The Most Powerful Blazars

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with
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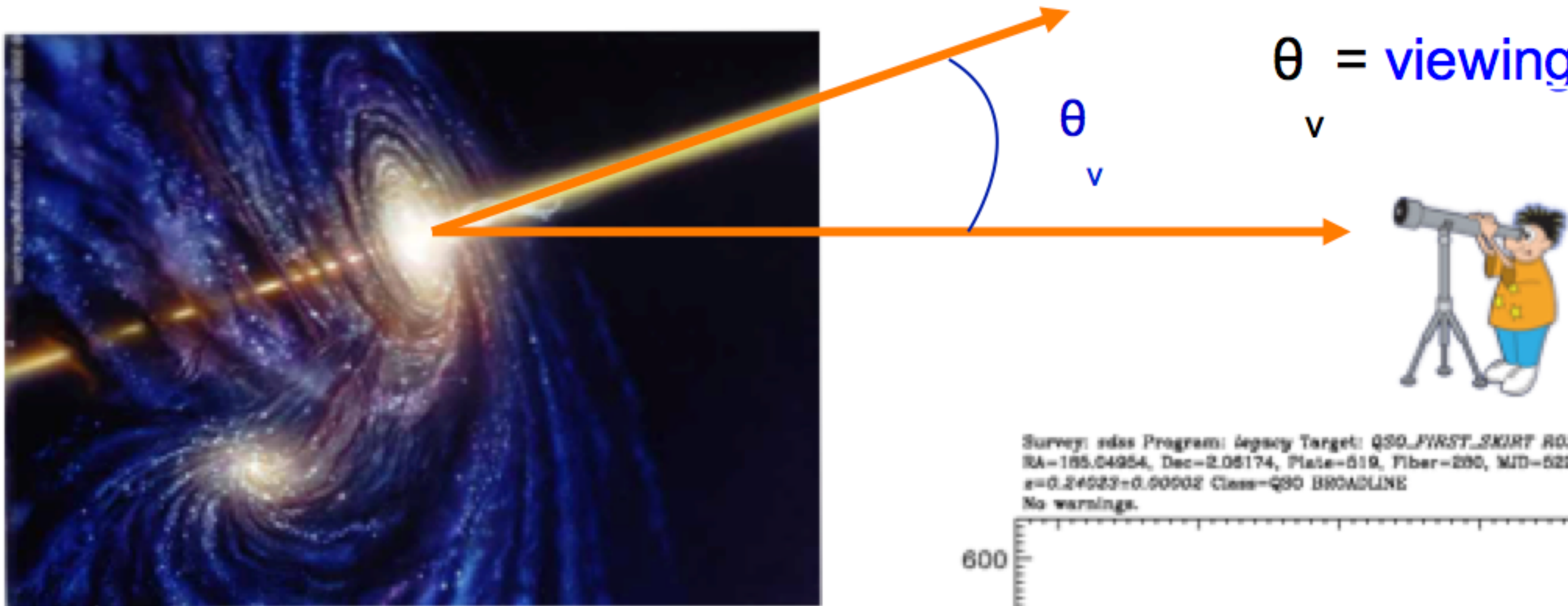
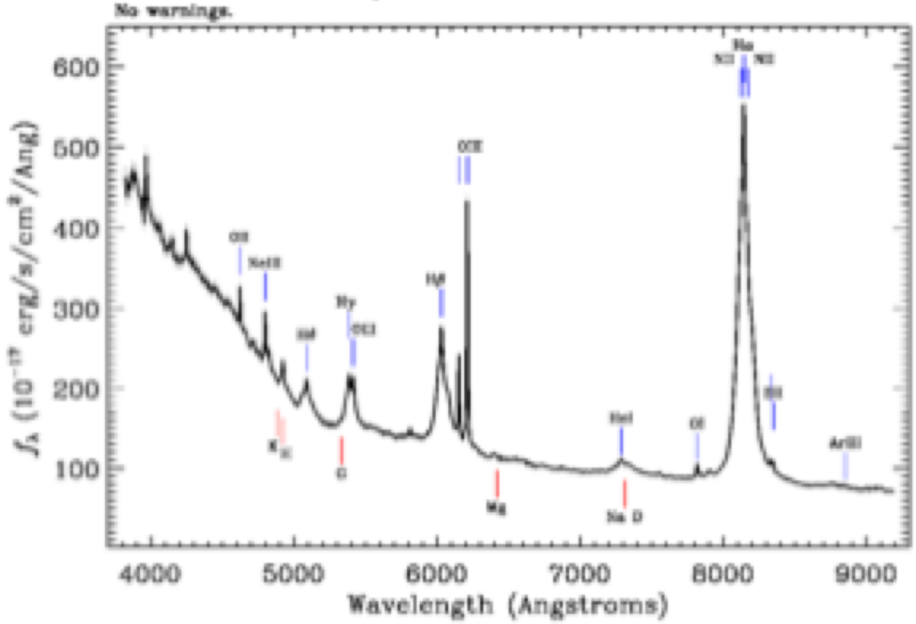
A TPC for MeV Astrophysics

Blazars



θ = viewing angle (≲5°-10°)

v

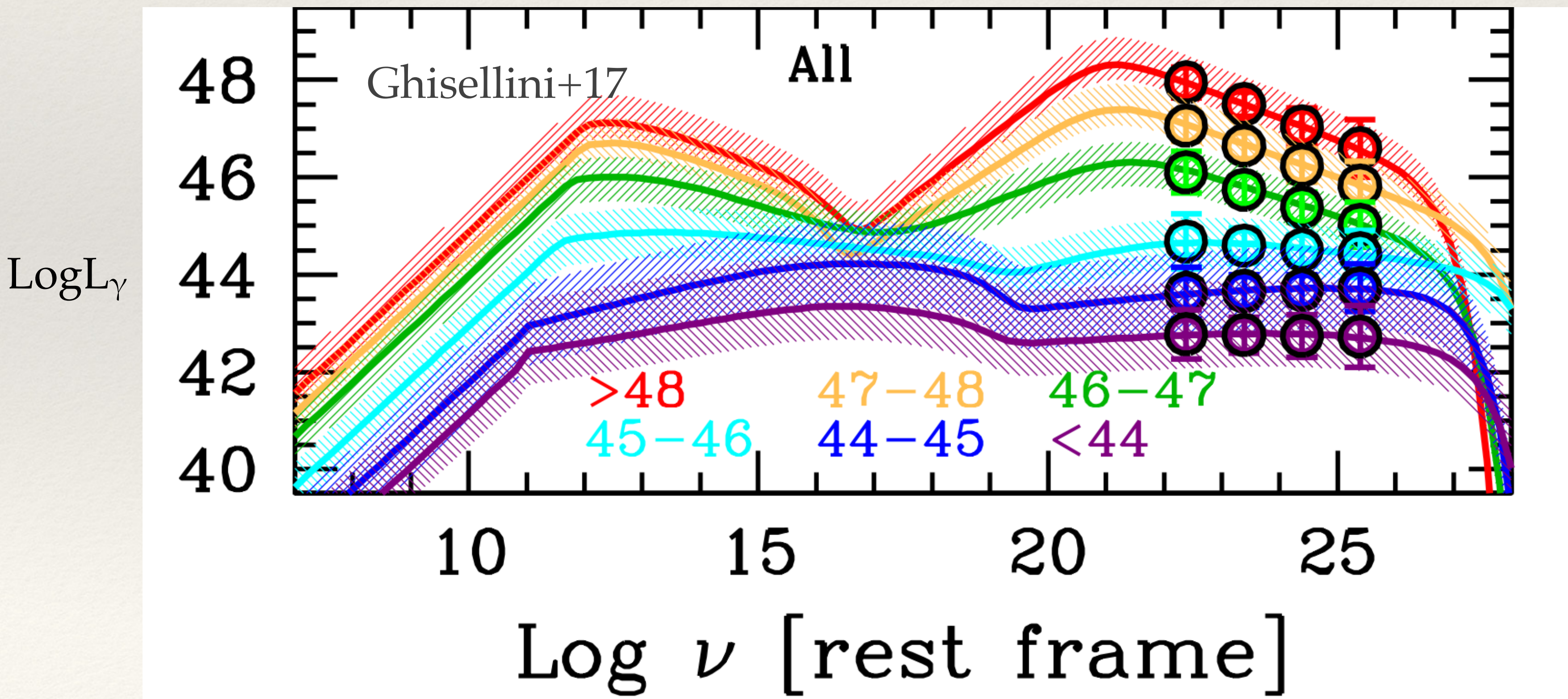


Blazars → BL Lac

Blazars → FSRQ

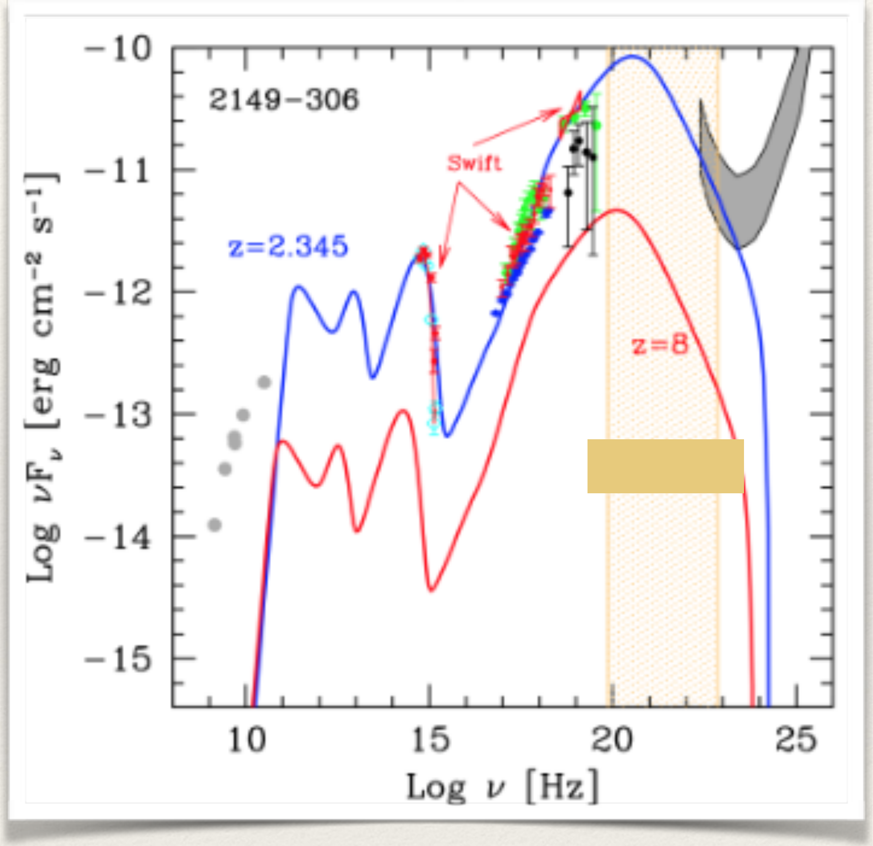
Blazar Population

- The more luminous blazars have a IC peak at <<100 MeV
- We refer to these class as MeV blazars



MeV Blazars

- Among most powerful persistent objects in the Universe
- Large jet power, easily larger than accretion luminosity
  - BH spin may be important
- Host massive black holes, near 1 billion solar masses (or more)
- They are detected up to very high redshift (Ajello et al. 2009)

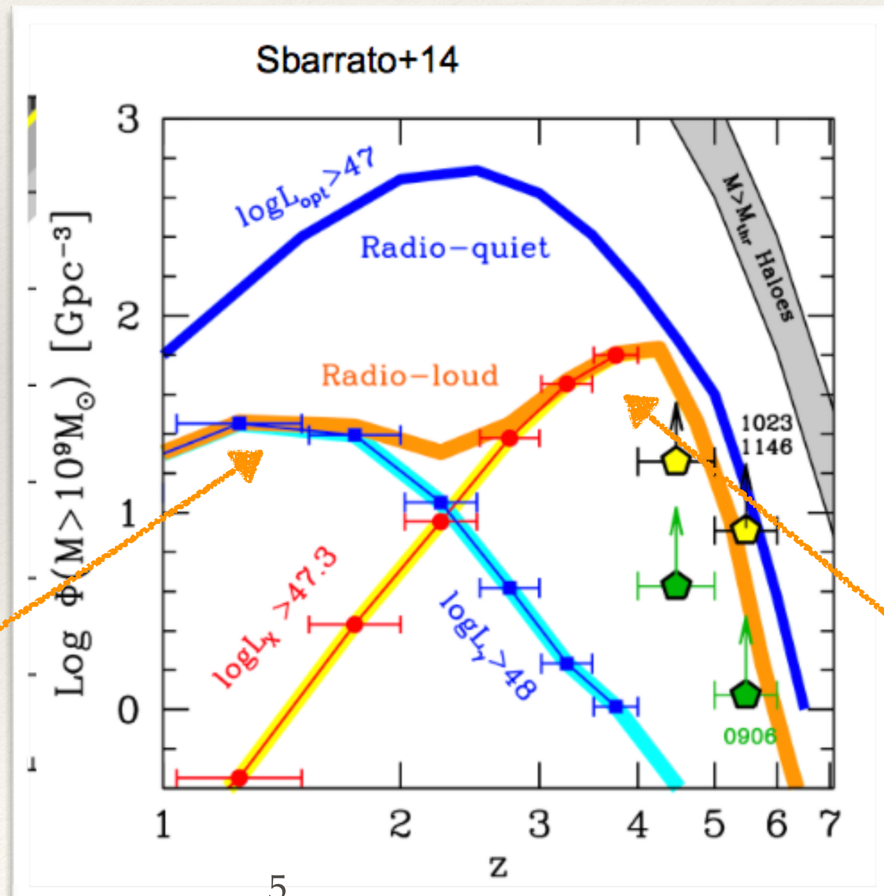


This population is not well understood, yet very important

Evolution of MeV blazars

- Evolution of MeV blazars is stronger than any other source class: i.e. their maximum density may be very early on

Clear that the radio-loud phase may play a very important role in the growing of massive black holes

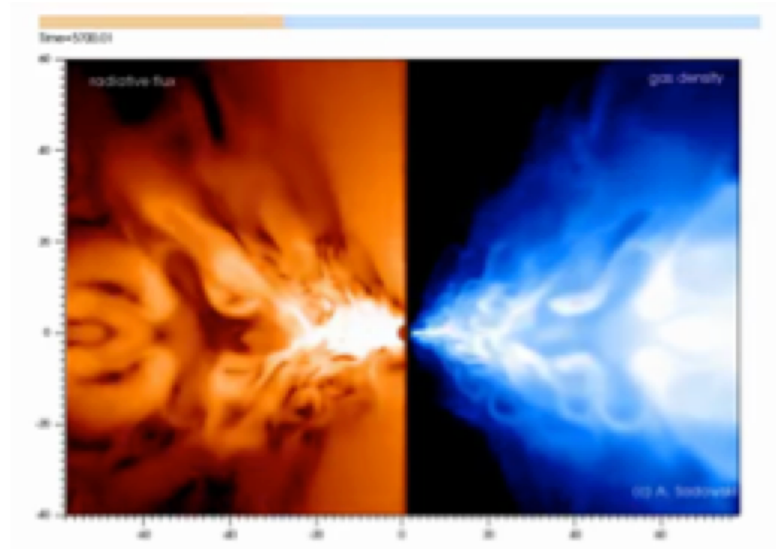


Ajello+12

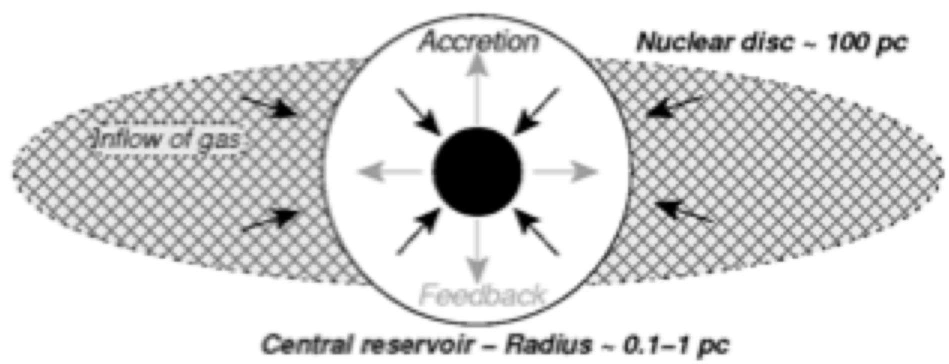
Ajello+09

How to grow quickly a black hole

Credit: HST image



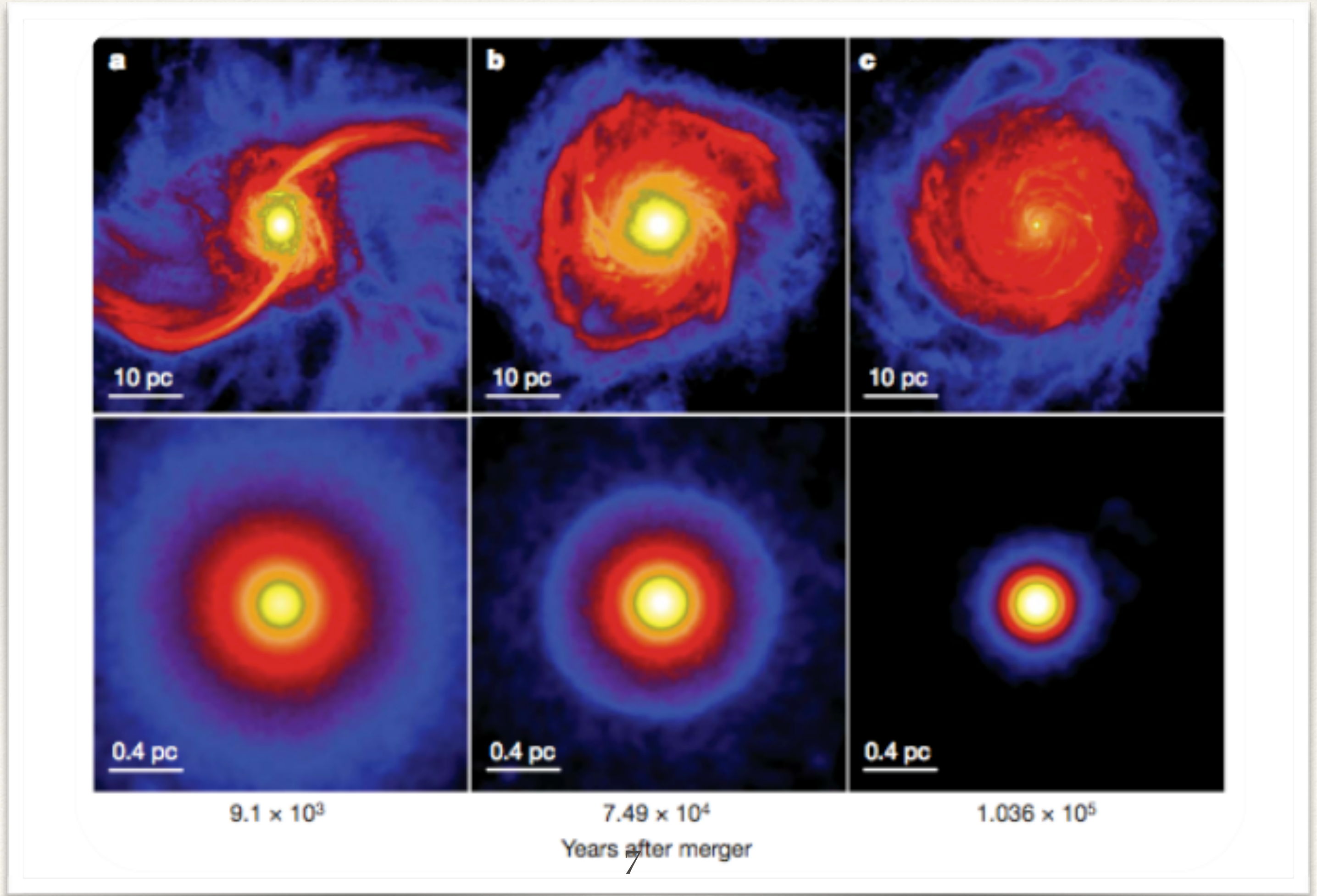
Simulation by
A. Sadowski



S. Bonoli, 201

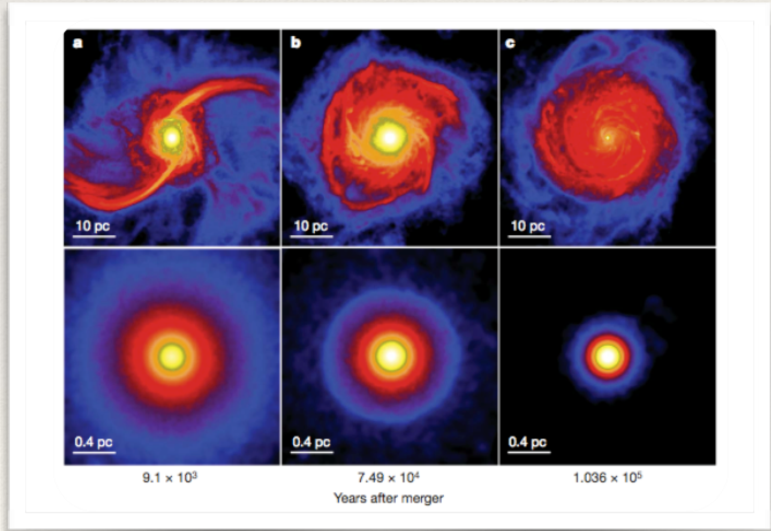
What can they tell us ?

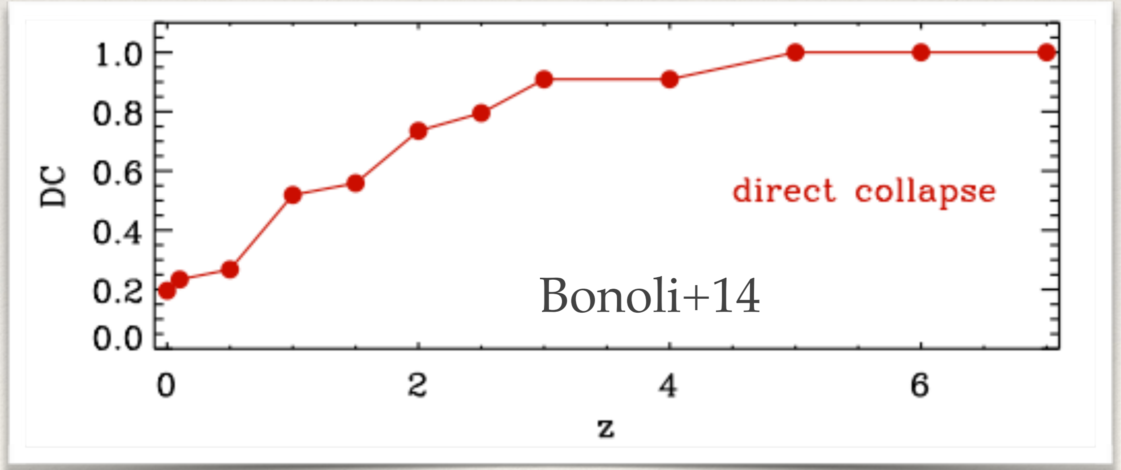
- 10^5 black hole formation from the collapse of a massive turbulent disk produced by a merger (Mayer+10, Nature)



What can they tell us ?

- 10^5 black hole formation from the collapse of a massive turbulent disk produced by a merger (Mayer+10, Nature)
- Fraction of major mergers that satisfy conditions to form heavy BH seeds steadily increases from z>2

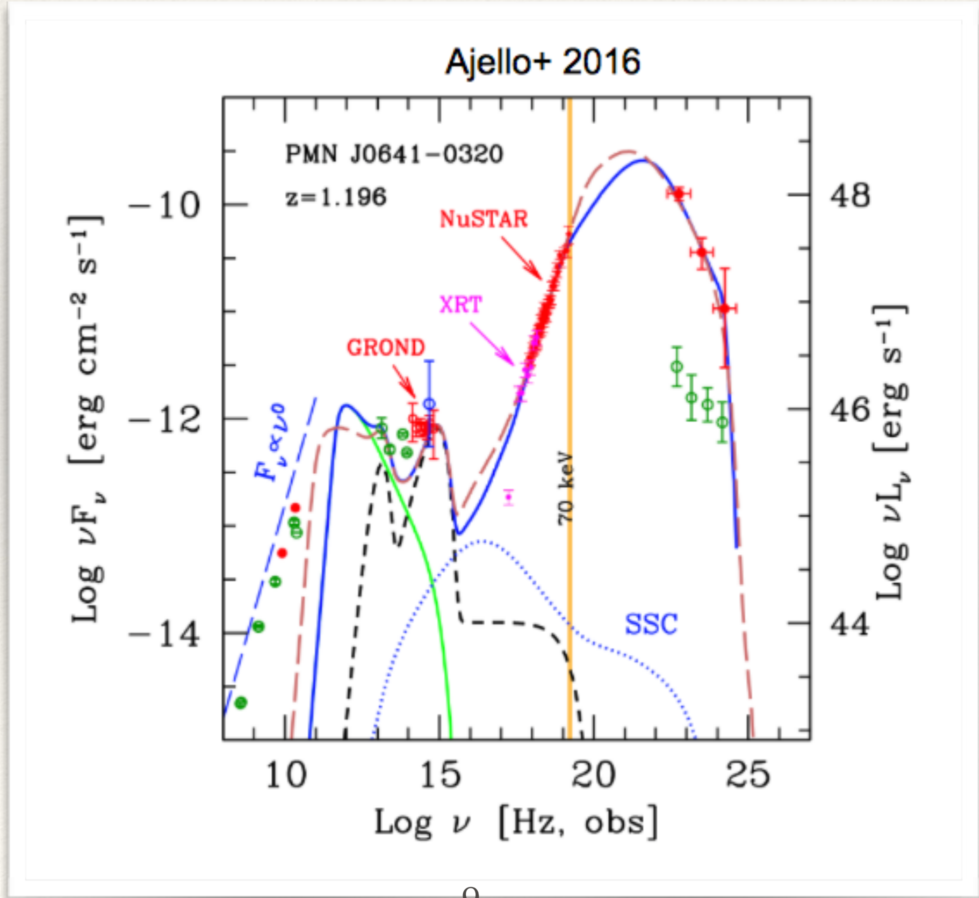




MeV blazars can pinpoint to BH formation mechanisms

Emission Region

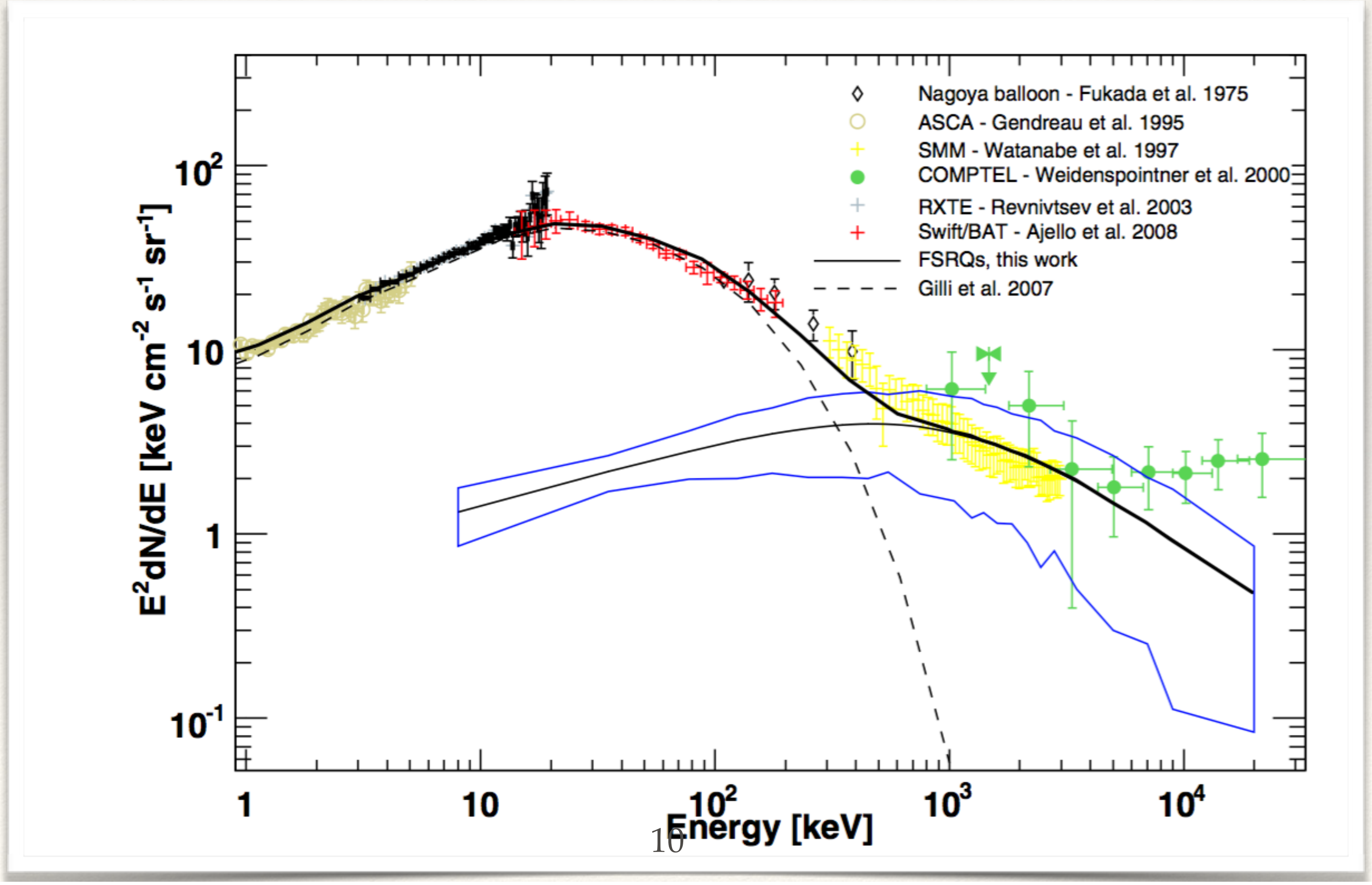
- Peak location and variability timescale will pinpoint the location of the emission region (BLR vs Torus)



MeV Background

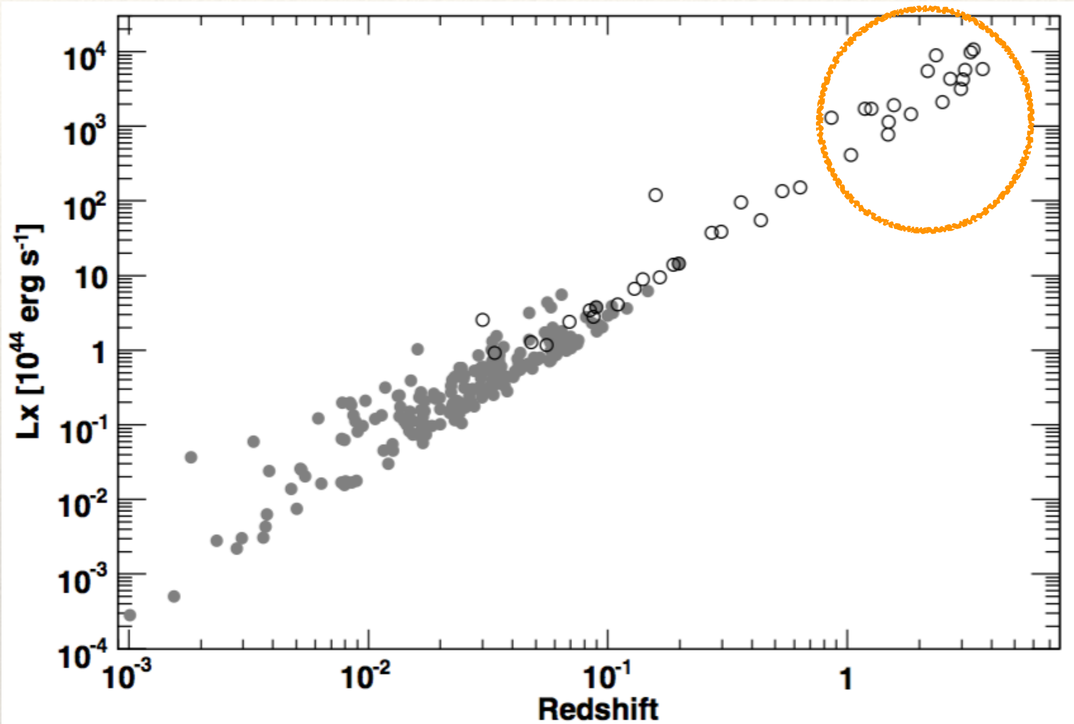
- MeV blazars may be responsible for the MeV background (Ajello+09)

  However see Inoue, Ruiz-LaPuente etc



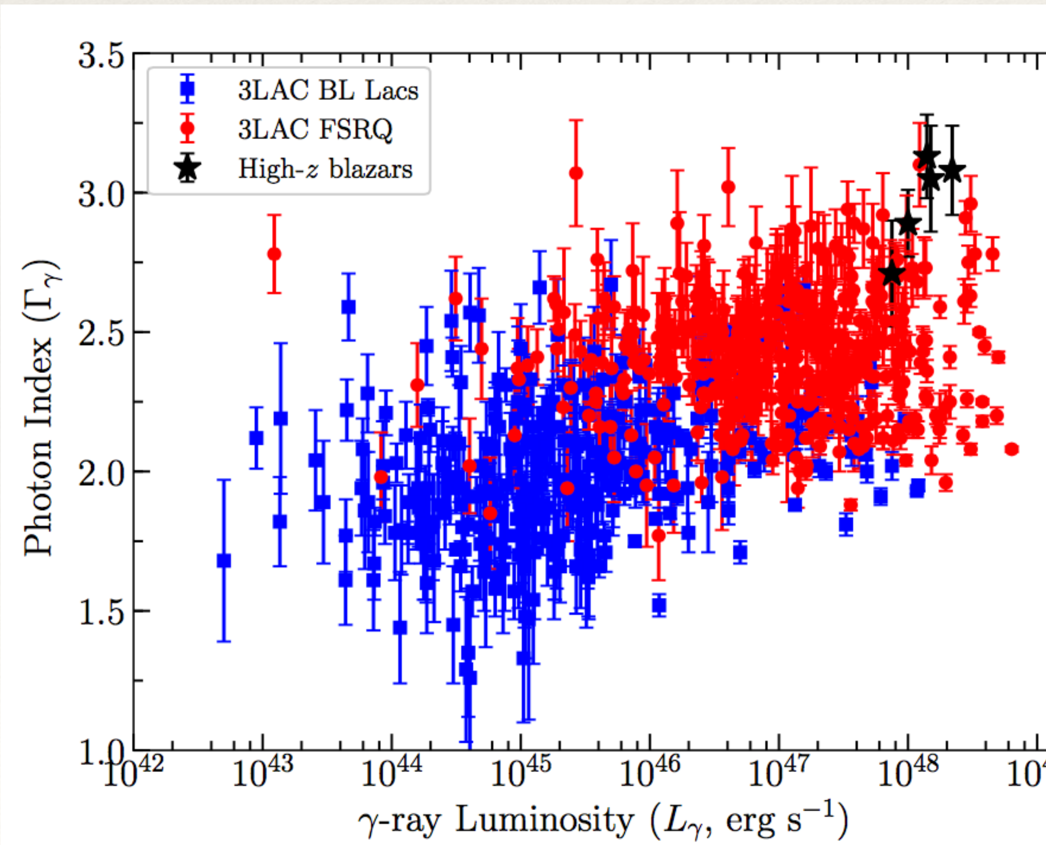
Current Status

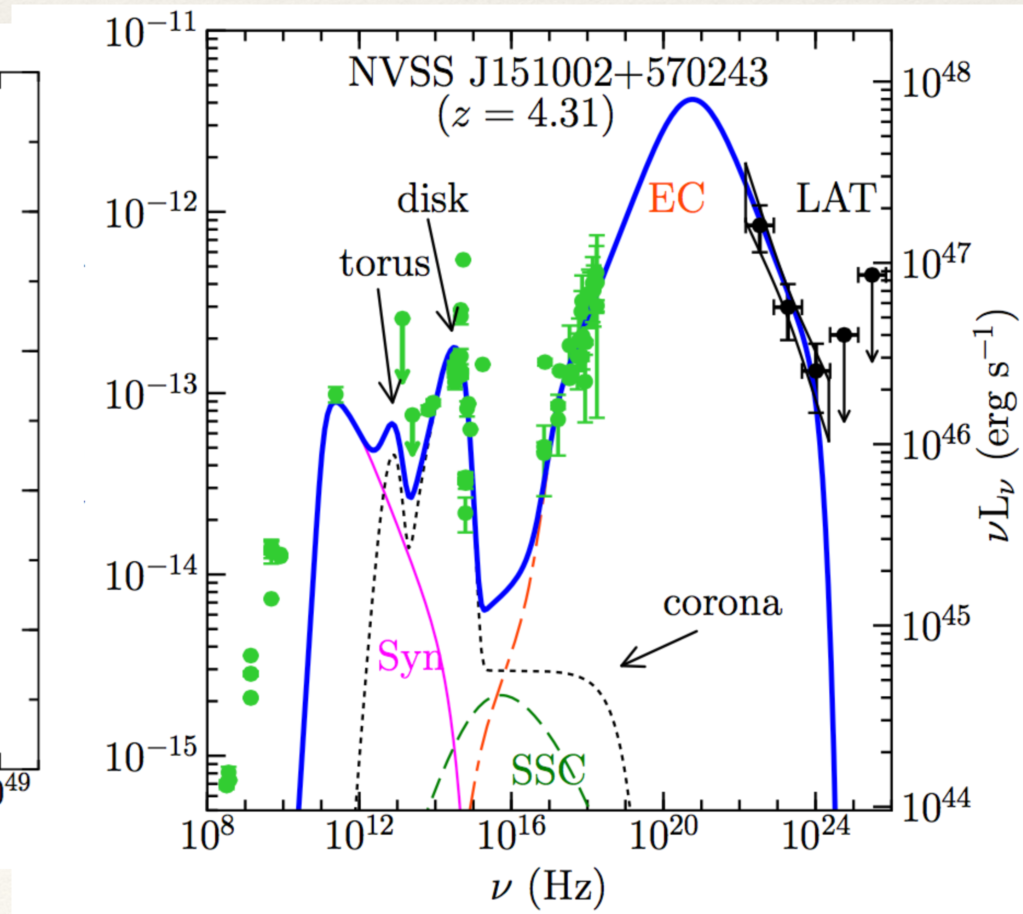
- MeV blazars are hard to detect despite being bright !
  - lack of an MeV mission
- Bright in X-rays
  - tens detected by *Swift*/BAT (Ajello +09)
  - a few discovered (via follow up) with NuSTAR (Ghisellini, Sbarrato etc)



Recent Detections

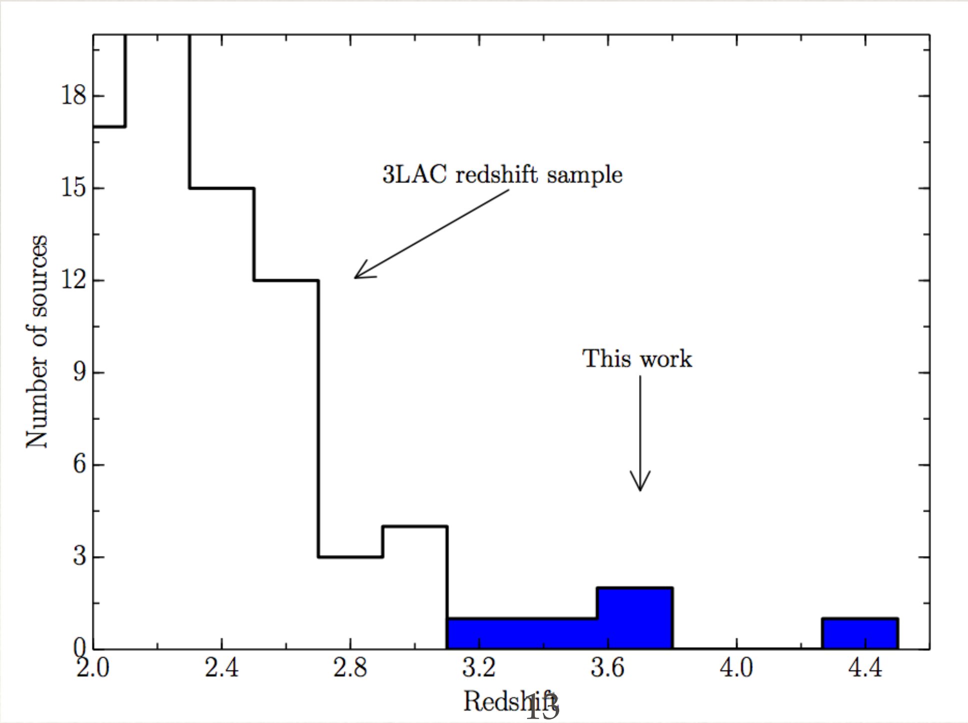
- Improved low-energy response (with P8) allowed Fermi-LAT to detect 5 z>3.1 blazars (Ackermann+17)





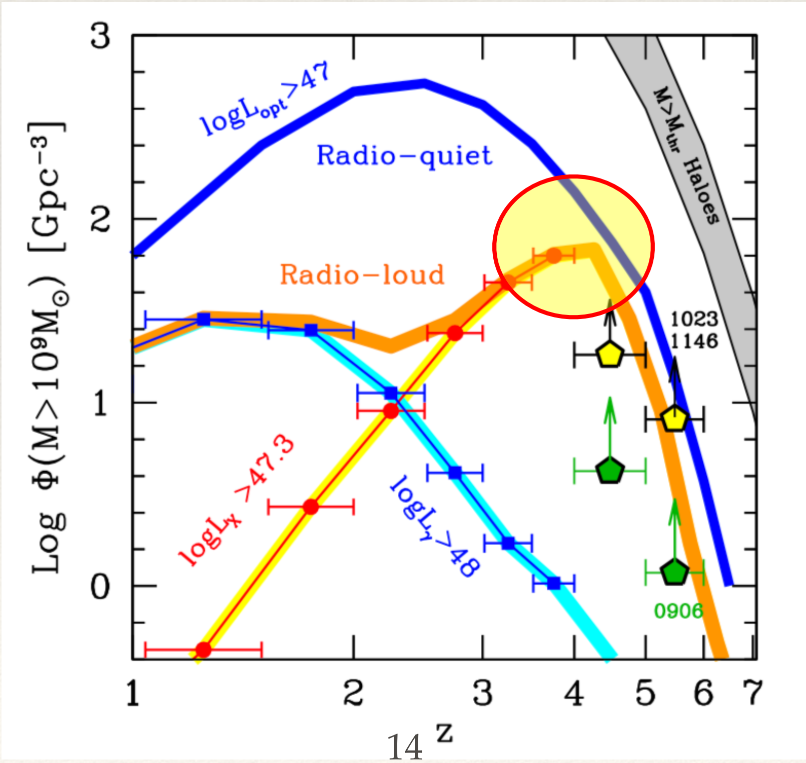
Recent Detections

- All are objects with $M_{BH} > 10^{8\text{-}9} M_{sun}$
- All have Γ~13-15
  - every single blazars implies $2\Gamma^2$ objects pointing somewhere else !



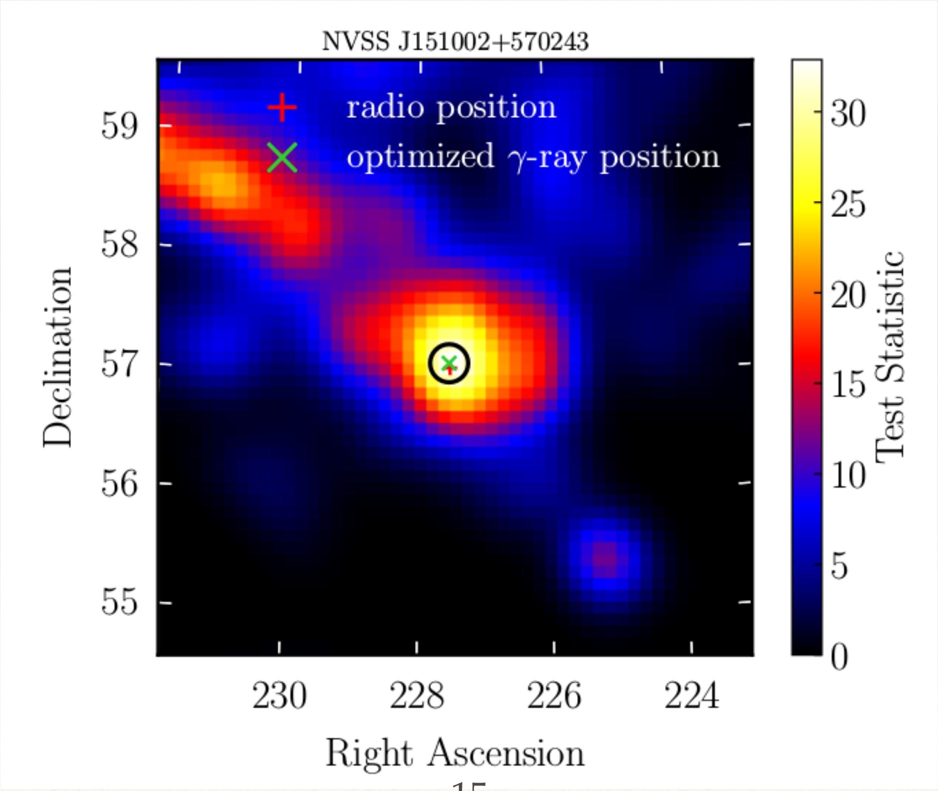
Recent Detections

- Between redshift 3 and 4 we have 2 blazars with $M_{BH}>10^9\ M_\odot$
  - They account for ~675 more objects at the same redshift
- Only 5 system were known before
  - Brings up the space density estimate by 40% !



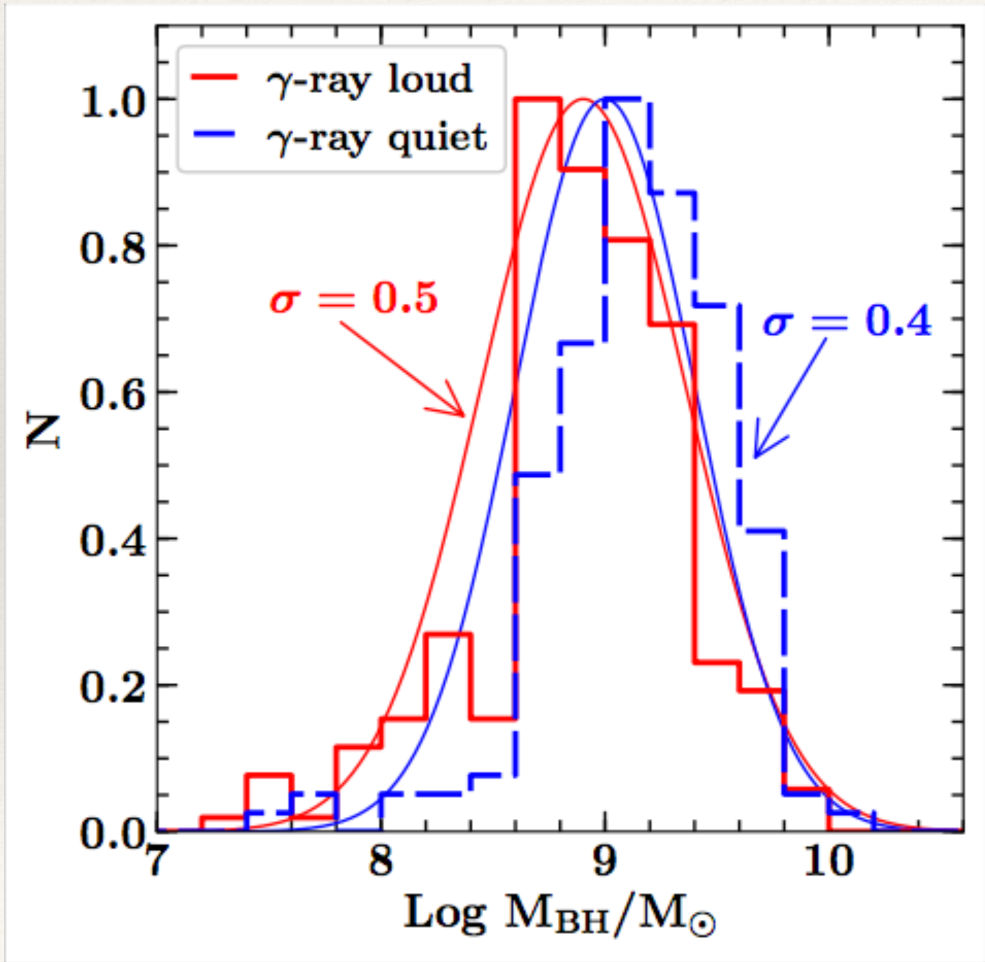
Recent Detections

- Despite the good news, they still remain very hard to detect in Fermi
- These objects are bright! but extremely soft, so their photons are spread everywhere
- Population of MeV blazars could be large

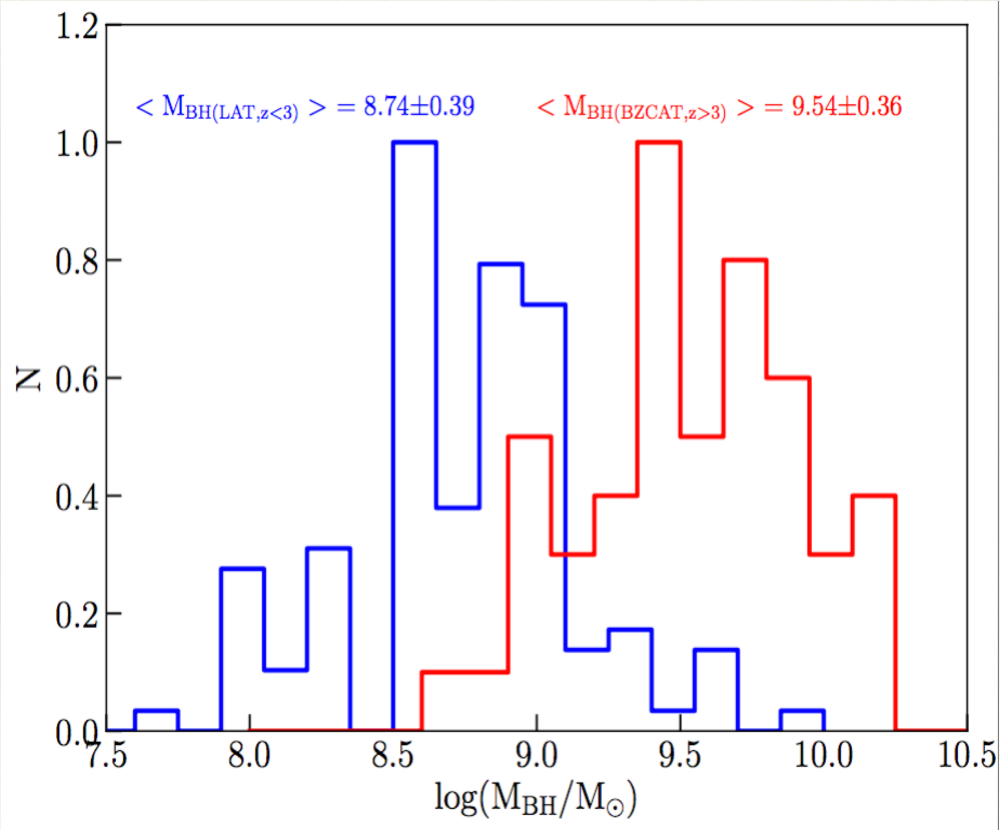


Favorable selection effect

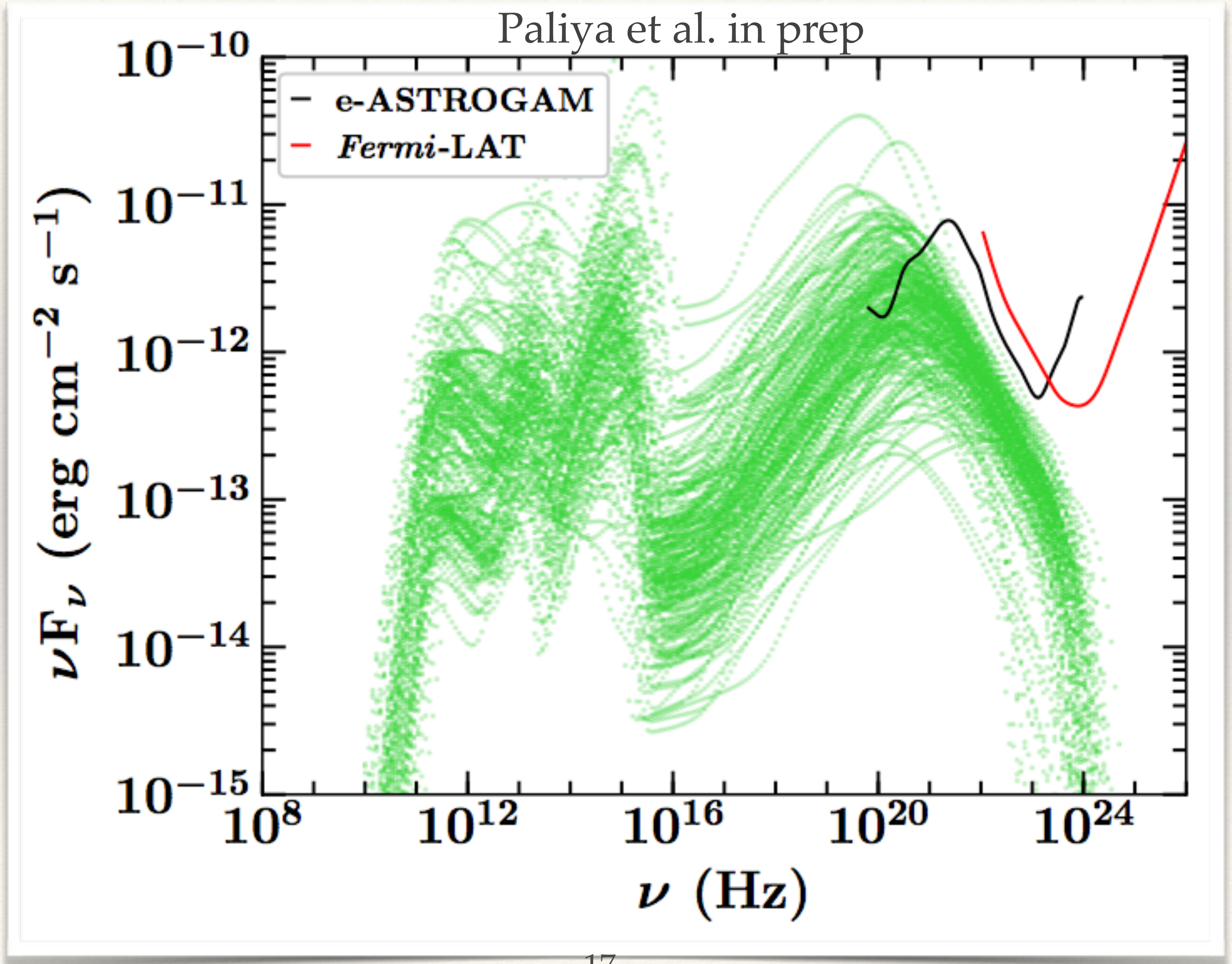
γ-ray quiet are MeV blazars



high-z are MeV blazars

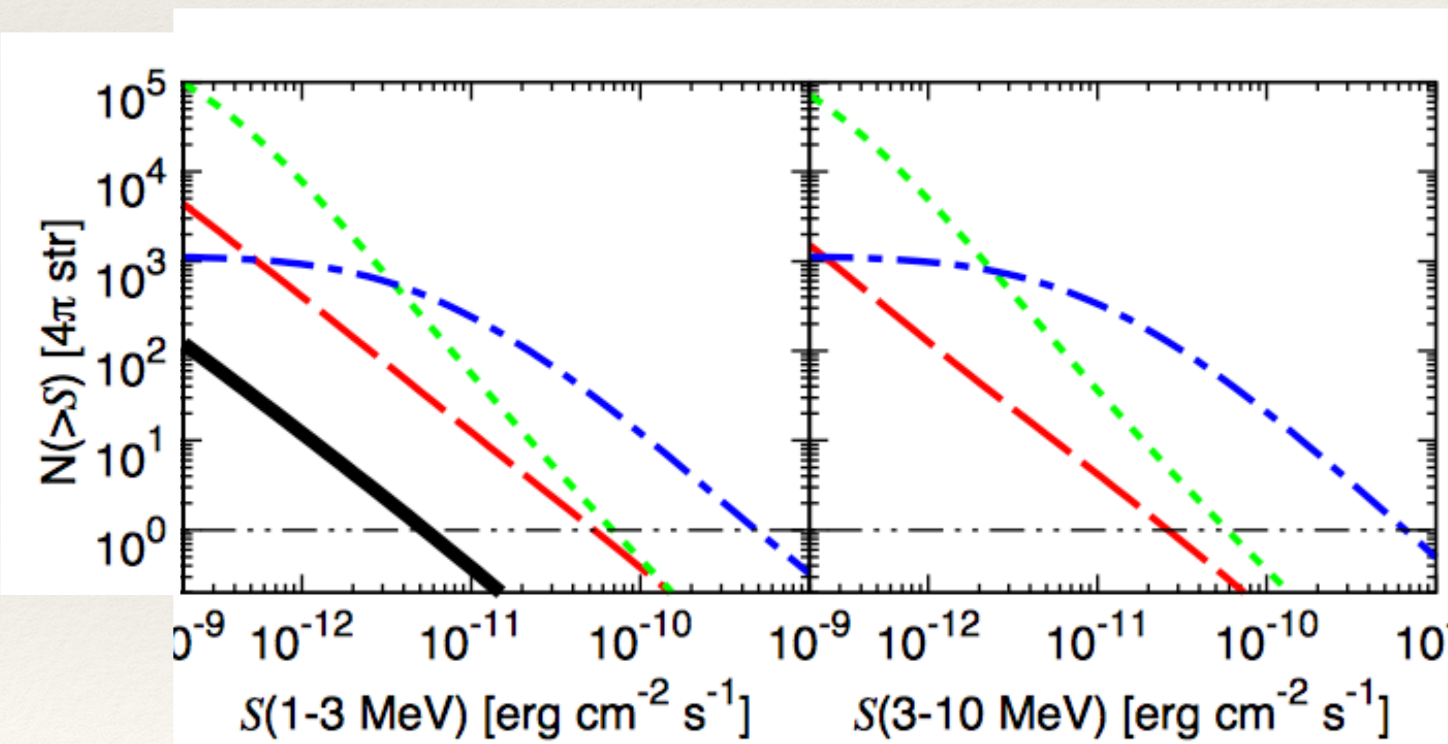


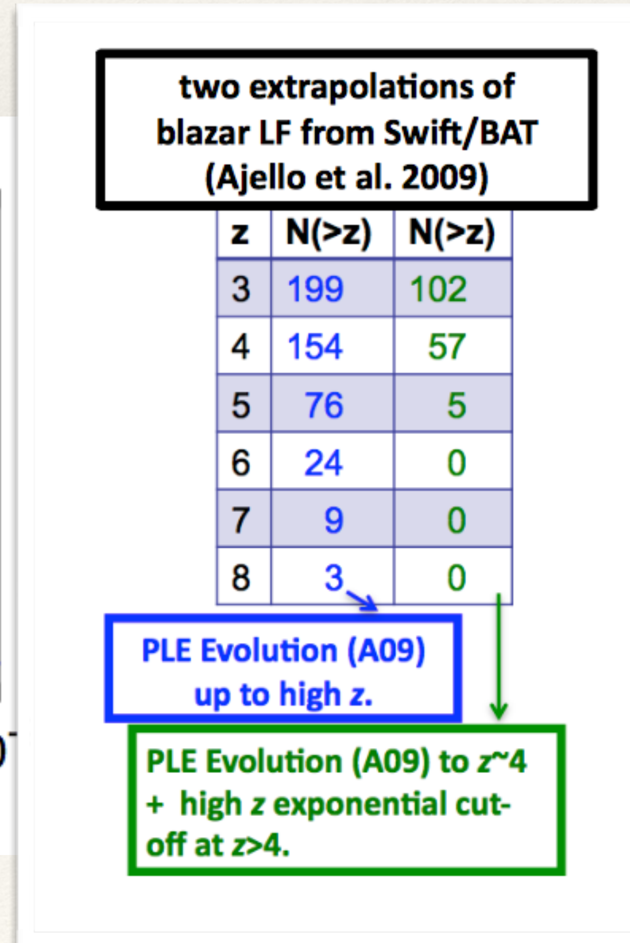
γ-ray undetected



How many MeV blazars can be detected ?

- It depends on sensitivity
- but >100 should be easily achieved





two extrapolations of blazar LF from Swift/BAT (Ajello et al. 2009)

z	N(>z)	N(>z)
3	199	102
4	154	57
5	76	5
6	24	0
7	9	0
8	3	0

PLE Evolution (A09) up to high *z*.

PLE Evolution (A09) to *z*~4 + high *z* exponential cut-off at *z*>4.

Summary

- An MeV mission (Harpo) may detect hundreds of MeV blazars up to z~5 and maybe beyond
  - SMBH growth
  - Location of emission region
  - MeV background