

# 47th ESLAB Symposium

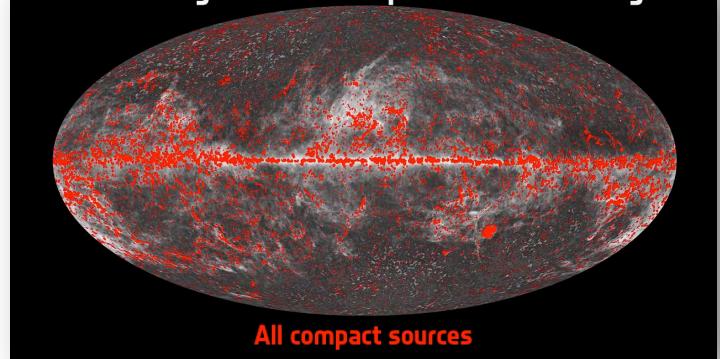
## The Universe as seen by Planck

2-5 April 2013

ESA/ESTEC, Noordwijk (The Netherlands)



Planck Early Release Compact Source Catalogue



All compact sources

Monthly Notices

of the

ROYAL ASTRONOMICAL SOCIETY

MNRAS 429, 1309–1323 (2013)



doi:10.1093/mnras/sts417

### The local luminosity function of star-forming galaxies derived from the *Planck* Early Release Compact Source Catalogue

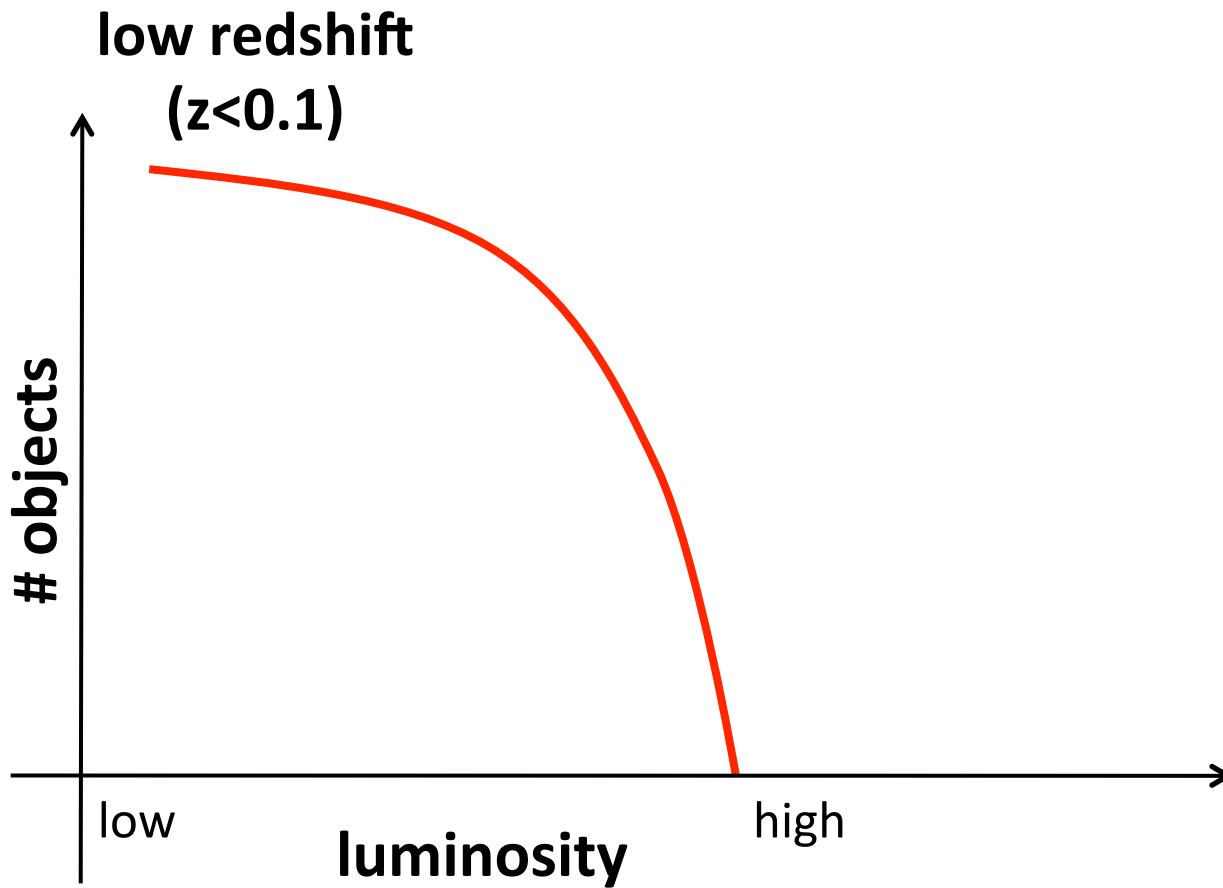
M. Negrello,<sup>1</sup>★ M. Clemens,<sup>1</sup> J. Gonzalez-Nuevo,<sup>2</sup> G. De Zotti,<sup>1,3</sup> L. Bonavera,<sup>2</sup> G. Cosco,<sup>4</sup> G. Guarese,<sup>4</sup> L. Boaretto,<sup>4</sup> S. Serjeant,<sup>5</sup> L. Toffolatti,<sup>6</sup> A. Lapi,<sup>3,7</sup> M. Bethermin,<sup>8</sup> G. Castex,<sup>9</sup> D. L. Clements,<sup>10</sup> J. Delabrouille,<sup>9</sup> H. Dole,<sup>11,12</sup> A. Franceschini,<sup>13</sup> N. Mandolcsi,<sup>14,15</sup> L. Marchetti,<sup>13</sup> B. Partridge<sup>16</sup> and A. Sajina<sup>17</sup>

# Outline

- Introduction
- Selection of local dusty galaxies in the ERCSC
- Luminosity function
- Conclusions

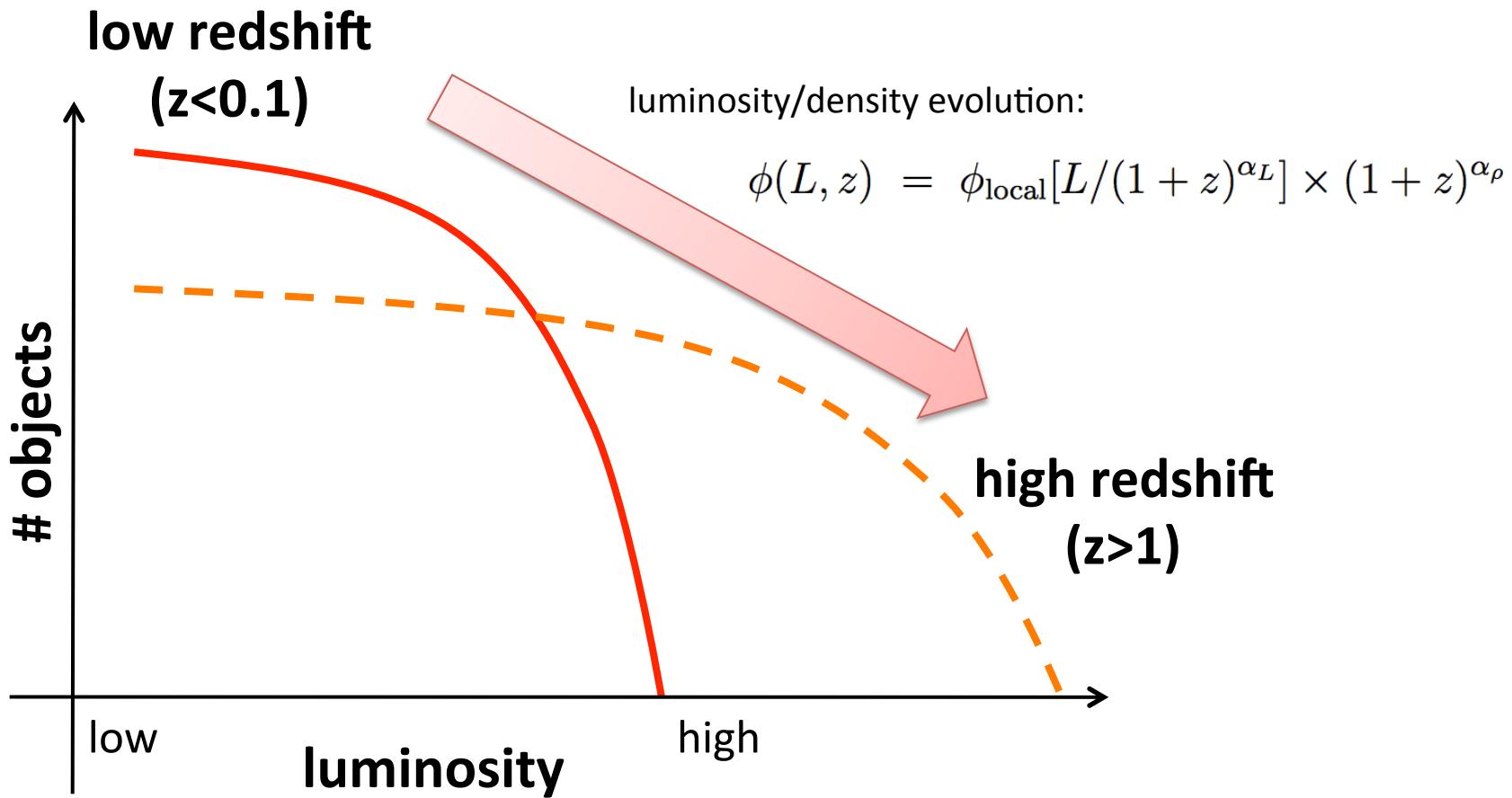
# The *local* luminosity function

Provides a benchmark for *galaxy-evolution* models



# The *local* luminosity function

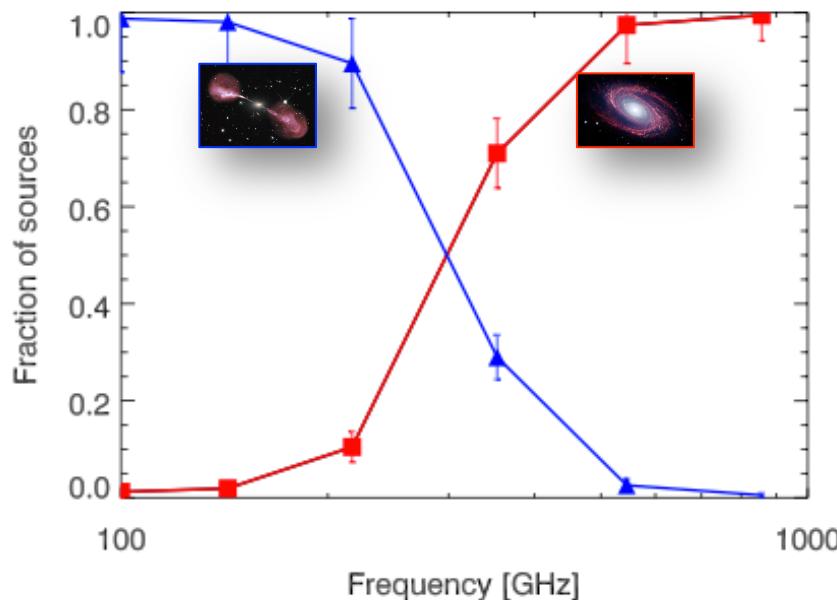
Provides a benchmark for *galaxy-evolution* models



# The sub-mm/mm source populations

The *extragalactic sources* detectable by *Planck* are

- **Low redshift spiral/starburst galaxies**
- **z~1 AGN-powered radio sources**



Planck Intermediate results VII, 2013,  
A&A, 550, 133

# The *Planck* ERCSC

***Planck* Early Release Compact Source Catalogue**  
(ERCSC; Planck Collaboration VII 2011):

- **857 GHz** (=350μm)
- **545 GHz** (=550μm)
- **353 GHz** (=850μm)
- **217 GHz** (=1.328mm)
- **143 GHz** (=2.1mm)
- **100 GHz** (=3mm)

High Frequency Instrument (HFI)

- **70 GHz** (=4.3mm)
- **44 GHz** (=6.8mm)
- **30 GHz** (=10mm)

Low Frequency Instrument (LFI)

We only consider  
these channels

# Local LF from the *Planck* ERCSC

## Warnings!

1. Large number of **galactic objects**
2. Contamination from **radio-sources**
3. **4 flux density estimates** provided
4. Focus on **reliability**, not **completeness**

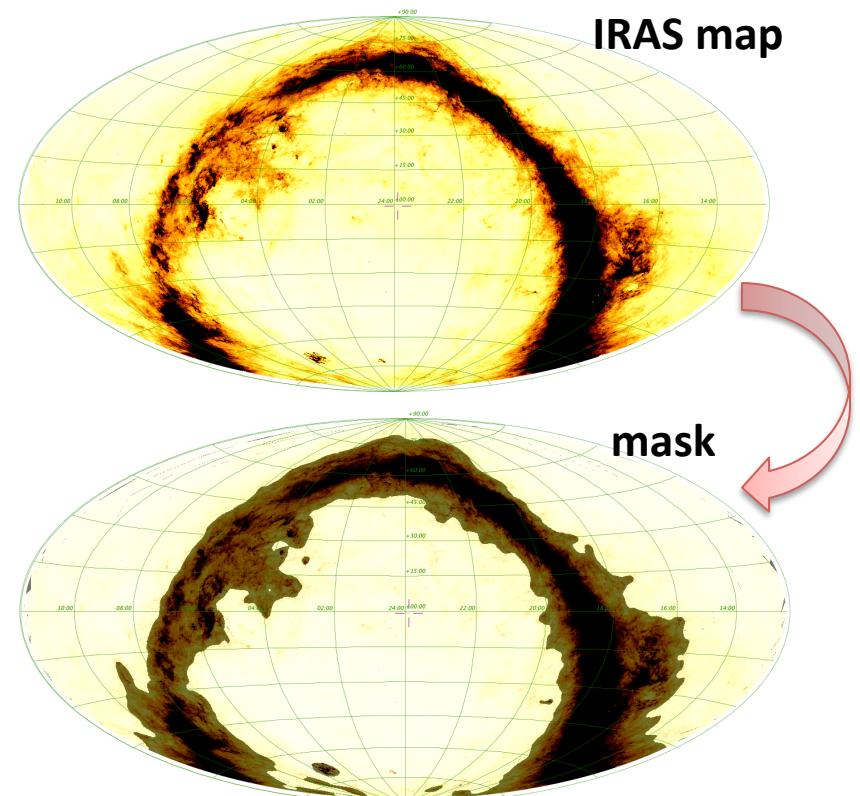
# 1. Galactic mask

Pixels in the upper intensity quartile of the **100μm map of Schlegel, Finkbeiner & Davis (1998)** are discarded as being heavily affected by Galactic emission.



29.1% of the sky is masked.

Area left = **29 250 deg<sup>2</sup>**



## 2. Selection of local dusty galaxies

**217 GHz**

1. @ 217GHz remove galaxies with  $F_{100\text{GHz}}/F_{217\text{GHz}} > 1$

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2. Inspect available **optical to far-infrared imaging data** + query the **NED database** in *Aladin* to reject sources showing:
  - A clump or a filamentary structure in IRAS maps
  - A nearby bright ( $F_{1.4\text{GHz}} > \sim 0.1\text{Jy}$ ) radio-source
  - A group/cluster of galaxies (e.g. Abell2218)

## 2. Selection of local dusty galaxies

217 GHz



353 GHz



545 GHz

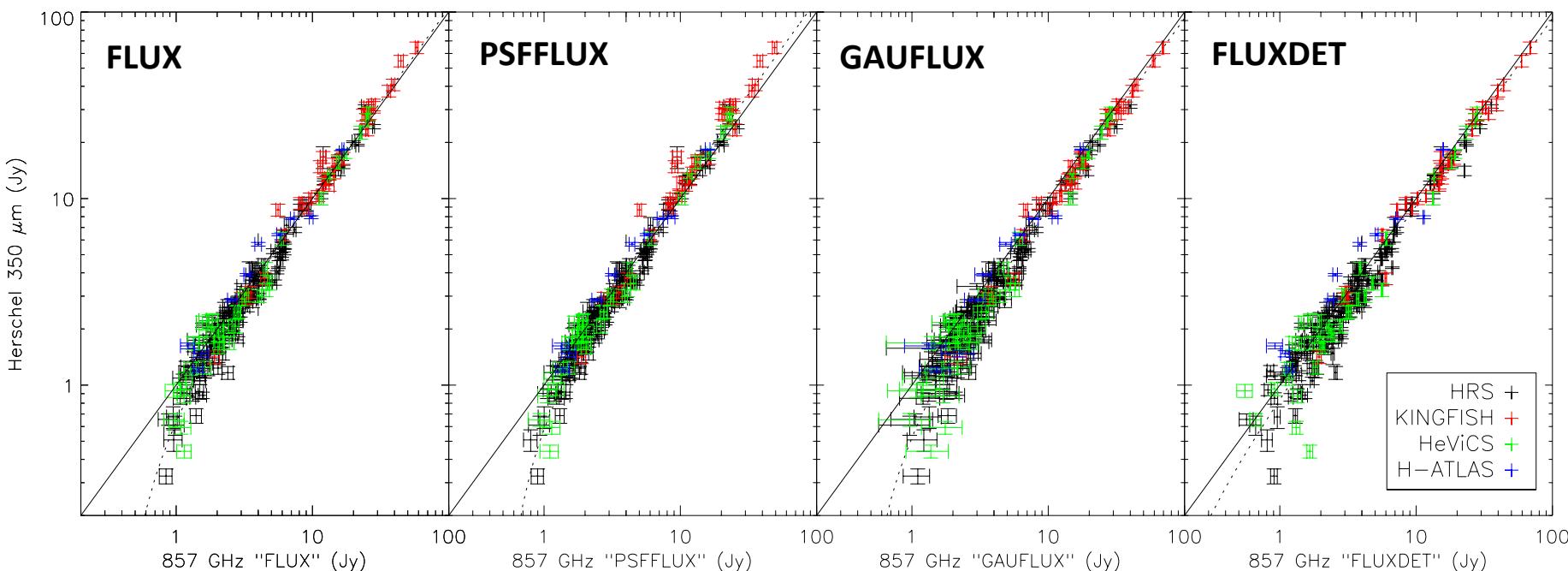


857 GHz

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3. @ higher frequencies remove previously identified contaminants and then repeat step 2

# 3. Adopted flux density estimate

Comparison with *Herschel* data @ 350 $\mu$ m/857GHz

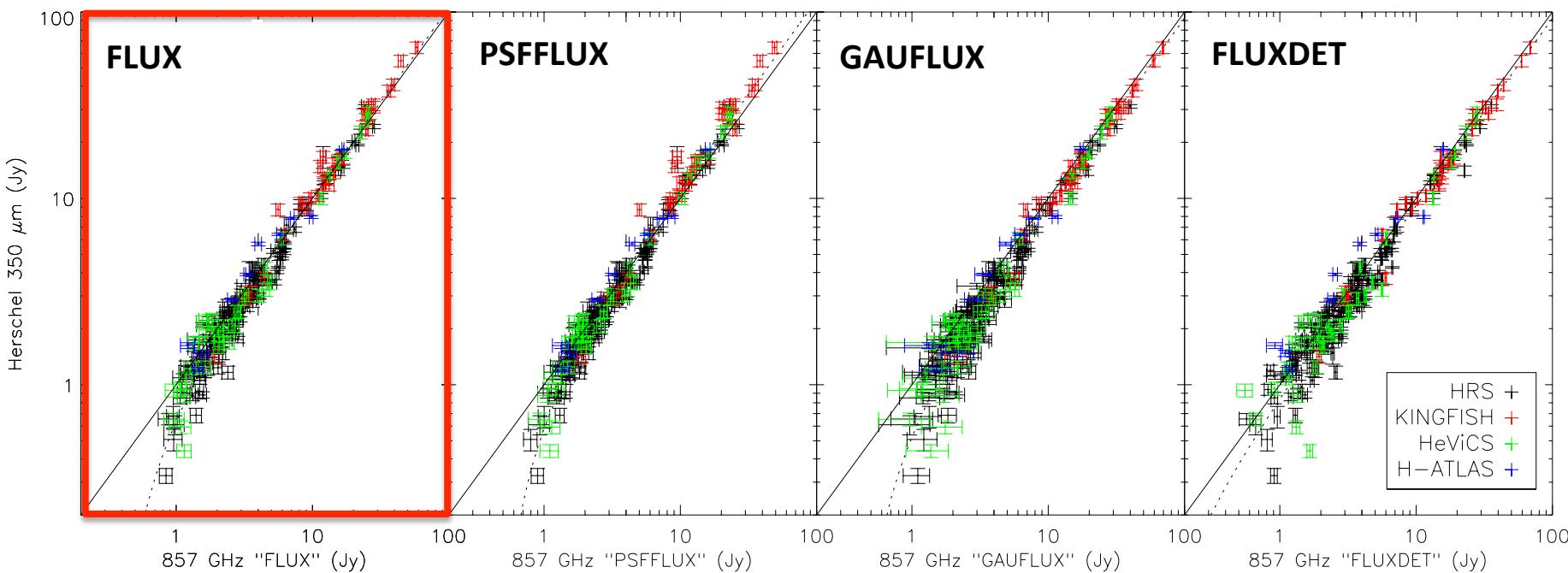


## References:

- *Herschel* Reference Survey (**HRS**; Boselli et al. 2010)
- Key Insights on Nearby Galaxies Survey (**KINGFISH**; Dale et al. 2012)
- *Herschel* Virgo Cluster Survey (**HeViCS**; Davies et al. 2012)
- *Herschel* Astrophysical Terahertz Large Area Survey (**H-ATLAS**; Herranz et al. 2012)

# 3. Adopted flux density estimate

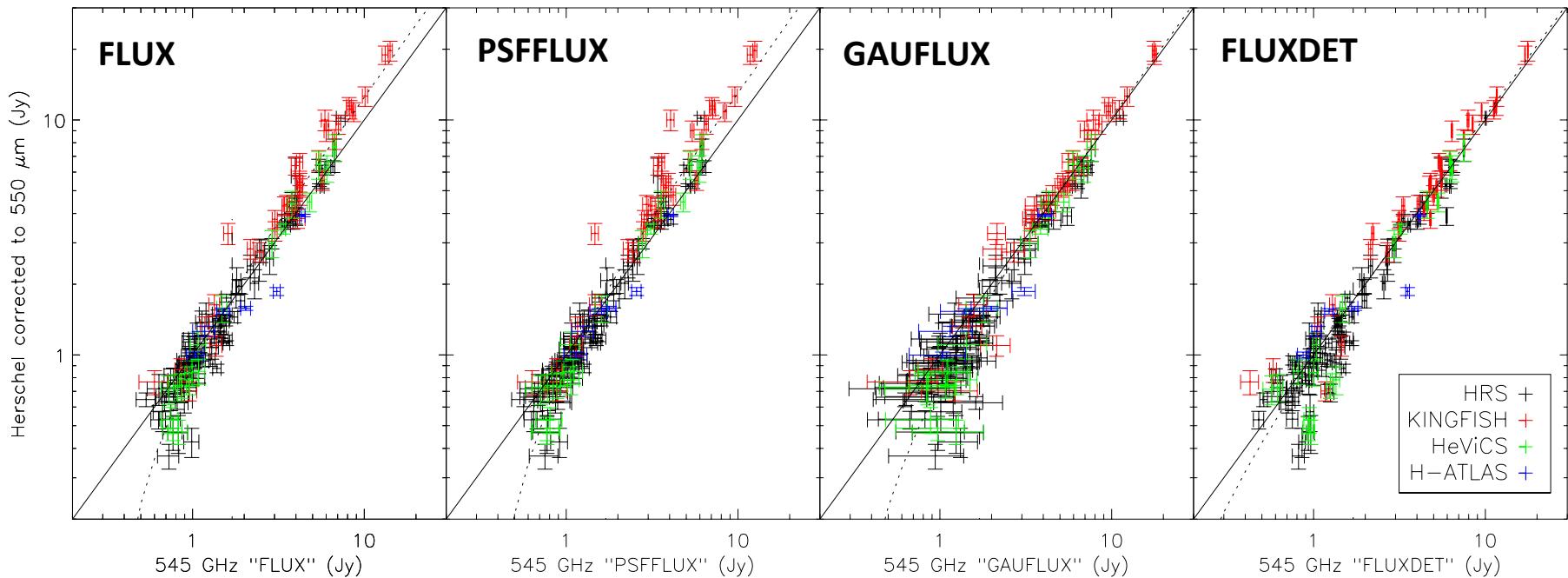
Comparison with *Herschel* data @ 350 $\mu$ m/857GHz



**FLUX** = adopted *Planck* flux density measurement @ 857GHz

# 3. Adopted flux density estimate

Comparison with *Herschel* data @ 550μm/545GHz



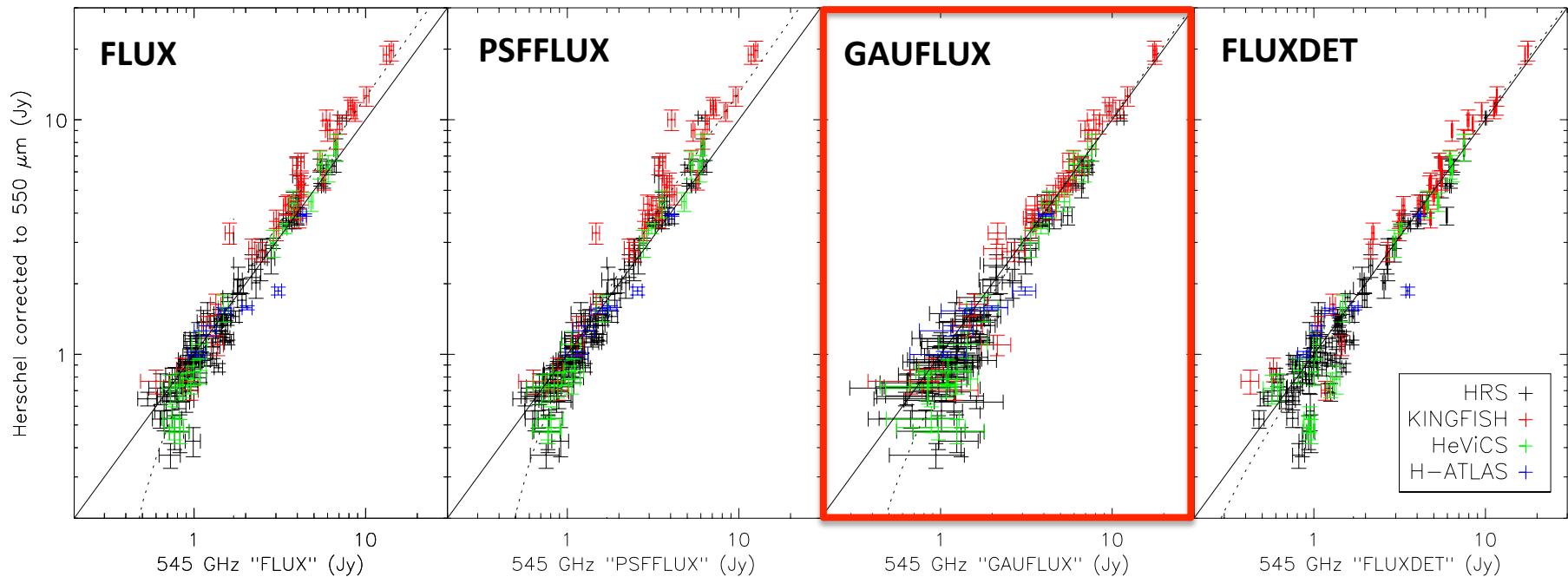
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500μm ---> 550μm  
assuming  $F_\nu = A \nu^{+2.7}$

# 3. Adopted flux density estimate

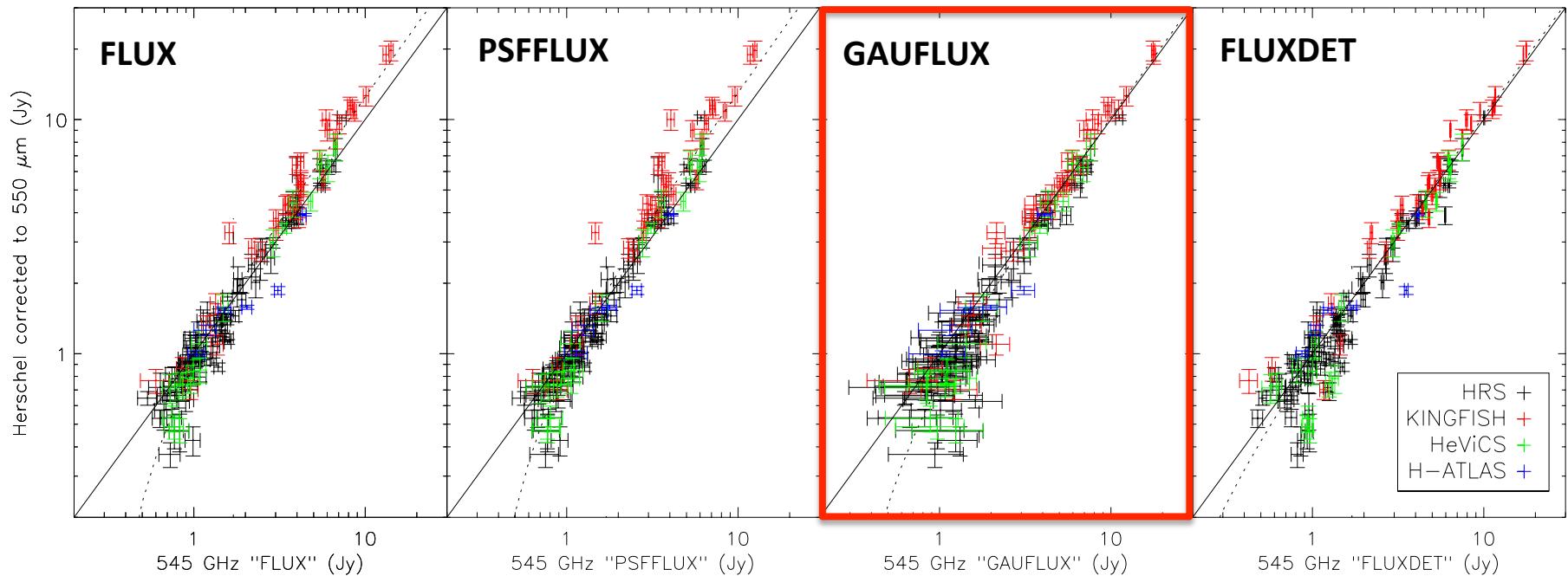
Comparison with *Herschel* data @ 550 $\mu$ m/545GHz



**GAUFLUX** = adopted *Planck* flux density measurement @ 545GHz

# 3. Adopted flux density estimate

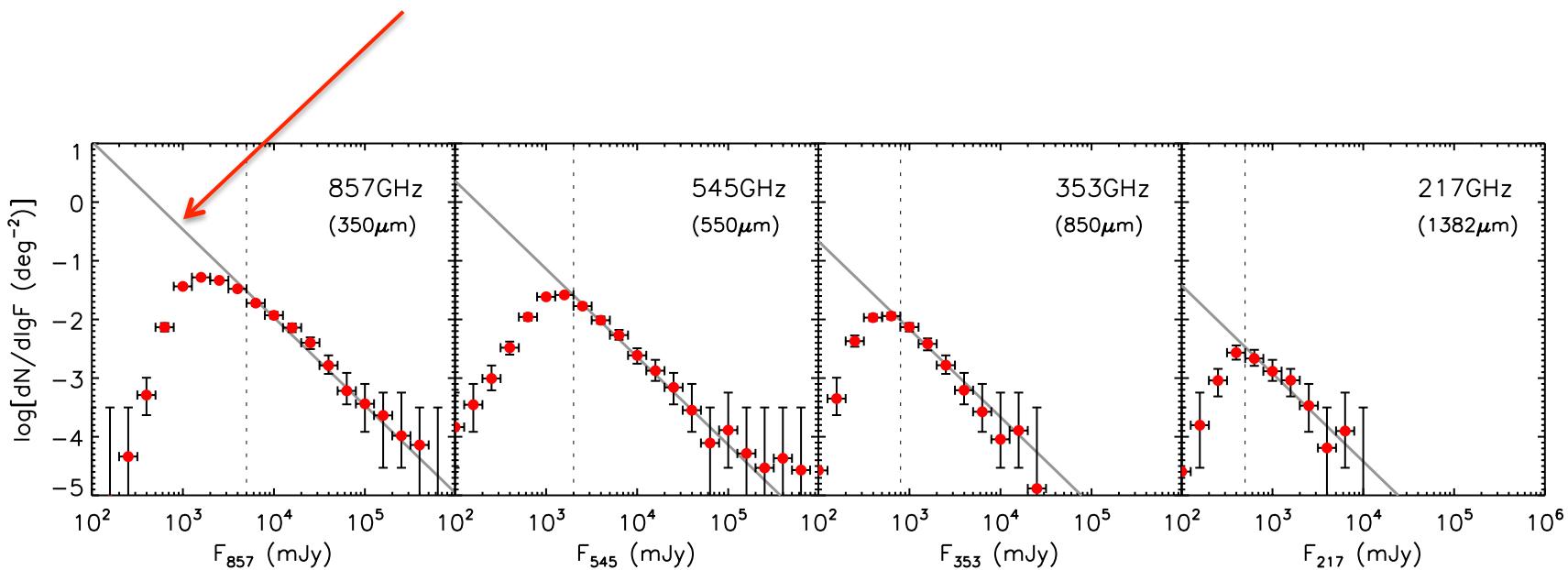
Comparison with *Herschel* data @ 550 $\mu$ m/545GHz



**GAUFLUX** = adopted *Planck* flux density measurement @ 545GHz  
@ 353GHz  
@ 217GHz

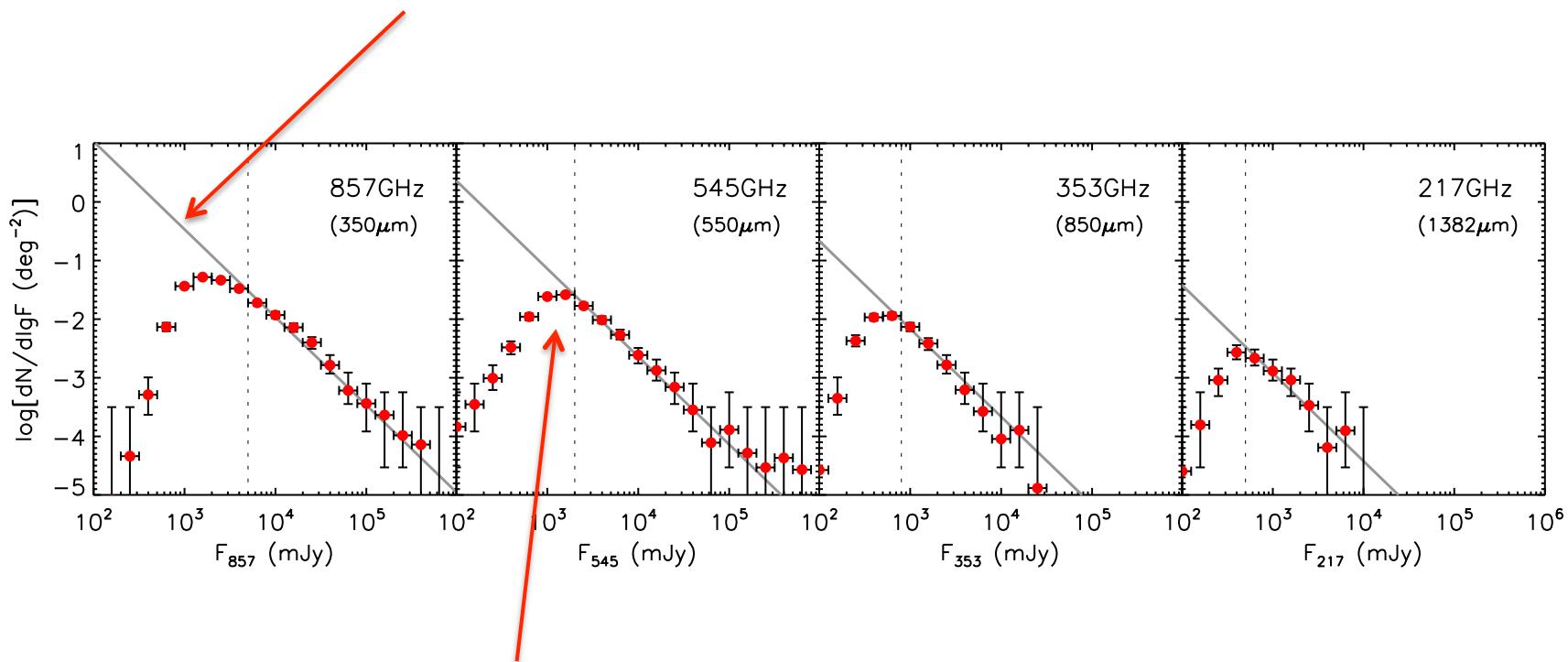
# 4. Number counts and completeness

➤  $dN/d\log F = \text{const} \times F^{-1.5}$  at bright flux densities



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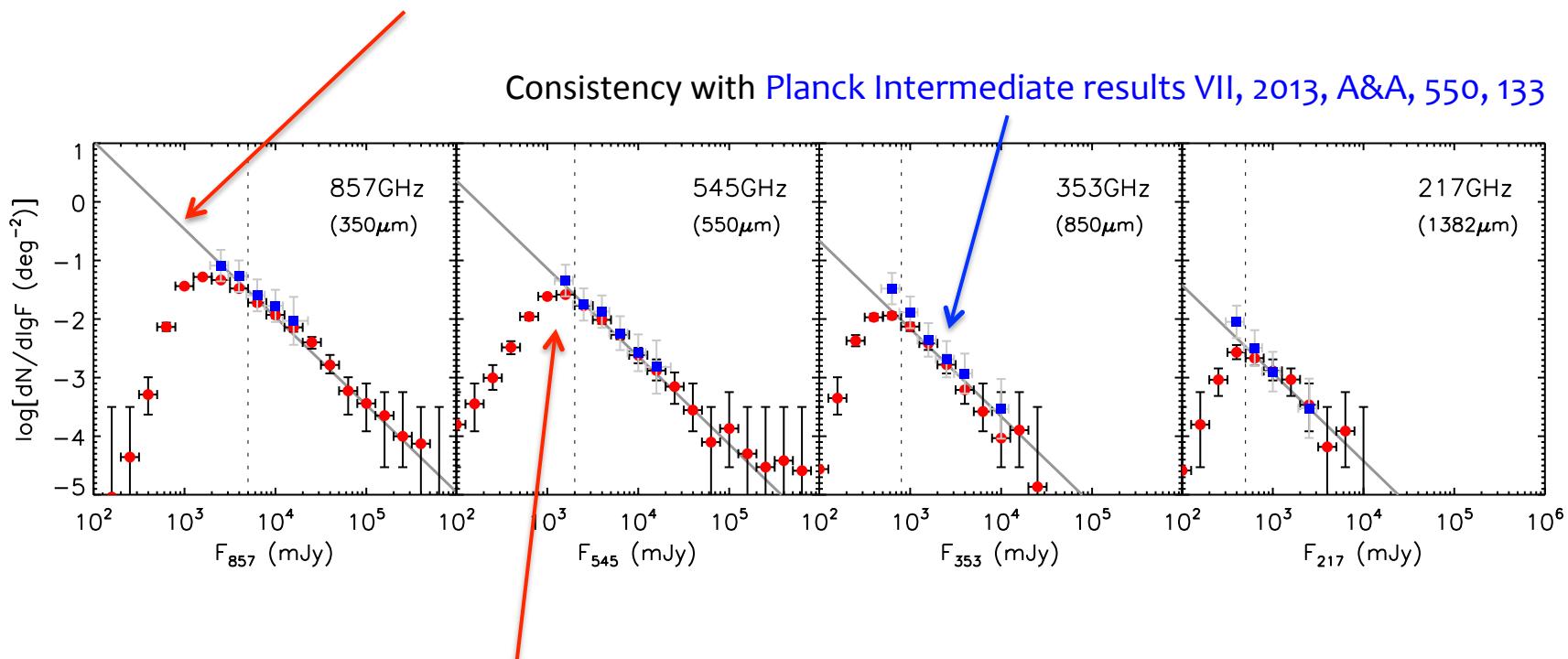
- $dN/d\log F = \text{const} \times F^{-1.5}$  at bright flux densities



- Down-turn at faint flux densities due to incompleteness

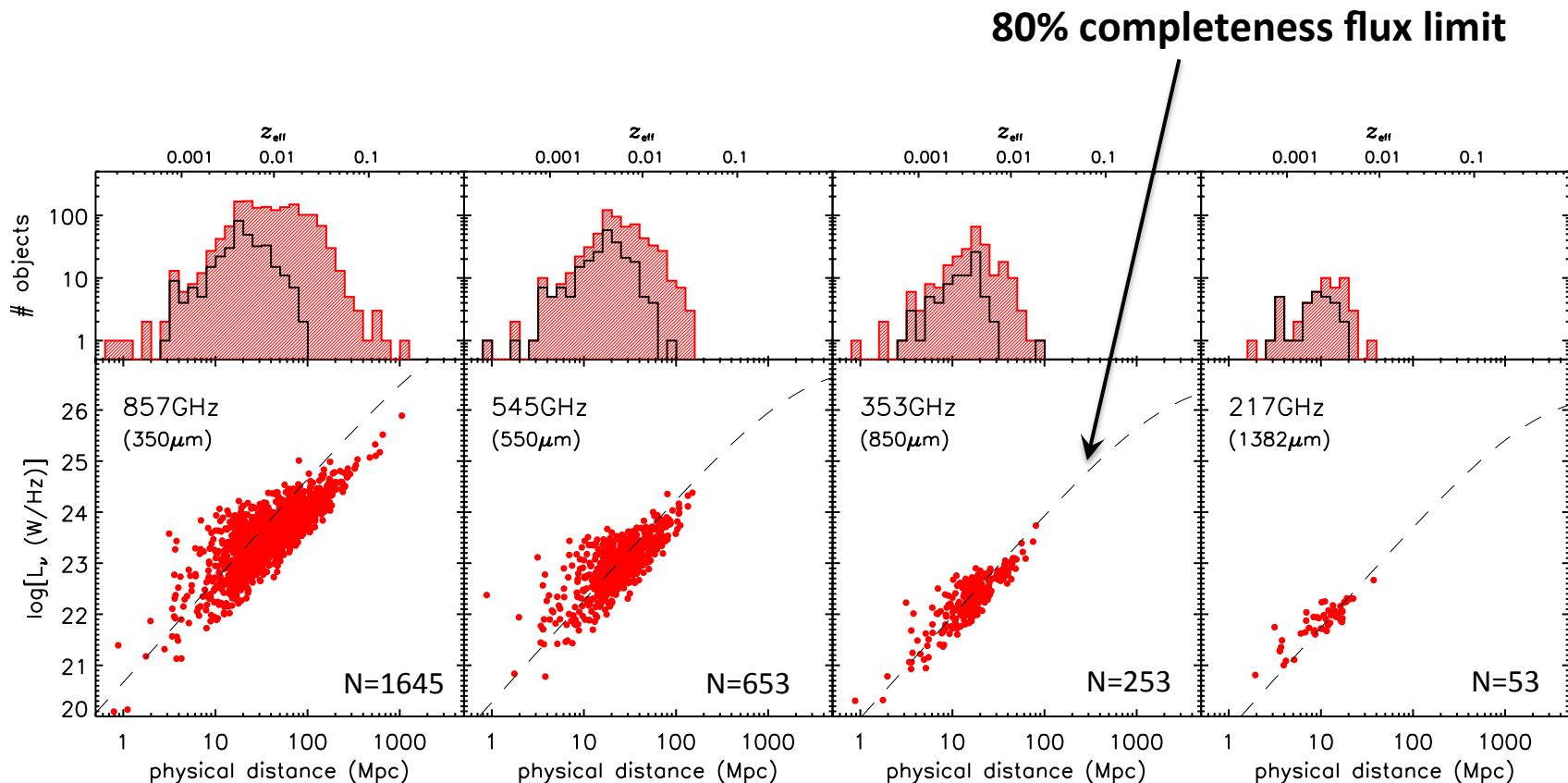
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# Luminosity and redshift distributions



$$F_{\text{lim}} = 4.1 \text{ Jy}$$
$$N_{\text{obj}} = 328$$

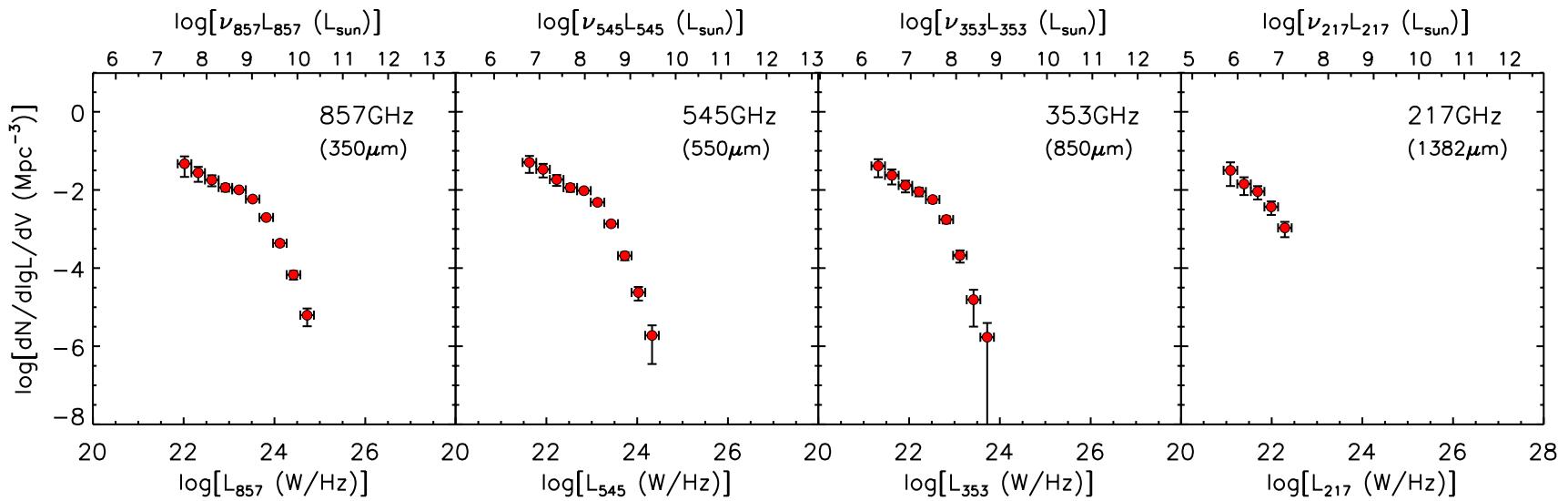
$$F_{\text{lim}} = 1.8 \text{ Jy}$$
$$N_{\text{obj}} = 234$$

$$F_{\text{lim}} = 0.8 \text{ Jy}$$
$$N_{\text{obj}} = 108$$

$$F_{\text{lim}} = 0.5 \text{ Jy}$$
$$N_{\text{obj}} = 30$$

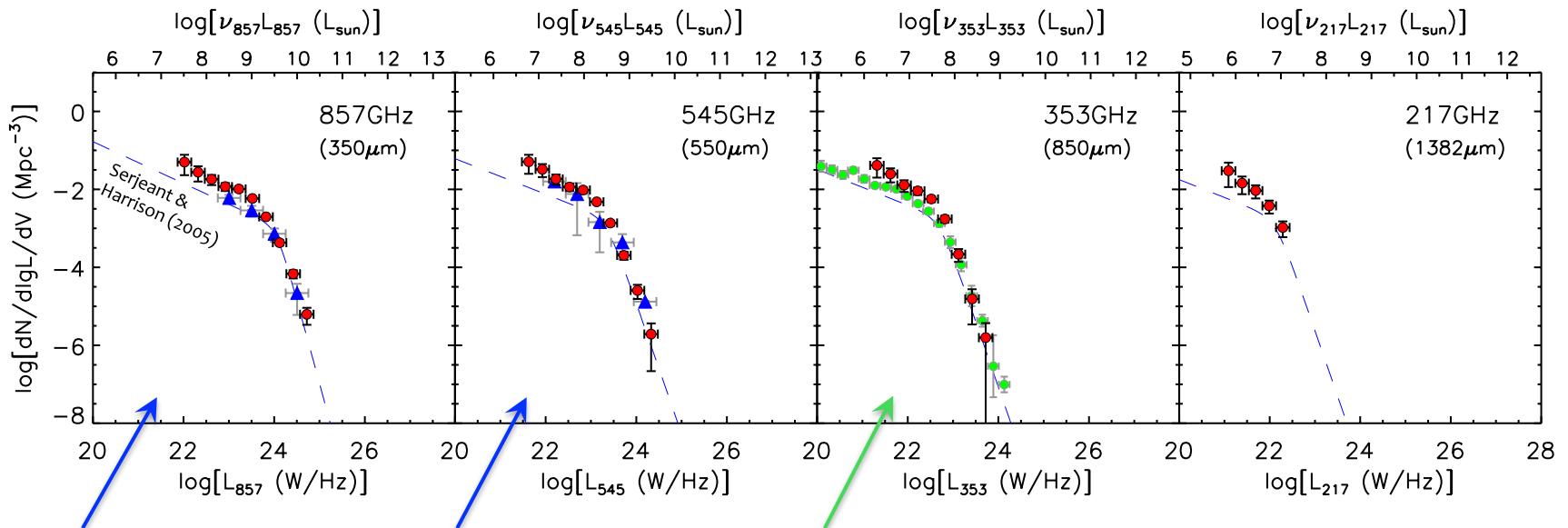
# Local sub-mm luminosity function

Here it is ... finally!



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**HerMES** (Vaccari et al. 2010)

**SLUGS** (Dunne et 2000, Vlahakis et al. 2005)

LF of the *IRAS PSCz* catalogue rescaled using the sub-mm/far-IR colors of the IRAS-selected + optically-selected samples

# Conclusions

The *Planck* ERCSC has provided the first samples of **truly local** galaxies blindly **selected at sub-mm/mm wavelengths**

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Applications: a first example

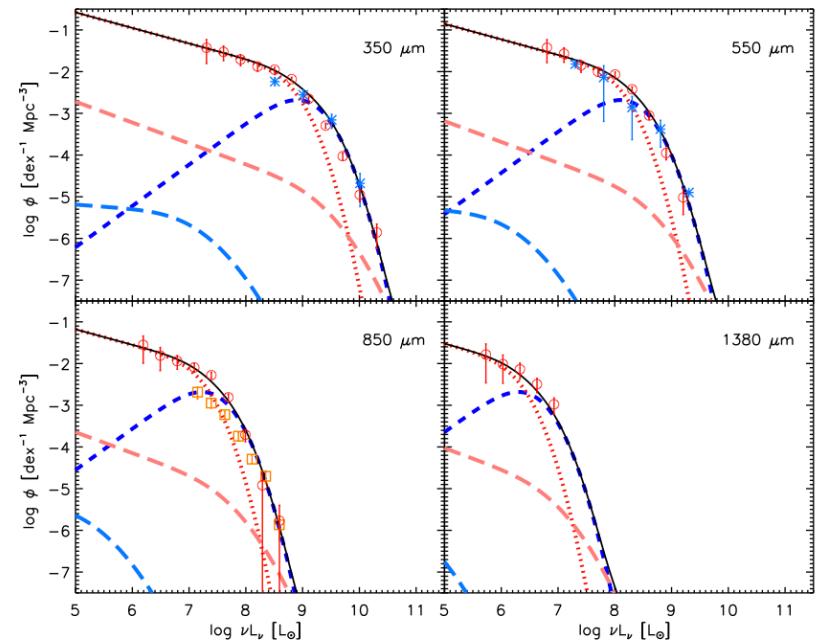


Fig. 11.— Local luminosity functions at (sub-)mm wavelengths. As in the other figures the short-dashed blue lines refer to “warm” galaxies, the dotted red lines to “cold” galaxies, the long-dashed pink lines to type-2 AGNs and the long-dashed light-blue lines to type-1 AGNs. Data are from Dunne et al. (2000, orange open squares), Vaccari et al. (2010, light-blue stars), and Negrello et al. (2012, red open circles).

# Conclusions

The *Planck* ERCSC has provided the first samples of **truly local** galaxies blindly **selected at sub-mm/mm wavelengths**

**SED properties and  
dust mass function:  
see next talk  
by Marcel Clemens**

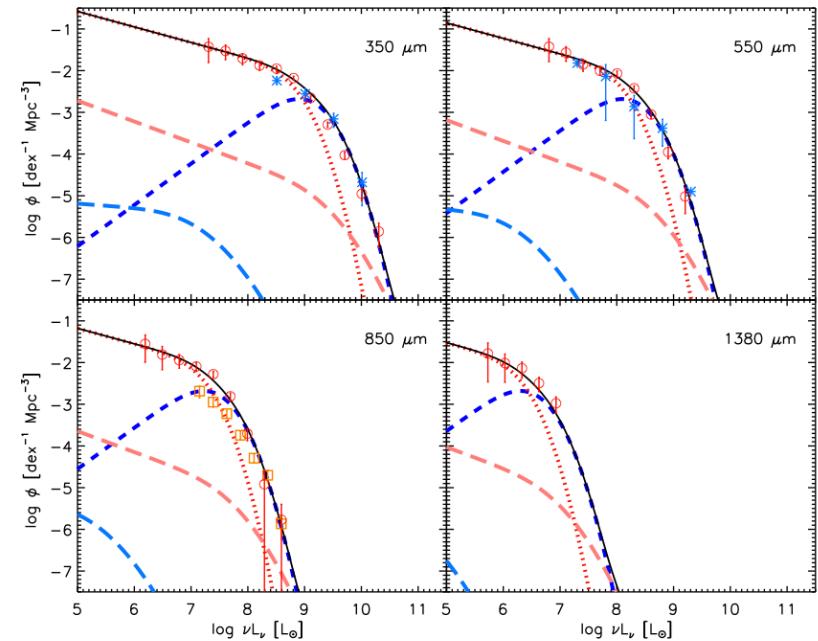
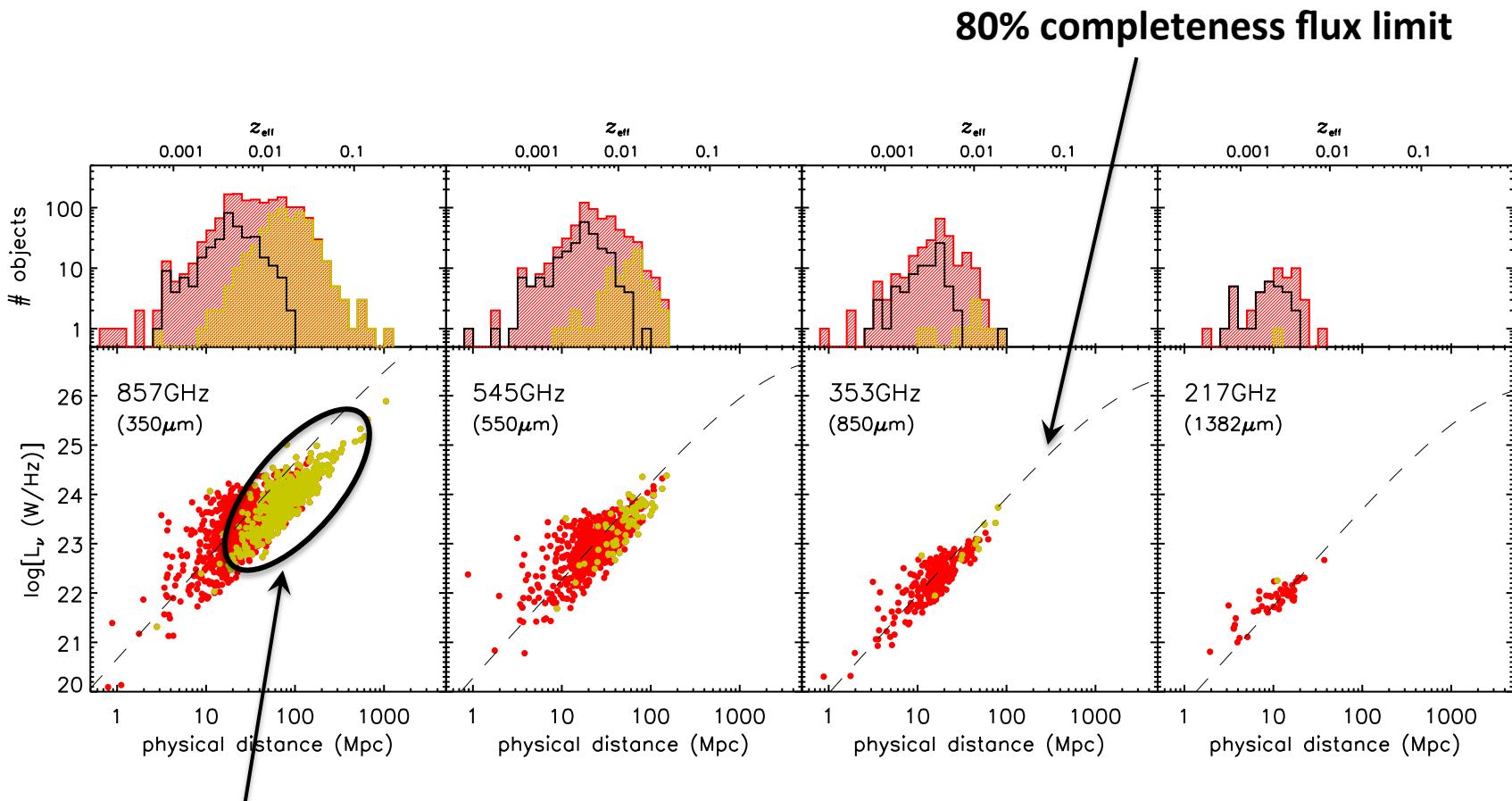


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# Luminosity and redshift distributions

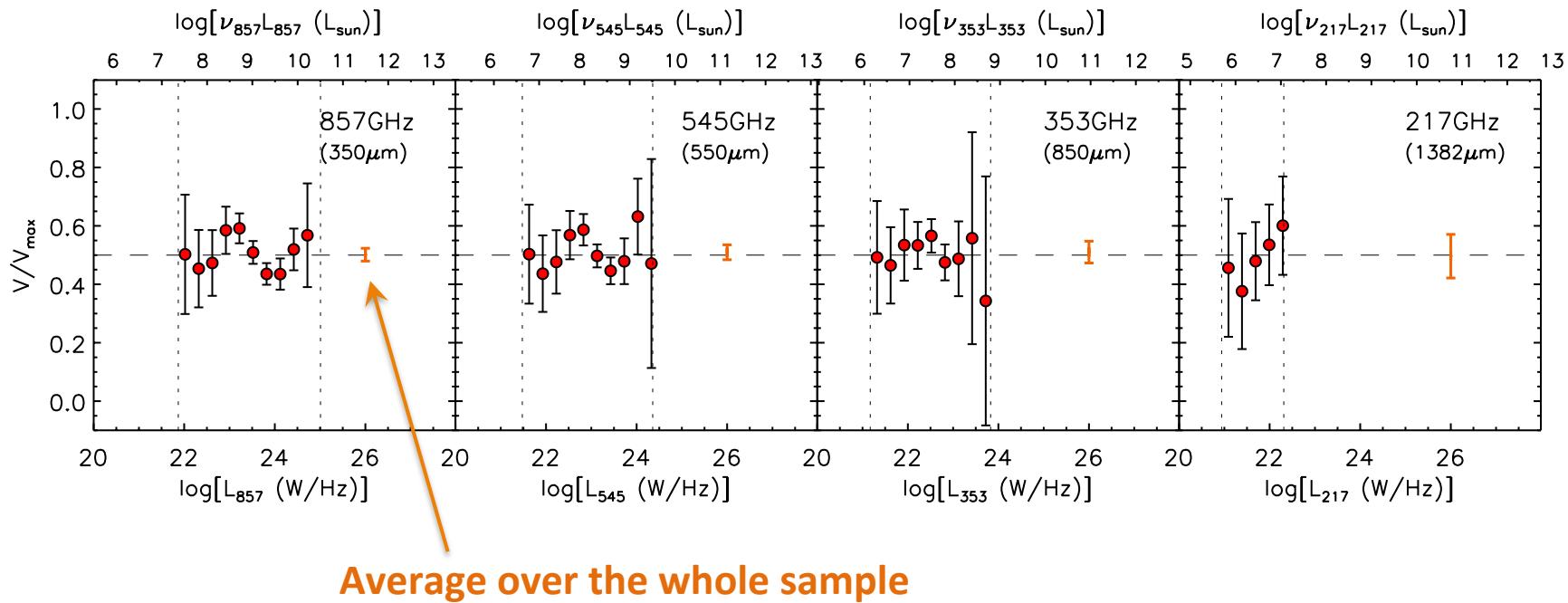


Galaxies without a redshift-independent measure of the distance

# Large scale structure effects

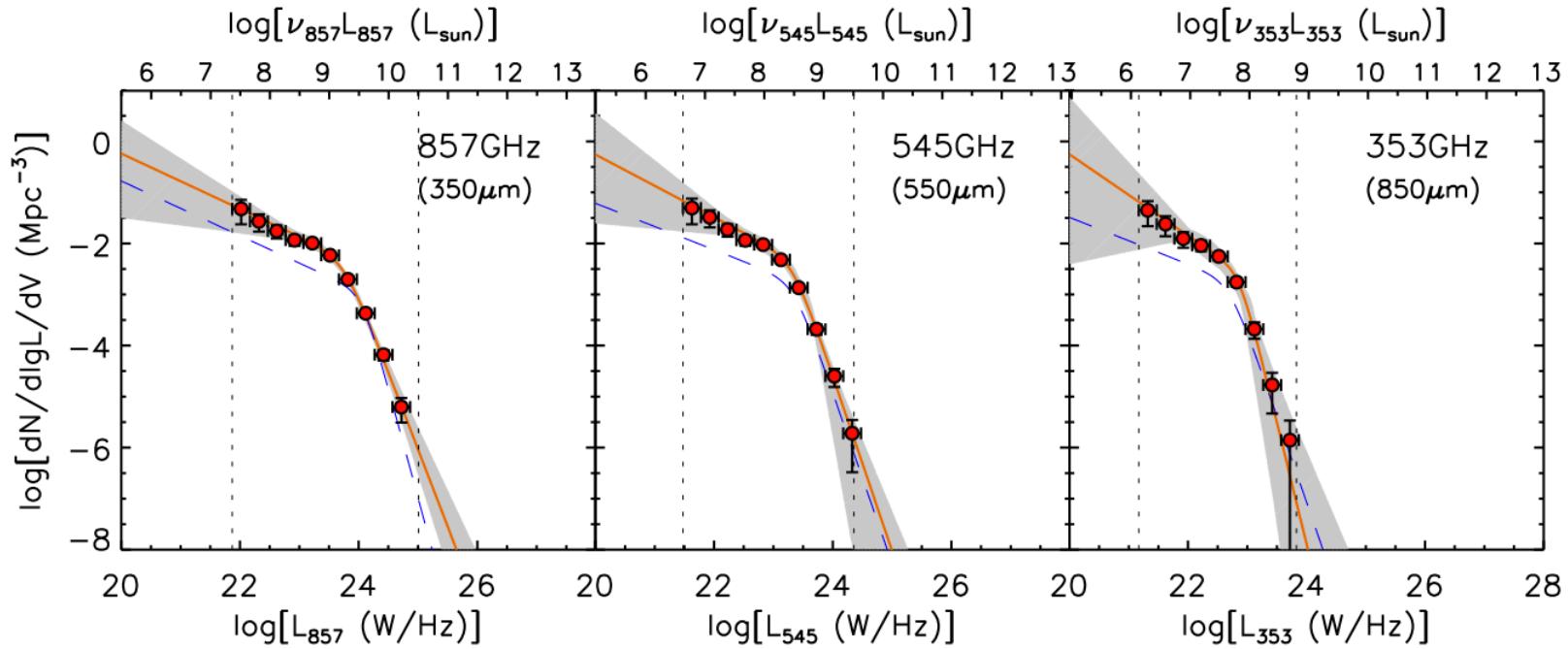
## $V/V_{\max}$ test

Homogeneous distribution  $\rightarrow V/V_{\max} = 0.5$



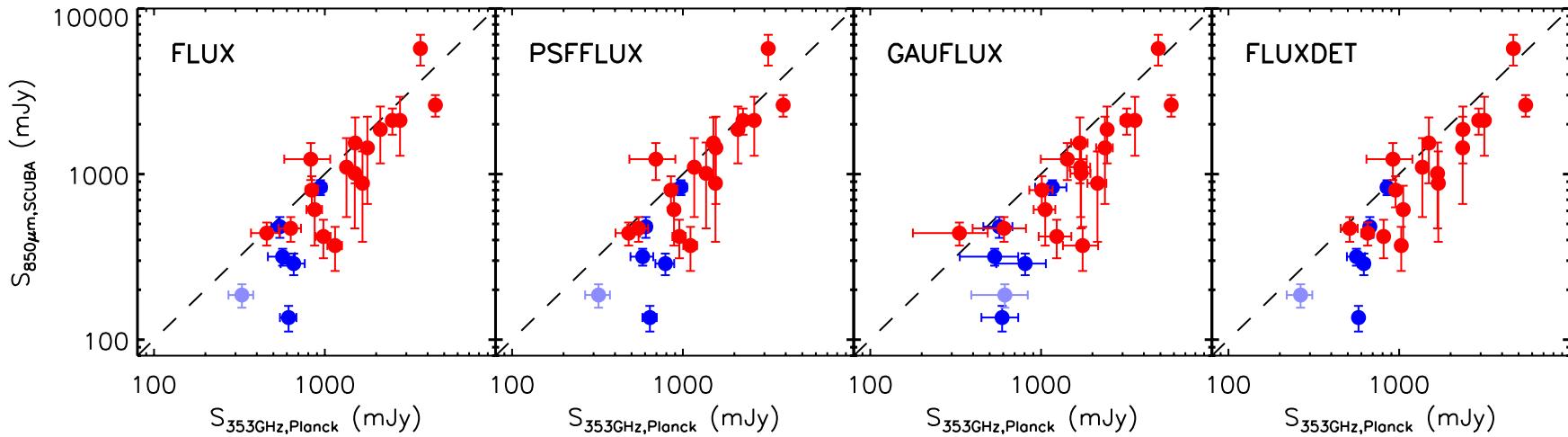
# Large scale structure effects

Parametric maximum-likelihood luminosity function



# 3. Adopted flux density estimate

Comparison with SCUBA data @ 850μm/353GHz



## 2. Selection of local dusty galaxies

217 GHz



353 GHz



545 GHz



857 GHz

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