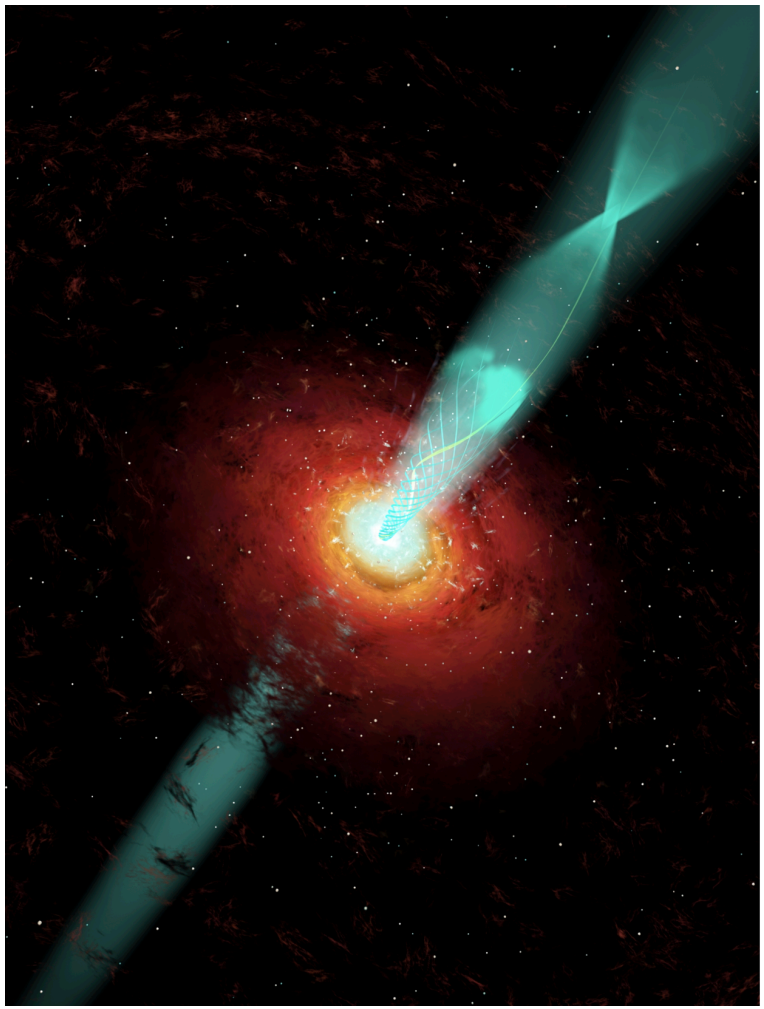
MeV Blazars: Why do we care ?



Marco Ajello

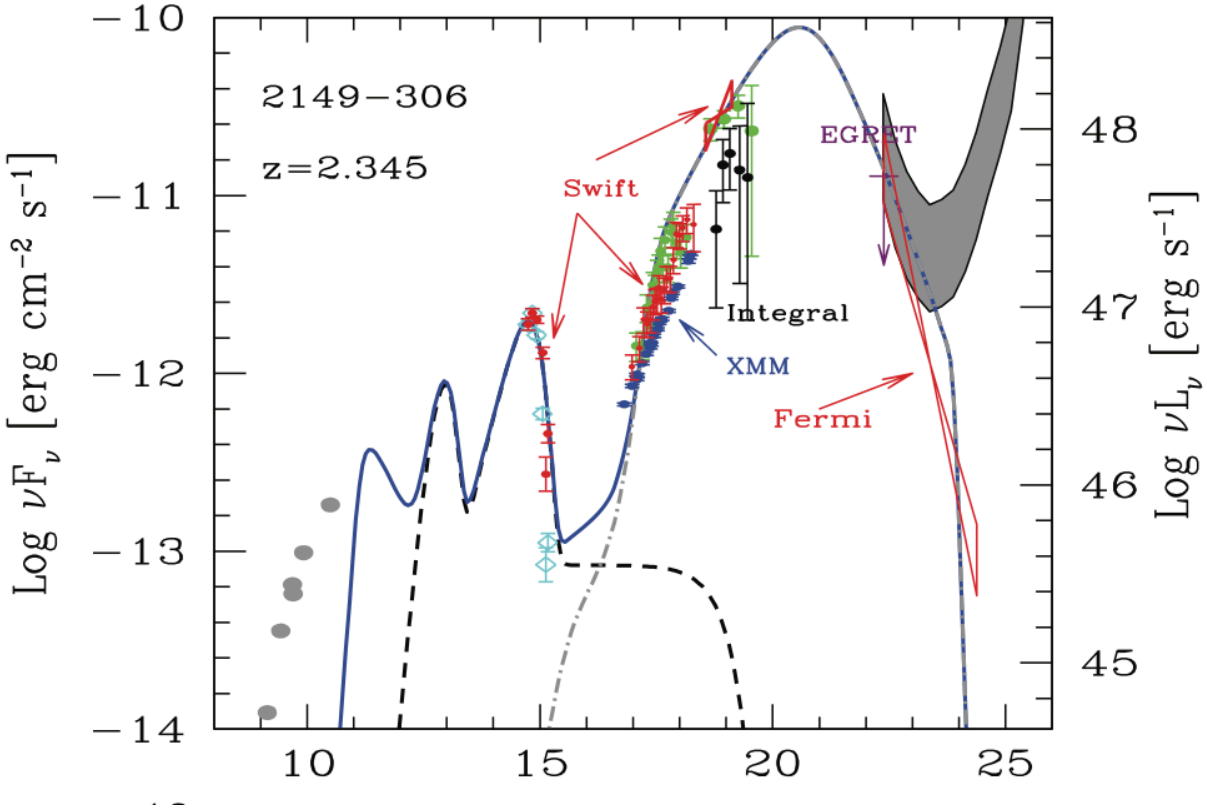
Clemson University

What are MeV Blazars ?

- Most luminous blazars
- Found at high z, often z>2
- Hard in X-ray and soft in gamma
- Compton dominance of O(100)
- Have fast jets

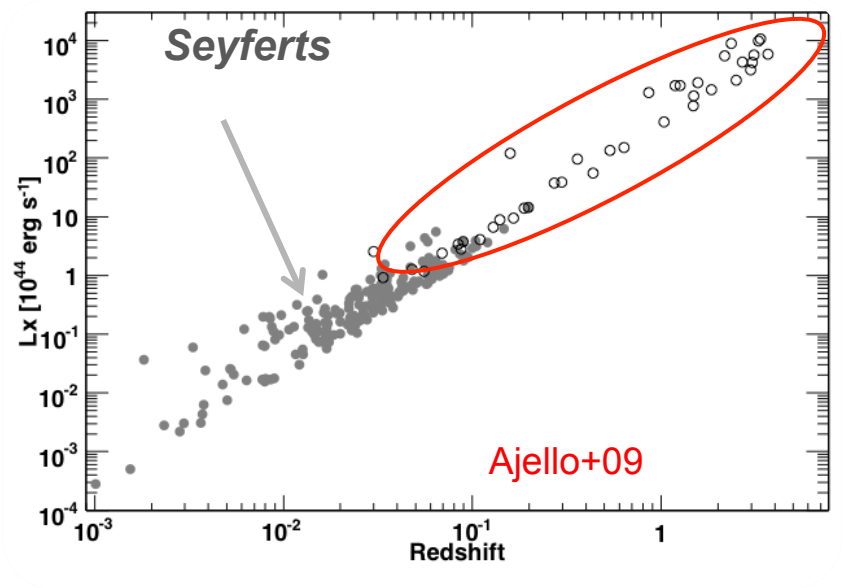
- Prominent disk/torus emission
- Radio bright
- Peak in the MeV
- Discovered by COMPTEL

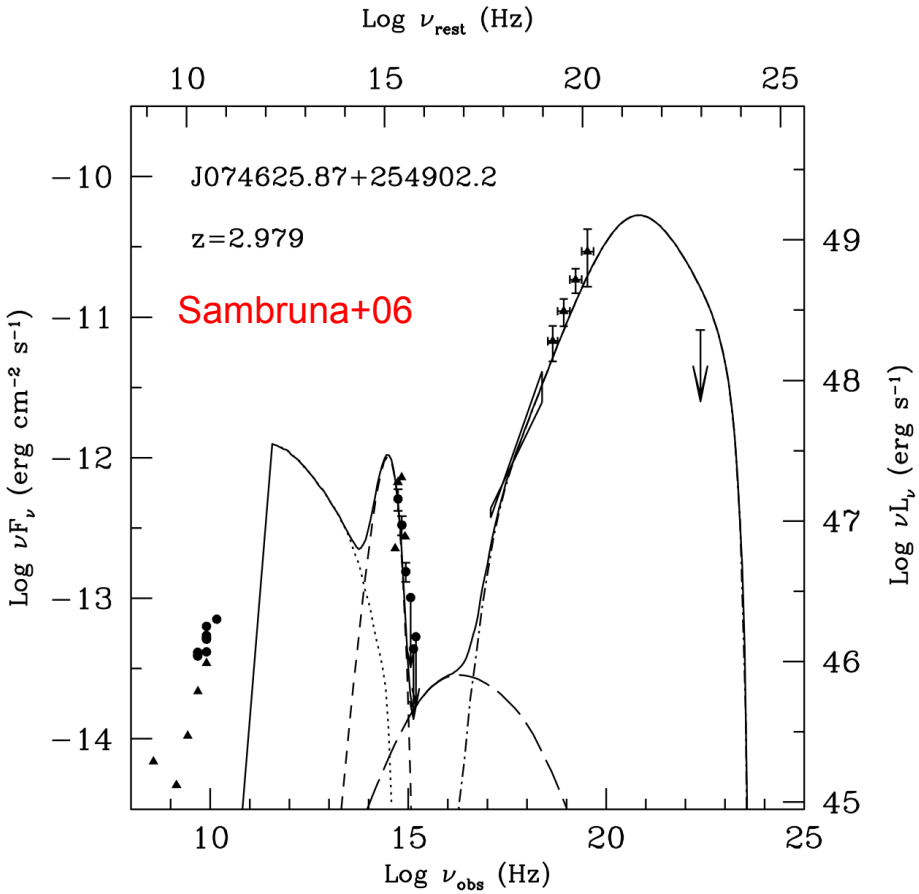
Bloemen+95
Sikora+02
Sambruna+06



Hard X-ray Observations

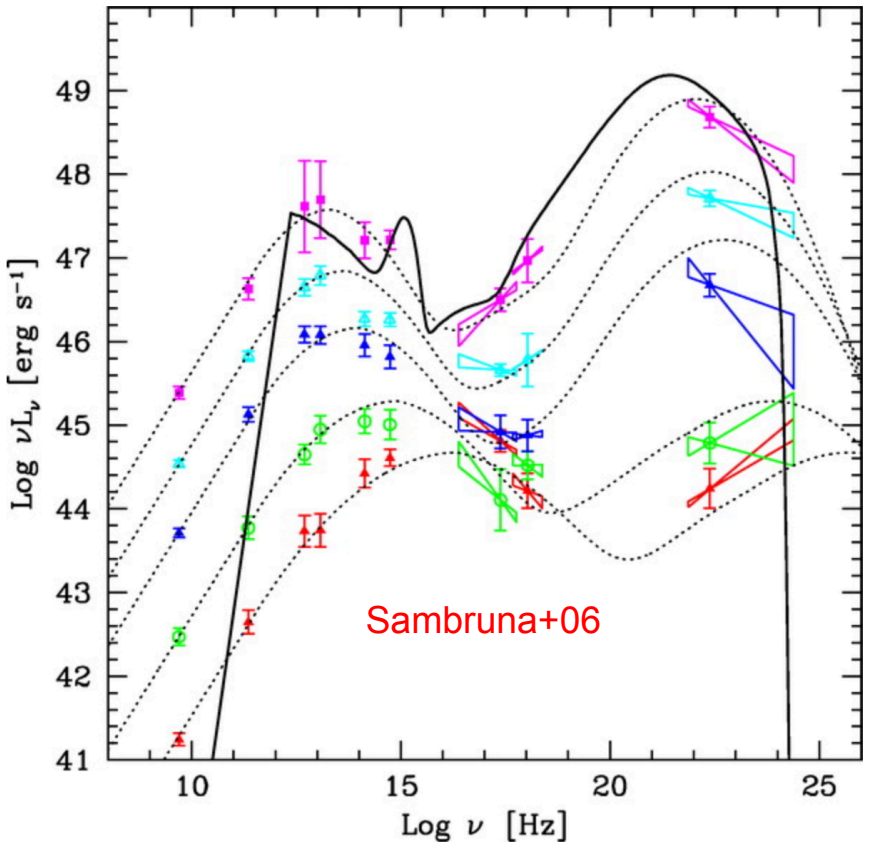
- **The high redshift (favorable k-correction) and hard continuum makes them easily detected in hard X rays**

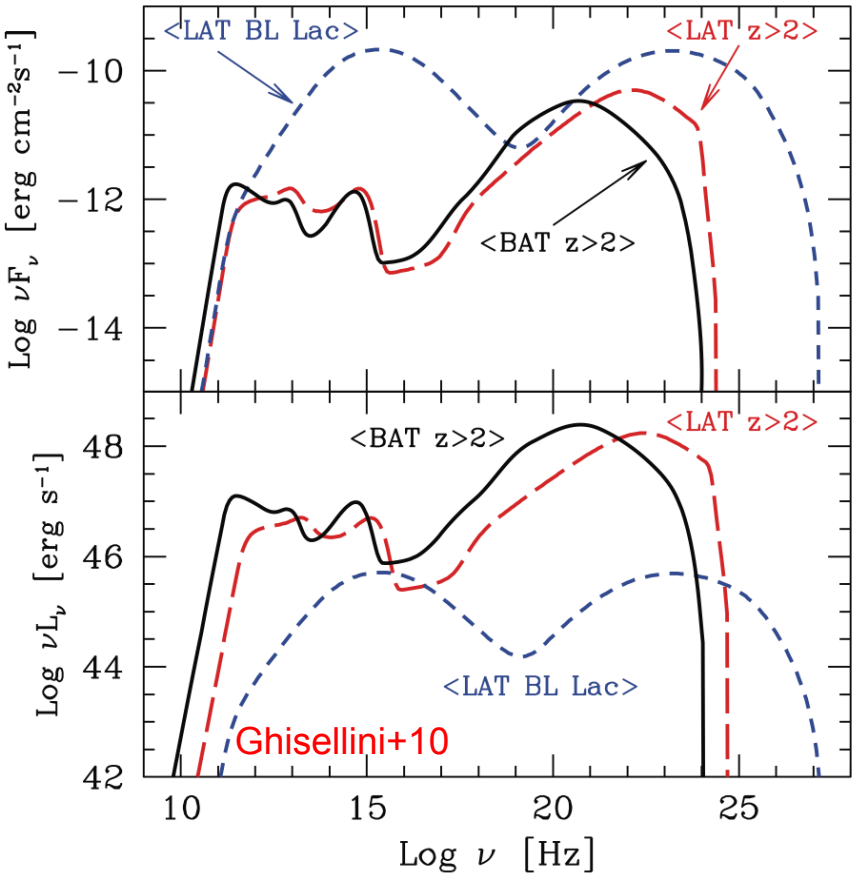




MeV Blazars in a contest

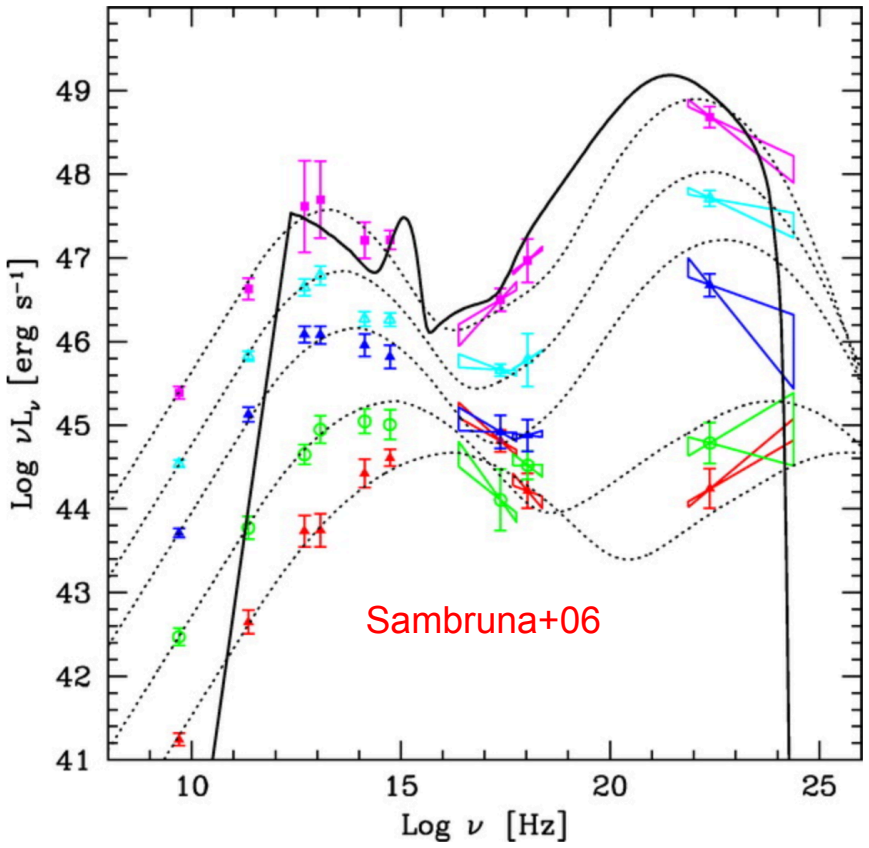
- **Their SED is 'redder' and they are more luminous than most LAT FSRQs**
  - Highest redshift blazar detetected by LAT is at z=3.1
  - MeV blazars easily reach z=5

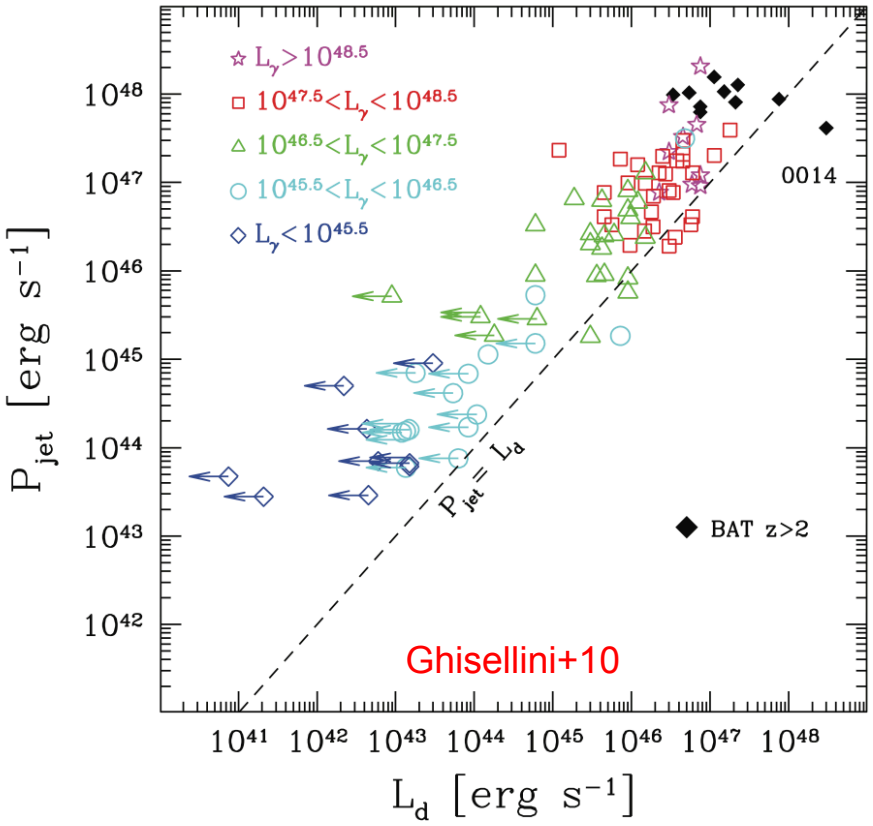




MeV Blazars in a contest

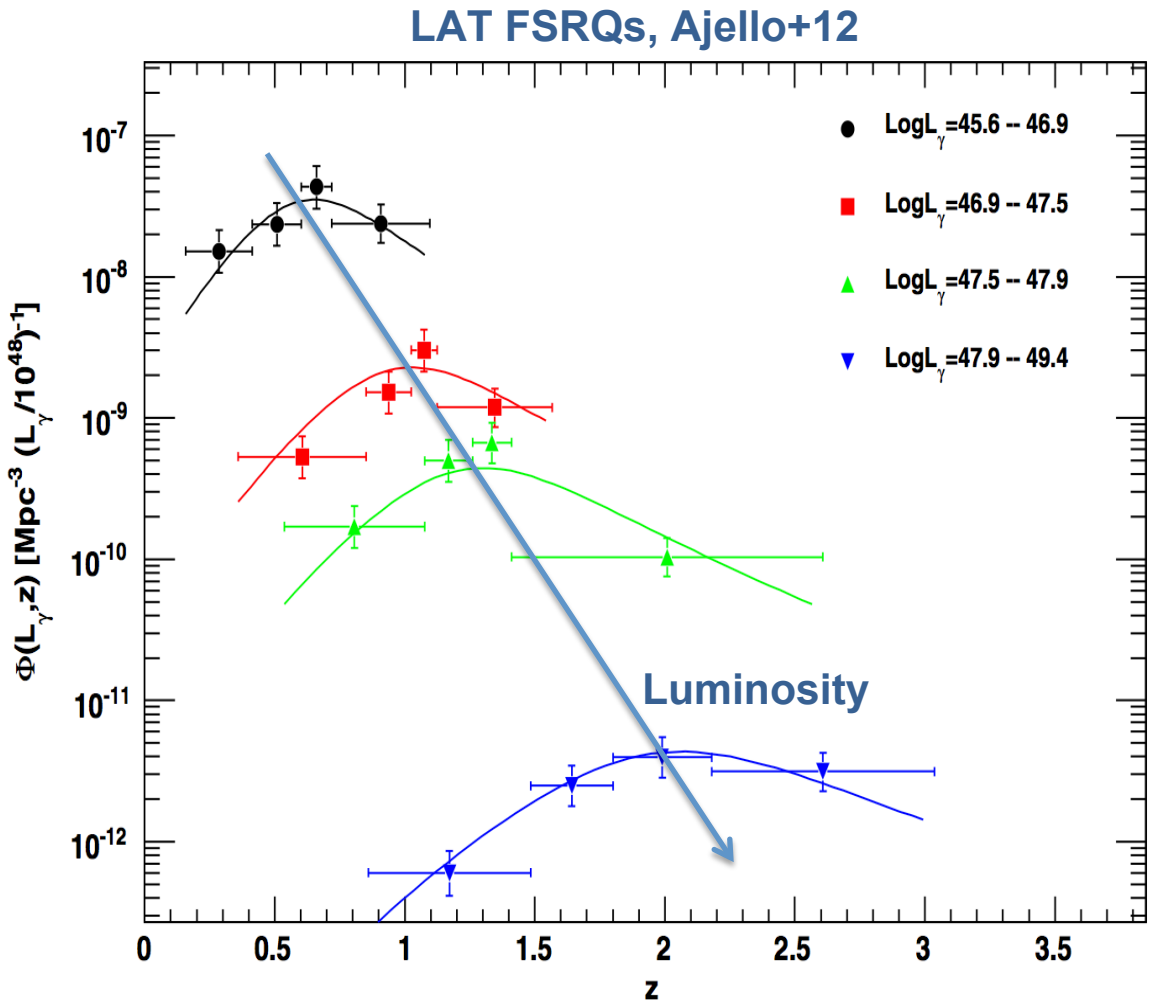
- **Their SED is 'redder' and they are more luminous than most LAT FSRQs**
- **They display the largest jet powers and accretion disk luminosities**





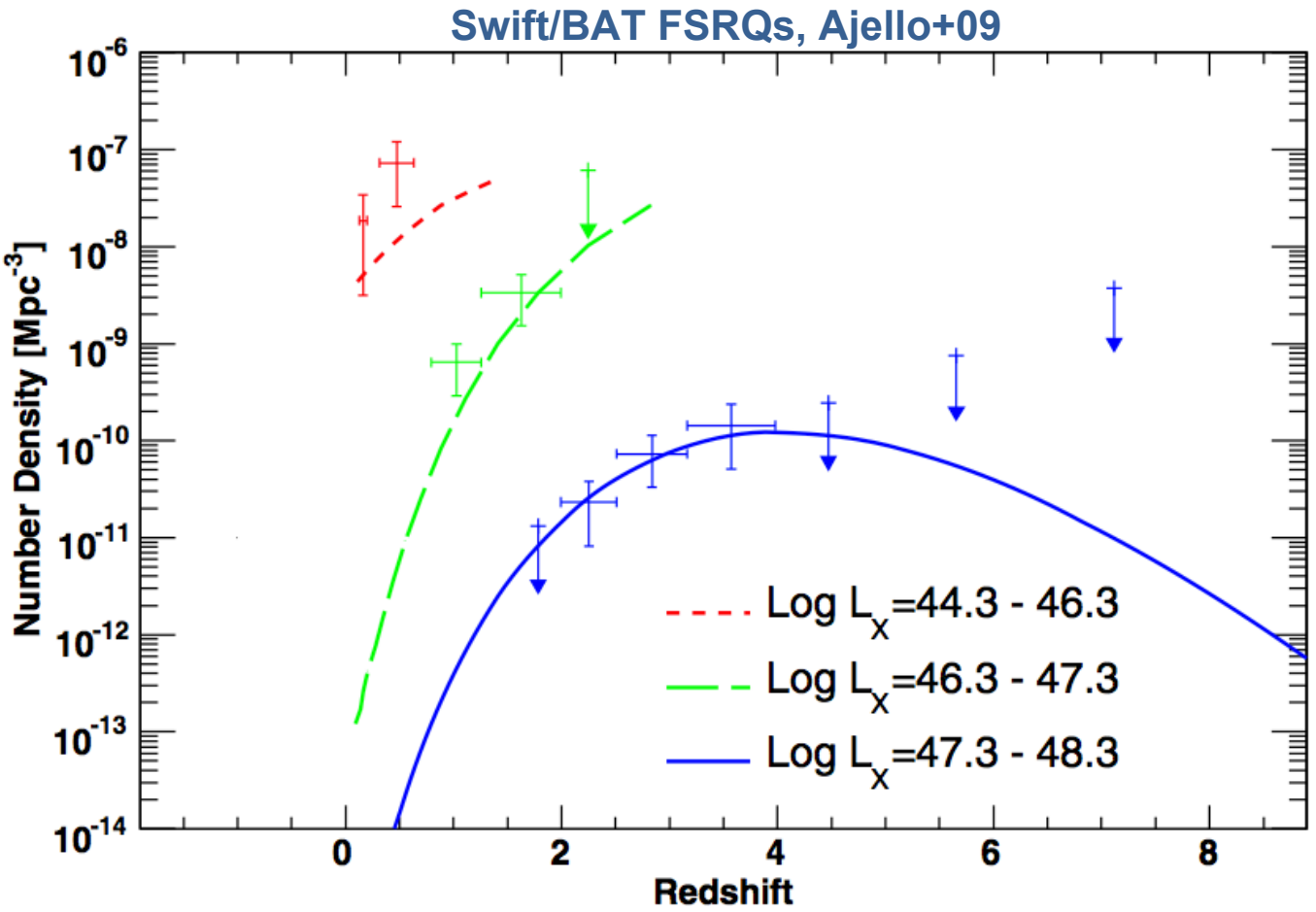
Evolution

- **FSRQs display the typical quasar evolution:**
  - **i.e. more luminous quasars were more active at earlier epochs**



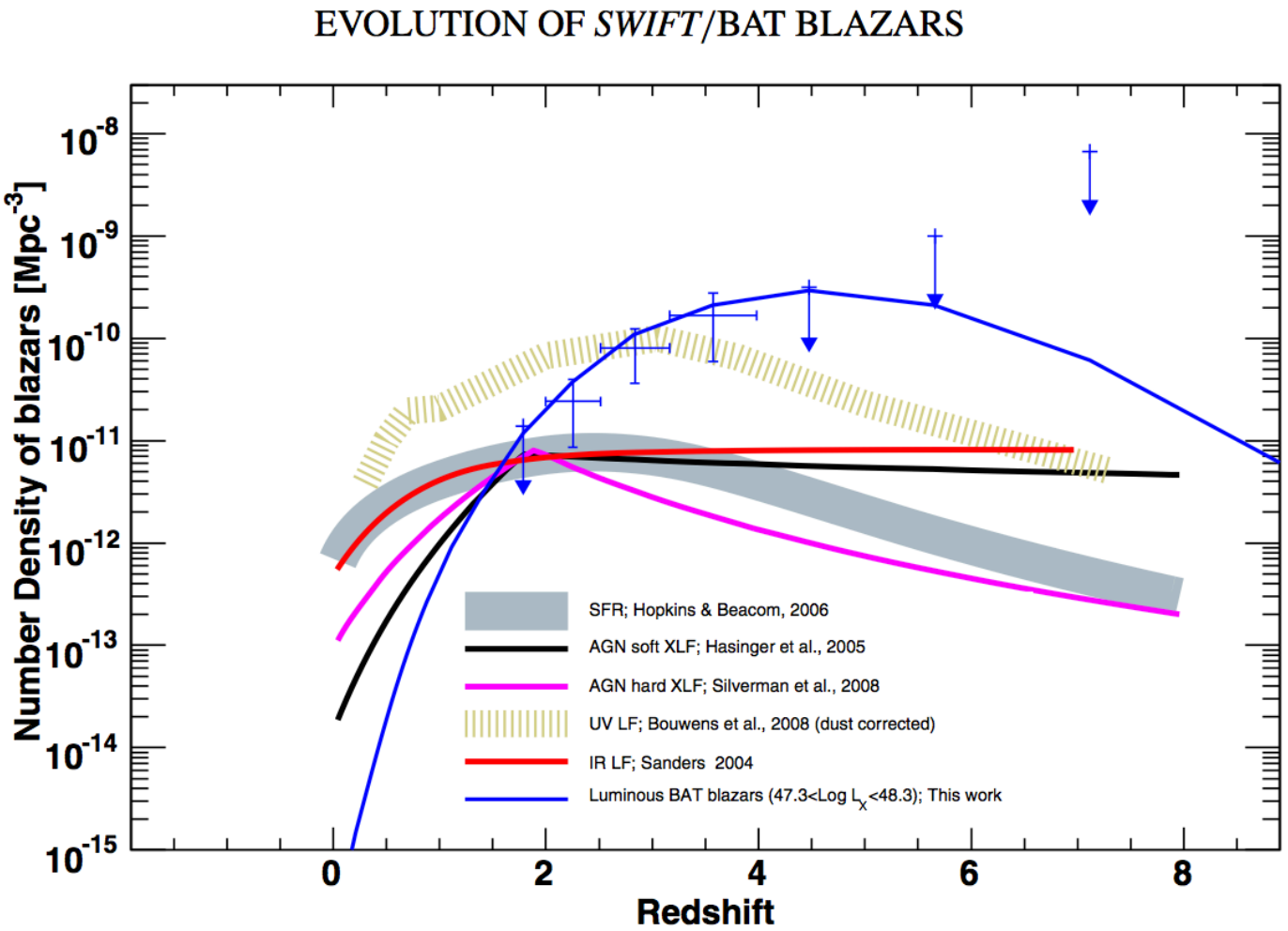
Evolution of MeV blazars

- It may follow the quasar evolution … to the extreme
  - The epoch of maximum activity could be at z~4



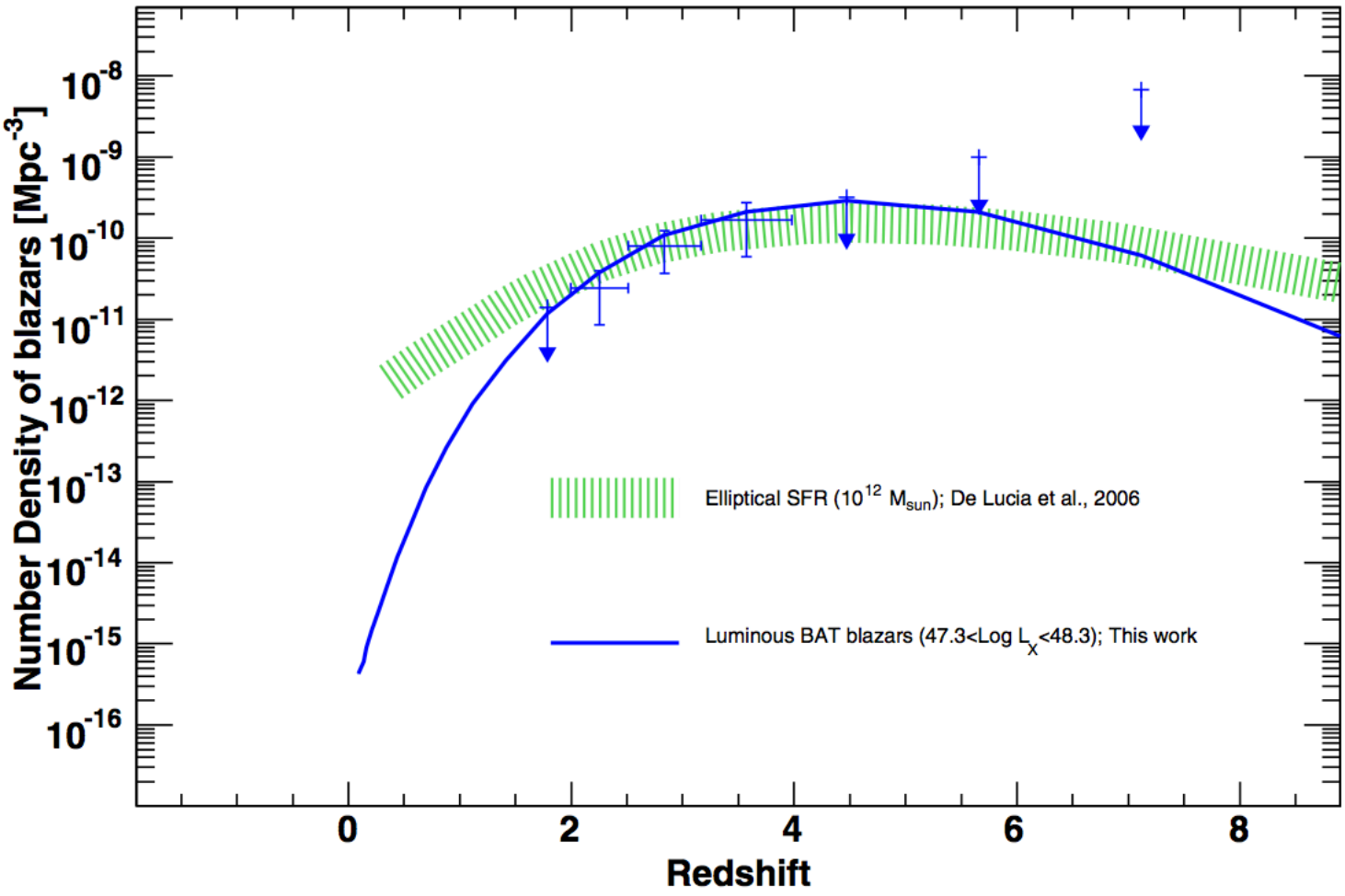
Evolution of MeV blazars

- **This extreme evolution was unheard of (to me at least)**



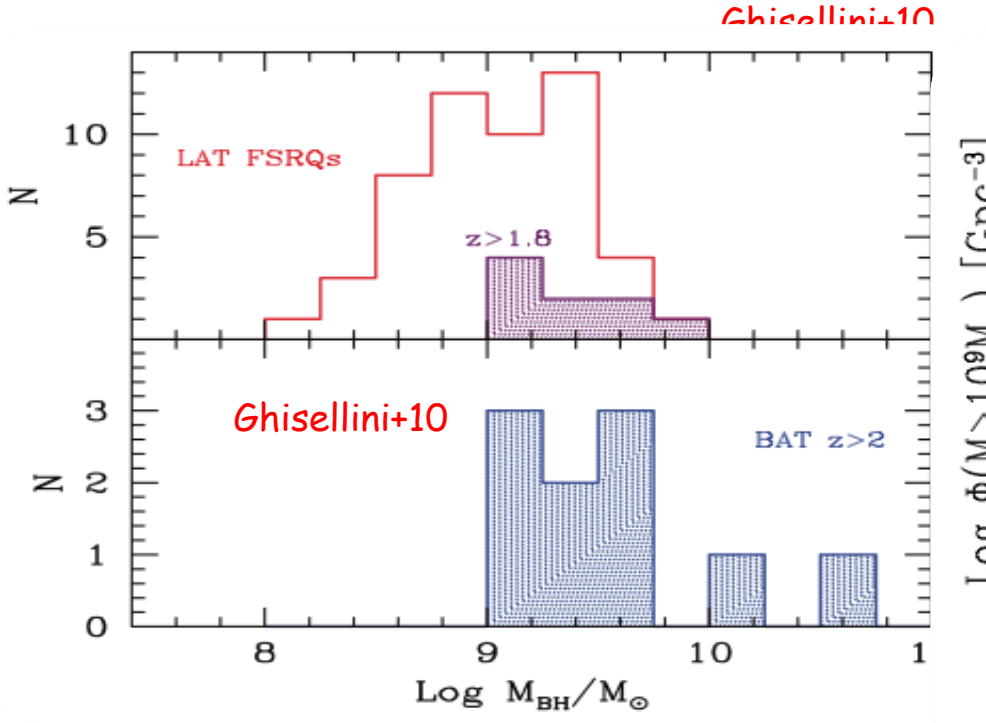
Evolution of MeV Blazars

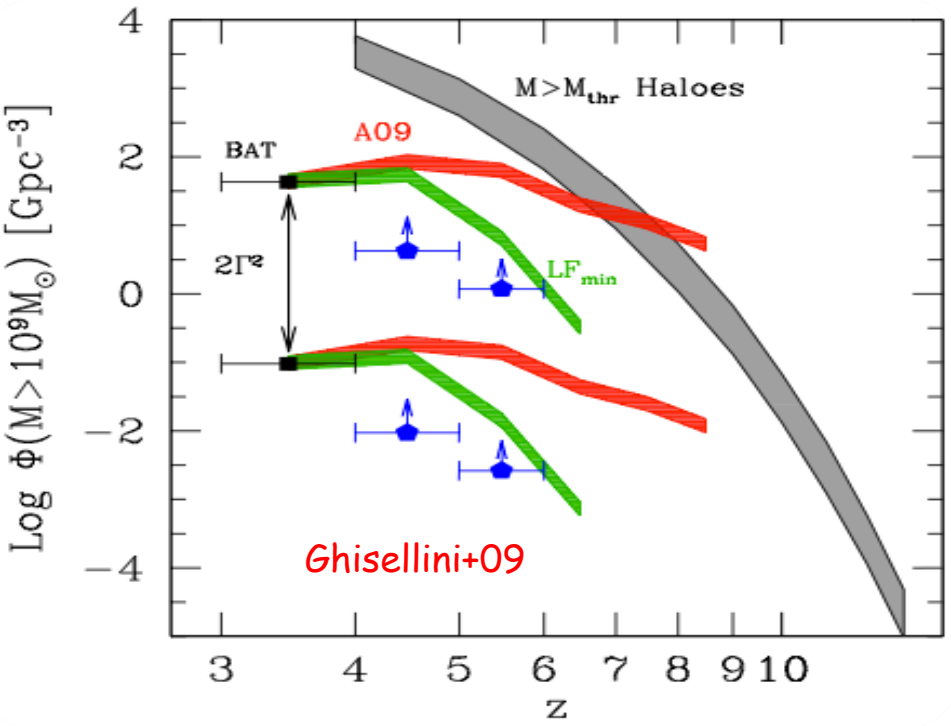
- **Only massive elliptical galaxies might display a similar evolution**



Black hole masses

- They (may) host heavy black holes with $M>10^9\ M_\odot$
- Because of the beaming correction (2) at z>4 one may be sampling the entire SMBH mass function





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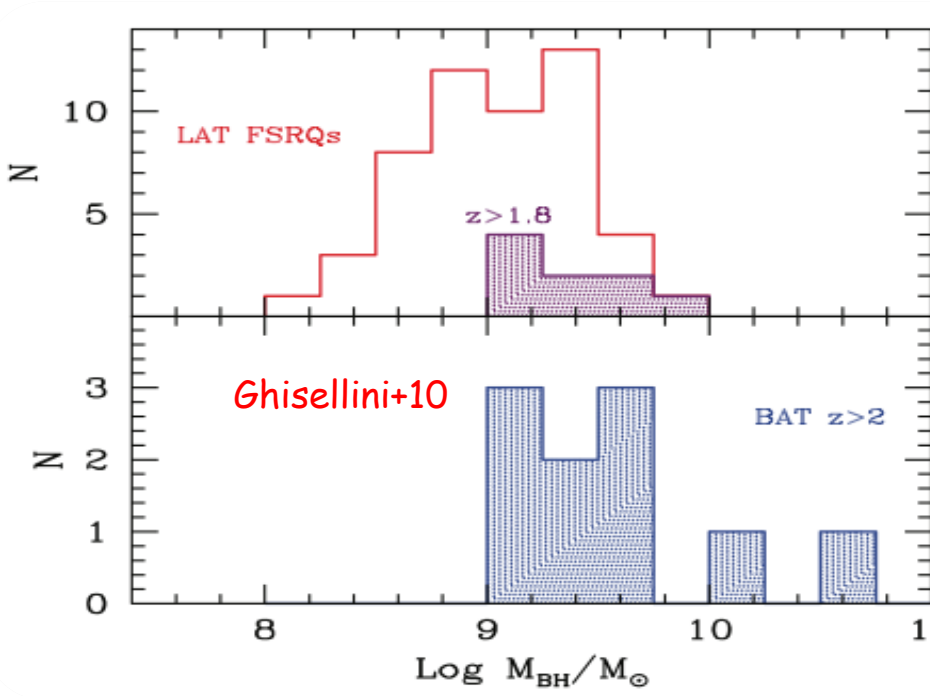
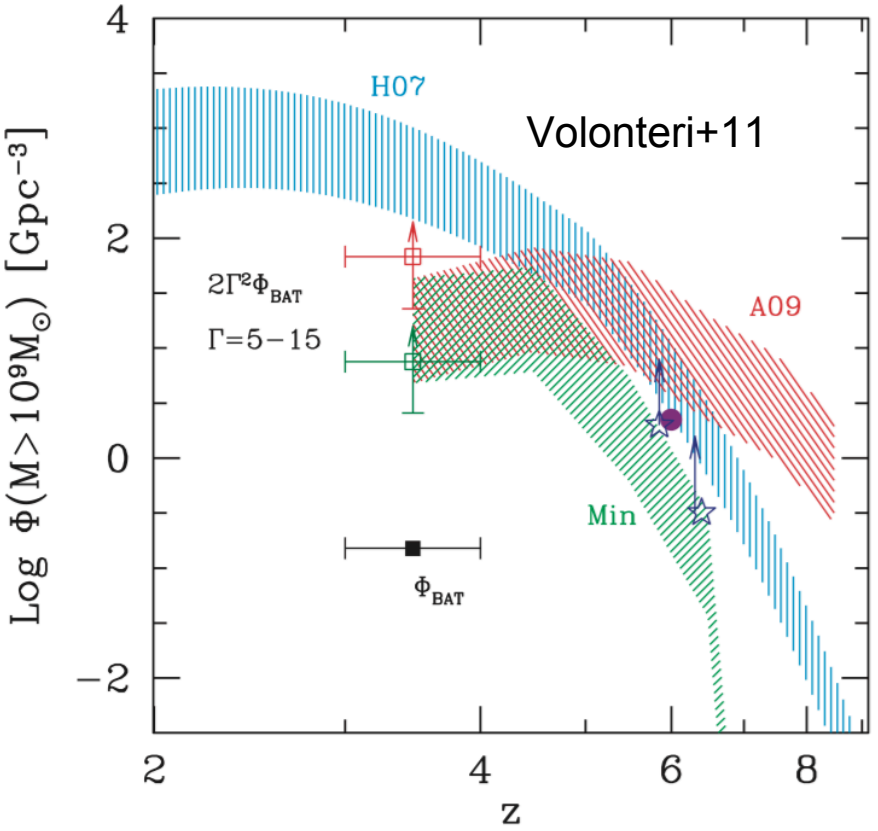
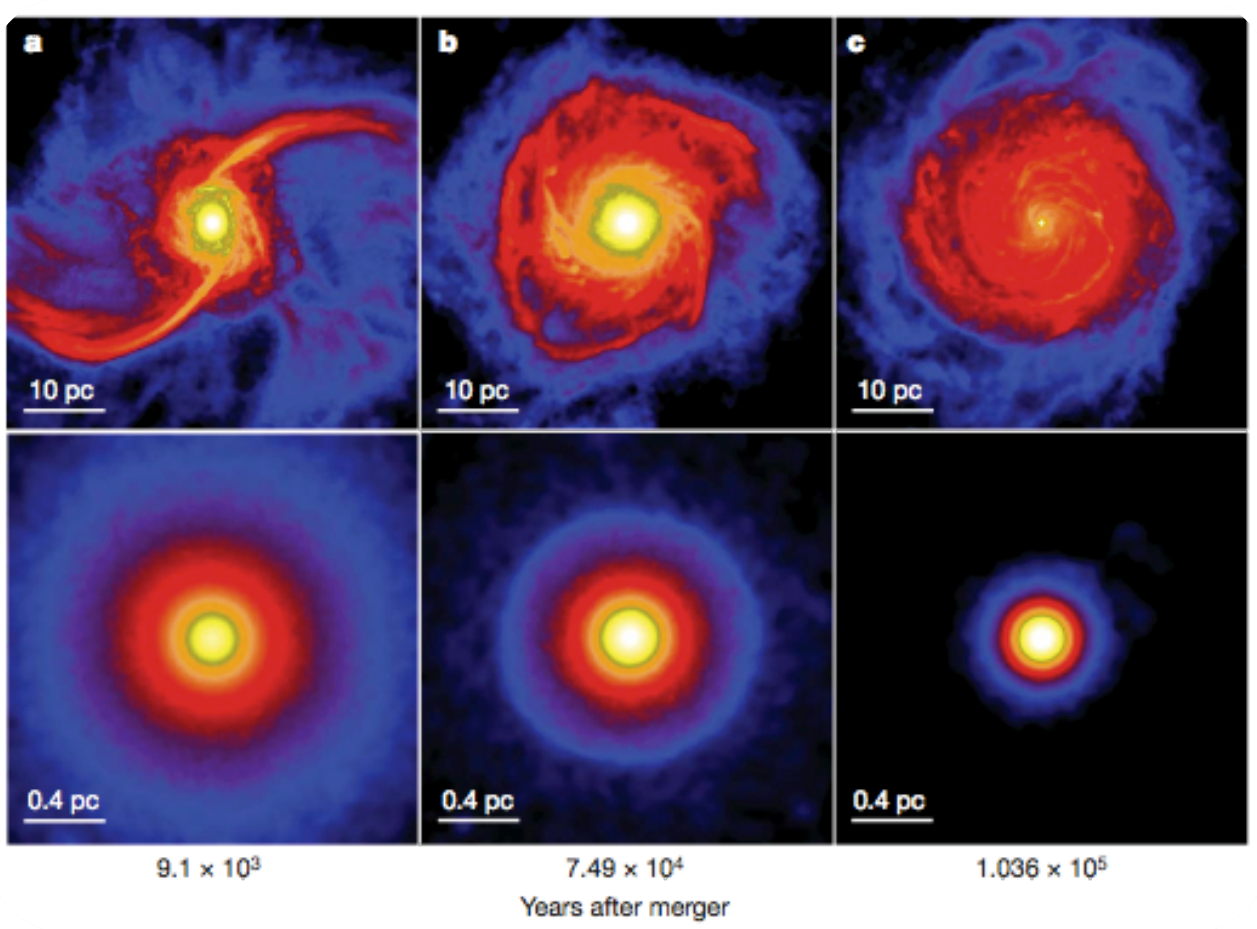




'Black Hole Arrived Early'

Nature Editor's summary, Aug. 2010

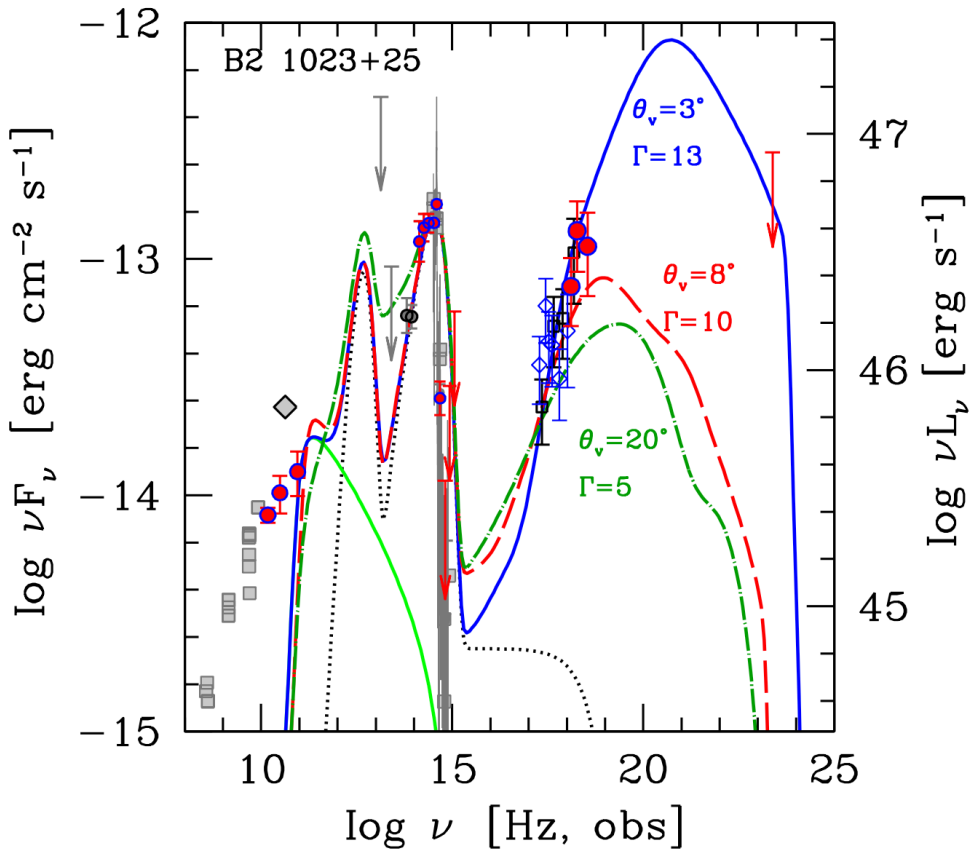
- **Direct formation of 10^5 M_{sun} BH from a massive turbulent disk produced by a merger seems feasible (Mayer+10, Nature)**



Follow up work

- **Lacking an MeV instrument (or a deep hard X-ray monitor), people have selected objects in other bands (radio/optical) and have resorted to NuSTAR**

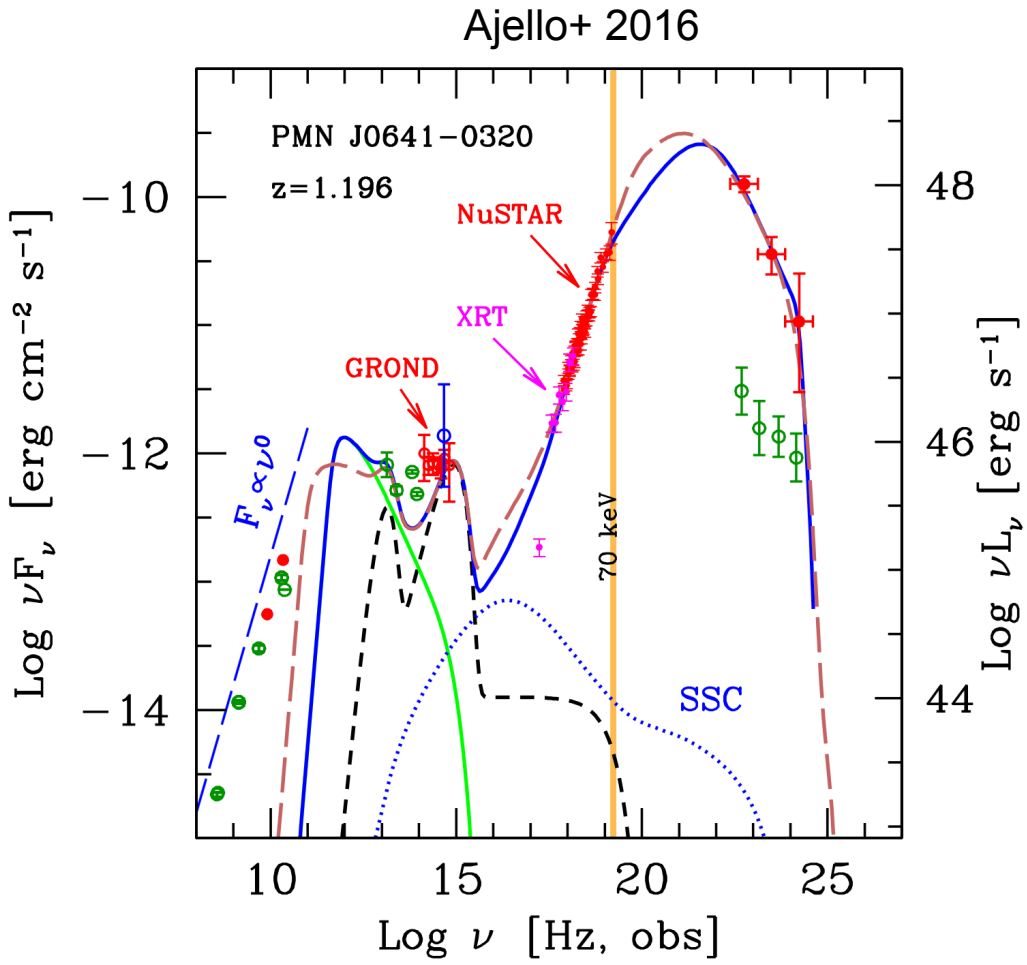
z=5.3 Sbarrato et al. 2013



Follow up work

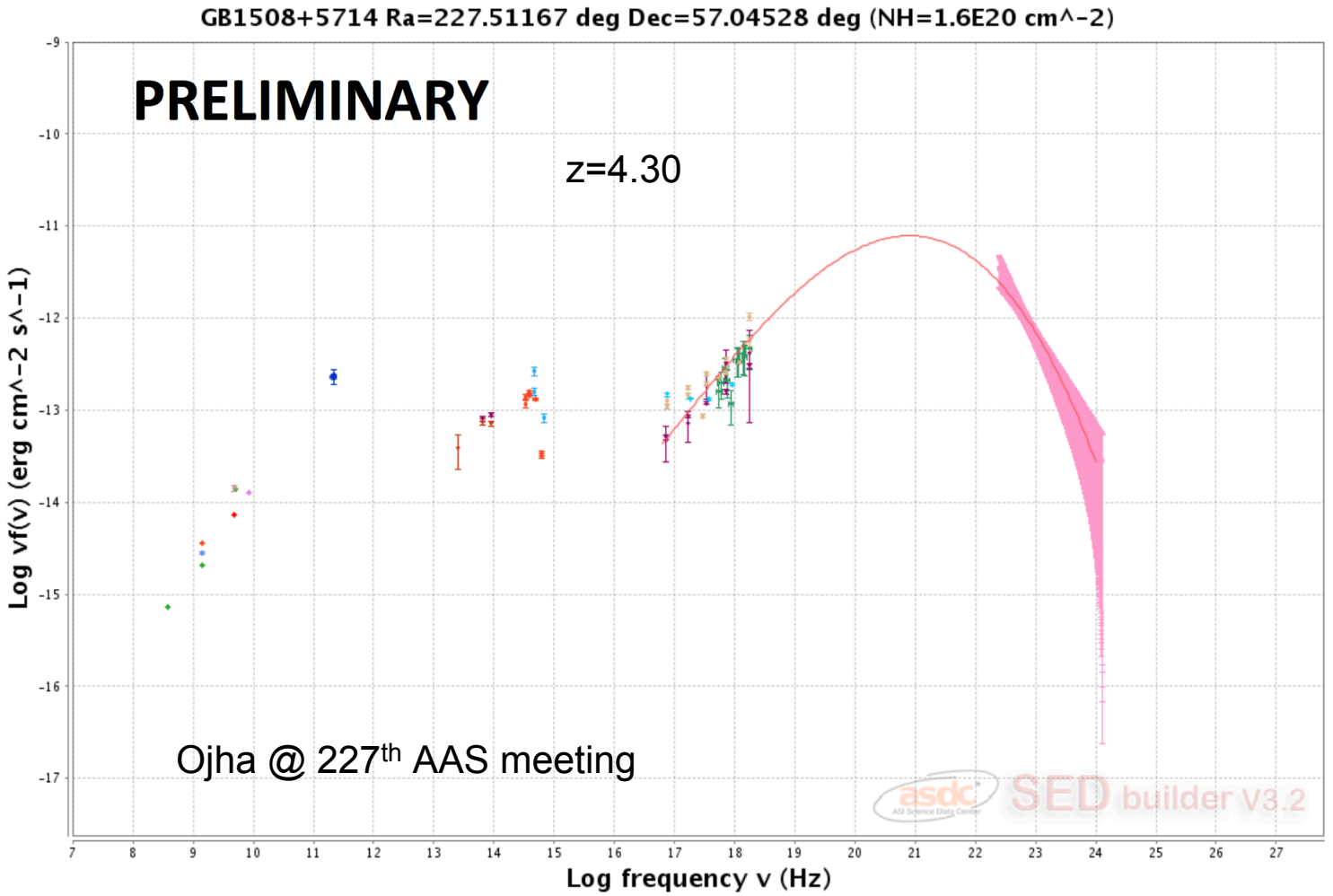
- **Catch them while flaring in the LAT !**
  - **and follow up with NuSTAR**

Hardest NuSTAR source known to date



Follow up work

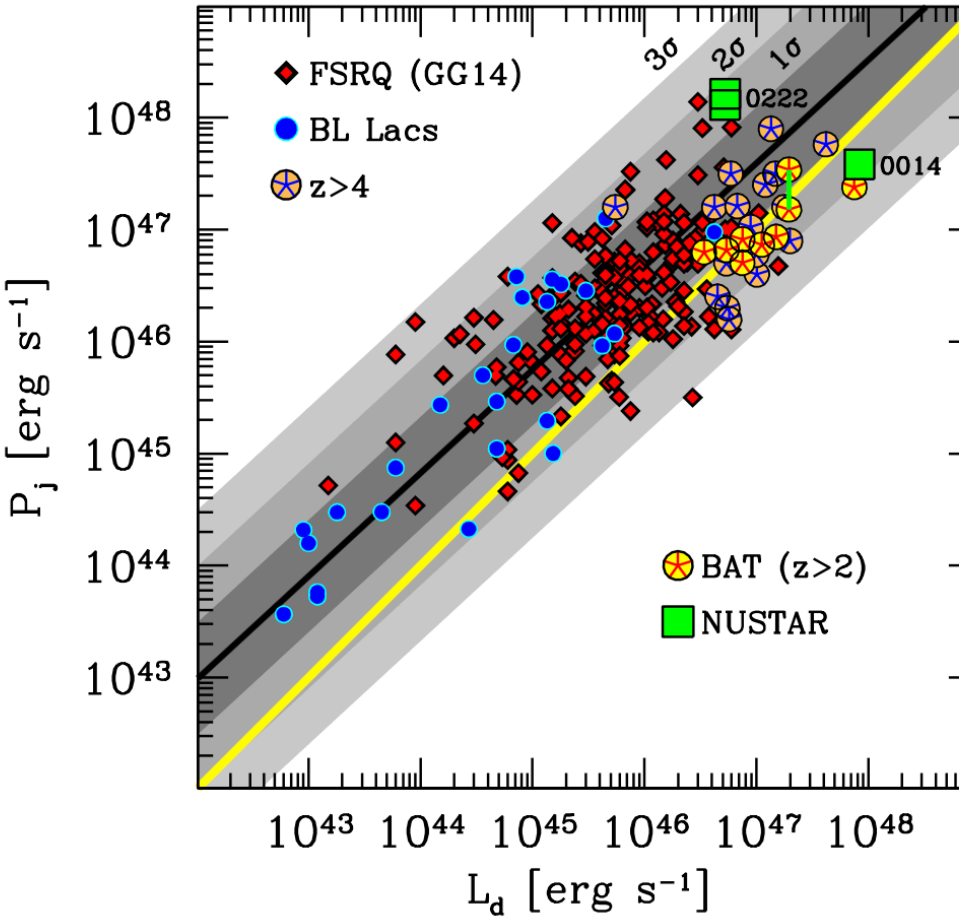
- **More powerful blazars to come thanks to Pass 8**



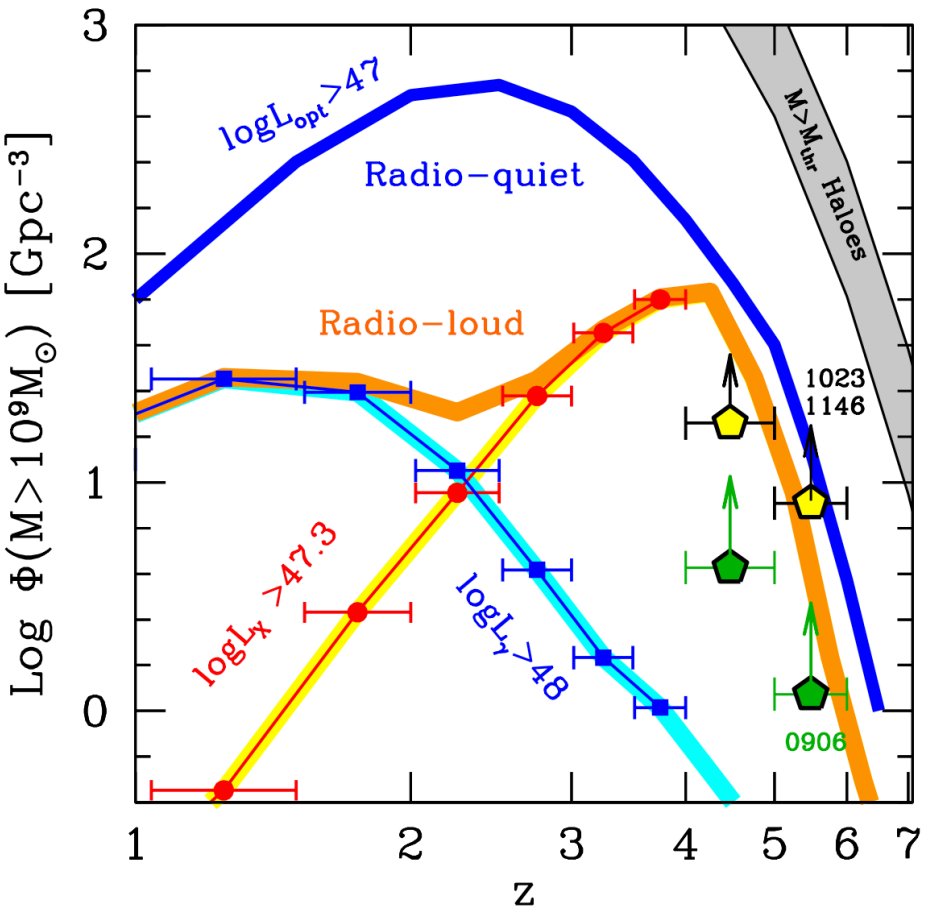
Current Status

- **MeV blazars follow the jet-accretion (powers) correlation**
- **There may be 2 epochs for formation of SMBHs**

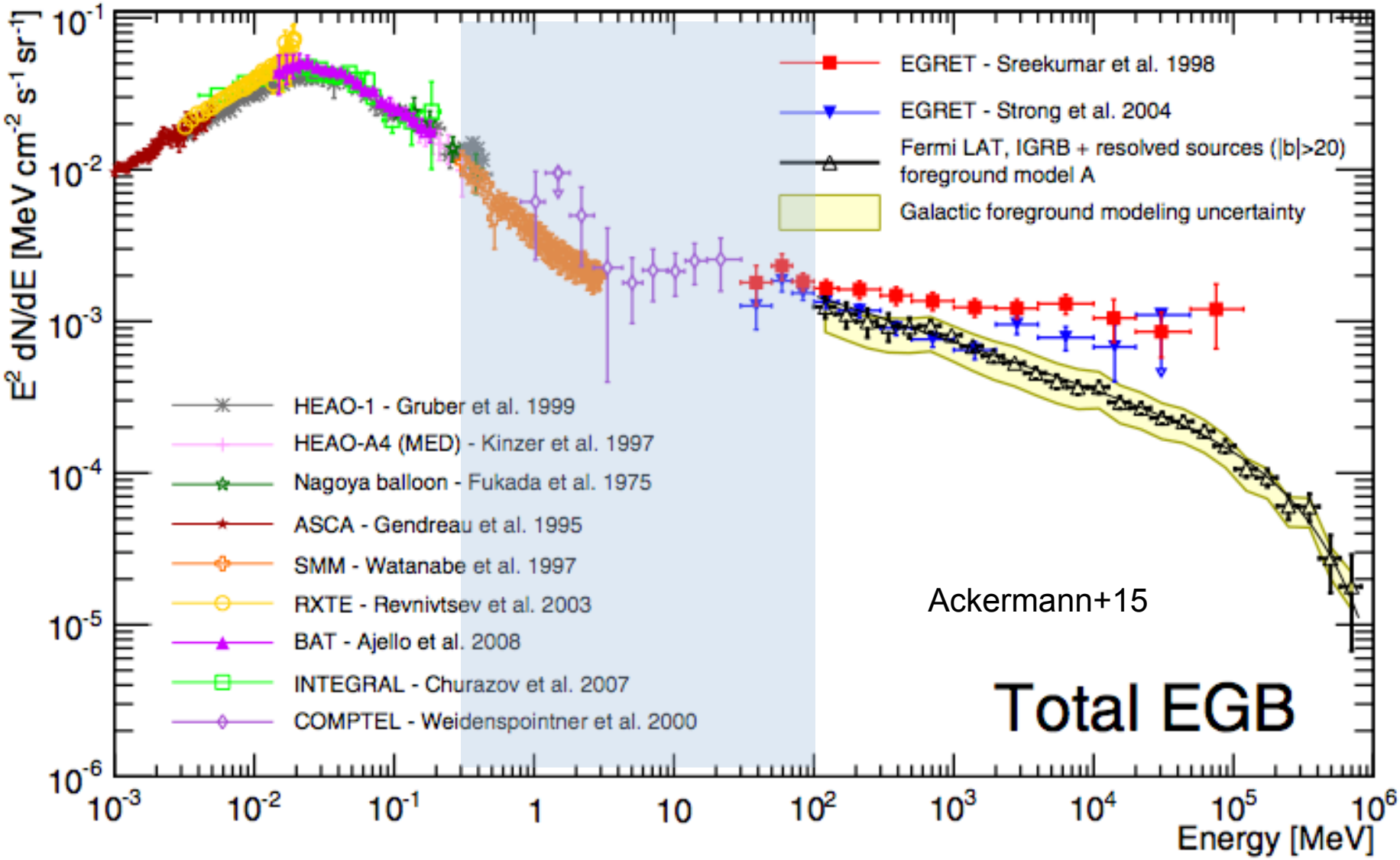
Sbarrato+15



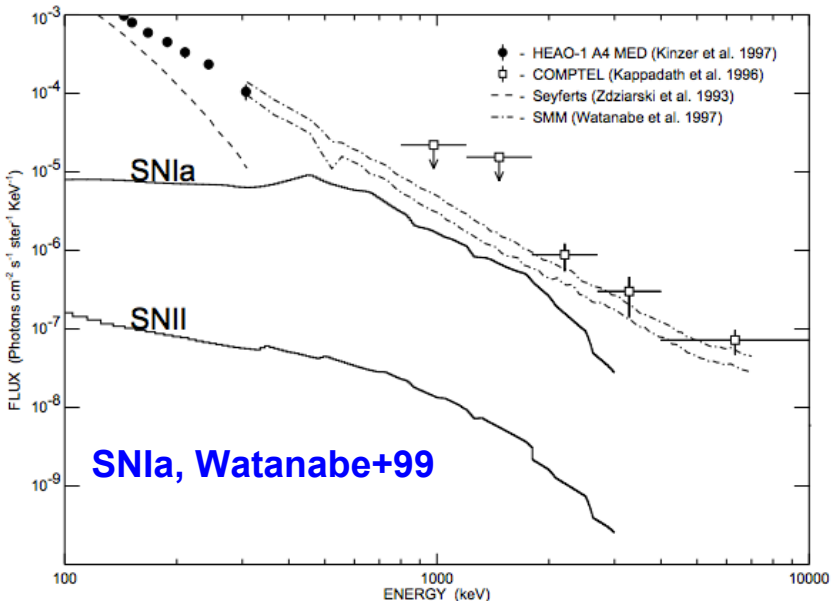
Sbarrato+14

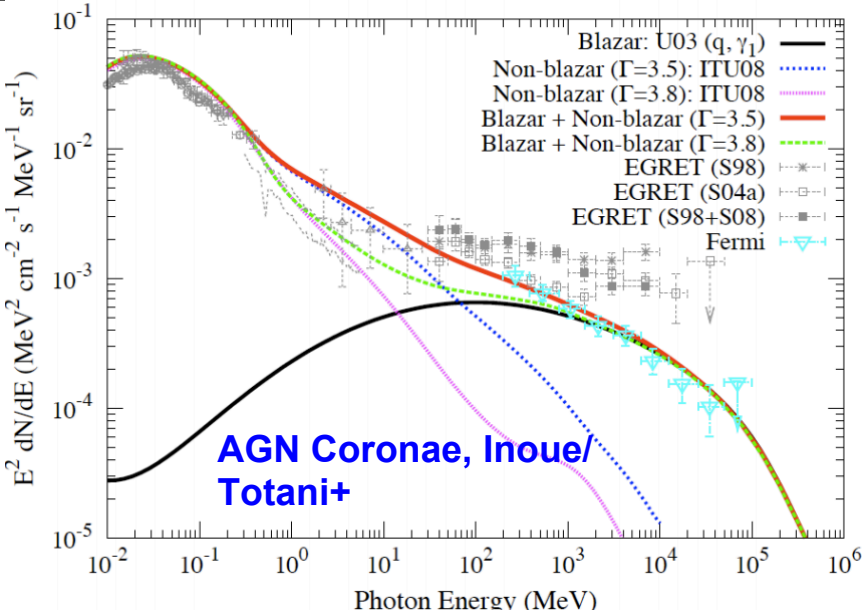


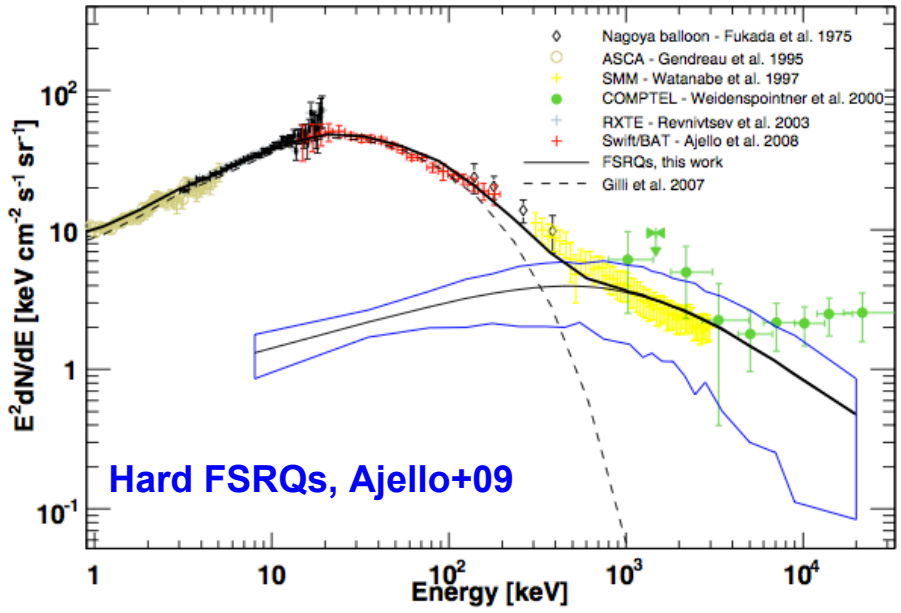
The MeV Background

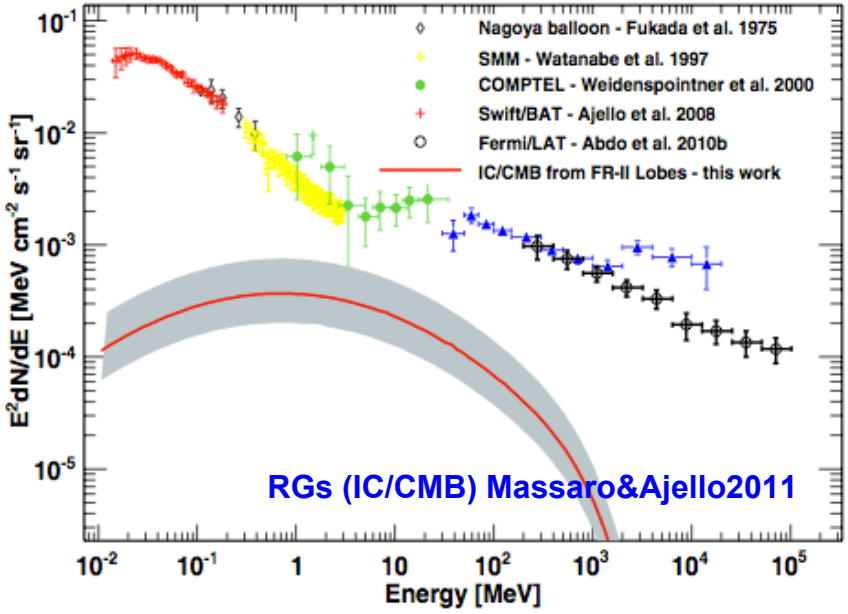


Many Hypotheses … few answers









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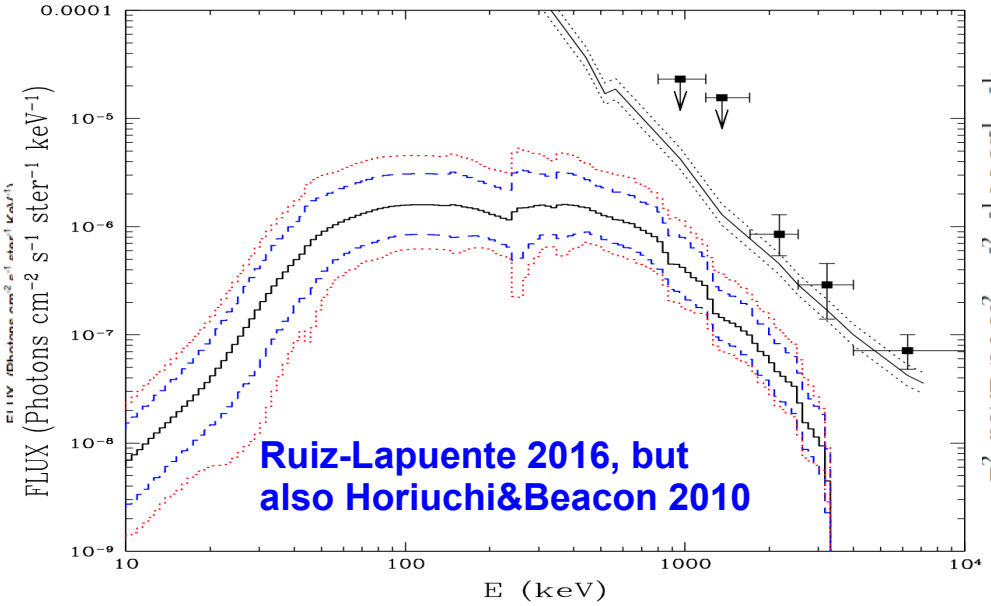
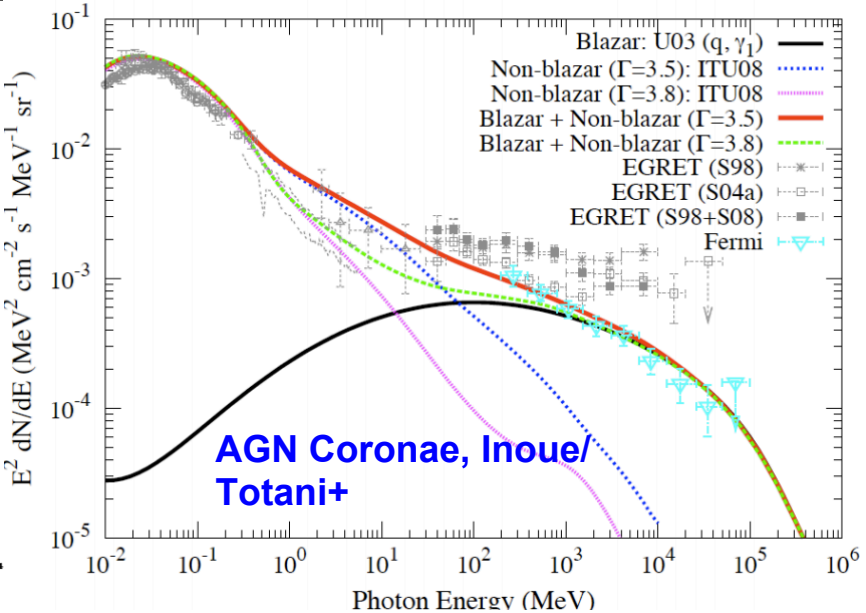
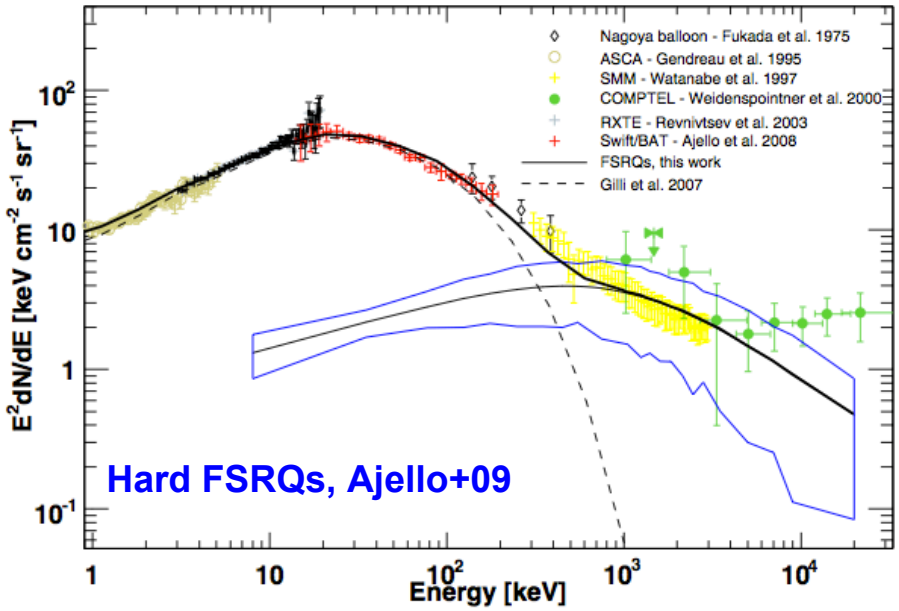
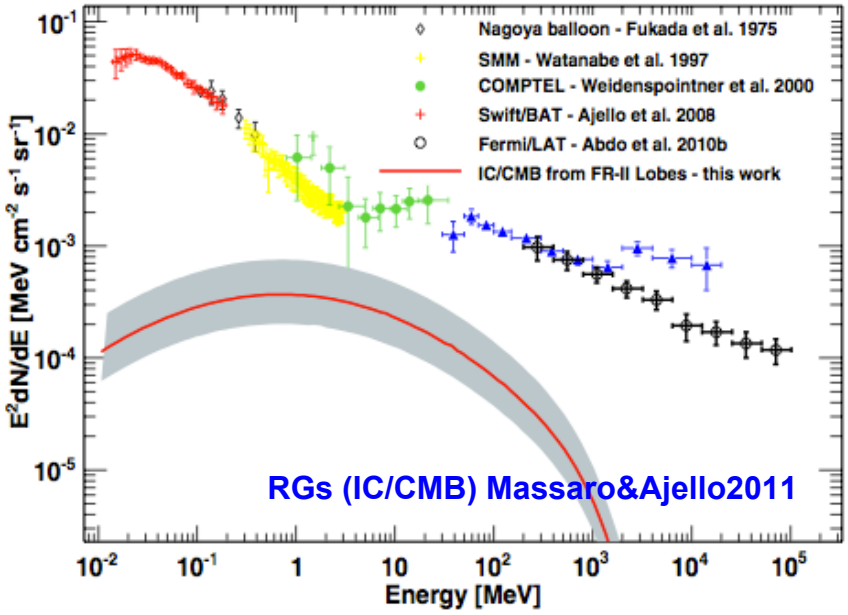


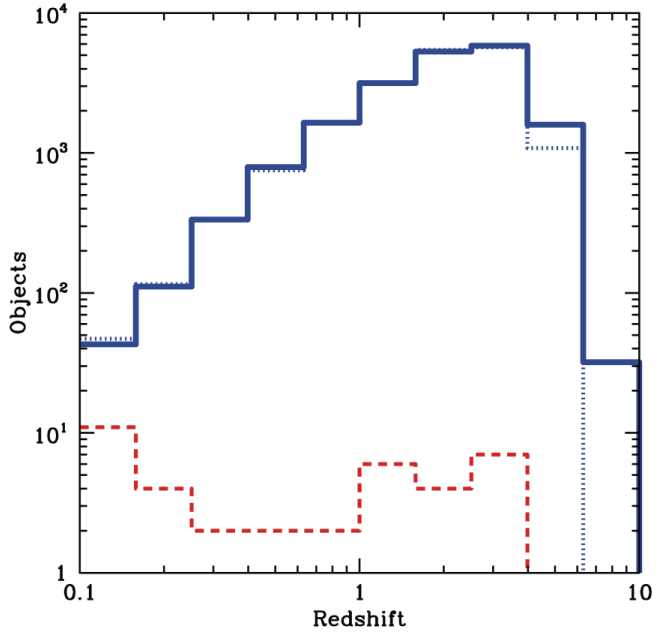






Prospects & Conclusions

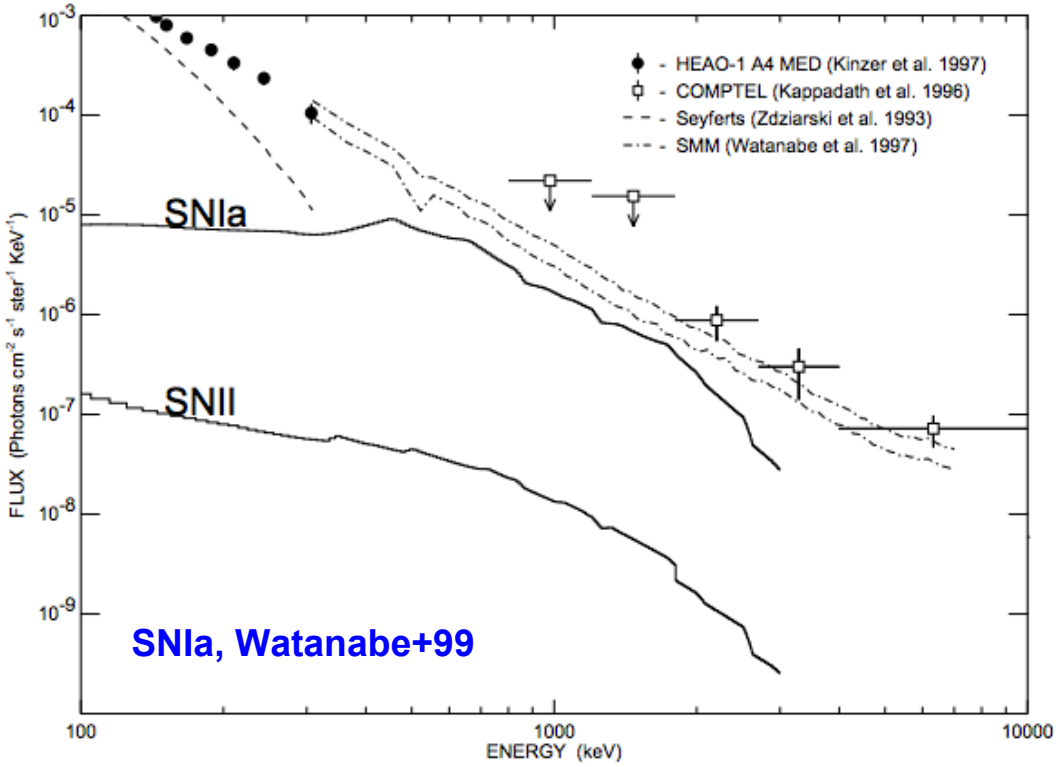
- Summary on MeV blazars
  - Large (disk, jet) luminosity
  - High redshift
  - Large jet power
  - Extreme blazars
  - May host heavy black holes
  - May be used to constrain BH formation



- **MeV missions (ComPair, NCT etc.) with continuum sensitivity of 10^{-11} erg cm^{-2} s^{-1} will detect *hundreds of them***
  - ***A fair fraction will be at redshift >3***

SN Ia

- SN Ia have strong gamma-ray emission due to radioactive decays and might contribute in a sizable way to the MeV background
- Largest uncertainty is the SN rates, particularly at high redshifts
- Newest measurements agree SNe Ia do not make the entire background although they certainly make some (~10%) !



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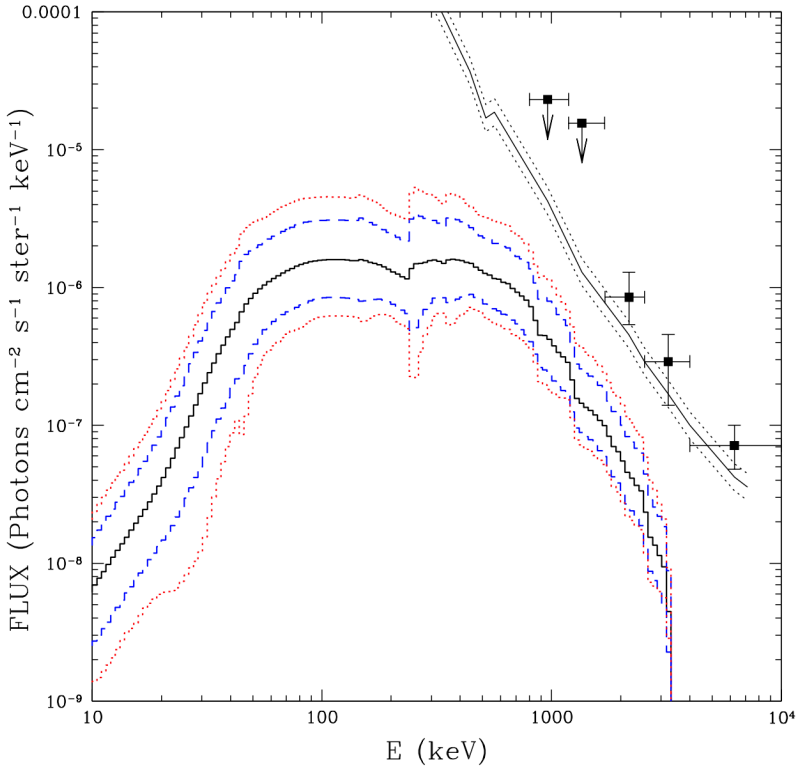
Ruiz-Lapuente 2016, but also Horiuchi&Beacon 2010



Blazars

- **MeV Blazars (Bloom+, Sambruna+, Sikora+) are among the most luminous persistent sources and will contribute some fraction of the MeV background**