0.021	**0.16 +/- 0.02**	**0.71 +/- 0.09**

Extragalactic Background Light

COB / CIB
~
1.0

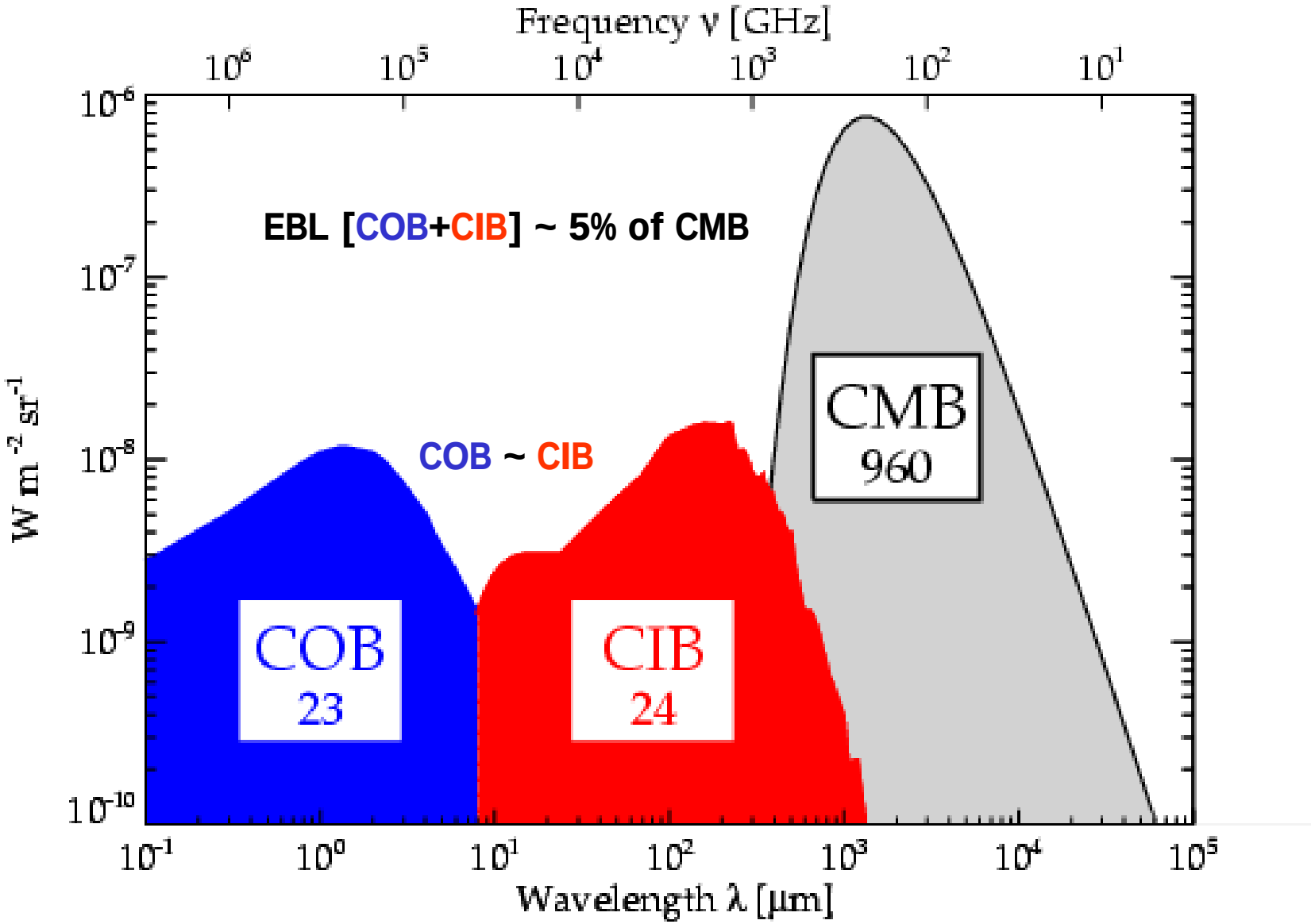
COB~
20 to 35

CIB~
24 to 27



Dole et al., 2006, A&A, 451, 417

Universe' Spectral Energy Distribution

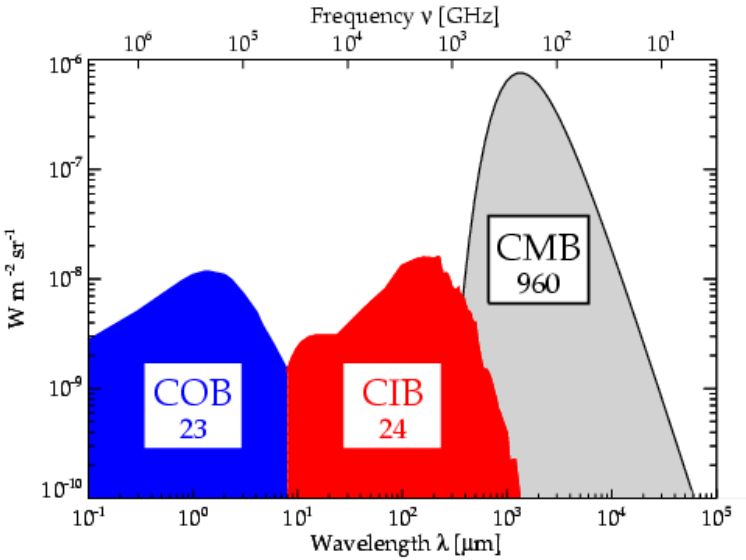


Dole et al., 2006, A&A, 451, 417

Conclusions

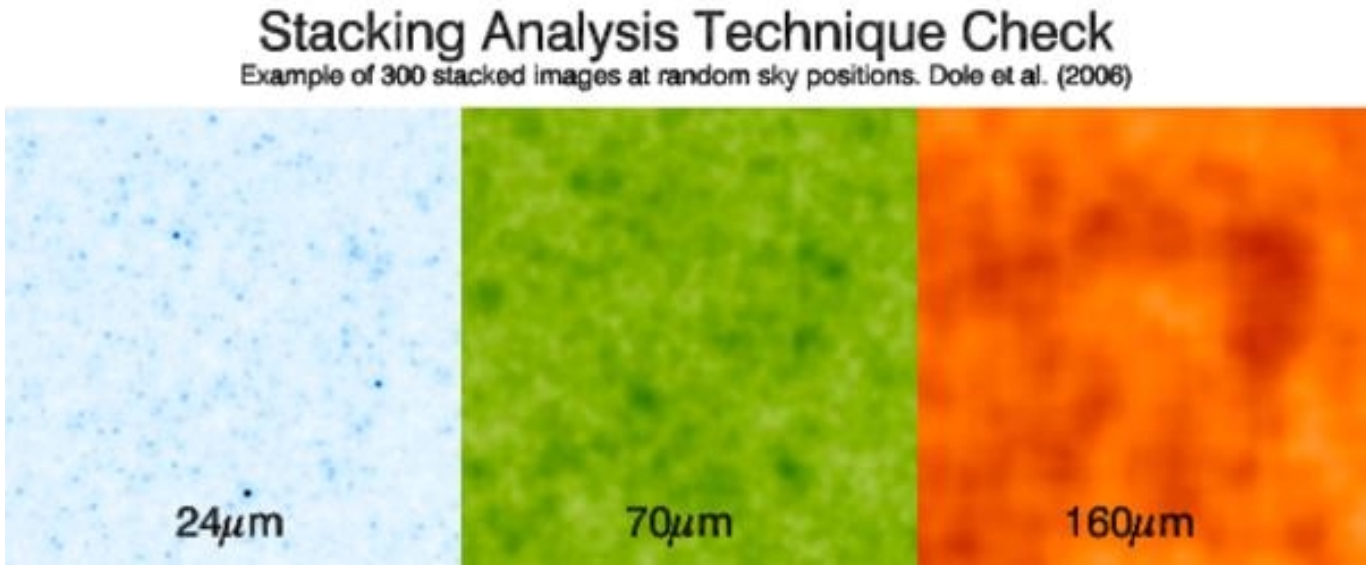
- Spitzer Resolves the CIB
  - FIR CIB now resolved up to 80%; new CIB estimates
  - MIR traces well the FIR (CIB peak) population

- CIB vs COB vs CMB
  - Extragalactic Background Light SED now well constrained
  - Budget for Galaxy Formation & Evolution
  - COB ~ CIB ~ 24/23 nW m^{-2} sr^{-1}
  - EBL: for 1 visible photon => 115 IR photons
  - EBL ~ 5% CMB



- Sources of the CIB
  - Bulk of the CIB: z ~1 to 2
  - FIR SEDs of faint sources are being measured
    - up to z~1.5
  - Next/Ongoing: Deep IRS spectroscopy + Deep Imaging Spitzer programs
  - Stacking Analysis: very promissing

Movie of the Stacking Analysis



Grab it here:

http://www.ias.u-psud.fr/irgalaxies

http://insu.cnrs.fr/web/article/art.php?art=1747

http://www.spitzer.caltech.edu/Media/happenings/20060420/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