# *LiteBIRD as a Radio Transient Factory*

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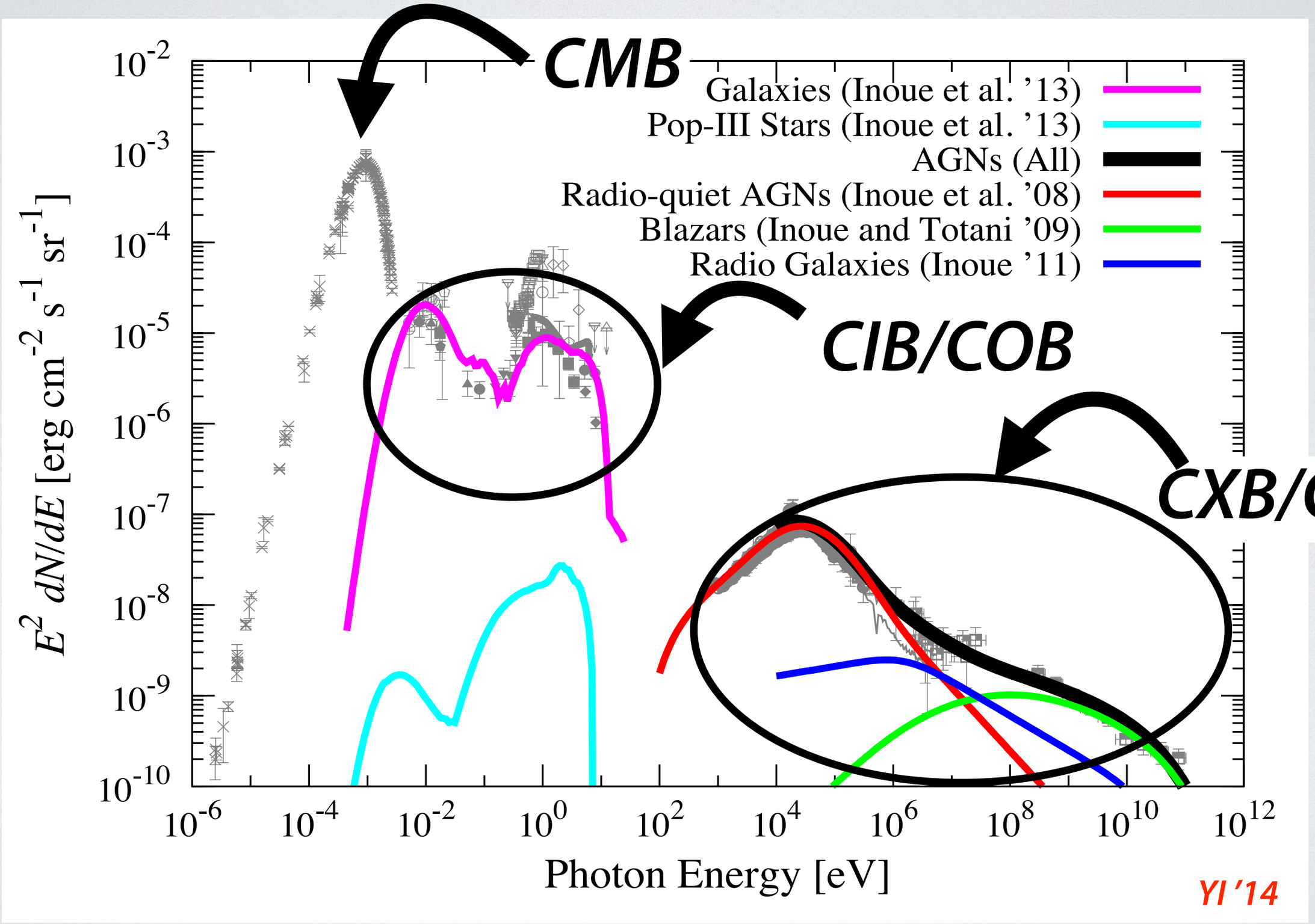
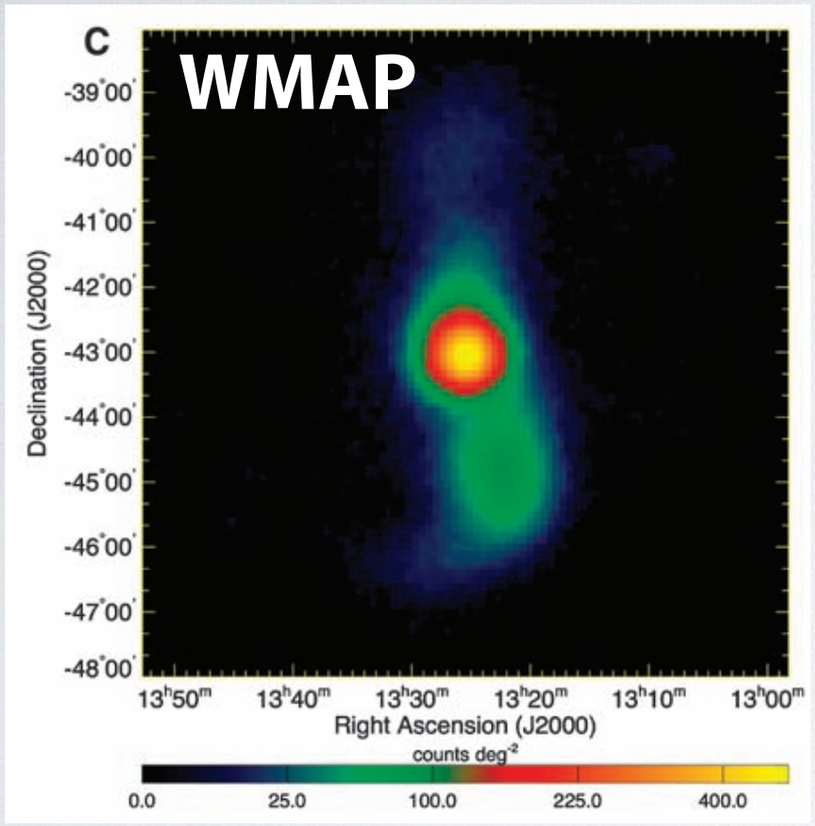
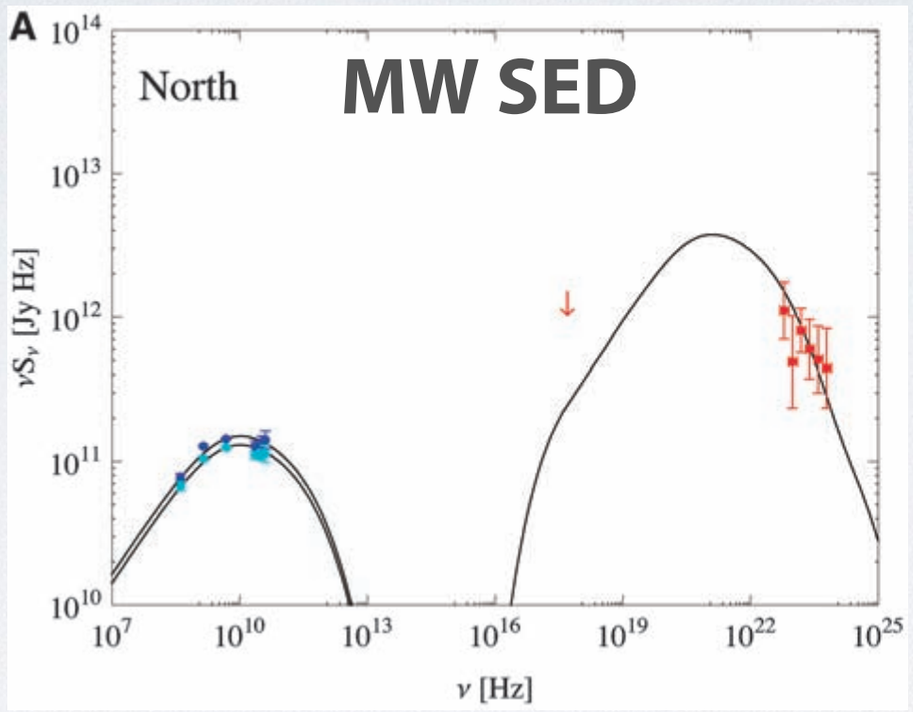
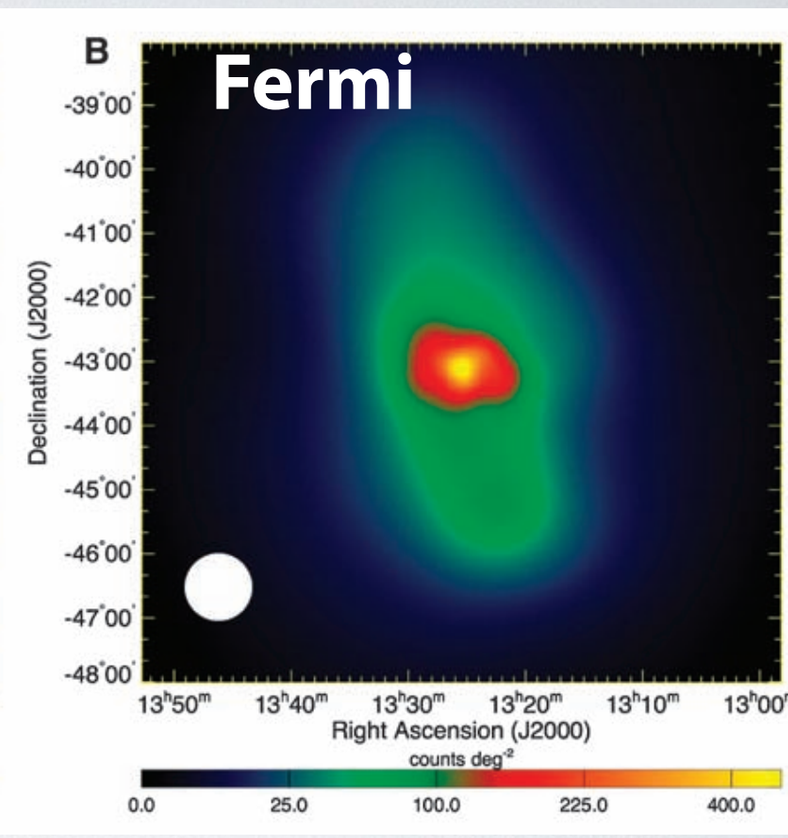
# Cosmic Background Radiation



# Particle Acceleration in a radio lobe: Centaurus A



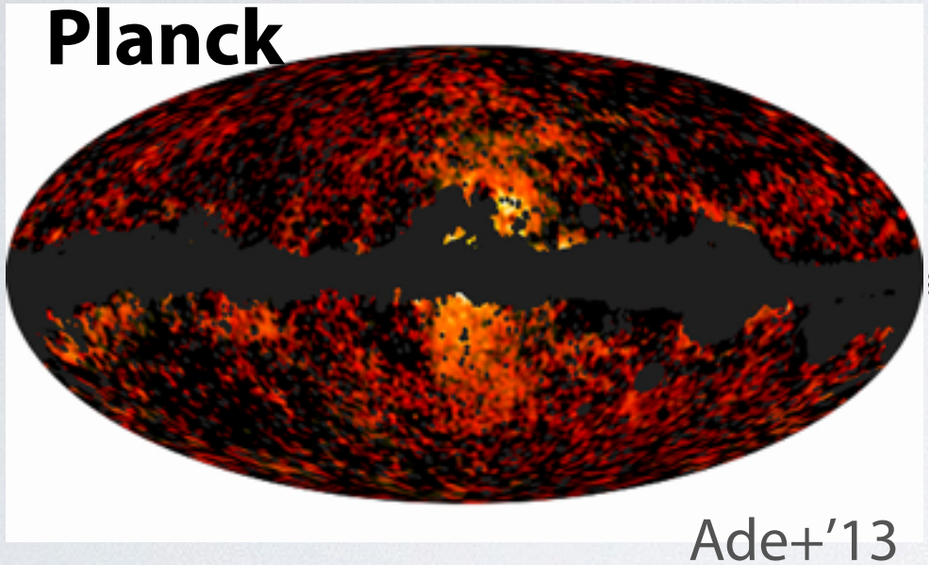




Abdo+'10

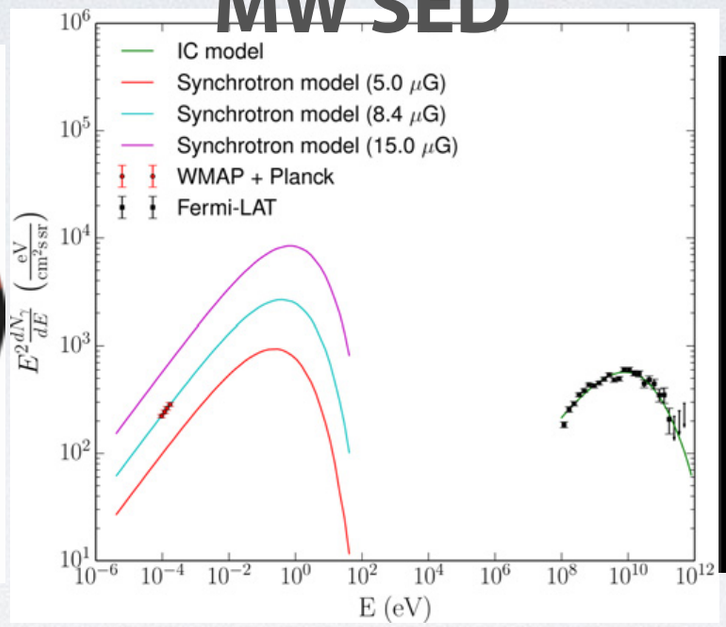
- Non-thermal emission over 600 kpc size (Abdo+'10)
- Particle acceleration mechanism?
  - Second order Fermi acceleration?

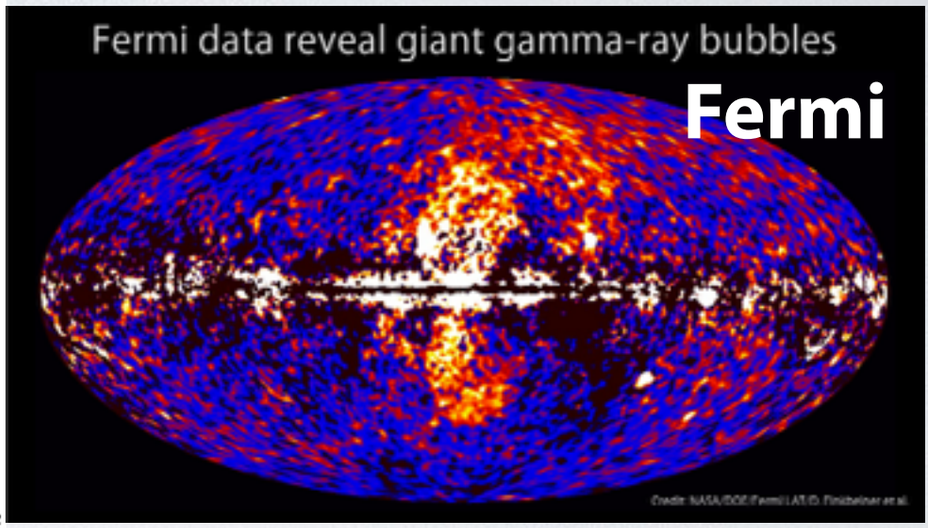
# Past History of the Galactic Center: Fermi Bubbles




Ade+'13

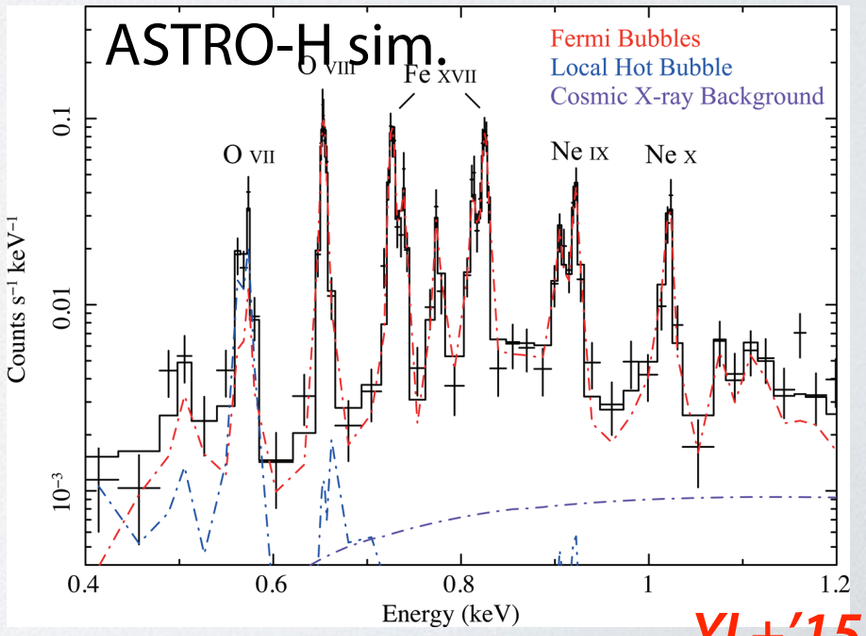
MW SED




Ackermann+'14

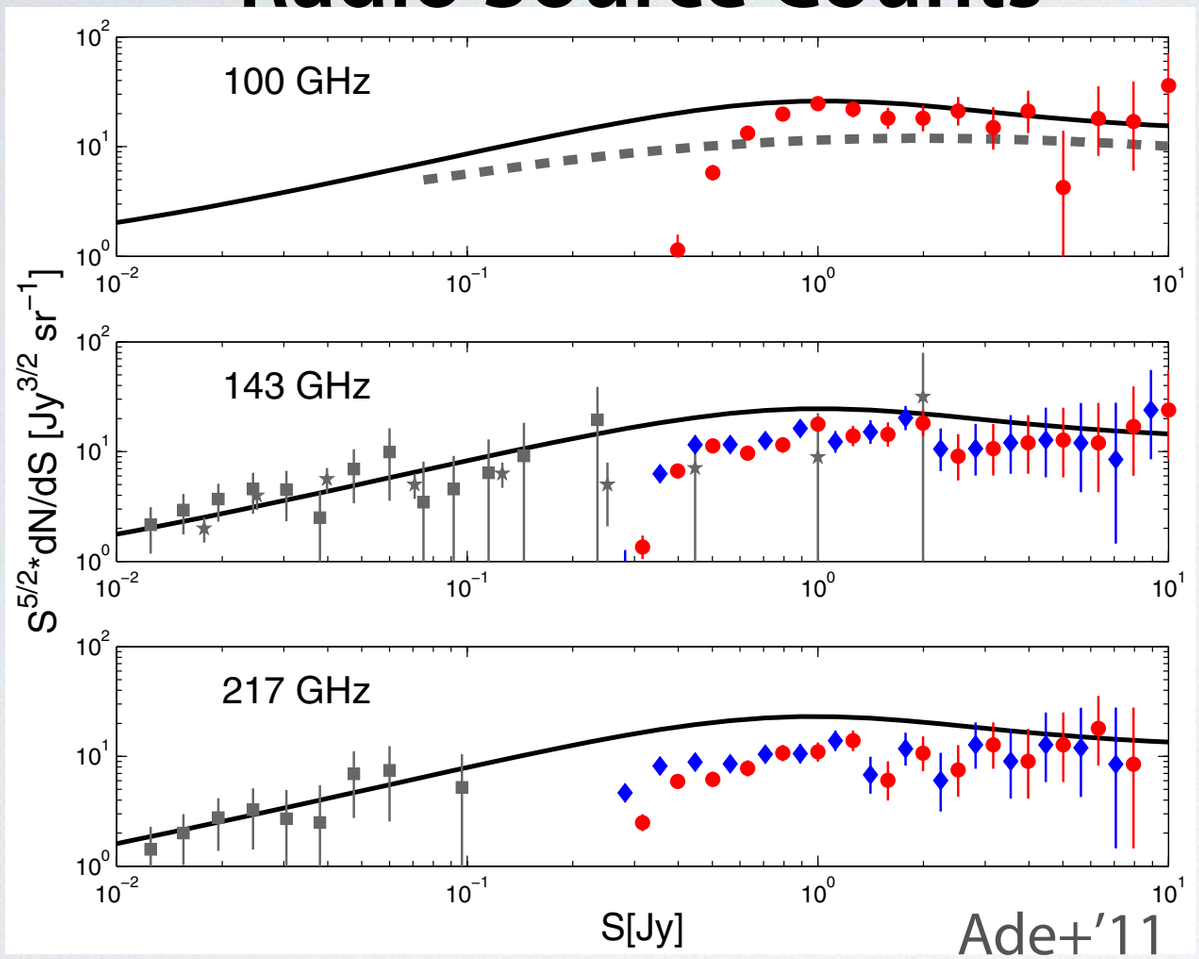
- 10 deg scale non-thermal diffuse emission structure in radio and gamma-ray sky (Su+'10).
- Origin is unknown. Past starburst or AGN activity?
- ASTRO-H observations will tell us their origins through abundance measurements.




*YI +'15*

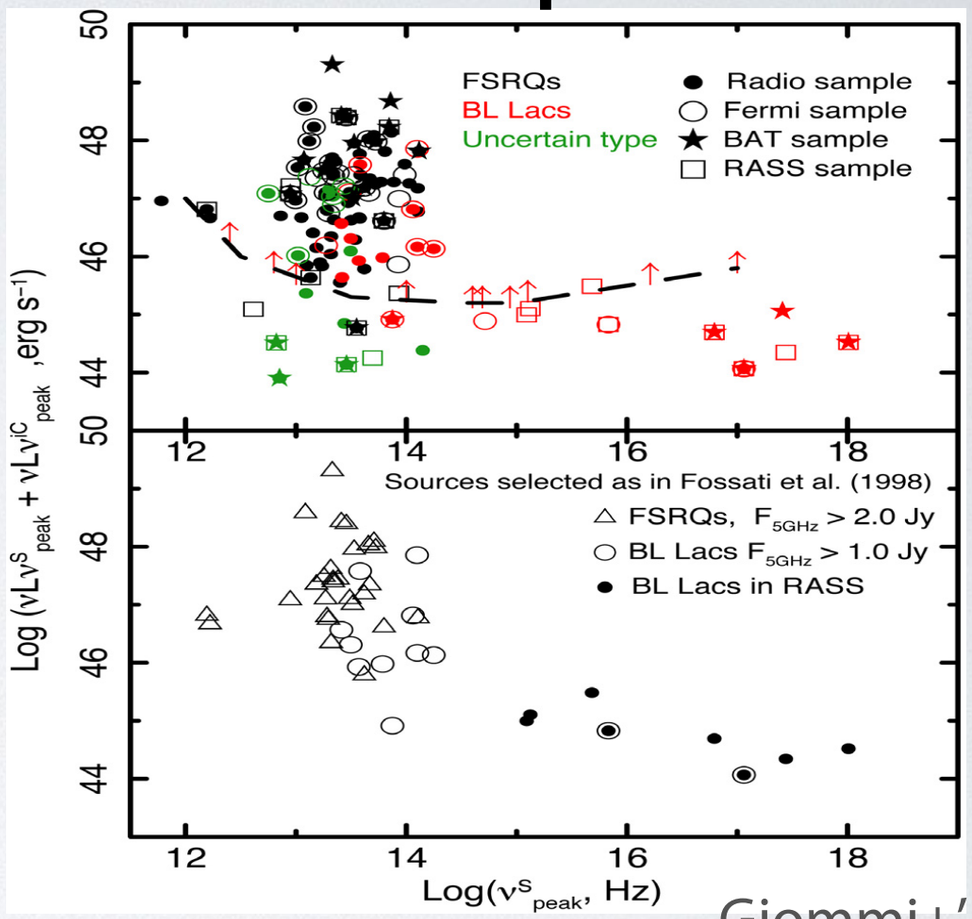
# Extragalactic Radio Source Population Studies

## Radio Source Counts




Ade+'11

## Blazar Sequence?

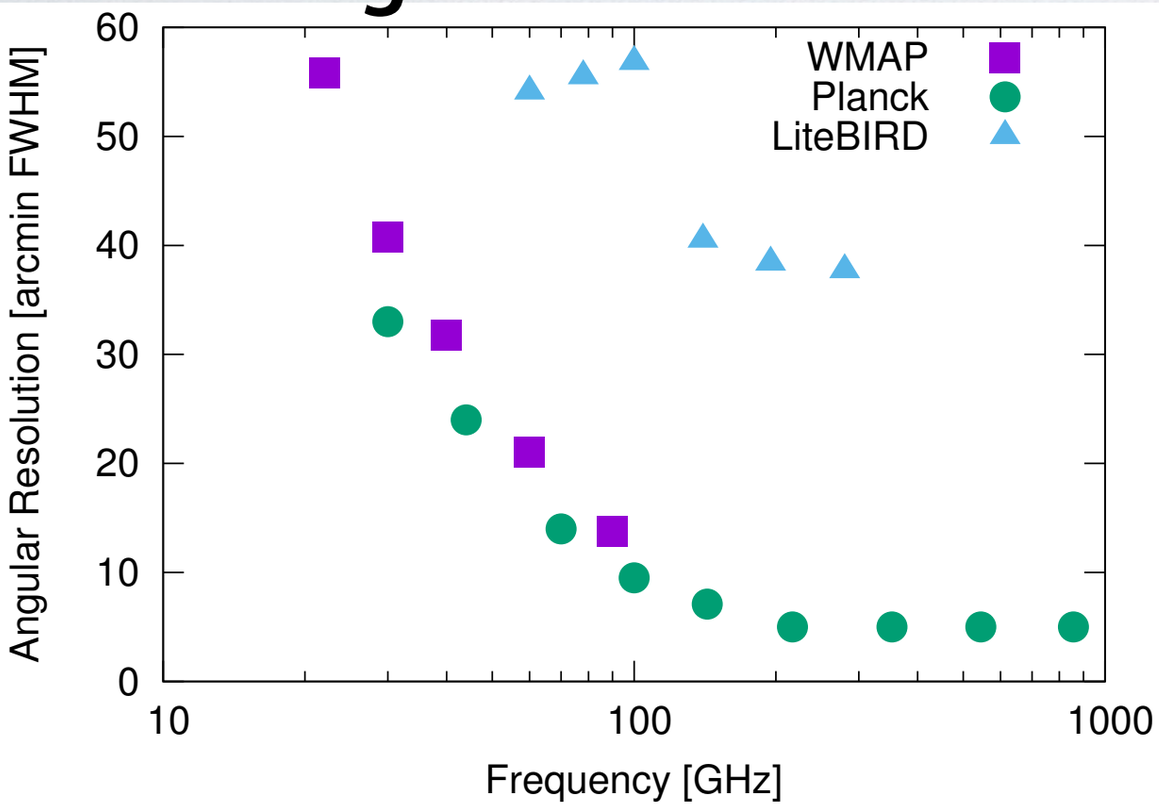



Giommi+'11

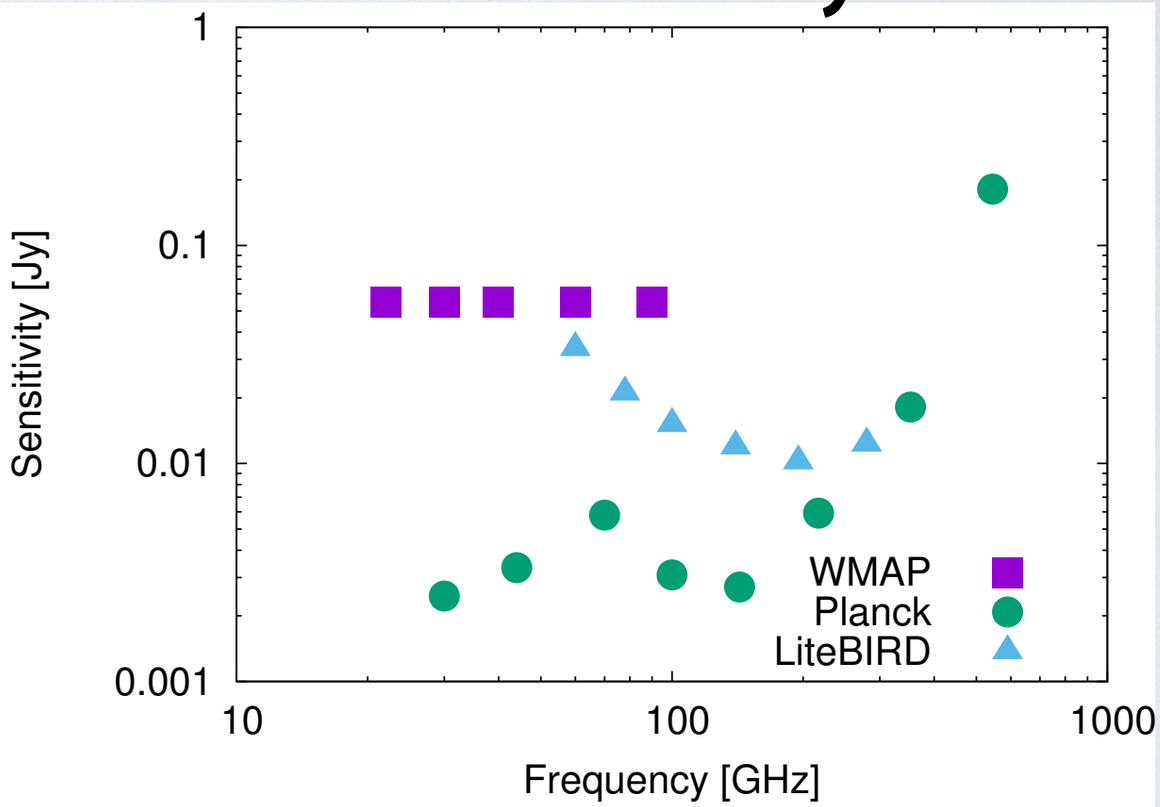
- Cover source count distribution at bright end (Ade+'11)
- 175 blazars simultaneously observed by Planck, Swift, and Fermi
  - Data challenge the blazar sequence correlation (Giommi+'11).

# Can LiteBIRD do like Planck?

## Angular Resolution



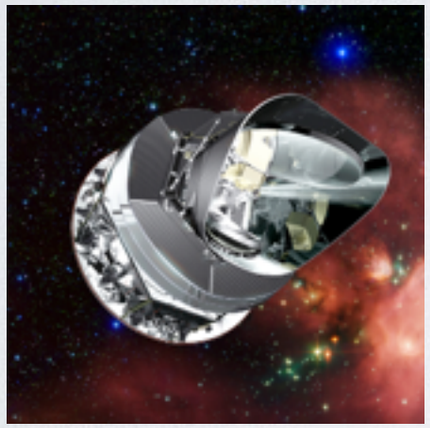

## Sensitivty




- Planck has better “angular resolution” & “sensitivity” for astronomical objects.

# *How Planck & LiteBIRD are different in the observation mode?*

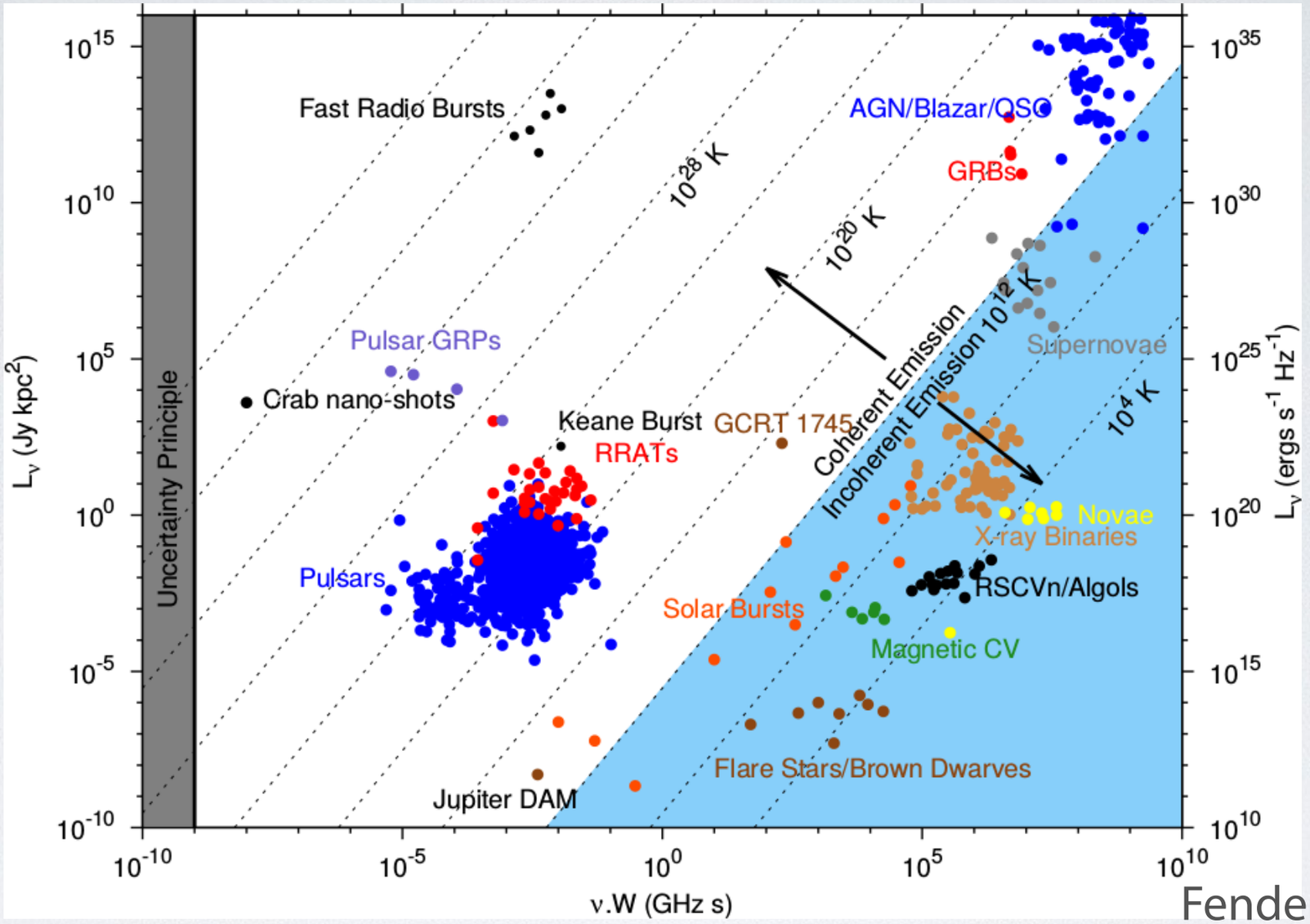
- All sky survey
- But



- Planck observed each patch of the sky for a few times with FoV of 50 $deg^2$ & monochroic observations
  - Deep but low-cadence survey

- LiteBIRD will observe the half of the sky everyday with FoV of 200 $deg^2$ & multi-chroic observations
  - Shallow but high-cadence survey → transient science

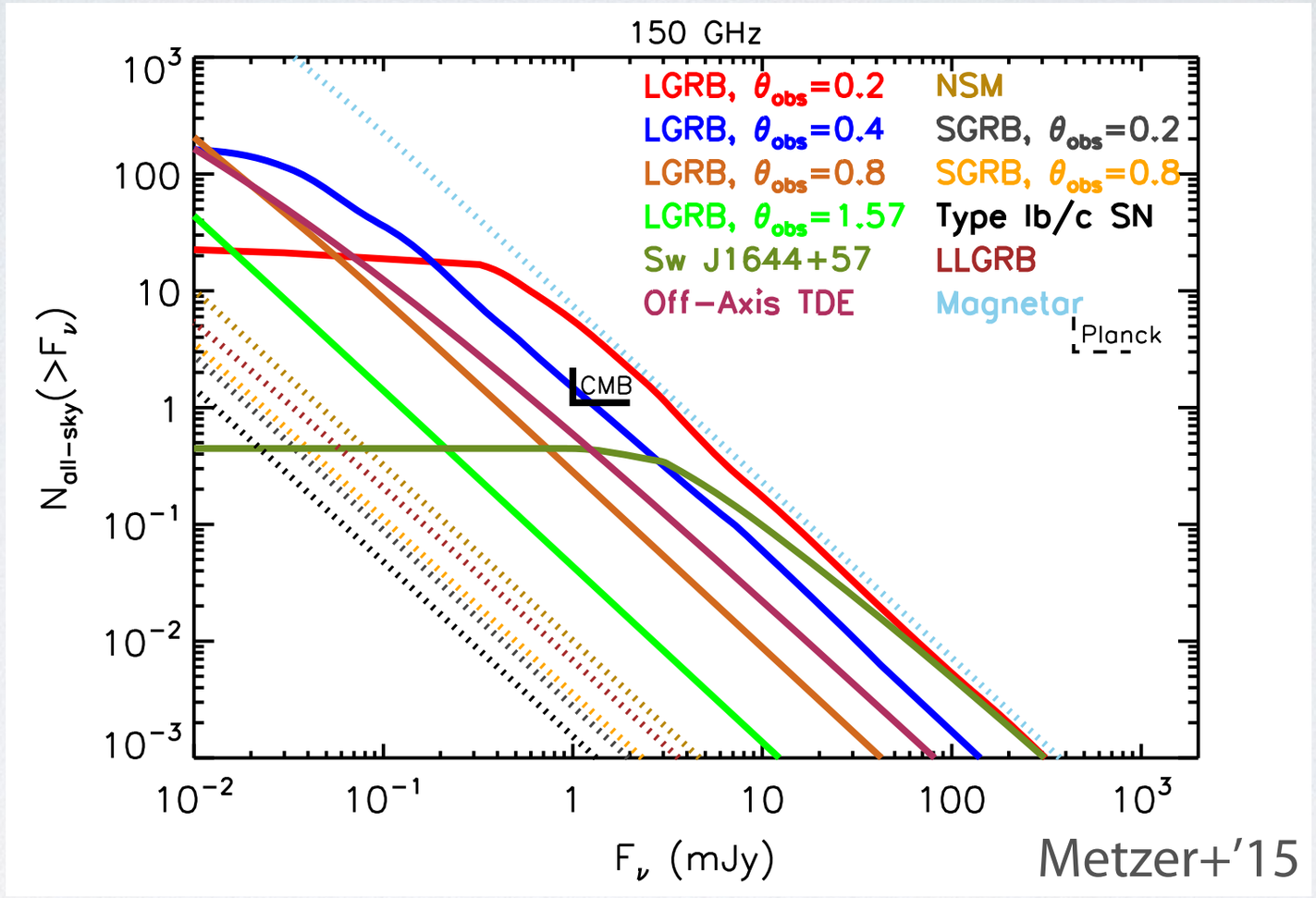
# Radio Transient Parameter Space




Fender+'15

- LiteBIRD will cover the unprobed parameter space.
  - will see unknown transient events.

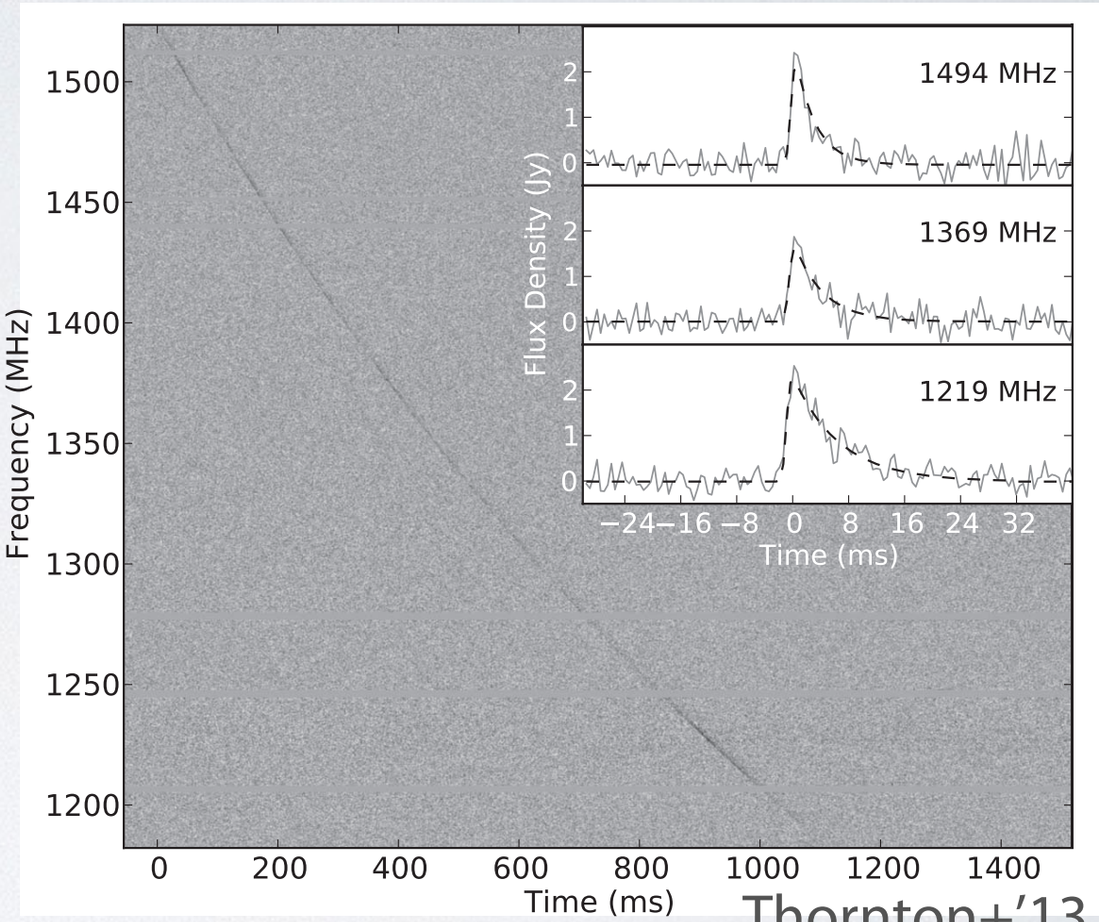
# Transient Survey in Sub-mm for "known" sources




- GRBs, TDEs, Type Ib/c SNe, neutron star mergers, magnetars are faint for LiteBIRD.

# *Fast Radio Bursts*

- ~15 events discovered
  (e.g. Lorimer+'07, Thornton+'13)
- ~1-10 Jy level flux at ~1-10 GHz
- pulse width < 1 msec
- ~21% circular polarization w/ 3-σ
  (FRB 140515; Petroff+'15)
- ~44% linear polarization (Masui+'15)
- dispersion measure (DM) indicates
  at cosmological distance z~0.5
- very high event rate 4000-10000 per day (e.g. Rane+'15).




Thornton+'13

# *Origin of FRBs*

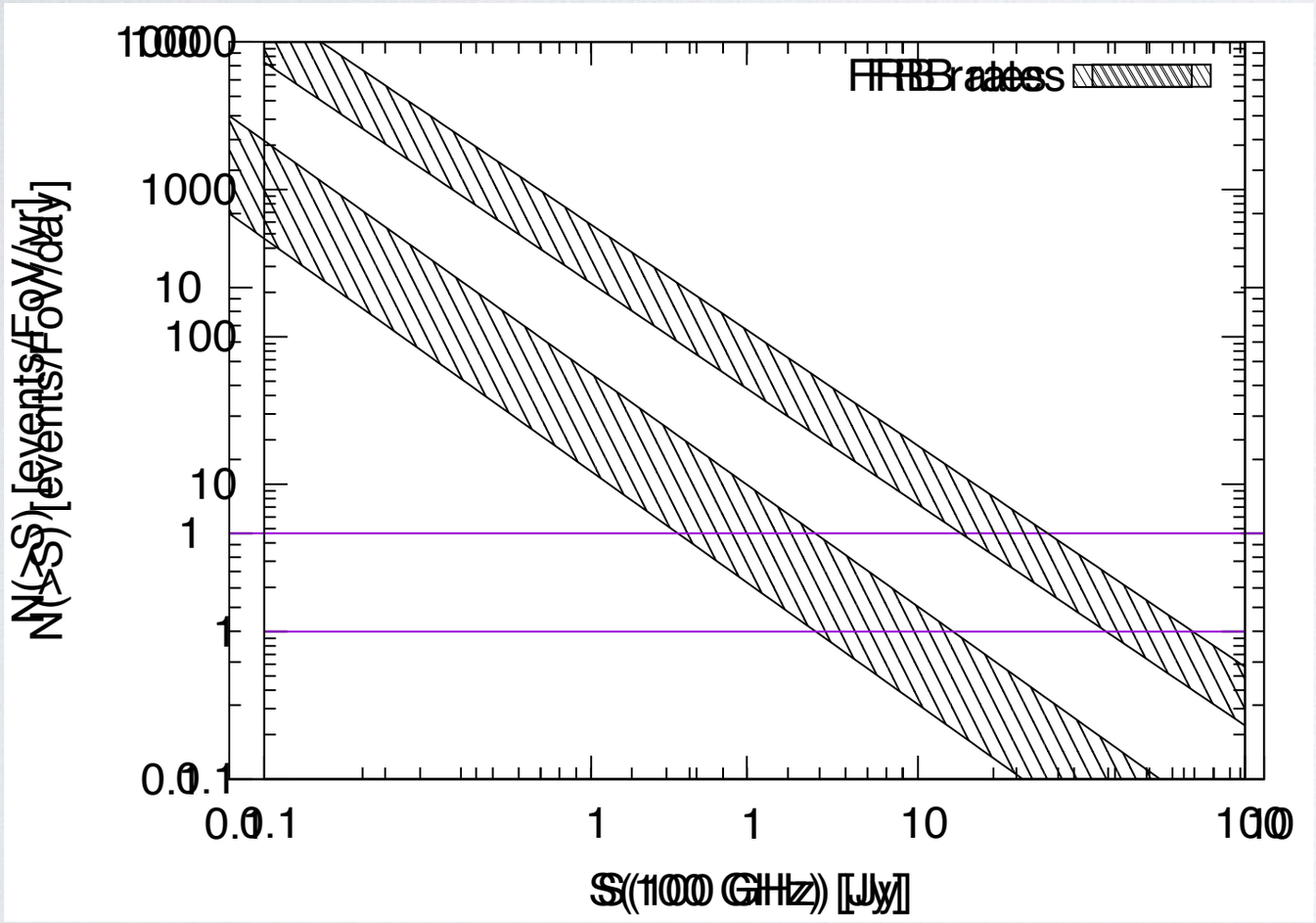
- Blackhole evaporation (Keane+'12)
- Magnetar hyper flares (Popov & Postnov '13; Katz '14)
- Neutron star mergers (Totani '13; Ravi &
- White dwarf mer… …a, & Meszaros '13)
- … …massive neutrons stars (Falcke & Rezzolla
- Flaring stars in the Galaxy (Loeb+'14)
- and more….

**we do not know the origin!**

# *What we can learn from FRBs?*

- Dispersion measure will tell us the IGM density.
  - Missing baryon (McQuinn'14)? Reionization (with high-z FRBs)?
- Polarization will tell us intergalactic magnetic field.
- Gravitational wave event counterparts?
- Cosmic rulers (Zhou+'14)?

# How many events with LiteBIRD?




- The FRB rate is not clear. But, 4000-10000 FRBs per day per all sky at 1 GHz.
- Assuming the Euclidean distribution & a spectral index of 0.5.
- a few FRBs everyday @ S(100 GHz) = 1 Jy
- ~10 FRBs every year @ S(100 GHz) = 10 Jy
  - ~μsec time resolution will be required to detect DM of FRBs ($\nu^{-2}$ dependence).
  - synergy with low-frequency experiments is important. (e.g. SKA)

# *Summary*

- Planck had better sensitivity & angular resolution, but LiteBIRD will have higher transient survey power
  - 2π str / day with 200 deg$^2$ FoV
- LiteBIRD is suitable for transient search like FRBs
  - a few faint events every day, ~10 bright events every year
  - synergy with low frequency telescopes is important.
  - <msec time resolution will be demanded.